Bushfire Threat Analysis of the Great Western Woodlands

Department of Environment and Conservation

Our environment, our future

Fire Management Services

September 2010

Acknowledgments

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Stakeholder Consultation

Advice on the location and vulnerability of assets in the study area was contributed by a range of asset managers and interest groups, including:

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Harry Kendall	Westnet Rail	Scott Miller	Water Corporation
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Alexander Watson	The Wilderness Society	Denise Crockford	Main Roads Department
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A Note on Nomenclature

In early 2010, the Western Australian Government replaced the term 'wildfire' with 'bushfire' as the preferred descriptor of unplanned fire events in the natural environment. Documents older than that date will, therefore, use the term wildfire, while the current document uses the term bushfire. The meaning of the two terms is identical, as are the meanings of Wildfire Threat Analysis (WTA) and Bushfire Threat Analysis (BTA).

Disclaimer

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Executive Summary

This report is an analysis of the likelihood and consequences of bushfires occurring in the 'Great Western Woodlands' (GWW). It is based on a process known as Bushfire Threat Analysis (BTA) that was developed by the Department of Environment and Conservation (DEC) in the early 1990s. BTA predicts the probability of a bushfire occurring in a given area by modelling the likelihood of an ignition, nature of fire behaviour and capacity of land managers to mount an effective suppression response. The likely consequences of a bushfire are then determined by considering the value and vulnerability to fire of assets that may be in the fire's path. The magnitude and spatial distribution of the factors that define likelihood and consequence determine the threat posed by bushfire in the study area.

The GWW is an internationally significant area of great biological richness. It is the largest remaining area of intact Mediterranean climate woodland left on Earth. It supports more than 3,000 flowering plant species as well as numerous species of mammals, reptiles, frogs and birds. Many of these plants and animals have specific fire regime requirements, making appropriate fire management critical to the protection of the region's biodiversity. The GWW also has great cultural significance, with Aboriginal people retaining strong links with, and responsibility for, country. Appropriate use of fire in the landscape is an important facet of this responsibility.

The study area for the GWW BTA has been slightly expanded from the recognised boundary of the GWW, in order to facilitate a more holistic approach to land management. The GWW BTA considers an area of approximately 22.2 million hectares, encompassing portions of 3 DEC regions and 12 Local Government Authorities (LGA). The majority of the area is Unallocated Crown Land, although there are also significant proportions of Pastoral Lease and Conservation Estate. DEC has responsibility for fire pre-suppression over most of the study area but for fire suppression over a lesser portion of it.

The BTA study area is sparsely populated and contains relatively little infrastructure. Mining and pastoralism are the main land uses, with tourism also of importance to the region's economy. The region has six major transport routes: Great Eastern Highway, Coolgardie-Esperance Highway, Goldfields Highway, Eyre Highway, the Perth to Kalgoorlie Railway and the Transcontinental Railway line. These connect Western Australia with the states to its east and allow travel within the region. The remainder of the region's transport network comprises minor, mostly gravel, roads that carry little traffic. Water and gas pipelines, electricity distribution lines and telecommunications cables generally follow the major transport routes and are essential for the provision of utilities to the Goldfields. The protection of this infrastructure is an important objective of fire management in the region.

The vegetation of the study area is dominated by five broad structural types: woodlands, shrublands, mallee, hummock grasslands and succulent steppe. Shrublands will burn readily, rapidly and intensely, under a range of weather conditions. They are also quick to recover following fires and may burn again in as little as five to six years. Woodlands are heterogeneous in structure and composition, meaning that fire behaviour in them is variable. In general, however, woodlands are less likely to burn than shrublands, exhibit less intense fire behaviour and are slower to recover following fire. Mallee communities form something of a transitional structure between shrubland and woodland. Fire behaviour in mallee also tends to fall between the extremes of shrubland and woodland. Succulent steppe is not flammable, being dominated by succulent leafed species. Hummock grasslands are highly flammable and accumulate fuel very rapidly following fires.

Lightning is the most common source of ignitions in the study area with many bushfires started by lightning strikes each year. Other sources of ignition include road and rail traffic, townsites, power lines and agricultural operations around the region's boundary. Most bushfires start where these occur within areas of mature shrubland.

Fire combat agencies have little capacity to mount an effective response to bushfire in the GWW. They are hampered by limited resources, vast distances and a lack of access routes. A suppression response is usually only attempted if fire threatens important assets. If attempted, suppression measures will be very slow to implement. Fire management in the area, therefore, tends to focus on pre-suppression activities, such as fuel modification.

1. Introduction

In 2008, the Government of Western Australia committed to developing a Biodiversity and Cultural Conservation Strategy for the Great Western Woodlands (GWW). The strategy development process identified fire management as a key issue in ensuring the protection of the region's unique environmental and cultural values. This emphasised the need for an integrated fire management plan for the region. A Bushfire Threat Analysis (BTA) is a foundation for the GWW fire management plan which is itself, a step on the way to a comprehensive biodiversity management strategy for the region.

The objective of the GWW BTA is to inform the fire management planning process. It quantifies the threat posed by bushfire by considering the likelihood of ignition occurring, the behaviour of any resultant fire and the consequences of its impact on assets. In doing so, it identifies where more detailed, site-specific planning may be required.

1.1. The Bushfire Threat Analysis Process

The methods used to model the threat posed by bushfire in the GWW have been adapted from a number of similar threat analyses conducted in recent years (e.g. CALM, 2003 and Muller 2008). Those documents describe bushfire threat as a function of the probability of a fire occurring and the consequences of a fire should it occur. Fire probability is determined by combining the likelihood of an ignition occurring, the behaviour of a fire once ignited and the capacity for an effective suppression response to be enacted. The consequences of a fire are defined by the value of the assets in a fire's path and the vulnerability of those assets to fire. The overall threat is, therefore, determined by considering the interaction of the four 'layers' that constitute the BTA: risk of ignition, headfire behaviour, suppression response capacity and assets at risk (Figure 1).

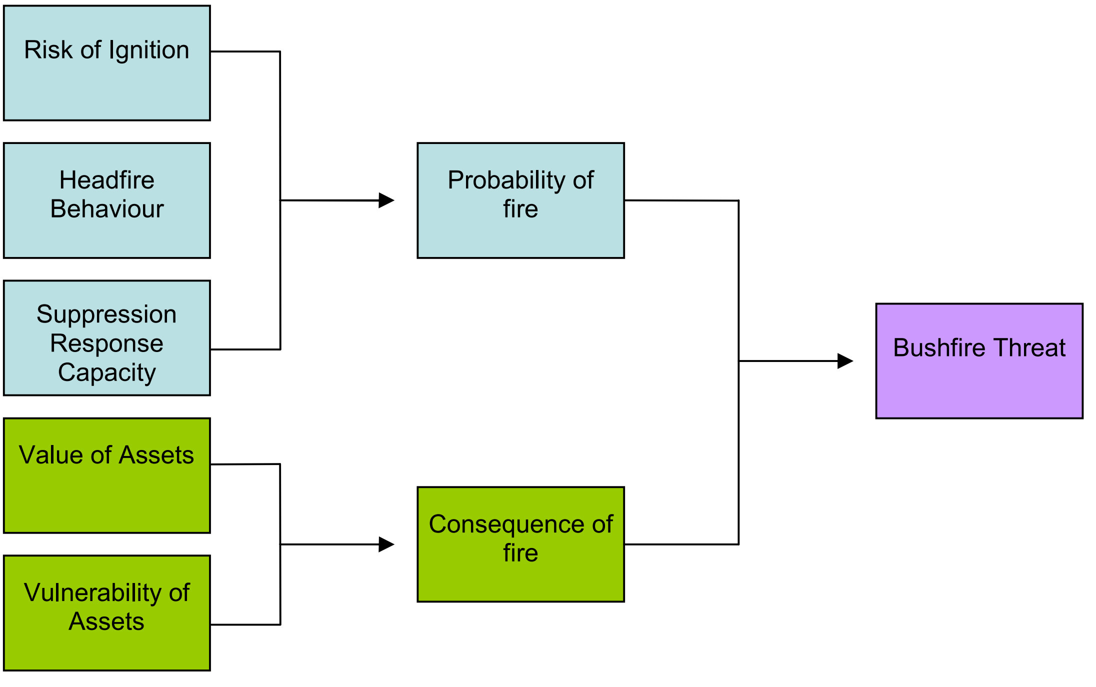

Figure 1: A model of the Bushfire Threat Analysis process.

In the GWW BTA, the previously described methods were adapted to overcome limited data availability and to allow for the difficulties encountered when managing fire in remote landscapes. For example, the risk of ignition layer in previous BTAs has been based on the historical record of fire occurrence. This was not done in the GWW BTA because records of fire occurrence in the study area are incomplete and identify mainly fires that grew to a large size. Instead, the GWW BTA models ignition risk by identifying locations where likely ignition sources and flammable vegetation co-occur.

A second variation from previous BTA methodologies is that, in the GWW BTA, headfire behaviour is expressed on a relative scale. This differs from past approaches where attempts were made to determine the actual rate of spread and energy output of a fire burning under standardised weather conditions. A relative scale has been used in the GWW BTA because the distribution of fuel in the study area is mapped only coarsely and many of the fuel types lack reliable fire behaviour models. Instead, the GWW BTA assigns each vegetation association to one of twelve fuel categories based on the height, density, dominant growth form and dominant taxa of the association. A fuel accumulation model is applied to each category which provides a fire danger rating based on the time elapsed since the last fire.

Finally, suppression response is not included in its usual form in the GWW BTA. Suppression response is a measure of the time required for local hazard management authorities to detect a bushfire, travel to its location and establish containment lines. It is not applicable in the GWW, where active suppression is not usual unless a fire threatens recognised community or environmental assets. This means that the rapidity of suppression response is primarily determined by whether combat agencies attend, after assessing the situation, its potential and their capacity. The theoretical minimum time required to mount a response is largely irrelevant. Instead, the GWW BTA identifies areas where pre suppression may be required in order to mitigate the potential need for an active suppression response.

1.2. Study Area Description

The GWW lies in the south east corner of Western Australia, between the state's agricultural zone and its arid interior. It spans approximately 1000 km east to west by 500 km north to south. The study area for the GWW BTA extends somewhat beyond the accepted boundary of the GWW, in order to facilitate a more holistic approach to land management. The western portion of BTA study area aligns with the boundary of the GWW but, to the east of Kalgoorlie, it extends northwards to the extent of the shires of Dundas and Kalgoorlie-Boulder and southwards to the coast (Figure 2).

The total area considered in the GWW BTA is approximately 22 162 000 ha. This encompasses portions of 13 Local Government Authorities which are, in order of descending representation in the study area: Dundas, Kalgoorlie-Boulder, Coolgardie, Esperance, Yilgarn, Menzies, Mount Marshall, Kondinin, Ravensthorpe, Lake Grace, Westonia and Mukinbudin (Table 1). It lies across three DEC regions: South Coast, Goldfields and Wheatbelt and two FESA regions: Goldfields/Midlands and Great Southern.

Table 1: Local Government Authorities (LGA) within the Great Western Woodlands Bushfire Threat Analysis study area.

Local Government Authority	Area of LGA in GWW BTA study area (ha)	LGA % in GWW BTA study area	% LGA in GWW BTA study area
Coolgardie	3 030 429	13.7	100.0
Dundas	8 277 082	37.3	86.3
Esperance	2 872 330	13.0	53.5
Kalgoorlie-Boulder	3 945 817	17.8	41.3
Kondinin	318 966	1.4	42.9
Lake Grace	160 620	0.7	13.5
Menzies	387 483	1.7	3.1
Mount Marshall	330 568	1.5	32.3
Mukinbudin	76 583	0.3	22.2
Ravensthorpe	186 280	0.8	17.1
Westonia	98 307	0.4	29.5
Yilgarn	2 477 492	11.2	81.2

1.2.1. Tenure and Land Use

Much of the GWW BTA study area is Unallocated Crown Land (49% of the study area); with pastoral leases (30%) and various types of conservation estate (17%) the other main tenure types. There is very little privately owned land in the region, with freehold properties comprising just 1.7% of the study area (Table 2).

Pastoralism and mining are the region's major industries. There are 44 individual pastoral leases in the study area and several hundred mines. Approximately 60% of the study area is subject to current or pending mining tenements. Significant settlements within the study area include Southern Cross, Coolgardie, Kalgoorlie-Boulder, Kambalda and Norseman. There are also several small communities and populated localities, as well as a number of mines with permanent onsite populations.

Table 2: Tenure of the Great Western Woodlands Bushfire Threat Analysis study area.

Tenure Category	Area (ha)	% of Study Area
Unallocated Crown Land	10848903	49.0
Unvested Crown Reserve	361279	1.6
Total Unvested Land	**11210182**	**50.6**
Pastoral Lease	6664146	30.1
Freehold	380616	1.7
Total Privately Managed Land	**7044762**	**31.8**
Nature Reserve	2415567	10.9
Former Leasehold	505996	2.3
National Park	473725	2.1
Conservation Park	182833	0.8
5(1)(g) Reserve	75412	0.3
Timber Reserve	32017	0.1
5(1)(h) Reserve	6103	0.0
State Forest	782	0.0
Total Conservation Estate	**3692435**	**16.7**
Miscellaneous Tenure	214716	1.0
Grand Total	**22162095**	**100.0**

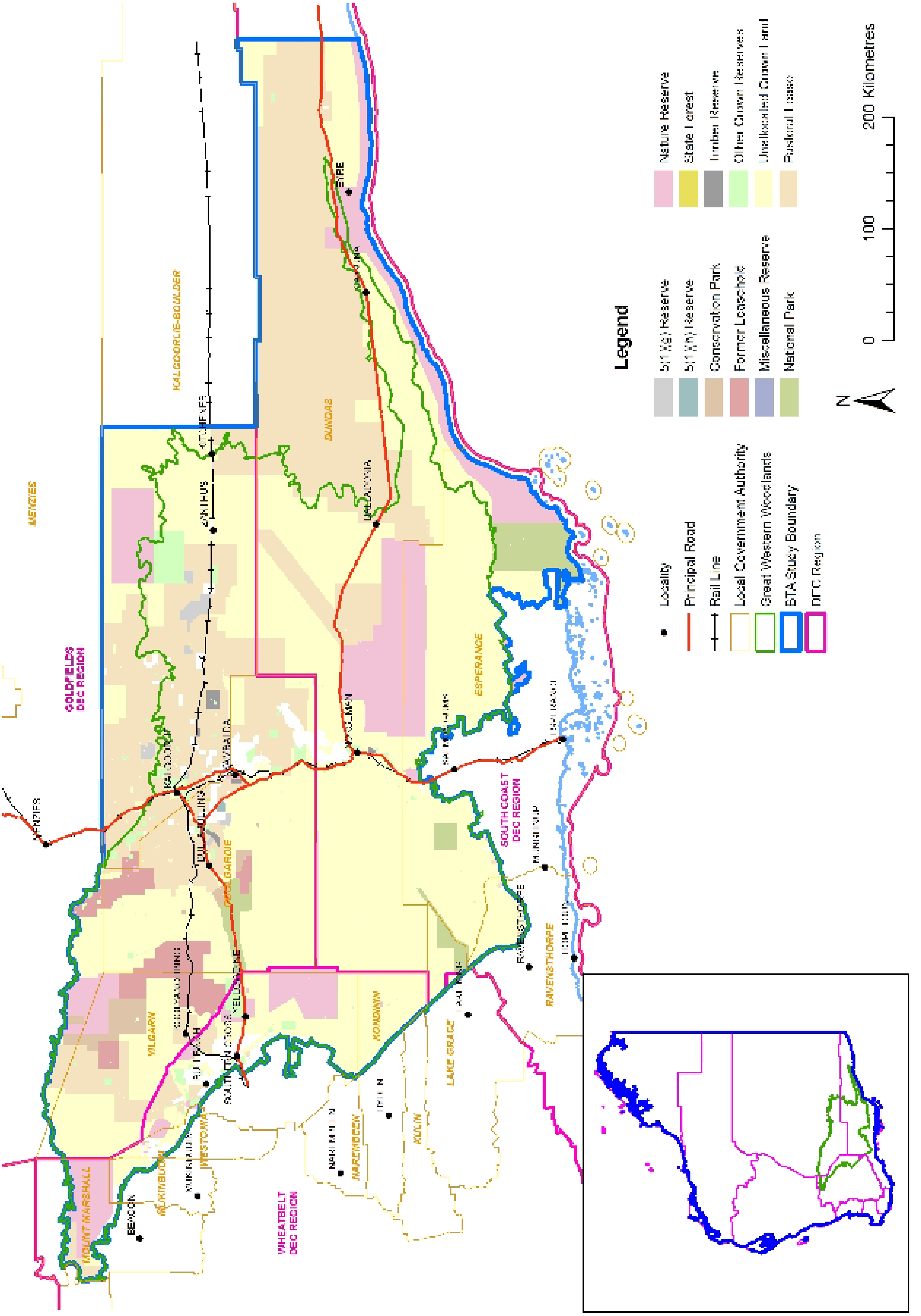

Figure 2: Cadastre and tenure of the Great Western Woodlands Bushfire Threat Analysis study area.

1.2.2. Climate

There is a significant climatic gradient north to south across the GWW BTA study area. Mean annual rainfall varies from approximately 600 mm in the far south of the area, to as little as 200 mm in its northeast (Figure 5). Data from four Bureau of Meteorology (BoM) weather stations are presented here, to provide an indication of climatic variability across the study area. The four weather stations are Southern Cross, Kalgoorlie, Salmon Gums and Eyre. Monthly mean minimum and maximum temperatures and rainfall for these sites are shown in Figure 5 and summarised in Table 3.

Proximity to the coast has a moderating effect on temperature, with January minima varying from 13.9°C at Salmon Gums to 18.2°C at Kalgoorlie and maxima from 26.4°C at Eyre to 34.5°C at Southern Cross. Similarly, mean winter temperatures are lower at the sites that are further inland than those near the coast.

Rainfall in the study area is unreliable (Figure 3) and occurs predominately in winter (Figure 5). The data for Kalgoorlie show a weak bimodal pattern, with a rainfall peak in summer, associated with the passage of decaying tropical lows, and one in winter due to cold fronts. This pattern is probably also seen in areas to the east of Kalgoorlie. Across most of the study area, however, rainfall follows a Mediterranean pattern.

There has been a weak trend of increasing rainfall in recent decades in the study area (Figure 3). For example, the long term mean rainfall at Southern Cross is 294.4 mm, but that site has received a mean annual rainfall of 350.4 mm since 1981. Similarly, Salmon Gums receives a long term mean annual rainfall of 350.7, but has received a mean 368.3 mm annually since 1981. This trend may not continue, however, with most climate change models predicting reduced rainfall across southern Western Australia in the coming decades (CSIRO and BoM, 2007).

Summer afternoon winds are typically southerly, south easterly or easterly across much of the GWW. This is illustrated by the roses of wind speed versus wind direction for Southern Cross, Kalgoorlie, Eyre and Salmon Gums shown in Figure 6. Of the four sites, only Southern Cross shows any appreciable degree of variability in wind direction. Winds also tend to be stronger in near coastal location than they are further inland.

Table 3: Climatic means for four Bureau of Meteorology weather stations within the Great Western Woodlands Bushfire Threat Analysis study area. Data from the BoM website (BoM, 2010).

Weather Station	January		July		Mean annual rain (mm)	Annual evaporation (mm)
	Mean min temp (ºC)	Mean max temp (ºC)	Mean min temp (ºC)	Mean max temp (ºC)		
Southern Cross	17.2	34.5	4.4	16.3	294.4	n/a
Kalgoorlie	18.2	33.6	5.0	16.7	264.9	2664
Salmon Gums	13.9	30.5	4.6	16.0	350.7	1533
Eyre	15.2	26.4	5.9	18.1	308.2	n/a

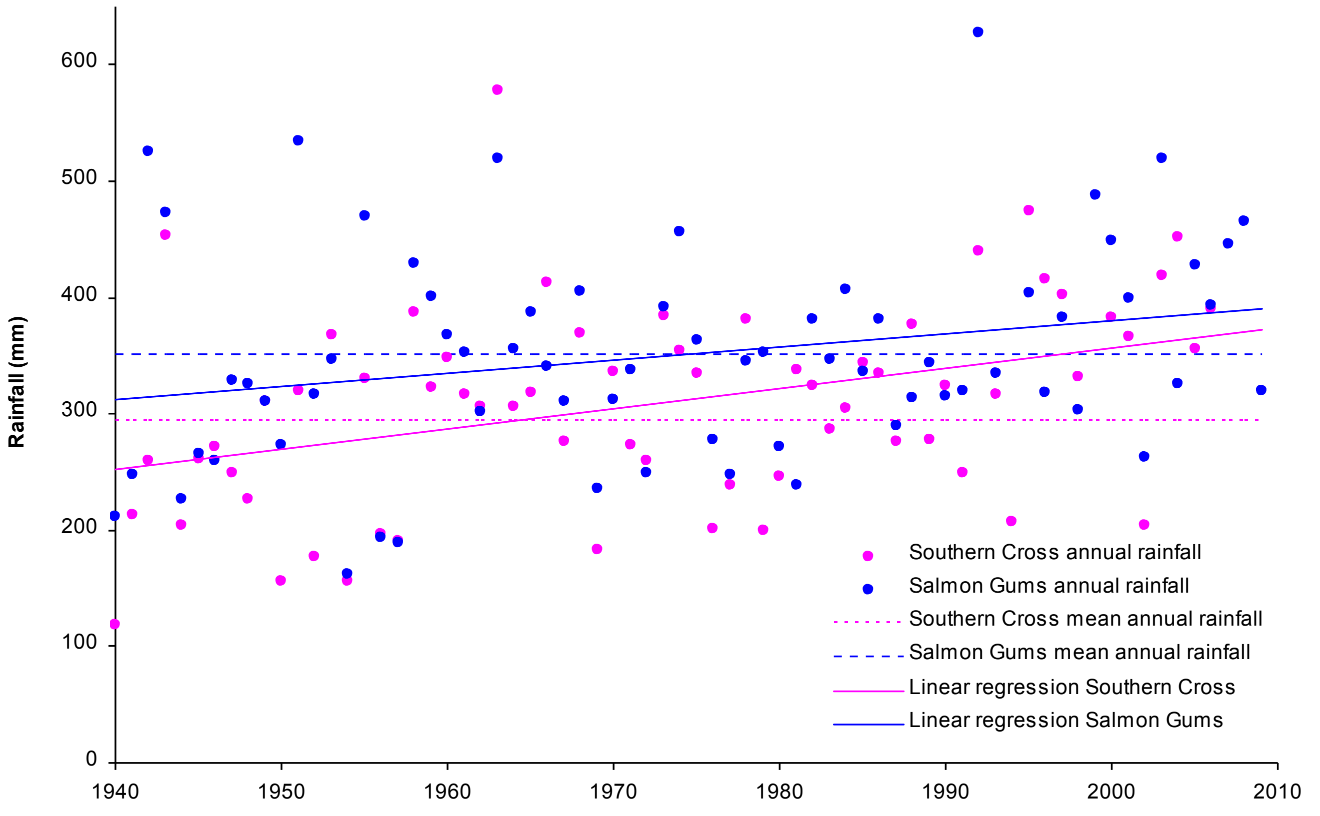

Figure 3: Annual rainfall recorded at Kalgoorlie and Salmon Gums between 1940 and 2009, with a linear regression showing the trend in rainfall at each site over that period. Data from the BoM website (BoM, 2010).

Figure 4: Granite rock outcrops harvest scarce rainfall, encouraging biological diversity.

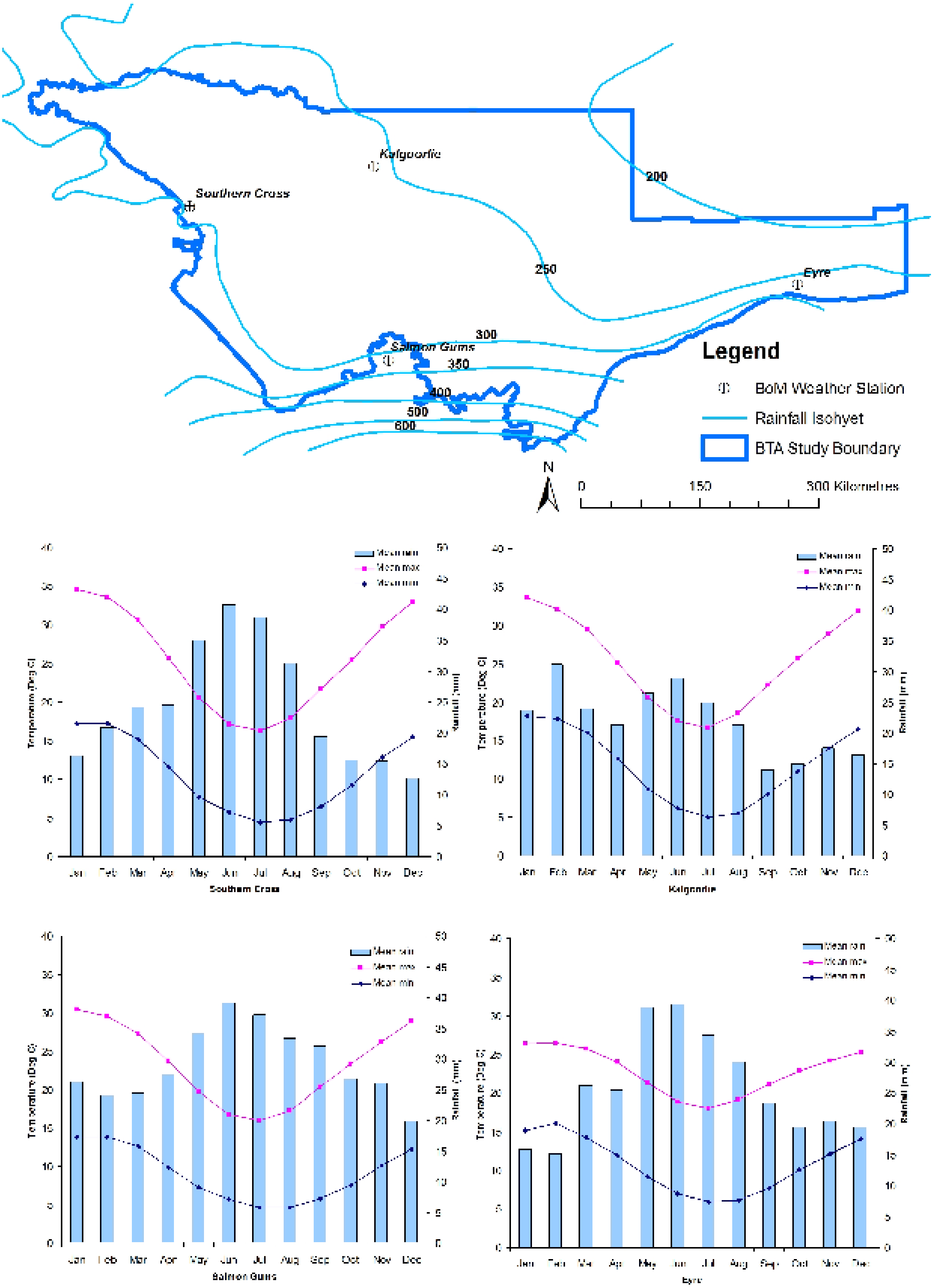

Figure 5: Rainfall isohyets across the Great Western Woodlands Bushfire Threat Analysis study area and climatic means for (clockwise from top left) Southern Cross, Kalgoorlie, Eyre and Salmon Gums. Data from the Bureau of Meteorology website (BoM, 2010).

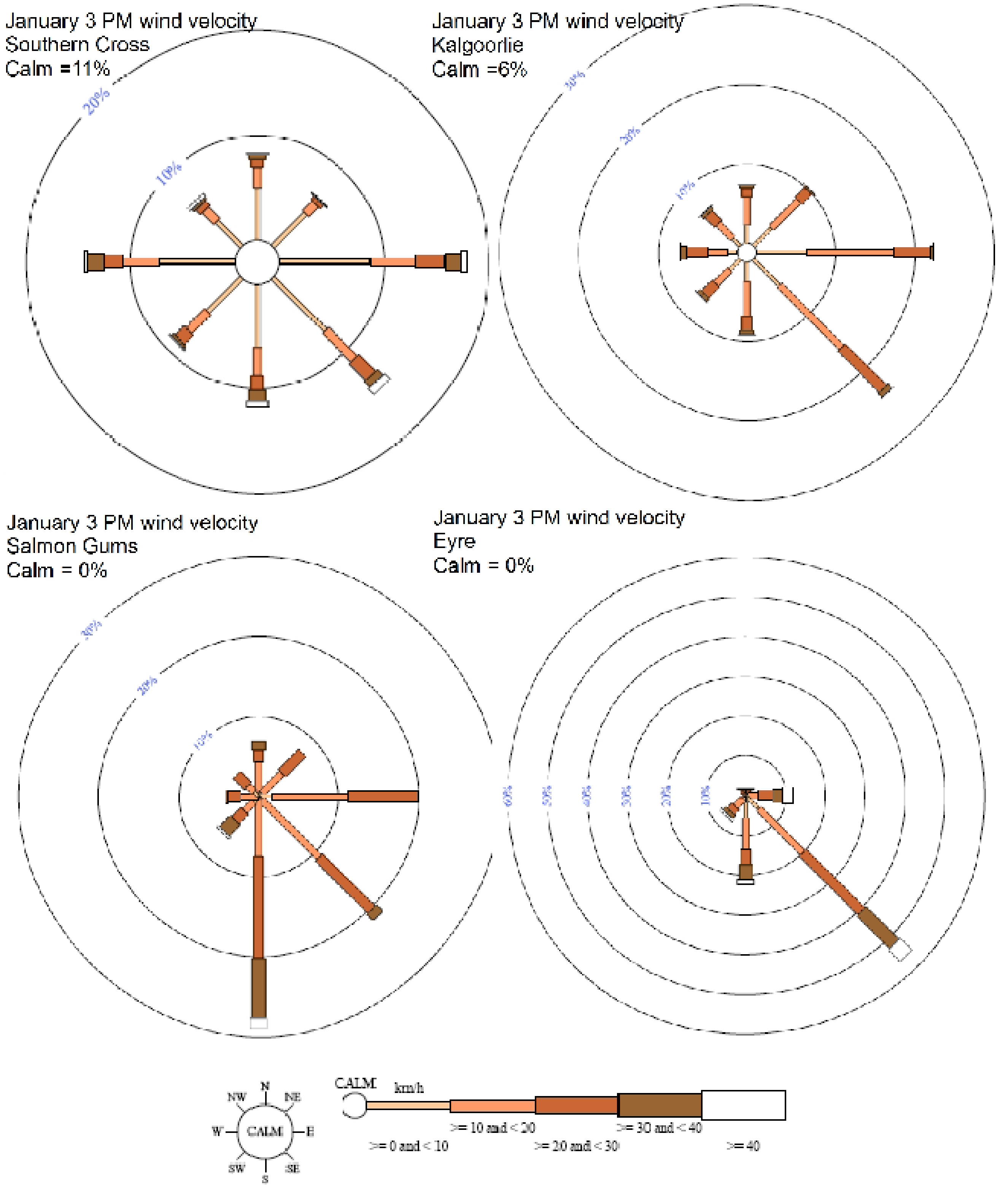

Figure 6: Rose of wind direction versus wind speed at (clockwise from top left) Southern Cross, Kalgoorlie, Eyre and Salmon Gums. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. The branches are divided into segments of different thickness and colour, which represent wind speed ranges from that direction. Speed increments of 10km/h are used. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction. (BoM, 2010).

1.2.3. Vegetation

Vegetation may be categorised and described by several different methods. The most suitable method for a given purpose depends on the spatial resolution and structural and floristic detail that is required. Three different methods are referenced in the current document. Firstly, the bioregions described in the Interim Bioregionalisation of Australia (IBRA) are used when providing an overview of the study area's natural environment. Secondly, Beard's vegetation mapping was used to categorise vegetation as an asset to be protected from inappropriate fire regimes. Finally, National Vegetation Information System (NVIS) descriptions were used to infer the fire behaviour that is probable in different vegetation units. These methods of vegetation categorisation are described in the following section.

The Interim Bioregionalisation of Australia

The Interim Bioregionalisation of Australia (IBRA) is an approach to classifying the nation into landscapes based on geomorphology, climate and characteristic flora. Each IBRA region and subregion has unifying environmental characteristics that are useful to consider when planning for management at a broad scale.

There are 12 IBRA subregions belonging to 8 IBRA regions within the GWW BTA study area. The Coolgardie Region is predominant, comprising approximately 58% of, and having its entire extent within, the GWW BTA study area. The Mallee IBRA region comprises a further 15% of the study area and the Nullabor region 14%. The Murchison (6%), Hampton (2%), Great Victoria Desert (2%), Esperance Plains (2%) and Avon Wheatbelt (1%) regions each comprise small portions of the study area (Figure 7).

The Coolgardie region contains three subregions: Southern Cross, Eastern Goldfields and Mardrabilla. It is characterised by gently undulating uplands, dissected by broad valleys. Valleys contain diverse Eucalyptus woodlands, chains of saline lakes and outcrops of the underlying granitic geology. Upper levels in the landscape are mantled by yellow sandplains, gravelly sandplains and laterite breakaways. Mallees of various Eucalyptus species and scrub-heaths dominated by Acacias and Myrtaceae occur on sandplains. Scrub-heaths are also found on lunettes around salt lakes and sand sheets around the granite outcrops (Cowan *et al.,* 2001).

The Mallee IBRA region is divided into eastern and western subregions. It is a gently undulating landscape, characterised by associations of mallee eucalypts over myrtaceous and proteaceous heaths. A mosaic of mixed eucalypt woodlands and mallee occur on calcareous earth plains and sandplains in the east of the region. Areas of alluvia are vegetated with Melaleuca shrublands, while Halosarcia low shrublands occur on saline alluvium (Beecham and Danks, 2001).

The Nullarbor bioregion extends from the eastern edge of the GWW BTA study area across most of the onshore part of the Eucla Basin. The study area includes part of the Central Band or Nullarbor Plain subregion. This subregion is a vast, flat plain of shallow calcareous soils, thinly mantling massive limestone. It supports a bluebush-saltbush steppe, although low woodlands of western Myall over bluebush are present in peripheral areas (McKenzie *et al*., 2002).

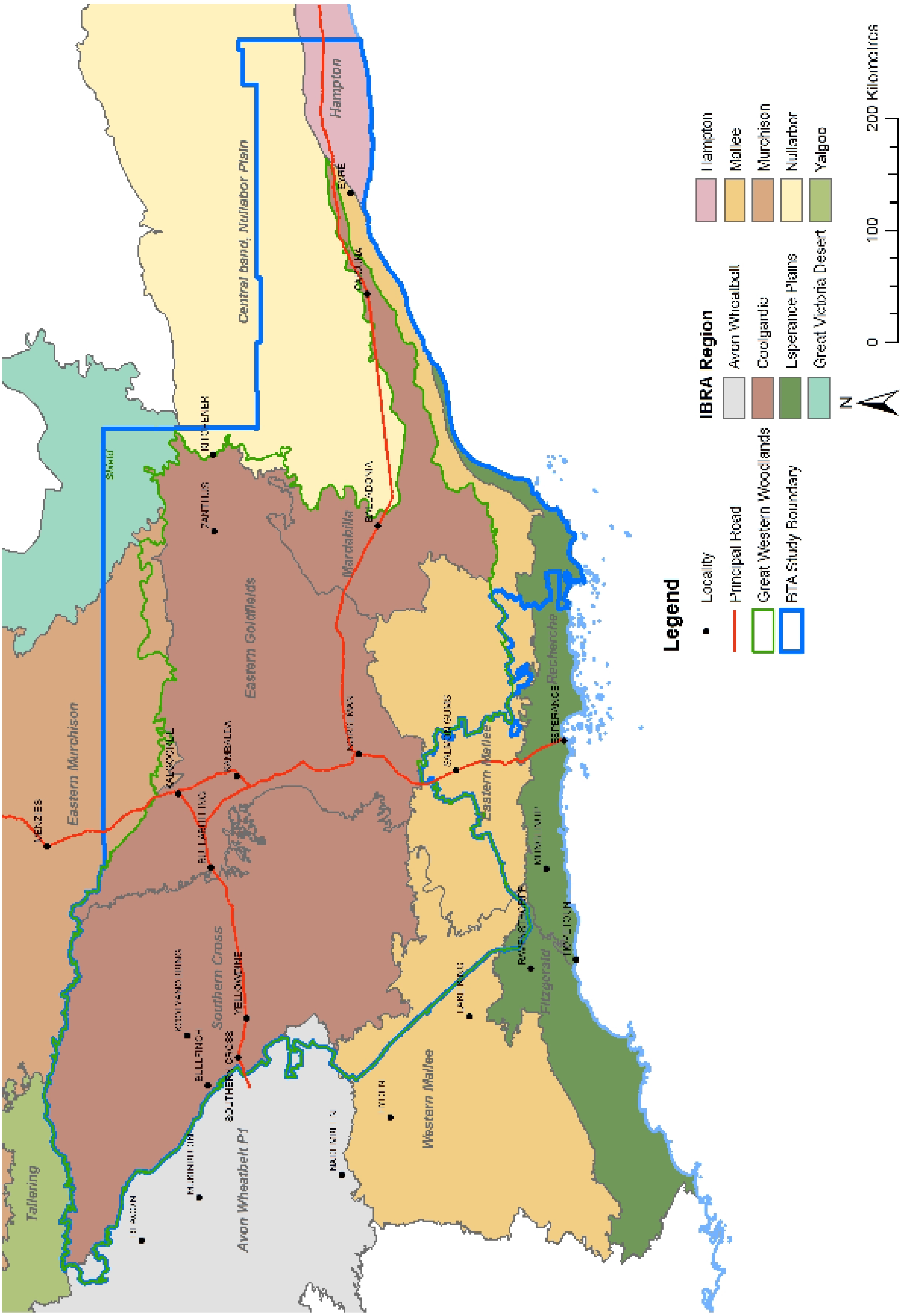

Figure 7: Interim Bioregionalisation of Australia (IBRA) regions within the Great Western Woodlands Bushfire Threat Analysis study area. Subregions within each region are delineated and named in grey font.

Beard's Vegetation Mapping

A more detailed description of the study area's vegetation is provided by the mapping of John Beard. Beard's mapping was based on geological maps, aerial photographs and field work. It describes *vegetation associations* which are repeating sequences of plant communities that are observable at a landscape scale (Beard, 1980). Beard's mapping provides a good strategic overview of vegetation, as it amalgamates spatial heterogeneity into succinctly described units. For this reason, it is commonly used when discussing landscape scale vegetation distribution. Beard's vegetation associations are used in the current document primarily when discussing vegetation as an asset to be protected from inappropriate fire.

There are 135 Beard's Vegetation Associations within the GWW BTA study area, although just 36 of these comprise over 85% of the area's vegetation. Associations are of seven broad structural types: Bare areas, hummock grasslands, low woodlands, medium woodlands, mosaics of woodland and shrubland, shrublands and succulent steppe. Medium woodlands are most common, with 36 different associations covering 33% of the study area. The area's 12 low woodland associations comprise a further 4% of the study area. The most common dominant species within the area's woodlands are salmon gum, merrit, York gum, gimlet, red wood, Goldfields blackbutt and red mallee. Shrublands are also widespread, with the study area's 41 different shrubland associations comprising 25% of all vegetation. Most of these are dominated by Acacia species and many also contain Eucalyptus species in mallee form. Mosaic associations often occupy a transitional area between shrublands and woodlands; there are 13 different mosaic association occupying 14% of the study area. Succulent steppe occurs across 16% of the study area and forms 23 different associations. The vast majority of the study area's succulent steppe occurs on the Nullarbor Plain, with lesser occurrences surrounding many of the region's salt lakes. Hummock grasslands are largely confined to the north east of the study area, where conditions become increasingly arid. The 6 different hummock grass associations cover 4% of the study area. Finally, bare areas include salt lakes, rock outcrops, drift sand and claypans and comprise the remaining 4% of the study area (Table 4, Figure 8). The Beard's vegetation associations that occur within the GWW BTA study area are listed in Appendix 1.

Table 4: Summary of the structures of the Beard's Vegetation Associations within the Great Western Woodlands Bushfire Threat Analysis study area. A complete list of associations is in Appendix 1.

Structure of Beard's Vegetation Association	**# of Associations**	**% of Study Area**
Bare Areas	4	4.0
Hummock Grassland	6	4.5
Low Woodland	12	3.9
Medium Woodland	36	33.3
Mosaic of woodland and shrubland	13	13.6
Shrubland	41	24.8
Succulent Steppe	23	15.9
Total	**135**	**100.0**

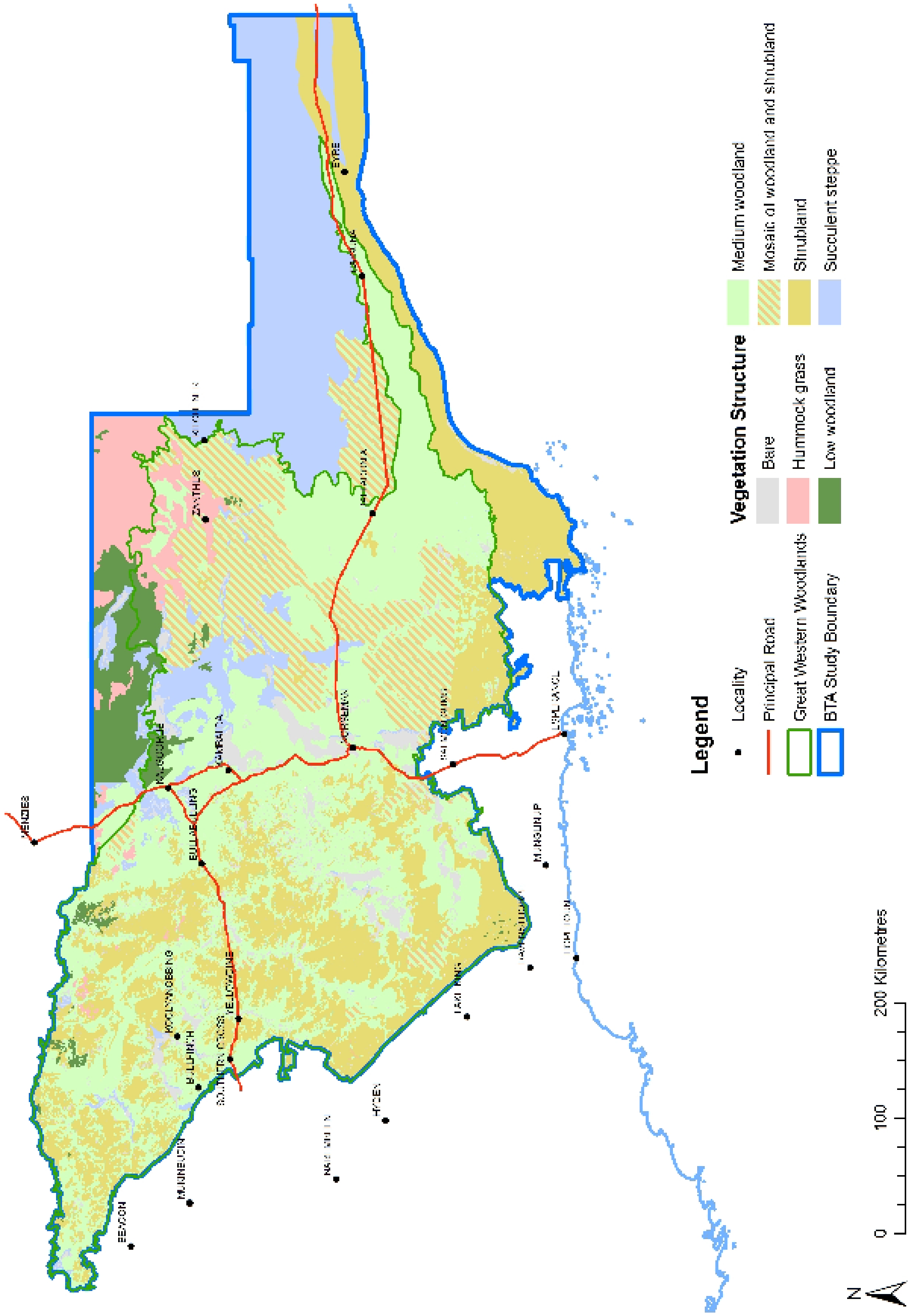

Figure 8: Vegetation of the Great Western Woodlands Bushfire Threat Analysis study area, according to Beard's broad structural descriptors (see Table 4).

The National Vegetation Information System

The National Vegetation Information System (NVIS) uses a combination of structure and floristics to describe vegetation. The NVIS system includes six levels of detail, with subsequent levels adding additional structural and floristic description (ESCAVI, 2003). This approach provides the flexibility to examine the vegetation at a level of detail that is appropriate for a given purpose. NVIS level 2 (structural formation) is useful for providing an overview of an area as it describes the dominant structure of the vegetation. There are 18 structural formations in the study area (Table 5). NVIS level 5 (association) provides significantly more detail. It describes the height, density, growth form and three most dominant taxa of the lower, mid and upper strata. NVIS level 5 was used to predict the flammability of vegetation in the GWW BTA study area as it provides information about the horizontal and vertical distribution of fuels, as well as indicating the potential for litter accumulation. It should be notes that the NVIS categorisation of WA's vegetation was achieved via a reinterpretation of Beard's mapping (Hopkins *et al.* 1996). This means that, although NVIS provides more detailed descriptions of vegetation, the spatial resolution of the dataset is the same as that of Beard's mapping (1:250 000).

At NVIS level 5, there are 220 distinct vegetation associations in the GWW BTA study area. These associations are variations on five broad vegetation structures: bare areas, succulent steppe, woodlands, mallee and hummock grasslands. Woodlands predominate, with approximately 54% of all vegetation in this broad category. The vast majority of woodlands are defined by a Eucalyptus overstorey. Some Acacia woodlands do occur in the study area, but they are far less common than those defined by eucalypts.

The next most common vegetation structure in the study area is shrubland, which comprises approximately 15% of all vegetation. The majority of shrublands are dominated by Acacia species with Adenanthos, Allocasuarina and Banksia dominated shrublands somewhat less common. Shrublands predominantly occur high in the landscape on sandplains and lateritic sandplains.

Plants in mallee form occur throughout much of the study area, but are structurally dominant in only around 14% of the area's vegetation. Mallee communities can be difficult to delineate as they tend to gradually integrate into shrublands or woodlands at either end of their environmental niche. Extensive areas of mallee occur in the south of the study area, but further north they tend to be confined to small pockets.

Almost 9% of the study area is vegetated with various types of succulent steppe. Succulent steppe fringes salt lakes, but may also be found across broad plains of calcareous soils such as in the Nullarbor IBRA region. These communities are dominated by Atriplex, Halosarcia and Maireana species but may also include some overstorey eucalypts or other trees.

A small portion of the study area (approximately 4%) is hummock grassland. Hummock grasses occur in small pockets in various parts of the study area, but only become dominant in its north east. Here, their presence signifies a transition to the more arid environment of the Great Victoria Desert.

The remaining portion of the study area (approximately 4%) is defined as bare. This includes salt lakes and their fringing lunettes and granite rock outcrops. Rock outcrops have little vegetation on their exposed surfaces, but are often surrounded by a dense fringe of shrubs and mallee. Outcrops of both granite and Banded Iron Formation are recognised as being ecologically important in the Wheatbelt and southern Goldfields, as they are centres of flora and fauna endemism (Beecham and Danks, 2001).

The most extensive individual vegetation association in the study area is a moderately dense association of medium height *Eucalyptus flocktoniae* trees and tall *Eucalyptus oleosa* mallee. This occupies 6% of the study area or approximately 1.35 million hectares. There are 30 other associations that each occupy more than 1% of the study area, meaning they occur over an area of greater than 200 000 ha. A further 28 associations occur over an area of greater than 100 000 ha, with the remaining 161 association making relatively minor contributions to the study area's vegetated area. More information about the associations that occur within the study area, and the nature of fire behaviour within them, is in Sections 1.2.5 and 3.1. A complete list of the study area's NVIS Level 5 Associations is in Appendix 2.

Table 5: Vegetation of the Great Western Woodlands Bushfire Threat Analysis study area, described at NVIS level 2 (structural formation).

NVIS Level 2 Structural Formation	Area (ha)	% of Study Area
Bare Areas	896460	4.0
Sparse chenopod shrubland	88839	0.4
Open chenopod shrubland	1671414	7.5
Chenopod shrubland	18563	0.1
Open samphire shrubland	121516	0.5
Total Succulent Steppe	**1900331**	**8.6**
Isolated trees	124192	0.6
Open forest	4414	0.0
Open woodland	672060	3.0
Woodland	11174770	50.4
Total Woodland	**11975435**	**54.1**
Sparse mallee shrubland	168107	0.8
Open mallee shrubland	2872737	13.0
Total Mallee	**3040844**	**13.7**
Sparse shrubland	609772	2.8
Open shrubland	529861	2.4
Shrubland	1117050	5.0
Closed shrubland	1126509	5.1
Heath	29331	0.1
Total Shrubland	**3412523**	**15.4**
Open hummock grassland	658052	3.0
Hummock grassland	272272	1.2
Total Hummock Grassland	**930323**	**4.2**

1.2.4. Fire History

The GWW BTA project mapped fires that occurred in the study area between 1970 and 2010. Fires were identified by comparing sequential years of Landsat satellite imagery. Fire boundaries were either captured by an automated process in ER Mapper or by Heads Up Digitisation in ArcMap.

Fires were dated according to the oldest satellite image on which they appeared. Where there were gaps in the chronosequence of satellite imagery, an estimate was made of the age of the fire on the first satellite image on which it appears. Where possible, DEC departmental records were used to validate and refine the date of occurrence.

Where possible, satellite imagery was sourced from the Australian Greenhouse Office (AGO), which creates mosaics of Landsat scenes that are distributed as 1:1 million mapsheets. The GWW BTA study area lies across mapsheets SH50-52 and SI50-52. AGO mosaics are not produced every year and so were available only for 1972 (Landsat I), 1977 (Landsat 2), 1980 (Landsat III), 1985, 1988, 1989, 1991, 1992 (Landsat IV), 1995, 1998 (Landsat V), 2000, 2002, 2004, 2005 and 2006 (Landsat VII). Imagery for the period 2006 to 2010 was sourced from the archive of the United States Geological Service (USGS). These images are supplied as individual Landsat scenes, named after the path and row. The GWW BTA study area lies approximately between path 111, row 081 and path 106, row 083.

Between 1970 and 2010, a total of approximately 9.52 million ha of the study area was burnt. The mean area burnt per year was approximately 233 000 ha and the median area burnt annually was approximately 103 000 ha. Of the area that was burnt in this 40 year period, 25% has experienced two fires and 2.5% three or more fires.

There is a strong correlation between the incidence of fires and the structure of vegetation in the GWW. Fires occur with disproportionate frequency in shrubland and mallee associations and are less prevalent in woodlands. In the GWW BTA study area, 25% of the total area burnt between 1970 and 2010 was within various types of shrubland. These vegetation types occupy only 15% of the study area. A further 25% of the burnt area was mallee, although mallee occurs in only 14% of the study area. Woodlands, meanwhile, occupy 54% of the study area but account for only 37% of the area that has been burnt (Table 6 andFigure 11). These figures suggest that rather than being random, fire occurrence is influenced by vegetation structure. This effect is explored in the following section.

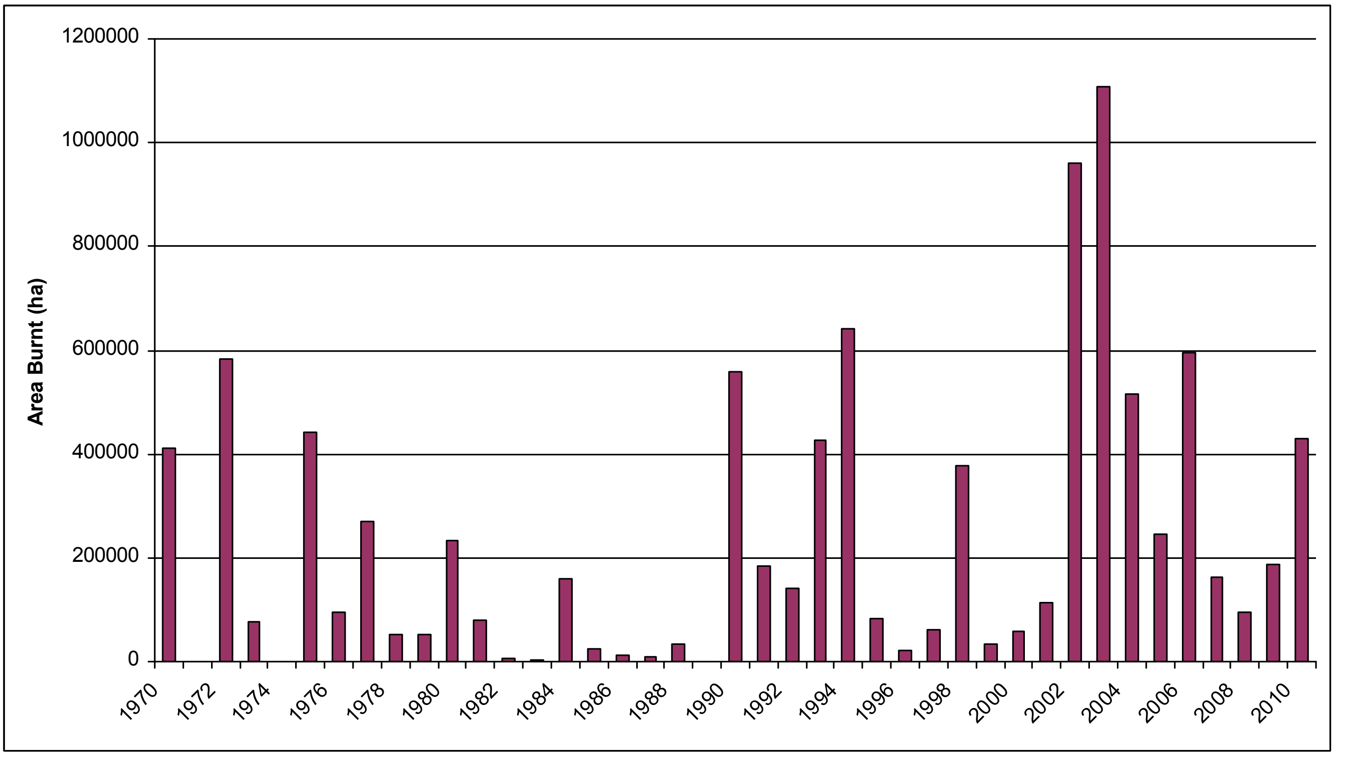

Figure 9: Area burnt annually in the Great Western Woodlands Bushfire Threat Analysis study area.

Table 6: Area and proportion of fires that occurred in each vegetation structural formation (NVIS Level 2) between 1970 and 2010 in the Great Western Woodlands Bushfire Threat Analysis study area.

NVIS Level 2 Structural Formation	Area Burnt	% of All Fires	% of Vegetation
Bare Areas	**123277**	**1.3**	**4.0**
Sparse chenopod shrubland	65098	0.7	0.4
Open chenopod shrubland	202615	2.1	7.5
Chenopod shrubland	628	0.0	0.1
Open samphire shrubland	1752	0.0	0.5
Total Succulent Steppe	**393370**	**4.2**	**8.6**
Isolated trees	157213	1.7	0.6
Open forest	7744	0.1	0.0
Open woodland	76457	0.8	3.0
Woodland	3238610	34.2	50.4
Total Woodland	**3480025**	**36.7**	**54.1**
Sparse mallee shrubland	221635	2.3	0.8
Open mallee shrubland	2095423	22.1	13.0
Total Mallee	**2317058**	**24.5**	**13.7**
Sparse shrubland	208045	2.2	2.8
Open shrubland	264298	2.8	2.4
Shrubland	943234	10.0	5.0
Closed shrubland	921530	9.7	5.1
Heath	26353	0.3	0.1
Total Shrubland	**2363460**	**25.0**	**15.4**
Open hummock grassland	592905	6.3	3.0
Hummock grassland	323450	3.4	1.2
Total Hummock Grassland	**916355**	**9.7**	**4.2**

Figure 10: Fire burns in low shrubland near the southern boundary of the Great Western Woodlands Bushfire Threat Analysis study area.

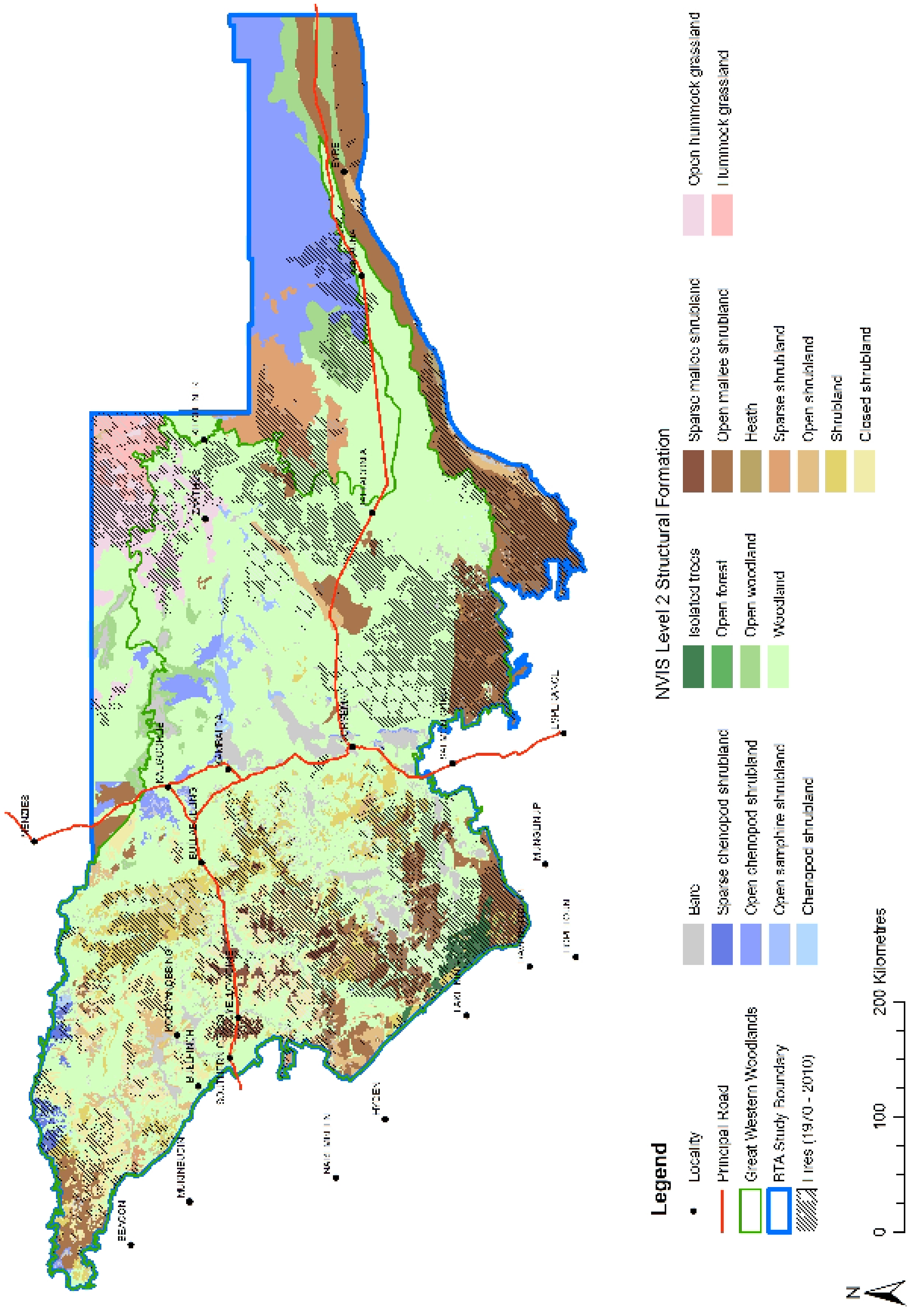

Figure 11: The occurrence of fires in the Great Western Woodlands Bushfire Threat Analysis study area in relation to broad vegetation structural formations (NVIS Level 2). Fires that occurred between 1970 and 2010 are shown.

1.2.5. Fuel Profile and Fire Behaviour

The fuel profile of an area of vegetation is the quantity, size and arrangement of flammable material that is present. These factors determine what proportion of the vegetation is available to burn and how it will burn under various conditions. When considering potential fire behaviour, the most important aspects of the fuel profile are the coarseness of individual fuel components, the degree of horizontal and vertical continuity in the fuel, the proportion of dead material that is present and the height of the most continuous fuel layer.

Fuels are divided into four layers, distinguished by their height above the soil surface. Surface fuels are the ‘litter’ on the ground surface, such as shed leaves, twigs and bark. The lowest layer of vegetative material forms the near-surface fuel layer. This may include grasses, herbs and low shrubs. Higher in the profile are elevated fuels, such as tall shrubs and immature trees. Finally, overstorey fuels comprise the canopy of taller trees (Gould *et al.*, 2007).

The availability of surface fuels is very important to fire spread. If surface fuels are discontinuous or absent, strong wind is required to allow a fire to spread through the near surface fuels. The lack of either surface or near surface fuels makes vegetation very unlikely to burn. In the GWW BTA study area shrublands and mallee usually have significant quantities of fuel in the surface and near surface layers, while woodlands do not. As such, shrublands and mallee tend to be more flammable than woodlands.

Shrublands typically feature a surface fuel component of leaf litter overlain by a near-surface fuel component of low shrubs. Above these is often a nearly continuous vertical profile of taller shrubs and scattered mallee. The continuity of surface fuels allows fires to spread under moderate conditions, while the continuity of the vertical profile allows fire to reach higher fuels. Higher fuels are usually well aerated and contain volatile oils, factors that facilitate rapid and intense combustion. When severe weather conditions prevail, fires will burn with great intensity, consuming surface, near surface and elevated fuels as well as any higher strata that are present. The lack of a tall overstorey to reduce wind speed also facilitates intense fire behaviour in shrublands.

Mediterranean and semi-arid woodlands, meanwhile, tend to have surface fuels accumulated only beneath individual trees, separated by areas of bare ground. Strong winds are required to allow fires to move between these discontinuous clumps of surface fuel and they will do so only slowly. There are usually few shrubs in the understorey and, again, these will be separated by bare ground. Combustion of the canopy is rare as the overstorey of woodlands tends to be composed of tall Eucalyptus species and there is usually little vertical continuity of fuels.

Mallee communities form something of a continuum between shrublands and woodlands. They vary in structure, approximating shrubland at one extreme of their environmental niche and woodland at the other. On the whole though, mallee vegetation is lower and denser than woodland, but more open than shrubland. Accordingly, it falls between these in terms of flammability. Mallee vegetation usually contains a substantial layer of ground fuels, primarily shed bark and leaf litter. These will usually be overlain by a discontinuous near ground fuel layer of grass and shrubs. Patches of bare ground may still occur, but they will be smaller and less frequent than in woodlands. Taller shrubs and hanging bark may also be present and will act as a ‘ladder’ to help fires reach the low overstorey canopy.

Much of the GWW BTA study area is dominated by woodlands. In the north of the study area, these tend to be tall and open while in the south they are relatively low and dense. Furthermore, mallee becomes more common further south in the study area. As a consequence, fires in the north of the study area tend to be confined to areas of shrubland, with woodlands acting as a barrier to fire. In the south of the study area, fires are more likely to spread extensively across the landscape. This is important for fire management, as woodlands may be utilised as a barrier to fires in the north of the study area, but this approach is unlikely to be effective in the south.

Figure 12: Some of the characteristic vegetation types found within the Great Western Woodlands Bushfire Threat Analysis study area. From top left: open woodland with a bluebush understorey (fuel category W1); open woodland with shrubby understorey (fuel category W4); regrowth woodland (fuel category W3); mallee-shrubland (fuel category S2); low shrubland (fuel category S4); hummock grassland (fuel category H1).

Fuel Classification

NVIS level 5 (association) vegetation descriptions were used as the basis for modelling fire behaviour in the GWW BTA. Each vegetation association was assigned to one of twelve fuel categories, based on the availability and distribution of fuels. Particular emphasis was given to the surface and near surface fuel layers, which are important to fire spread. In order from least to most flammable, the twelve fuel categories range from bare areas, tall woodlands with little ground fuel, lower woodlands with a shrubby understorey, shrub dominated associations that are increasingly horizontally and vertically continuous to hummock grasslands. A summary of the classification matrix is shown in Table 8; Figure 13 shows this classification system applied to the study area.

Fuel classification is somewhat subjective as it requires interpretation of the NVIS description to predict the horizontal and vertical distribution of fuels and the likely degree of litter accumulation. The height and density of vegetation in each stratum is given in the NVIS description, but its arrangement must be inferred. Also, the majority of surface fuel will be plant litter which is not identified in the association description. The availability of surface fuel must, therefore, be estimated based on the taxa that comprise the vegetation and the density at which they occur. The fuel categories used in the GWW BTA project are described below. Note that standard NVIS descriptors are used in these descriptions; see Table 7 for a summary of these.

Table 7: NVIS descriptors of density and height used in the Great Western Woodlands fuel categorisation.

Density Descriptor	Sparse	Open	Dense	Closed
% Canopy Cover	0.25-20%	25-50%	50-80%	>80%

	Growth Form			
Height Range	Tree	Mallee	Shrub, chenopod shrub, grass tree	Tussock grass, hummock grass, forb
10 – 30	Medium	Tall		
<10	Low	Medium		
<3		Low		
>2			Tall	Tall
1 – 2			Medium	Tall
0.5 – 1			Low	Medium
<0.5			Low	Low

The following is a description of the characteristics of each of the 12 fuel categories used in the GWW BTA:

Fuel category *B*: naturally bare areas such as salt lakes and rock outcrops; non flammable vegetation such as succulent steppe and recently burnt areas. B areas will not burn under any conditions.

Fuel category *W1*: areas dominated by sparse medium trees or tall mallee. They have very little understorey or midstorey or an understorey of succulent plants, and so, contain virtually no surface or near surface fuels. W1 areas are highly unlikely to burn, except for short fire runs under the most extreme conditions.

Fuel category *W2*: areas dominated by low, dense trees or medium, open mallee. The denser canopy means that more litter is likely to accumulate that in category W1. The canopy is also more likely to be ignited by ground fires because it is lower. Surface and near surface fuels are still sparse, however, so W2 areas will usually only burn if a fire enters them on a broad front from a more flammable vegetation type. Even if this occurs, long fire runs in W2 fuels are unlikely except if a period of high rainfall encourages a flush of annual plant growth.

Fuel category *W3*: tree or mallee dominated areas that have an understorey of sparse, tall shrubs. W3 areas have some surface fuels and near surface fuels beneath a low to medium tree canopy. They may burn if winds are sufficient to allow fire to spread through the discontinuous fuels. It is likely, however, that fires in these fuels will self extinguish when winds drop or relative humidity begins to rise.

Fuel Category *W4*: tree or mallee dominated areas with an open, shrubby understorey. W4 areas lack significant groundcover, although the greater density of midstorey shrubs may provide some litter to the surface fuel load. The midstorey is low enough to be ignited by a fire burning in the surface fuels. Although W4 areas usually only burn under extreme weather conditions, it is possible that fire in them may continue to spread slowly even after weather conditions moderate.

Fuel Category *S1*: areas with a sparse to open cover of medium to tall shrubs, with very little groundcover. They generally also feature mallee or trees in the overstorey, but these may not be structurally dominant. As with categories W3 and W4, fire is significantly wind driven and is likely to self-extinguish if winds drop.

Fuel category *S2*: areas with 25-50% canopy cover of shrubs in the lowest, and at least one other, stratum. They may also have an open mallee or low tree overstorey. S2 fuels are relatively continuous, allowing fires to spread rapidly and burn with great intensity. Moderate winds will still be required, however, as significant areas of bare ground will be present.

Fuel category *S3*: thickets; very dense, single age stands of shrubs, often with significant litter accumulated beneath them. Some thickets may also have emergent mallee. The density of vegetation within thickets tends to significantly reduce wind strength within them. This, combined with a lack of near ground fuel, can reduce fire behaviour in thickets below what may be expected based on the biomass that is present. When conditions are suitable, however, thickets may burn with great intensity.

Fuel category *S4*: areas with dense ground cover and sparse shrubs in the upper strata or open groundcover with dense, low shrubs in the mid or upper strata. Significant litter is likely to be present. This, combined with low, dense vegetation, allows fires to spread readily under relatively mild conditions and rapidly under more extreme conditions.

Fuel category *S5*: areas with dense groundcover and dense shrubs in at least one of the other two strata. They also usually feature sparse to open mallee in the overstorey. S5 are the most continuous fuels, in both the horizontal and vertical planes. Fires will burn very rapidly and with great intensity under a range of weather conditions.

Category *H1*: open hummock grasslands, with 20-50% cover of hummocks. H1 fuels will burn rapidly if winds are sufficient to allow flame contact between hummocks.

Category *H2*: dense hummock grassland, with greater than 50% cover of hummocks. The relative continuity of hummocks allows fire to spread through H2 fuels and burn with great intensity when wind strength is moderate.

Table 8: Summary of the fuel classification used in the Great Western Woodlands Bushfire Threat Analysis.

Fuel Category	Vegetation Description	Fuel Description
B	Bare Ground or succulent steppe	No fuel: bare ground or succulents only
W1	Medium woodland	No groundcover, no mid stratum and: • Tall mallee or medium tree overstorey or • Sparse low tree or mallee overstorey
W2	Low woodland	No groundcover, no mid stratum and: • Open-closed low-medium mallee overstorey or • Open-closed low tree overstorey
W3	Woodland with sparse shrub understorey	No groundcover, sparse tall shrub midstorey and sparse to open tree overstorey
W4	Woodland with open shrub understorey	No groundcover, open shrub midstorey and sparse to open tree or mallee overstorey
S1	Open shrubland / mallee shrubland without groundcover	• Bare-sparse groundcover and open medium-tall shrub midstorey or • No groundcover, sparse midstorey and open low shrub overstorey +/- tree or mallee component in overstorey
S2	Open shrubland / mallee shrubland with groundcover	Open groundcover with open vegetation in at least one other stratum +/- tree or mallee component in overstorey
S3	Shrub thicket / thicket with mallee	Bare-sparse groundcover and dense-closed shrubs in either mid or upper stratum +/- tree or mallee component in overstorey
S4	Dense, low shrubland / mallee shrubland	• Dense-closed groundcover with bare-sparse mid and upper stratum or • Open groundcover with dense mid or upper stratum +/- tree or mallee component in overstorey
S5	Very dense, low shrubland / mallee shrubland	Dense groundcover plus dense vegetation in either mid or upper stratum +/- tree or mallee component in overstorey
H1	Open hummock grassland	Open hummock grass +/- tree or mallee overstorey
H2	Dense hummock grassland	Dense hummock grass +/- tree or mallee overstorey

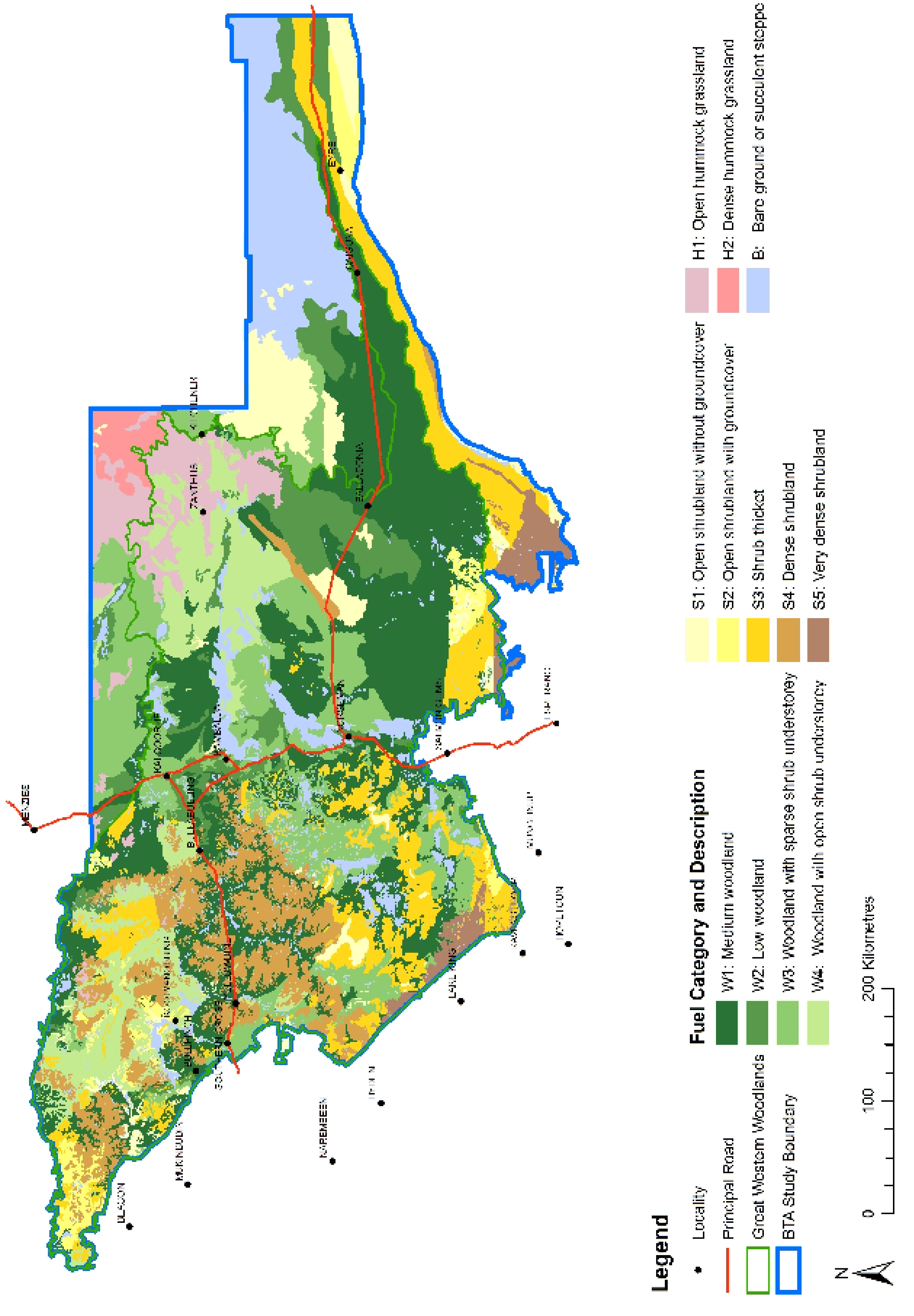

Figure 13: Fuel classification of the Great Western Woodlands Bushfire Threat Analysis study area according to the categorisation shown in Table 8.

When predicting the probable fire behaviour in the fuels of the study area, it is also necessary to account for variations in fuel age. Immediately following a fire the risk of fire is nil, as all available fuels are assumed to have been consumed. As the time since the last fire increases, plants germinate or resprout and grow, accumulating biomass and litter. The rate at which different vegetation associations regenerate their fuel load after a fire is dependent on many variables. These may include the fertility of the site, taxa in the association, intensity of the fire, interval between the most recent fire and the one that preceded it, climatic factors pre and post fire and effects of various threatening processes. Many of these cannot be taken into account in the BTA process due to a lack of data or a lack of understanding of the ecosystem. Instead, the BTA must rely on highly generalised models of fuel accumulation. In general, fuels will accumulate more rapidly in associations that are dominated by grasses and shrubs than in those dominated by trees. Mallee associations may rapidly recover a shrubby understorey while the overstorey species take longer to return.

The rate of fuel accumulation spinifex grasslands is primarily driven by rainfall. In particular, significant rainfall events will stimulate spinifex hummocks to rapidly add biomass, which they will lose during more arid periods. Also, periods of above average rainfall will encourage strong growth of annual taxa that facilitate the spread of fire between discontinuous spinifex hummocks (Allan and Southgate, 2002). This strong climatic effect makes it difficult to predict the period of time that must elapse before spinifex will burn again following a fire. As a conservative estimate, however, the spinifex grasslands in the GWW BTA study area are unlikely to burn within 3 years of a prior fire. The risk of fire will continue to increase with increasing fuel loads for approximately 20 years after a fire. After 20 years, both the biomass and proportion of dead material in hummocks will be maximised.

Shrub dominated associations in the GWW BTA study area are unlikely to burn in the first seven years following a fire, unless the original fire was very patchy. Fires that run into such young fuels are likely to self extinguish, or will be readily extinguished without the aid of heavy machinery. A moderate fire risk exists in shrubland fuels that are 7 to 9 years old. These may burn, but a confluence of high temperature, low humidity and strong winds will be required to allow any significant fire spread. Fire behaviour will drop significantly when conditions moderate, making direct attack on the fire possible. At 10 to 11 years post-fire; shrublands begin to accumulate significant quantities of fine fuels, litter and dead material. These materials generate intense fire behaviour, with rapid rates of spread and high intensity. Suppression will be difficult, even under moderate conditions, but will probably be achievable with heavy machinery and sufficient support. By 12 years of age, the accumulation of fine fuels in shrublands will be at a maximum. Until age 20, however, the amount of litter and the proportion of dead material in the vegetation will continue to increase. Any fires during this period will be of very high intensity. Suppression is unlikely to be successful under hot or windy conditions and a moderation in climate will be required to make active suppression safe. The highest risk of fire is in areas of shrubland that are unburnt for at least 20 years. By this age, the accumulation of vegetative biomass and litter fuels are at their maximum, as is the proportion of dead matter in the vegetation. Any fire that occurs is likely to be extremely intense and exhibit a very rapid rate of spread. Suppression is unlikely to succeed unless weather conditions are very mild (DEC, 2009).

It is very difficult to predict the time required for woodlands to regenerate sufficient fuel to burn following a prior fire. In general, the flammability of woodlands is largely determined by the nature of the understorey species. It is the return of these species that will allow the return of fire to the association. Overstorey species may take several decades to recover to something akin to their pre-fire state. Understorey taxa will return much more rapidly, however, particularly if fires are followed by seasons of good rainfall. Indeed, in both regenerating and mature woodlands, rainfall can lead to a flush of annual growth that will significantly increase the risk of fire.

There is anecdotal evidence to suggest that woodland associations may be ‘converted’ to mallee by the impacts of fire or other severe disturbance events (Hopkins and Robinson, 1981). This theory suggests that major disturbance events create an environmental niche that may be filled with grassy or shrubby species. Also, that eucalypt species may return in a mallee habit, and at greater density, post fire. These changes to the fuel profile make the area more flammable than it was in its original state. It is unclear if the structural changes are permanent or are a transitory stage on the way to a mature open woodland structure. There is not yet sufficient knowledge of woodland ecology to account for the effects of long-lasting structural change in the BTA process. This is an area in which more research is required.

The combination of fuel type and fuel age was used to assign a fire behaviour rating to each area of vegetation, as shown in Table 9. These are broad generalisations and the actual flammability of the vegetation will be affected by the quantity and seasonality of rainfall received in the years post-fire. This effect will be particularly pronounced for hummock grasslands. Woodlands, meanwhile, may become significantly more fire prone for a short period of time if a year of above average rainfall leads to a flush of growth of annual species. The fire behaviour ratings across the study area are shown in Figure 16. These predictions assume that weather conditions are conducive to bushfire spread, that is temperatures in the high 30s, winds at least 30 kmh^{-1} and relative humidity 10 or less. They also assume that fuels are dry, with no rain having fallen recently.

Table 9: Fire behaviour ratings for fuels of different ages in the Great Western Woodlands Bushfire Threat Analysis study area. The key to colour codes is shown below the main table.

TSLF* (years)	Fuel Category											
	B	W1	W2	W3	W4	S1	S2	S3	S4	S5	H1	H2
0	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Very Low	Very Low
2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Very Low	Very Low
3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Very Low	Moderate
4	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Moderate	Moderate - High
5	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Moderate - High	High
6	Nil	Nil	Nil	Nil	Nil	Nil	Very Low	Very Low	Very Low	Very Low	Moderate - High	High
7	Nil	Nil	Nil	Very Low	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	High
8	Nil	Nil	Nil	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	High	Very High
9	Nil	Nil	Nil	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	High	Very High
10	Nil	Nil	Nil	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Very High	Extreme
11	Nil	Very Low	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Very High	Extreme
12	Nil	Very Low	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Very High	Extreme
13	Nil	Very Low	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Extreme	Extreme
14	Nil	Very Low	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Extreme	Extreme
15	Nil	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Extreme	Extreme	Extreme
16	Nil	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Extreme	Extreme	Extreme
17	Nil	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Extreme	Extreme	Extreme
18	Nil	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Extreme	Extreme	Extreme
19	Nil	Very Low	Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High	Extreme	Extreme	Extreme
20	Nil	Very Low	Low	Low	Low - Moderate	Moderate - High	High	Very High	Extreme	Extreme	Extreme	Extreme

* Time since last fire

Fire Behaviour Rating
Nil
Very Low
Low
Low - Moderate
Moderate
Moderate - High
High
Very High
Extreme

2. Objectives for Fire Management

The broad goal for fire management in the Great Western Woodlands is to protect human life and community and cultural assets whilst promoting the conservation of biodiversity. This may be achieved by creating and maintaining a mosaic of differing fire regimes within the vegetation. Such a mosaic will impede the spread of fires in the landscape and, if managed appropriately, will maintain the region's biological diversity. Specific assets may then be further protected via the development of strategic low fuel areas. Finally, fire managers should continue to work toward an improved understanding of fire behaviour and ecology in the vegetation of the Great Western Woodlands.

More specifically, the objectives for fire management in the Great Western Woodlands are to:

- Protect from unplanned fire events:
  - People residing in or visiting the GWW.
  - Infrastructure, particularly that which is required for the delivery of essential services.
  - Developed lands within and adjoining the GWW.
  - Cultural sites that may be damaged by fire.
- Achieve protection of the above in a manner that promotes the conservation of biodiversity, habitats and ecosystem processes.
- Raise community awareness of fire and its management and engage stakeholders in planning and managing fire.
- Continue to develop an improved understanding of the role of fire in shaping and maintaining the ecosystems of the GWW.

Figure 14: A prescribed burn conducted under mild weather conditions removes ground fuels with minimal impact on overstorey taxa.

3. Threat Analysis

The following section describes the methods used to develop the 'layers' of the GWW BTA and the results of the subsequent threat analysis. The results should be considered in the context of our incomplete understanding of the study area's natural environment. In particular, some facets of the analysis rely on assumptions or data that are qualitative in nature. More information about identified knowledge gaps and the assumptions made to overcome them is provided in the relevant parts of Section 3.

3.1. Probability of Fire

The first half of a BTA entails calculating the probability that a bushfire will affect a given location. This is a function of the risk of an ignition occurring, the behaviour of a fire once started and the capacity of local hazard management authorities to respond and suppress a fire.

3.1.1. Risk of Ignition: likely points of fire origin

The Risk of Ignition layer identifies where a fire is likely to start, due to a confluence of an ignition source and flammable fuel. To begin with, potential sources of ignition in the study area were assigned a probability of causing an ignition according to the categories in Muller (2008). This probability is expressed as the period of time within which the ignition source will provide one ignition per linear kilometre, or kilometre of perimeter in the case of non-linear features.

The most probable sources of ignitions in the GWW are major roads, railway lines, high voltage carrier powerlines and heavily used camp sites. These are expected to provide one ignition per kilometre every 10 to 20 years. Agricultural land, townsites, minor roads, moderately used camp sites and popular day-use recreation sites may provide one ignition per kilometre every 20 – 50 years. Tracks, low usage recreation sites and high voltage power transmission lines may be expected to provide one ignition per kilometre less frequently than once every 50 years.

Several difficulties were encountered when attempting to categorise lightning as an ignition source. Lightning is the most common cause of fires in the GWW BTA study area, however, the probability of lightning striking any given point is relatively low. Also, unlike the other ignition sources, lightning does not have an interface with native vegetation so cannot be described in terms of ignitions per linear kilometre. Finally, the probability of a lightning strike is thought to be influenced by features of the landscape, such as elevated rock exposures. Insufficient data are available, however, to quantify this effect in the GWW. As such, in the GWW BTA, the probability of a lightning strike was considered to be equal across the study area. This means that the likelihood of lightning causing a fire is determined solely by the availability of fuels to be ignited at the point that is struck. Lightning was, therefore, placed into the 'possible' ignition source category. It provides a 'background' ignition risk that the other ignition sources add to.

An ignition from any of the sources described above will only develop into a fire if it occurs within fuels that are likely to be ignited. To complete the risk of ignition layer, therefore, the location of ignition sources was compared to the location of flammable fuels. To achieve this, the vegetation of the study area was divided into three categories by amalgamating the categories shown in Table 9. Areas of non flammable fuels, very low flammability and low flammability are combined into a single group when calculating the risk of ignition. The fire behaviour categories from low-medium to medium high are similarly grouped, as are areas of high, very high and extreme flammability. This grouping is done to simplify the risk of ignition layer and because a less detailed fire behaviour model is sufficient for calculating ignition risk.

Table 10 shows how ignition sources and fuel categories were combined to provide a risk of ignition rating. The output is the probability that a fire will occur due to both an ignition source and a fuel source being present. The result of applying this matrix to the GWW BTA study area is shown in Figure 15.

The maximum likelihood of fire occurrence is where highways, primary roads, rail lines and high voltage carrier powerlines pass through long unburnt shrublands and hummock grasslands. This includes significant portions of Great Eastern Highway between Southern Cross and Boorabbin and between Bullabulling and Coolgardie. Also, along the Perth to Kalgoorlie railway line around the Koolyanobbing and Stewart sidings and the transcontinental railway line between Zanthus and Kitchener. Other areas of very high and extreme risk occur around Ora Banda, Fraser Range and Three Mile Rock; and along Eyre Highway east of Eyre and the agricultural interface between Southern Cross and Beacon (Figure 15).

Table 10: Matrix of ignition source vs. fuel flammability used to determine locations where a fire is likely to originate in the Great Western Woodlands Bushfire Threat Analysis study area. Fire behaviour ratings are described in Section 1.2.5.

Probability of Ignition		Fire Behaviour Rating of Fuel		
Ignition Source	**Frequency of Ignition**	**Nil, Very Low or Low Flammability**	**Low-Moderate, Moderate or Moderate-High Flammability**	**High, Very High or Extreme Flammability**
Combined occurrences of the sources below	Almost certain: more than one ignition per km in 10 years	Low	Very High	Extreme
Highways and primary roads, railway lines, high voltage carrier powerlines, high use camping sites	Very likely: One ignition per km in 10 - 20 years	Low	High	Very High
Minor roads, Agricultural land, townsites, camping sites and high use day sites	Likely: One ignition per km in 20 - 50 years	Very Low	Moderate	High
Tracks, low use recreation sites, apiary sites, high voltage transmission lines, buildings, pastoral leases, mining leases, lightning	Possible: less than one ignition per km in 50 years	Very Low	Low	Moderate

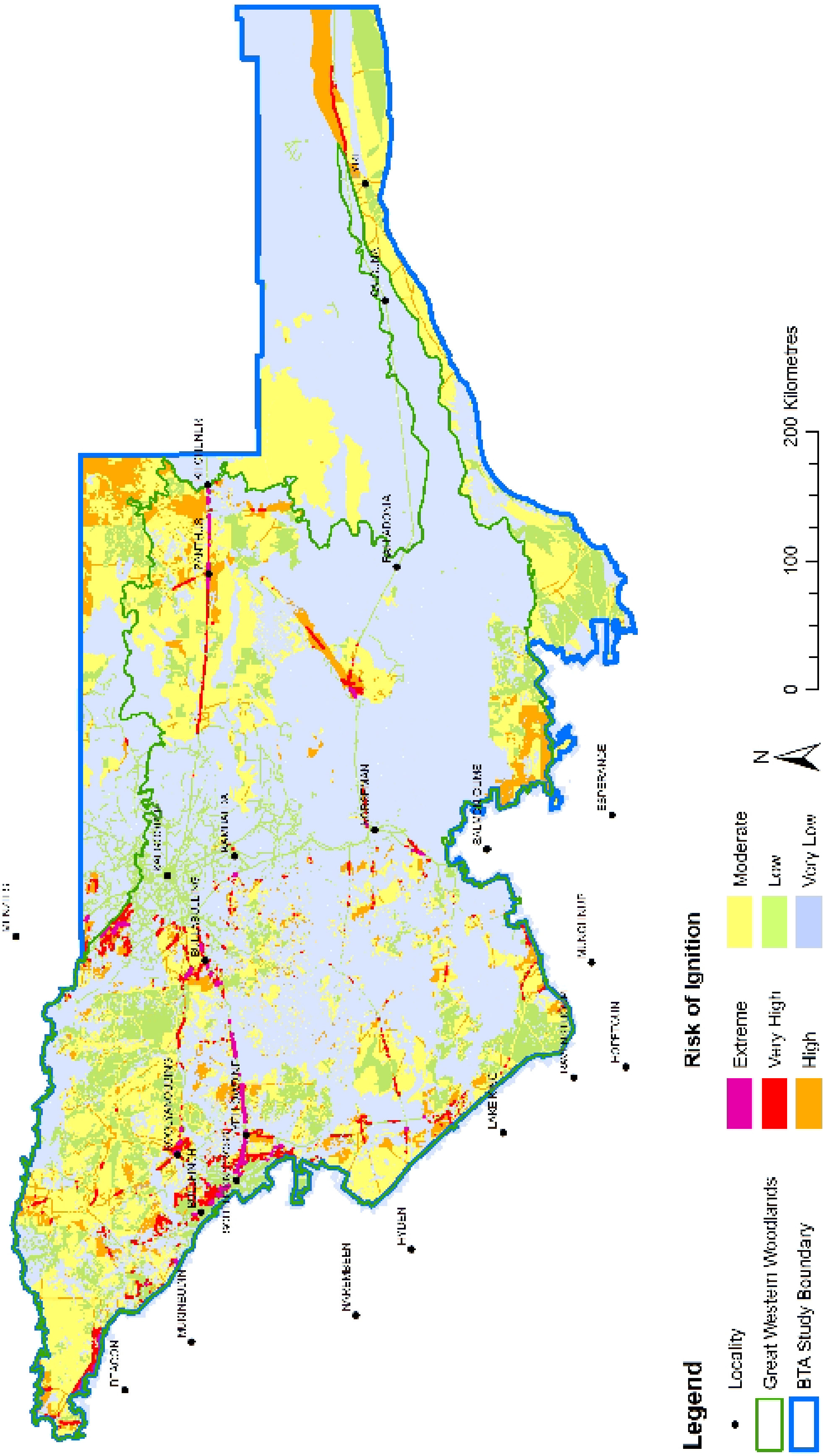

Figure 15: Risk of Ignition: the likelihood of a fire originating in the Great Western Woodlands Bushfire Threat Analysis study area.

3.1.2. Headfire Behaviour: fire growth and spread

The rate at which fires spread and the intensity with which they burn are affected by many environmental factors. The most important of these include the quantity and nature of the available fuels, prevailing weather conditions, seasonal climatic conditions and topography. It is not practical to model all of these factors in a planning tool such as a BTA. For example, it is impossible to predict what the climatic and weather conditions will be at the time of a fire. Instead, these factors are fixed so that fuel type, fuel quantity and topography are the variables that determine fire behaviour. In the GWW BTA, topography was also standardised because the study area has very little relief and areas of high relief are too small to show at the scale of the mapping required.

The standardisation of several variables in the GWW BTA means that the headfire behaviour layer relies on qualitative measures. It provides a comparative measure of the intensity and rate of spread of a bushfire in different parts of the study area. The categorisation of the area's fuels is described in Section 1.2.5 and is based on the nature of the vegetation and the time elapsed since it was last burnt.

Both anecdotal evidence and historical records show that fires in the study area occur with disproportionate frequency in shrublands and mallee (Table 6). This effect is particularly pronounced in the north and west of the study area where woodlands tend to have a tall, open structure. Recent fires have shown, however, that woodlands will burn when conditions are suitable and they cannot be relied on as a barrier to fire. Also, the tendency for woodlands to regenerate in a mallee habit after an intense fire means that some areas mapped as woodland may be more flammable than this categorisation suggests.

Currently, over 60% of the study area is in Fire Behaviour Rating categories nil, very low and low. These areas would not be expected to burn except under the most extreme conditions. Areas in Fire Behaviour Rating categories low-moderate, moderate and moderate-high are probably the most difficult to manage, as they will burn under bushfire conditions, but might not under prescribed burning conditions. This limits the management options in approximately 14% of the study area. The high, very high and extreme Fire Behaviour Rating categories can comprise a maximum of almost 30% of the study area, but currently only 19% of fuels are in these categories (Table 11, Figure 16). These are the areas fires are likely to burn under the widest range of conditions and with the greatest intensity in any given conditions.

Table 11: Area and proportion of the south western Goldfields BTA study area within each headfire behaviour category. Also shown is the theoretical area and percentage when all fuels are long unburnt.

Fire Behaviour Rating Category	Current Area	Current %	Area if all unburnt (ha)	% (of study area) if all unburnt
Nil	4 356 821	19.7	2 499 997	11.3
Very Low	5 629 385	25.4	5 616 434	25.4
Low	3 778 206	17.1	4 477 924	20.2
Low – Moderate	1 906 993	8.6	1 875 763	8.5
Moderate	740 451	3.3	0	0.0
Moderate – High	1 591 545	7.2	1 176 090	5.3
High	1 013 523	4.6	589 690	2.7
Very High	1 415 743	6.4	2 319 532	10.5
Extreme	1 723 254	7.8	3 600 486	16.2

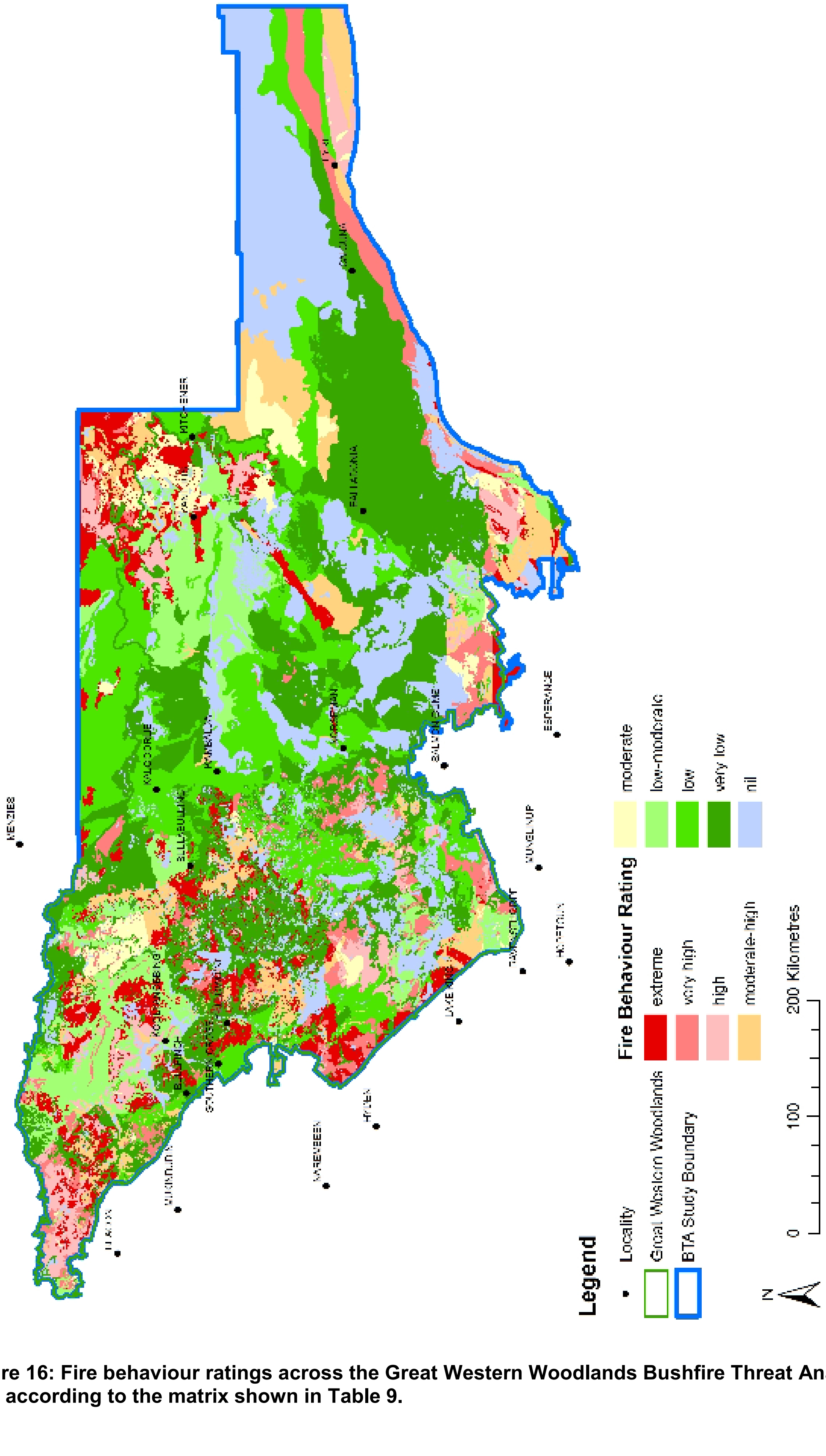

Figure 16: Fire behaviour ratings across the Great Western Woodlands Bushfire Threat Analysis study area according to the matrix shown in Table 9.

3.1.3. Suppression Response: responding to the threat of fire

The suppression response capacity layer of a BTA models the time required for fire management authorities to detect, travel to and contain a bushfire (e.g. Muller, 2008). The layer assumes that a dedicated detection network exists, suppression resources are available and that they will be dispatched immediately upon a fire's detection. In the GWW BTA study area, however, a sparse population hampers fire detection, a response from fire management authorities is not guaranteed and a paucity of resources and access impedes the construction of containment lines. As a consequence, fire suppression in the study area operates at a temporal scale that is highly variable and difficult to model.

The GWW contains a sparse human population, whose movements are restricted to a small number of transport routes. This means there are few people in the area to observe and report fires in their initial stages. Early detection may occur if fires occur along major transport routes. Usually, however, fires are detected by satellites that identify 'hotspots' on the Earth's surface. These satellites may pass over the region as infrequently as once per day, meaning there is likely to be a significant delay between a fire's ignition and its detection.

When a fire in the GWW is detected, the relevant fire management agency must decide whether any attempt will be made to contain it. Many fires will not elicit an active response, due to difficult access or a perceived lack of assets in the fire's path. Such fires will be monitored until they self-extinguish or spread to threaten assets.

If the decision is made to combat a fire, suppression will rely on the use of heavy machinery. These are not dedicated fire fighting resources and are leased from private operators when required. The location and availability of machinery, and therefore the time required to acquire and transport it, is unpredictable. Also, there is a relatively sparse road network in the study area, meaning that some fires cannot be readily accessed.

These factors mean that the most rapid response to fires in the GWW is likely to be very slow by the standards of more populous areas of the state. They also make it virtually impossible to model the probable time required to enact a suppression effort. As such, it is considered inappropriate to create a traditional suppression response layer in the GWW BTA. Instead, the current project recognises that pre-suppression is the most important facet of fire management in the study area. Accordingly, areas have been identified where pre-suppression may be required to achieve the objectives for fire management. These locations are discussed in Section 3.3, along with locations where active suppression may be required in the event of a fire.

3.1.4. Results of Fire Probability Analysis

Bushfires in the GWW are most likely to originate within large patches of long unburnt shrubland or mallee. These present a large target for lightning and may also be vulnerable to other sources of ignition. Fires within these fuels spread very rapidly and burn with high intensity, even under relatively mild conditions. As such, they are where the most extensive and damaging fires have historically occurred. Fires that affect woodlands often begin in shrublands or mallee and burn into wooded areas by virtue of the 'momentum' generated within the more flammable fuels. Preventing extensive fires in the most flammable fuels is, therefore, the most effective way of minimizing the size of fires in the study area and protecting people, infrastructure and sensitive environmental assets. Minimizing the area of shrubland or mallee likely to be burnt in a single fire is a high priority for pre-suppression.

Figure 17 identifies locations where there are currently large areas (> 5000 ha) of contiguous shrubland, mallee or hummock grassland fuels in fire behaviour categories high, very high or extreme. Overlain on these are areas where the risk of ignition is very high or extreme. The intersection of these two datasets, locations where fires are likely to start within large areas of highly flammable vegetation, should be a priority for pre-suppression treatment. This is particularly pertinent where such patches encompass high value assets (see Section 3.2 for more information). Pre-suppression activities should aim to break the large blocks of vegetation into management units in a way that prevents the entire block from being burnt in a single fire event. The spatial distribution of the areas requiring treatment will alter each year as fuel accumulation, prescribed burning and fire occurrence affects the distribution of fuel categories across the landscape.

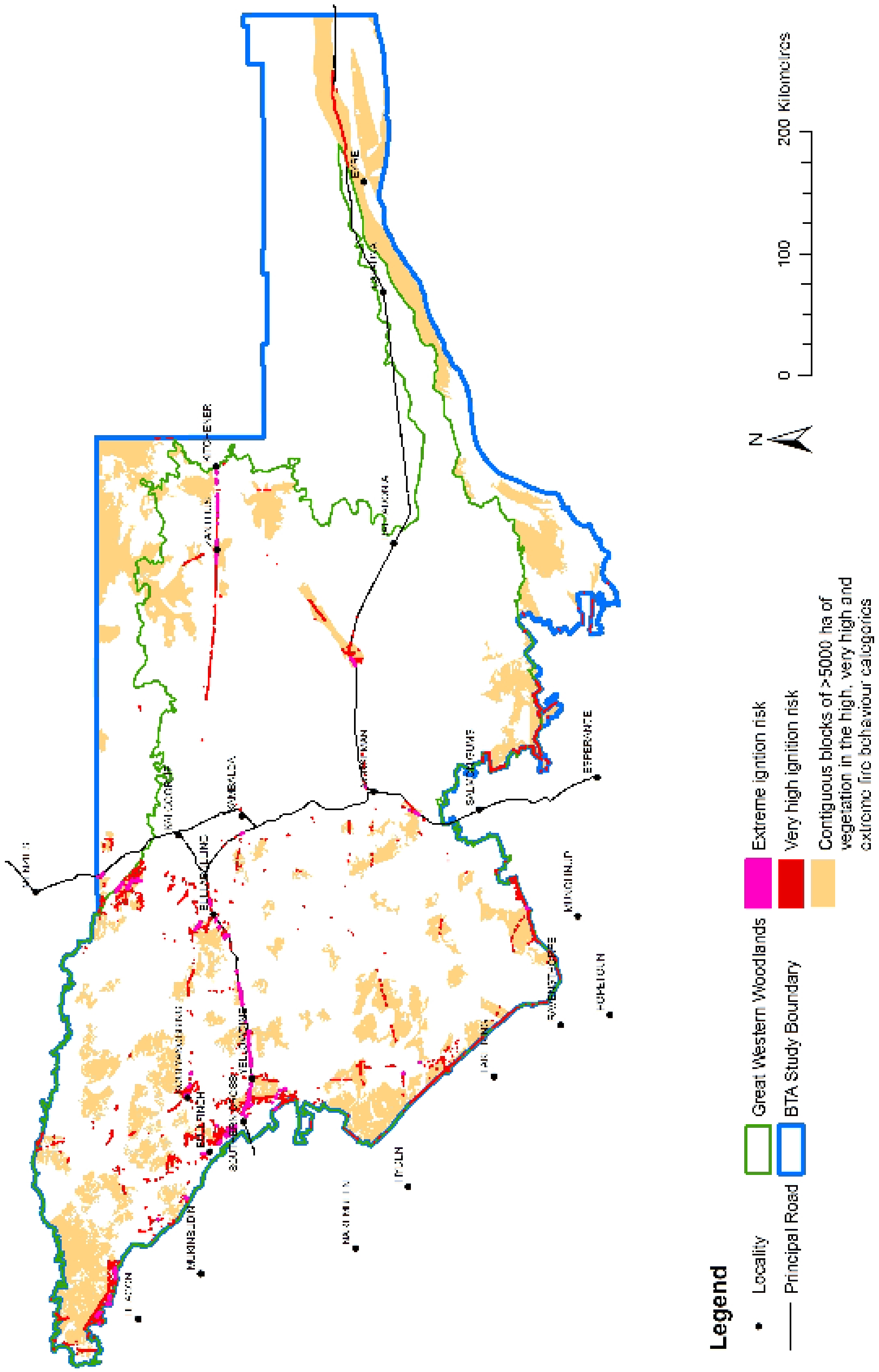

Figure 17: An overview of fire probability in the Great Western Woodlands Bushfire Threat Analysis study area. Shown are contiguous blocks of fuel in the high, very high and extreme fire behaviour categories that contained 5000 hectares or more of fuel in the year 2010. Overlain on these are areas where the risk of ignition is very high or extreme.

3.2. Consequences of fire: value and vulnerability of assets

The primary intent of a Bushfire Threat Analysis is to identify locations where fire is likely to have a negative impact on important assets. This requires that assets be ascribed a comparative value, reflective of their importance to stakeholders and vulnerability to fire. Valuation is complex, as it requires purely economic considerations to be balanced against the social and environmental costs of a fire. The results of such a comparison will be influenced by the internal principles of the individual or group making these judgements. In short, different people will value non-economic commodities differently according to their perception of the worth of the item.

Further complicating the valuation process is the requirement to consider costs that are spatially and temporally disjunct from the fire. For example, a fire that burns a railway line will necessitate the replacement of some infrastructure. The cost of this is readily calculated by combining the value of the materials and wages required to undertake the work. The damaged railway will also, however, delay rail traffic while repairs are made. The flow on costs from this may extend to income lost from the breach of transport contracts, disruption to manufacturing due to interrupted supply of materials or even opportunities lost by delayed passengers. These costs will vary according to the situation and are very difficult to calculate or predict.

Another difficulty inherent in the valuation process is determining the vulnerability to fire of elements of the biodiversity. The severity of the impact of a fire on the natural environment is related to the scale, intensity, seasonality, time and patchiness of a conflagration, climatic factors pre and post fire and longer term considerations of the fire regime. It is not possible to consider all of these variables in a static planning tool such as a BTA. Instead, it is necessary to predict vulnerability based on generalisations about the rarity of taxa and communities and their fire response. Where fire response is unknown, it must be inferred from characteristics of the habitat or landscape setting.

The asset valuation scheme presented here is based on the method described by Muller (1993, 2001, 2008) with some amendments to reflect localised concerns and circumstances. Assets are considered in two broad classes: the built environment and the natural environment. The former of these classes includes considerations of community protection, the value of products of primary industries, constructed cultural heritage sites and developed recreation sites. The latter asset class includes elements of the biodiversity and cultural heritage sites with natural elements. Within the two broad asset classes, individual assets are categorised according to the perceived consequence of a fire impacting on them (Table 15). Categorisation reflects both the value of an asset and its perceived vulnerability to fire. Occurrences of asset types that are thought to be resilient to fire will be categorised less highly than similar assets thought more likely to be damaged by fire. The highest priority is given to locations where there is a significant risk of people being injured or killed in a bushfire. Economic imposts and environmental degradation resultant from bush fires are given lesser weight.

Although the asset valuation process broadly follows Muller, the method used in the GIS analysis of the ‘assets at risk layer’ does not. The difference in approach relates to the treatment of locations where multiple assets occur. Where assets overlap, Muller applies the highest value of the assets that occur there. So, if a category C and a category D asset occur together, that location is simply described as asset category C. It stands to reason, however, that a location where multiple assets occur should be valued more highly than one where a single asset is present. For example, a fire vulnerable Aboriginal heritage site where a Priority 1 plant occurs is more important than an occurrence of that same plant in another area or than an equivalent Aboriginal heritage site where no priority flora occurs.

In the GWW BTA, each asset category was given an ‘asset score’ of double the value of the category that precedes it (Table 15). This means that a category A asset is worth double the value of a category B asset and so on. All assets were overlain in a GIS and the scores of over-lapping assets summed. For example, a location where a category F, category C and category B asset all occur would receive an asset score of 1 + 8 + 16 = 25 (Figure 18). The final step in developing the assets at risk layer was to re-categorise the summed asset scores according to the total value of assets at a location (Table 16).

The weighting of asset categories was not based on empirical evidence. Rather, it was developed heuristically during the development of the assets at risk layer. It is designed to ensure that multiple asset occurrences are prioritised, without overemphasising clusters of low value assets. It also ensures that no location can be prioritised at the expense of locations where there is a significant risk to human life in the event of a fire.

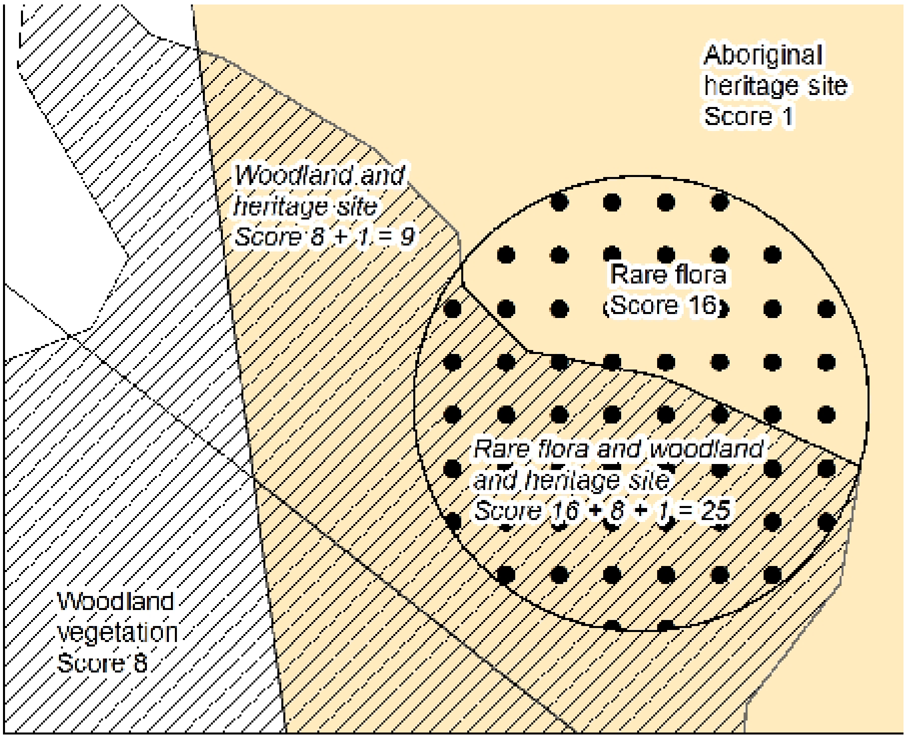

Figure 18: Example of the asset scoring system used in the GWW BTA project. Where assets overlap, their scores are summed to give a total asset value for that point.

3.2.1. The Built Environment

The first broad class of assets incorporates infrastructure and community protection. The most consideration is the protection of locations where people may be injured or killed during a bushfire. These include roads where a quickly developing fire may trap travellers, townsites, popular bush campsites, service stations and minesites. The monetary value of infrastructure damaged by fires and the subsequent cost of disruption to essential services is of secondary importance to the preservation of human life. Finally, heritage values may be damaged by fires, with impacts that can be difficult to express in financial terms.

Roads

Roads are important assets primarily because of the potential for road users to become trapped during a fire. The financial costs of disruption to the transport network can also be significant, particularly if fires affect important freight routes. The monetary value of road surfaces, markers and signage is a further consideration.

The most significant roads in the study area are the Eyre Highway and Great Eastern Highway. These form the main land link between Western Australia and the states to its east and between Perth and the Goldfields. As such, they carry a high volume of traffic and freight. A bushfire impacting these highways may endanger human life, while closure of either route causes significant economic costs. The Coolgardie-Esperance highway and Goldfields highway are also important transport links. These four highways are category A assets, primarily because of the risk to human life in the event of a fire. Secondary roads in the study area carry much less traffic and have minimal associated infrastructure. As such, they are category C assets. Minor roads and tracks are category F assets as they are rarely used and have no associated infrastructure.

There are a number of popular tourist routes that pass through the study area, such as the Holland Track and the Granite and Woodlands Discovery trail. People using these are particularly vulnerable to fire as there are long stretches that have little egress and progress can be slow due to difficult terrain. The fire season usage of these routes is relatively low however, as the hot weather tends to discourage tourists. The Holland Track and Granite and Woodlands Discovery Trail are category C assets indicating there is a slight risk of serious injuries or fatalities to road users in the event of a fire.

Townsites, Minesites and Buildings

To maximise community safety, it is important that bushfires be excluded from townsites, isolated buildings and minesites. Fortunately, all of the townsites in the GWW BTA study area are fairly resilient to fire as they are situated in areas of low fuel and have cleared surroundings. The level of threat to human life in the event of a fire is, therefore, relatively low. As such, the study area's townsites are category B assets.

It is difficult to generalise about the vulnerability of buildings to fire, as the characteristics of individual sites need to be considered. BTA is a broadscale planning tool and it is not possible to include such a case-by-case assessment of the buildings of the study area. An assumption was made, therefore, that buildings would be prepared to withstand fire or have sufficient egress to allow a timely evacuation. The threat to human life in the event of a fire was, therefore, considered to be only moderate and buildings were assigned to asset category B.

The numerous service stations located on the region's highways are particularly important buildings. This is because they are locations where significant numbers of people are likely to be present if a bushfire were to affect the highway, including travellers seeking refuge. They also house highly combustible chemicals and fuels. These factors increase the likelihood of people being injured or killed at service stations during a bushfire. However, the vulnerability of service stations is usually less than that of other buildings as they have large cleared areas around them. As such, service stations are also category B assets.

It is important to protect minesites from fire, both to ensure the safety of people working around the site and to prevent financial impacts from damage to infrastructure or delays to production. The vulnerability of minesites to fire is generally low, due to the presence of cleared areas, mine voids and roads. In the GWW BTA, minesites were placed into three categories. Mines with permanent onsite populations are category B assets, sites with significant infrastructure but transient populations category C assets and sites with neither infrastructure nor permanent residents category F assets. The categorisation was completed by assessing each minesite on satellite imagery and aerial photography to check for the presence of accommodation and other infrastructure. There will, no doubt, have been changes to the patterns of usage at many sites since the most recent available images. At present, however, it is not practical to assess mines in any other way. This may be an area where more work is required as fire planning in the region progresses.

Electricity Transmission and Distribution Infrastructure

The 220 kV electricity transmission line that connects Perth and Kalgoorlie runs through the study area, roughly parallel to Great Eastern Highway. This transmission line is required to ensure electricity supply to Kalgoorlie and locations beyond. If it ceases to function, power supply for the goldfields can be maintained by drawing on privately operated gas turbines in Kalgoorlie. This takes several hours to achieve and, without significant warning, disruption to supply will result. The towers that support the 220 kV line are constructed of steel and will not burn. If the line is enveloped by thick smoke, however, arcing may occur, and this can disrupt power supply.

Several smaller power transmission lines also run through the study area, supplying private residences, mine sites and other installations. Of these, the lines that supply power to Water Corporation pumping stations are the most important. Without power, the pumping stations cannot operate and water supply to the goldfields may be disrupted. Sub-stations, located in or near the residential areas of Kalgoorlie, Coolgardie and Southern Cross are required for the operation of these lines. Most of the minor power transmission lines in the study area have wooden poles and are considered highly vulnerable to fire. A five metre easement has been cleared beneath all power lines, but this may not be sufficient to protect them in the event of a bushfire.

In the GWW BTA high voltage power transmission lines and high voltage power carrier lines that supply water infrastructure category B assets as vulnerable essential utilities. Other high voltage power carrier lines are category C assets as public utilities.

Water Supply Infrastructure

The GWW BTA study area contains infrastructure essential to maintaining the supply of water to the Goldfields. This includes the Mundaring-Kalgoorlie water pipeline, eight water pumping stations, seven storage tanks, one reservoir, four radio repeaters and distribution lines to supply power to these locations. There are also pipelines that distribute water from Kalgoorlie to Kambalda, Norseman and Ora Banda.

Water pipelines are at minimal risk from fire. They are constructed of steel and concrete and heat from a bushfire is unlikely to cause structural damage. Tanks and reservoirs are also unlikely to be damaged by fire, although water quality issues may arise from airborne ash in the vicinity of reservoirs. For this reason, mechanical clearance of vegetation around reservoirs is preferred to prescribed burning. Pumping stations and radio repeaters are more readily damaged by fire. In particular, the power supply to pumping stations is a point of vulnerability in the system.

In recent years, the Water Corporation has taken a number of steps toward fire proofing its operations in the Goldfields. Firstly, water storage capacity in Kalgoorlie has been increased. This means that disruptions to supply do not cause immediate hardship to the community. The water pipeline can also retain limited functionality without all of the pumping stations and tanks in operation. It is possible to operate the pipeline with a limited capacity as long as the following structures remain operational: Ghooli tank and pumping station; the Koorarawalyee tanks; Dedari pumping station, reservoir and radio repeater; Bullabulling pumping station and reservoir; Spargoville tanks no. 1 and 2 and the Coolgardie pumping station. Contingency measures, such as alternative power supply for Dedari, are also maintained through the fire season. Finally, large fire breaks have been cleared around significant infrastructure, increasing its resilience to fire.

The minimum infrastructure components required to maintain water supply are category B assets as they are vulnerable essential utilities. Other water supply infrastructure components are category C assets as public utilities. The water pipelines are category E assets, reflecting their relative resilience to fire.

Figure 19: Power lines and the water pipeline between Coolgardie and Southern Cross.

Railway Lines

The GWW BTA study area contains four railway lines. WestNet Rail operates the Perth to Kalgoorlie line, the Kalgoorlie to Esperance line and the Kalgoorlie to Menzies line. ARTC operate the transcontinental railway line that runs east from Kalgoorlie. The Perth to Kalgoorlie and Transcontinental lines are the most important of these as they constitute a vital route for freight from eastern Australia and are used by the Prospector and Indian Pacific passenger trains. The Kalgoorlie to Esperance and Kalgoorlie to Menzies lines predominantly carry mining products and are of less importance.

The Perth to Kalgoorlie railway line is predominantly constructed of concrete sleepers, making it relatively resilient to fire. The extreme heat generated by a bushfire, however, may cause the tracks to buckle. This will cause all rail traffic in the area to be halted until the fault is rectified. There are also timber sleepered crossing loops at Bonnievale, Stewart, Wallaroo, Jaurdi, Darrine and Koolyanobbing. These are more readily damaged by fire.

Communications infrastructure, related to the signalling system, is also sensitive to fire. Cabling for the signal system is below ground, however, fibre optics booster stations are located alongside the line. These consist of a demountable shed with a bank of solar panels. They do not require connection to mains power as all equipment used for signalling and detection is solar powered. Banks of solar panels are located at each booster station and signal point. There are also telephone communications towers located at two of these booster stations: one in the Wallaroo to Jaurdi Section and one at Darrine Station. These provide communications along the length of the railway line.

The Kalgoorlie to Esperance line is constructed of timber and steel, making it more likely to be damaged if a fire impinges on it. This track is not circuited; each station along its route has signalling equipment and infrastructure for the operation of points in its vicinity. The Kalgoorlie to Menzies line is predominantly timber and steel track. The only circuited areas on this line are the locations of flashlight level crossings, all of which are within townsites.

The Perth to Kalgoorlie and Transcontinental railway lines are category B assets, due to their importance as a transport route. The other two lines in the study area are category E assets, reflecting their lower freight tonnage and non-use as a passenger line.

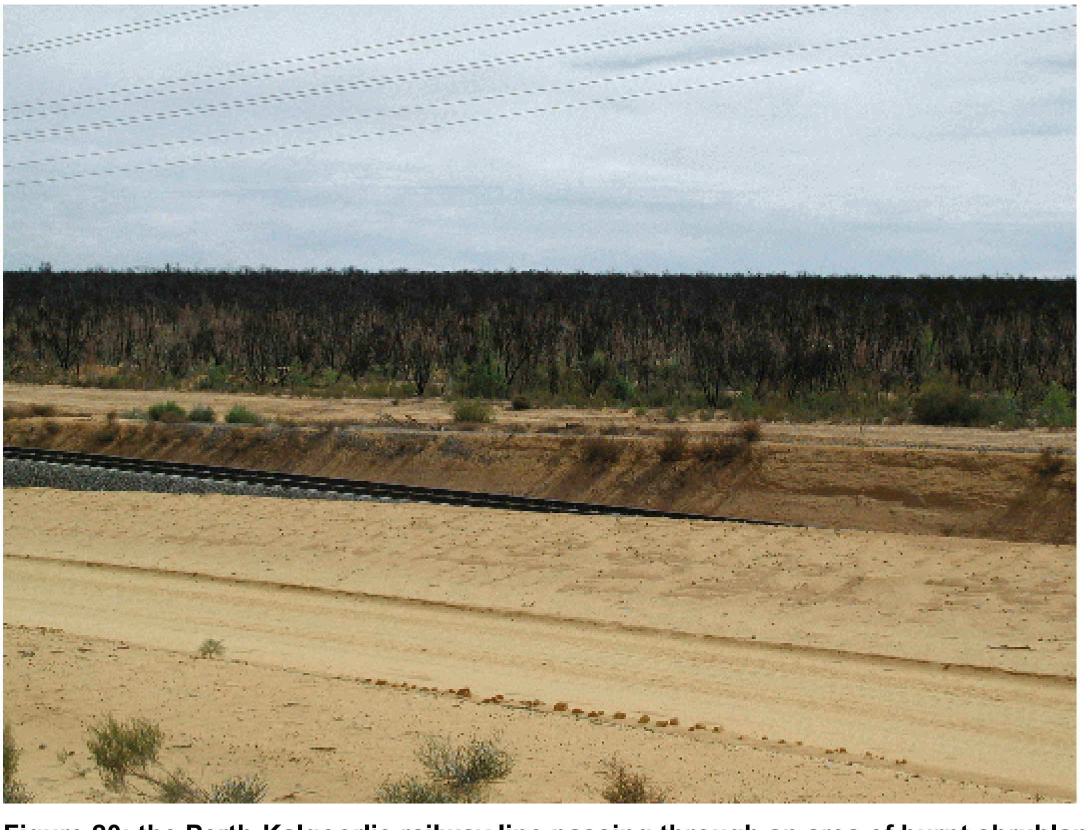

Figure 20: the Perth-Kalgoorlie railway line passing through an area of burnt shrubland.

Communication Infrastructure

There are a number of data cables, communications towers, aerials and masts within the GWW BTA study area. These are essential for maintaining intra and inter regional communications. Key infrastructure includes:

- Telstra microwave repeater towers:
  - Ghooli, Boorabbin and Finlayson along the route of Great Eastern Highway
  - Widgiemooltha, Pioneer, Norseman and Dundas along the route of the Coolgardie-Esperance Highway
  - Buldonia, Heartbreak ridge, Fraser range, Harns Lake, Balladonia, Baxter and Madura along the route of the Eyre Highway.
- Repeaters required for the operation of rail lines:
  - Jaurdi and Darrine on the Perth to Kalgoorlie rail line
  - Curtin, Rainbow Dam, Coonana Hill, Zanthus and Kitchener on the Transcontinental rail line
- Repeaters required for the operation of the water pipeline at Ghooli and No. 7 tank
- FESA communication towers; at Southern Cross, Corinthia, Coolgardie, Mount Burges and Norseman
- VHF repeaters at a number of places, including Emu Hill, Black Range, Mt Vetters, Mt Thirsty, Culver, Noorina, Oomblegabby and on many of the major minesites.
- Optus optical fibre cables following the routes of the Coolgardie-Esperance Highway, the Norseman-Lake King Road and Old Lake King Road. The cables are buried but above ground signal regeneration stations may be affected by fire.
- Telstra underground services along the edge of the Kalgoorlie to Menzies railway reserve and optic fibre cables following the route of the Eyre Highway and Parango Road.

The remote nature of the GWW BTA study area means that the communications network has little inbuilt redundancy. Fire affecting any of these sites can, therefore, have wide ranging impacts. This may be particularly detrimental during the fire suppression effort, when reliable communications will be essential. All elements of the communication network are category C assets as public utilities, except for infrastructure essential to the operation of the water pipeline and Perth to Kalgoorlie and Transcontinental rail lines. These are discussed in the relevant sections above and below.

Fences

There is a total length of approximately 9500 km of fences within the GWW BTA study area, excluding those within townsites. Two state barrier fences run through the area, for a combined length of approximately 600 km. The remainder of the area’s fences are privately owned and located on pastoral leases. These fences have significant financial value, for example, in 2003 the Department of Agriculture and Food Western Australia estimated the value of the state barrier fences at $5500 per km (pers. comm. DAFWA). Most fences are constructed entirely of metal and are contained within easements that provide them some protection from fire. Older fences may still have wooden strainer posts, however, and these will burn readily. Also, steel fences will be damaged if burnt by high intensity fires.

Although fences have a significant total monetary value, only finite sections are likely to be affected by a fire and their loss would not have far reaching impacts. Fences are therefore category D assets. An extension of the state barrier fence is proposed to approximately follow the southern boundary of the BTA study area. It has not been included as an asset in the current report as it is yet to be constructed. Once erected, it will have significant financial value and should be included in any future revision of the current documents as an asset to be protected.

Figure 21: The state barrier fence passes through an area of shrubland.

Primary Production

The primary production group of assets values the raw materials and products of primary industries that may be lost in a fire. Infrastructure associated with the operation of these industries is considered in the other asset groups.

The main primary industries in the GWW BTA study area are mining, pastoralism and bee keeping. Fire does not impact on the products of mining. Accordingly, mines are not categorised as primary production assets in the current report, although they are categorised as locations where people or infrastructure may be at risk from fire (see above).

The effect of fire on pastoral leases is highly dependant on the extent of fires. Provided sufficient areas remain unburnt on a lease, stock can be moved away from burn areas with minimal financial impost. There may even be beneficial consequences, with fire often encouraging a flush of growth of palatable species. A fire that affects a large proportion of a lease may cause hardship, however, such fires are uncommon. Pastoral leases are categorised as 'developed farmland / pasture' under Muller's valuation scheme, and so, are category E assets. This recognises that grazing pastures are important to the pastoral industry, but that only a relatively small proportion of a lease is likely to be affected by a single fire event.

The study area is extensively utilised by beekeepers, as local Eucalyptus species provide significant honey flow at times when it is minimal elsewhere. Large-scale bushfires can significantly reduce honey flow in the affected area for several seasons, resulting in short term hardship for beekeepers. Fire regimes that do not cater for the persistence of 'nectar providing' species at the required stage of maturity can also affect the long-term viability of the industry (DEC, 2008). Apiary sites are category E assets because, while fire may have an effect on a group of sites, it is likely that compensatory sites will be available elsewhere.

Recreation Sites

The categorisation of developed recreation sites as assets to be protected is based primarily on the threat to site users in the event of a fire. Sites known to have high visitation rates during the fire season and limited egress are rated most highly. A secondary consideration is the financial value of infrastructure that may be damaged by a fire.

There are relatively few developed recreation sites within the GWW BTA study area. The most significant sites are listed in Table 12. Of these, the sites that receive the most visitation are: Peak Charles, Benari day use area, Boondi campground, Fraser Range Campground, Karalee Rocks and Rowles Lagoon None of these sites experience summer usage that is heavy by the standards of more populous parts of the state. This is largely due to the inhospitable weather conditions that prevail. Furthermore, visitors should be relatively safe in the event of a fire as all of these sites feature large cleared areas that would provide refuge (Figure 22, for example).

The highest risk to life is at popular bush camp sites that have limited egress and refuge. The only example of such a site in the study area is Peak Charles, which is a category B asset. Other Bush camp sites with good egress or refuge areas and popular day use sites are category C assets. Examples of such sites include Rowles Lagoon, Fraser Range, Victoria Rock, sites on the route of the Granite and Woodlands Discovery Trail (the Breakaways, Disappointment Rock, McDermid Rock, Lake Johnson, Gemfields, Lake Cowan and Woodlands) and the DEC managed homesteads at Credo and Jaurdi. Developed recreation sites that receive low levels of visitation are placed are category D assets, while non developed recreation sites are category F assets (Table 12).

Figure 22: the recreation site at Karalee rock.

Table 12: Recreation sites in the Great Western Woodlands Bushfire Threat Analysis study area.

Site Name	Site Description	Site Type	Usage	Asset Category
Balbinya (Brooks)	Old Homestead	D	L	D
Benari	Day use area	D	M	D
Booanya	Old Homestead	D	L	D
Boondi	Campground	D	M	D
Bromus Dam	Campground	UD	L	F
Burra Rock	Campground	U	L	C
Caiguna Blowhole	Day Use area	UD	M	F
Cave Hill	Campground	D	L	F
Cave Rock	Day Use area	UD	L	F
Credo	Homestead and campsite	D	L	F
Deralinya	Old Homestead	D	L	C
Disappointment Rock	Campground	D	L	D
Dundas Coach Road	Day Use area	D	L -	C
Dundas Rocks	Campground	D	L	C
Fraser Range	Campground	D	M	C
Fraser Range	Old Homestead	H	L	D
Gemfields	Day Use area	D	L	F
Jaurdi	Homestead and campsite	D	L	C
Jimbalana Hill	Day Use area	UD	L	F
Karalee Rocks	Campground	D	M	D
Lake Johnston	Campground	D	L	C
Lillian Stokes Rock	Day Use area	UD	L	F
McDermid Rock	Campground	D	L-M	C
Moir Rock	Day Use area/Water Tank	UD	L	F
Mt Ney	Day Use area /Dams	UD	L	F
Mt. Andrew	Day Use area	UD	L	F
Mt. Ridley	Campground / Day Use	D	L	C
Nanambinia	Old Homestead	D	L	D
Newman Rock	Campground	UD	L	C
Ninety Mile Tank	Covered water tanks	D	L	D
No. 6 Pump	Day use site	U	L	F
No. 7 Pump	Day use site	U	M	F
Peak Charles	Campground	D	H	B
Peak Eleanora	Day Use area	UD	L	F
Red Lake - East	MRWA O/N Campground	D	L	D
Red Lake -West	MRWA O/N Campground	D	L	D
Rowles Lagoon	Campground	D	M	C
Stennet Rock	Day Use area /Dam	UD	L	F
Ten Mile Rocks	Day Use area	UD	L	F
The Breakaways	Campground	D	L	D
Theatre Rocks	Day Use area	UD	L	F
Thursday Rock	Campground	U	L	F
Victoria Rock	Campground	D	L	D
Woodlands	Campground	D	L	C
Woolgangie	Day use site	U	L	F

Heritage Sites

There are two different types of heritage sites in the GWW BTA study area. Those discussed here are sites protected under the Heritage Act of Western Australia (1980). These are generally locations related to the European history of the region. Aboriginal heritage sites are discussed in section 3.2.2.

There are 43 sites protected under the Heritage Act of Western Australia within the study area These are category C assets if they are likely to be damaged by the passage of a bushfire, or category F assets if they are not. The majority of sites (39 of the 43) are buildings that are within townsites. This location that puts them at relatively low risk from bushfire and so they are category F assets. The remaining four sites are the Coolgardie Pioneer Cemetery, the old pumping stations at Benari and Ghooli and the Israelite Bay post and telegraph station. These are probably more vulnerable to fire and are category C assets.

3.2.2. The Natural Environment

Elements of the biodiversity are the most difficult assets to categorise, largely because biodiversity is such a broad concept. Biodiversity incorporates both spatial and temporal scales, as well as a biological hierarchy. It is inclusive of the different genes, species, populations and ecosystems that occur in an area over a period of time. Also, it is not static; genetic and community composition and relationships change through successional sequences and in response to threatening processes.

This dynamism is difficult to include in a strategic planning process. As such, it is common for land managers to plan for the top of the biological hierarchy, working at the scale of ecosystems. This is an issue of practicality, but also reflects that the lower ‘rungs’ on the biodiversity hierarchy cannot survive in isolation. They persist as elements of the ecosystems to which they belong.

Vegetation is a critical component of almost all ecosystems as it is integral to many of the processes that support life. For example, plants convert solar radiation into forms of energy that may be utilised by animals, in the process producing oxygen and cycling carbon, nitrogen and other nutrients. Plants also provide shelter for biota, regulate hydrological fluxes and play a crucial role in maintaining soil health. Because of the importance of plants to ecosystem function, and also because plant communities are relatively easy to define, vegetation is commonly used as a surrogate for ecosystems.

The GWW BTA project has adopted such an approach, using the vegetation associations mapped by Beard as a surrogate measure for the broader suite of biodiversity. This is appropriate because Beard’s associations are defined by a combination of floristic and structural composition and reflect geological and topographic variables. This means that vegetation associations reflect characteristic environmental and habitat conditions, and so, suites of biota.

Populations of rare and priority flora and fauna are also valued elements of the biodiversity. Such restricted taxa are both important and vulnerable. Their persistence often depends on the alleviation of threatening processes that have caused a reduction in range and/or population size. Inappropriate fire regimes can contribute to these declines.

Ideally, potential habitat for rare taxa would also be included as an asset in this BTA, in order to facilitate the protection of undiscovered populations. Unfortunately, such areas are difficult to identify due to our limited knowledge of the habitat requirements of taxa and a lack of suitably detailed environmental mapping. Instead, it is necessary to rely on the general principle that maintaining a mosaic of fire regimes will result in a mosaic of vegetation successional stages that maximises habitat availability. The best way to protect the broad suite of biodiversity, therefore, is to prevent the occurrence of very large, intense or frequent fires.

Vegetation Associations

The categorisation of vegetation as an asset is based primarily on its response to fire. This is because it is difficult to build a compelling argument for the value of any particular vegetation type being greater than that of others. Instead, it is important to ensure that all vegetation is protected from fire regimes that may lead to the loss of important taxa or structural integrity. Doing so will help ensure that the current extent and diversity of vegetation types in the study area is maintained. This, in turn, will maximise the diversity of habitat available and reduce the likelihood of losing biodiversity in the region.

Each vegetation association will exhibit a unique response to being burnt and will recover species and biomass at a different rate. This post fire recovery, which often includes progression through several different seral stages, will be affected by the intensity of the fire, interval between fires, site characteristics and climatic conditions. These variables combine to determine the minimum sustainable interfire interval for the association. That is the minimum time that must elapse between fires if long lasting structural and floristic changes are to avoided.

It is difficult to define the minimum sustainable interfire interval for a vegetation association without detailed study. For the GWW BTA, an approximation of this interval was made by considering the life cycle attributes of an association's key structural species (the species that define the association, such as the salmon gum in salmon gum woodland). Of interest is whether these species are killed by fire, meaning that their persistence relies on the recruitment of a new generation from seed (obligate seeders) or if individuals resprout following the loss of above ground biomass in a fire (resprouters). Obligate seeders tend to be less resilient to frequent fires as their persistence relies on an interfire interval of sufficient length to allow seedlings to mature and replenish the seed store. The length of time required for the key structural species to be replaced by a new generation of reproductively mature individuals, and for the seed store to be replenished, is the minimum sustainable interfere period for the association. This period is often equated to 2.5 times the length of the juvenile period of the key structural species. Some obligate seeder species will also have a maximum tolerable interfire period. This is because they rely on the heat or smoke from fires to cause seeds to germinate. In its absence, the seed store may become depleted as mature plants senesce and stop producing seeds and previously produced seeds lose viability or are scavenged by granivores.

Species that are able to resprout after a fire will generally recover more rapidly than equivalent seeder species. That said, resprouters will also suffer if inter-fire intervals are too short to allow them to redevelop the lignotuber on which they rely while redeveloping their photosynthetic potential post fire.

To determine the minimum sustainable interfire interval of each vegetation association, the first step was to identify the key structural species that define the association. The time required for post fire recovery of those species was then determined from references including Barrett *et al.* (2009) and Shedley (2007). Where no reliable information on the recovery rate of a taxon was available, a conservative estimate was made based on known taxa that share a similar habitat and life history. The post fire recovery time was broadly classed as rapid, medium or slow for both obligate seeding and resprouting taxa and this categorisation used to define the minimum sustainable inter-fire interval for the association, as shown in Figure 23. Note that the sustainable interfire period will be shorter if fires are patchy or of low intensity.

The most important vegetation in which to manage fire is, therefore, that which is dominated by obligate seeders with long post-fire times to flowering, such as Eucalyptus woodlands. These have high value if long unburnt, due to their relative scarcity and because they are the most iconic of the GWW's vegetation. If these associations are burnt, they will be highly vulnerable to fire for at least 50 years (Shedley, 2007), as the key structural species are very slow to reach maturity. A fire within this period may result in permanent loss of species diversity. For both unburnt and recently burnt examples, therefore, the importance of fire management is high and the exclusion of all but the mildest of fires is desirable. The sustainable interval for the occurrence of intense fires in such vegetation is well beyond the limits of human planning cycles.

Vegetation associations dominated by obligate seeders that have shorter post-fire times to flowering are generally of less importance as they are more common and more resilient to fire. They may still be vulnerable to fire, however, for up to 50 years after being burnt. The occurrence of multiple fires within this period may render them highly vulnerable to deleterious impacts and will necessitate a significant period of fire exclusion to facilitate their recovery.

Vegetation associations that are dominated by resprouting species will be far less vulnerable to fire than that dominated by obligate seeders. From the point of view of fire management, this makes them less important assets to protect. If such areas are affected by multiple fires in quick succession, however, they may become more vulnerable and a period of fire exclusion may be required.

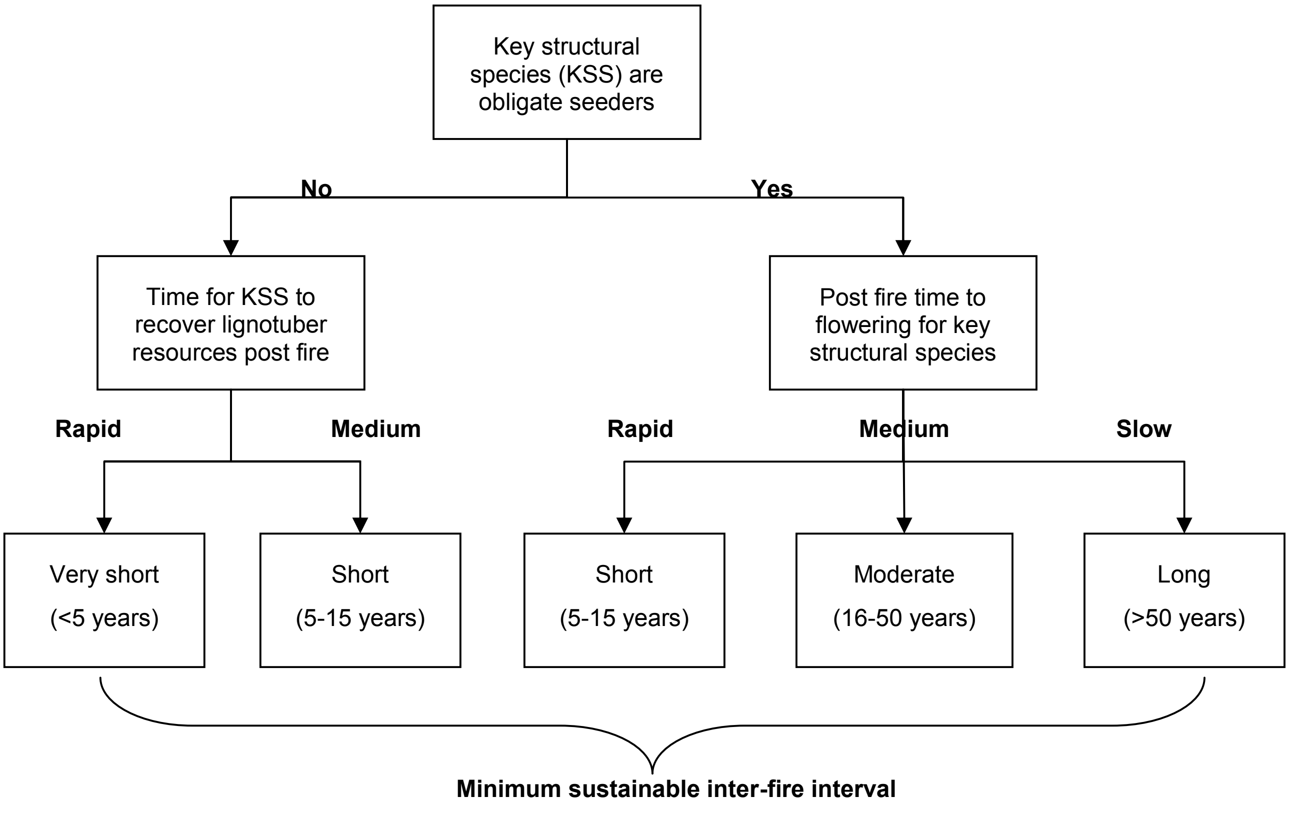

Figure 23: Flow chart showing how the minimum sustainable inter-fire interval was determined for vegetation associations in the Great Western Woodlands Bushfire Threat Analysis study area.

Table 13: Allocation of asset categories to vegetation associations according to the time since last fire and minimum sustainable inter-fire interval.

Minimum Sustainable Fire Interval	Asset Category of Vegetation Association	
	Unburnt for at least the minimum period	Burnt within the minimum period
Non Flammable	F	F
Very short (<5 years)	F	E
Short (5-15 years)	E	D
Moderate (16-50 years)	D	C
Long (>50 years)	C	B

The categorisation of vegetation associations as assets was based on each association's minimum sustainable inter-fire interval and the occurrence of fires within that period. This process may be summarised as follows (see also Table 13):

- Vegetation associations with no flammable components such as succulent steppe, salt lakes and bare areas are category F assets.
- Vegetation associations with very short minimum interfire interval, such as hummock grasslands, are category F assets or category E assets if they have been burnt within the last 5 years.
- Vegetation associations with a short minimum interfire interval, such as *Eucalyptus socialis* mallee, are category E assets or category D assets if they have been burnt within the last 15 years.

- Vegetation associations with a moderate minimum interfire interval, such as *Acacia aneura* woodland, are category D assets or category C assets if they have been burnt within the last 50 years.
- Vegetation associations with a long minimum interfire interval, such as *Eucalyptus salmonophloia* woodland, are category C assets or category B assets if they have been burnt within the last 50 years.

Special Ecosystems

Rock outcrops are usually not fire prone, and so may provide a habitat niche for biota that are not well adapted to fire. They are also typically centres of endemism and rarity because the rock surface harvests water, allowing the persistence of temperate adapted biota in an arid environment. Due to the high likelihood of the occurrence of rare and endemic taxa with specific fire regime requirements, fire should be excluded from rock outcrops and their fringing vegetation. Rock outcrops are category D assets, elevated to category C if they are known to have experienced a fire in the last 40 years and category B if they have experienced multiple fires in that time.

Declared Rare and Priority Flora

There are 1128 populations of 286 Declared Rare Flora (DRF) and Priority Flora (P) taxa that occur within the GWW BTA study area (Table 14 and Appendix 3). Populations of these taxa were categorised as assets according to their distribution and adaptation to fire. Distribution data were obtained from Florabase and fire response from references including Barrett *et al.* (2009) and Shedley (2007). Where there is uncertainty regarding a taxon's resilience to fire, a conservative approach has been adopted whereby fire exclusion is assumed to be the preferred management strategy.

The most highly valued flora populations are those that are the only known occurrence of a taxon that is likely to be killed by fire. It is possible that a fire affecting one such a population could cause the extinction of the species. There are four such populations in the GWW BTA study area; these are category A assets. Other DRF are unlikely to become extinct in a single fire event as they are known from multiple populations distributed over a significant geographic range. The other 37 DRF taxa in the study area are, therefore, category B assets.

There are also a number of Priority 1 taxa that are known from only a single population, or a number of tightly clustered populations. This highly restricted distribution means that some of these taxa could become locally extinct if adversely affected by a fire. These taxa are category B assets, while more widely distributed Priority 1 taxa are category C assets. Similarly, Priority 2 taxa thought to be at risk from fire are category C assets, while other Priority 2 flora and all Priority 3 and Priority 4 flora are in category E.

Table 14: Summary of declared rare and priority flora occurrence in the Great Western Woodlands Bushfire Threat Analysis study area. Species data were extracted from the Rare Flora Database on the 9th of July, 2010.

Conservation Class	# of taxa	# of populations
Declared Rare Flora	41	231
Priority 1	85	238
Priority 2	67	220
Priority 3	71	311
Priority 4	22	128
Total	**286**	**1128**

Fauna and Fauna habitat

There have been relatively few coordinated fauna surveys in the GWW BTA study area and most fauna records are from opportunistic observations or species-specific studies. In total, there are 464 records of protected fauna in the study area. Of these, 36 are critically endangered taxa, 137 are endangered taxa and 112 are vulnerable taxa under International Union for Conservation of Nature (IUCN) criteria. Further to these, there are 11 records of Priority 1 taxa, 1 of a Priority 2 taxon, 5 of Priority 3 taxa, 117 of Priority 4 taxa and 42 of specially protected taxa in the area.

Many of the fauna records are old, of limited reliability or relate to mobile taxa that may not permanently occupy the area they were observed in. This means that protect these locations might not actually protect any fauna populations. The protection of significant fauna can only be effectively achieved by landscape scale habitat conservation. In the context of fire management, this means maintaining an appropriate mosaic of fire regimes across the study area.

Despite this, locations where protected fauna have been recorded were assigned to asset categories B to E, according to the taxon's conservation category and the importance of the study area population to the total species population (Table 15). Ideally, these locations would be supplemented by the protection of other potential habitat. Unfortunately, the habitat requirements of some of the taxa are not well understood. Where habitat requirements are known, the capacity to identify suitable areas is hampered by the scale of the available environmental mapping. As such, fauna habitat can only be protected by applying sensitive fire management at a landscape scale.

Aboriginal Heritage Sites

The Great Western Woodlands has a long history of occupation by Aboriginal people and encompasses many locations that are of cultural significance. There are currently 758 registered Aboriginal Heritage sites within the GWW BTA study area, although this is not a comprehensive catalogue of the area's significant sites. Also, under the Aboriginal Heritage Act (1972), sites of historical significance are protected even if they are not listed on the heritage register. The registered Aboriginal heritage sites in the GWW BTA study area comprise:

- 394 Artefact scatters
- 72 Ceremonial sites
- 67 Mythological sites
- 44 quarries
- 38 man made structures (primarily excavated water sources)
- 32 burial sites
- 16 historical sites
- 15 paintings
- 5 modified trees
- 4 engravings
- 3 grinding patches
- 3 caches
- 67 assorted unclassified sites, mainly water sources

These are category B assets if they are likely to be destroyed or irretrievably damaged by the passage of a bushfire, category C if they are likely to be temporarily degraded or damaged by fire or category F if they are not thought to be sensitive to fire. Assessment of the sensitivity of these sites should be considered preliminary at this stage. Consultation with traditional owners about the nature of these sites has only occurred within the Central West claimant group's Native Title claim area. That claim incorporates most of the western half of the GWW BTA study area. Representatives of the Central West claimant group have advised that neither bushfire nor prescribed burning is likely to damage any of the heritage sites within their claim area. Earthworks may cause damage to sites, however, and permission should be sought from Traditional Owners before undertaking fire control works near sites. In the remainder of the study area, a judgement regarding sensitivity has been made by the author based on the description and location of the site. Modified trees are likely to be seriously damaged by fire and are category B assets. Art sites are category C assets and the remainder of sites are likely to be resilient to fire and are category F assets.

Table 15: A guide to the classification of assets in the Great Western Woodlands Bushfire Threat Analysis, adapted from Muller (1993, 2001, 2008). Asset locations are shown in Figure 26 to Figure 30.

Natural Environment	Built Environment
Asset Category A: Asset score = 32 Bushfire likely to cause:	
Species extinction.	Significant risk of one or more fatalities or serious injuries
Only known occurrence of fire vulnerable Declared Rare Flora. Fire likely to result in extinction.	*Great Eastern Highway, Eyre Highway, Coolgardie to Esperance Highway, Goldfields Highway*
Asset Category B: Asset score = 16 Bushfire likely to cause:	
Local extinction or Major reduction in total population.	Some risk of fatalities or serious injuries Damage >$5 million or Interruption to essential regional services
Occurrence of Declared Rare Flora not thought to be fire sensitive or with multiple known populations. Population of critically endangered fauna species. Severely under-represented fire seral stages of communities with vulnerable species severely under-represented structural types: *vegetation associations with long minimum sustainable interfire intervals that have been burnt in the last 50 years.* *Rock outcrops that have been burnt more than once in the last 30 years.*	Vulnerable essential utilities (regional power, water, gas supply): *High voltage power transmission lines.* Railway infrastructure: *Perth to Kalgoorlie rail line.* *Essential water pumping stations and associated infrastructure: Ghooli tank and pumping station; the Koorarawalyee tanks; Dedari pumping station, reservoir and radio repeater; Bullabulling pumping station and reservoir; Spargoville tanks no. 1 and 2 and the Coolgardie pumping station.* *Power distribution lines to water pumping stations.* Built up areas and subdivisions with poor access, reticulated water and regular fuel modification: *townsites in study area, Mines with permanent population onsite.* *Individual buildings.* Popular bush camp sites with limited egress and refuge. Aboriginal heritage sites that are likely to be irretrievably damaged or destroyed by fire: *water trees.*

Natural Environment	Built Environment
Asset Category C: Asset score = 8 Bushfire likely to cause:	
Local extinction of poorly known species or Major reduction in local extent	Slight risk of one or more fatalities or serious injuries Permanent loss of heritage values or Damage $1 – $5 million
Population of endangered fauna species. Fire sensitive Priority 2 flora species. Areas significant to maintenance of overall structural diversity, species richness and under-represented structural types: *Vegetation associations with long minimum sustainable interfire intervals that have not been burnt in the last 50 years.* *Vegetation associations with moderate minimum sustainable interfire intervals that have been burnt in the last 50 years.* *Fire vulnerable Aboriginal Heritage sites.* *Rock outcrops that have been burnt once in the last 30 years.*	Secondary Roads and popular tourist routes *Holland Track, Granite and Woodlands Discover Trail* Built up areas with good access, reticulated water and regular fuel modification: *mines with significant infrastructure but no permanent population.* Public utilities: *High voltage power carrier lines, water distribution infrastructure other than that in asset category B.* *Communications repeaters, towers and masts.* Registered heritage and Aboriginal heritage sites that may be damaged or degraded by fire. Bush camp sites with good egress or refuge areas. Popular day use sites.
Asset Category D: Asset score = 4 Bushfire likely to cause:	
Loss of priority species populations or Loss of habitat and species diversity	Damage $100 000 to $1 million
Priority 2 flora species not known to be fire sensitive. Fire vulnerable Priority 3 flora species. Areas of regionally significant species richness, structural diversity and regionally under-represented seral stages or structural types: *Vegetation associations with moderate minimum sustainable interfire intervals that have not been burnt in the last 50 years.* *Vegetation associations with short minimum sustainable interfire intervals that have been burnt in the last 15 years.* *Rock outcrops.*	*Kalgoorlie to Esperance and Kalgoorlie to Menzies railway lines.* State barrier and privately managed fences. Low use developed recreation sites and associated infrastructure.

Natural Environment	Built Environment
Asset Category E: Asset score = 2 Bushfire likely to cause:	
Loss of locally significant species and communities	Damage $10 000 to $100 000
Priority 3 and 4 flora species and communities, fire sensitivity unknown. Locally significant fauna species. *Vegetation associations with short minimum sustainable interfire intervals that have not been burnt in the last 15 years.* *Vegetation associations with very short minimum sustainable interfire intervals that have been burnt in the last 5 years.*	Water pipelines. Developed farmland / pasture. Pastoral leases Individual apiary sites.
Asset Category F: Asset score = 1 Bushfire likely to cause:	
Other aspects of the natural environment	Damage < $10 000
Other native vegetation: *Vegetation associations with very short minimum sustainable interfire intervals that have not been burnt in the last 5 years.* *Non flammable vegetation* *Natural heritage sites not thought to be sensitive to fire.*	Mines without permanent on-site staff or significant infrastructure, minor roads and tracks. Heritage sites not thought to be sensitive to fire. Non developed recreation sites.

3.2.3. Summary of Fire Consequences

The assets described above were allocated an ‘asset score’ according to the categorisation shown inTable 15. All assets were combined using a GIS, with point and linear features buffered to a distance of 500 metres. The total asset score at each point was then determined by summing the value of all assets that occur there. The summed scores indicate the consequences of a fire affecting that location. The consequence categories are shown in Table 16. A total asset score of ≥ 32 meant the consequences of that location being burnt were catastrophic. Note that an asset score of 32 is allocated to a location where there is a significant risk of human casualties in a fire. The ‘catastrophic’ consequence class, therefore, includes all such locations, as well as locations where there is a confluence of several lower priority assets. This categorisation system is structured such that clusters of assets will be elevated in importance, but no location can be prioritised at the expense of locations where there is a significant risk to human life in the event of a fire. The results of the summed asset categorisation are shown in Figure 24 and Table 16.

Table 16: Summary of fire consequence classification in the Great Western Woodlands Bushfire Threat Analysis study area. The proportion of the study area within each category is also shown.

Total Asset Score	Consequence	Area in asset class (ha)	% of study area
1	Insignificant	1 504 946	6.78
2-3	Minor	3 758 456	16.93
4-7	Moderate	6 010 867	27.08
8-15	Serious	18 418 865	37.93
16-31	Major	2 304 031	10.38
≥32	Catastrophic	196 829	0.89

Only around one quarter of the study area falls into the lowest asset categories, where the consequences of a fire are predicted to be insignificant or minor. This is indicative of the tremendous value of the area’s natural environment, which elevates asset scores even in the absence of infrastructure. The highest asset scores, however, are located on the study area’s major transport routes. In particular, many high value assets co-occur at points on Great Eastern Highway, including Southern Cross, Ghooli, Yellowdine, Koorawalyee, Bullabulling, Coolgardie and Kalgoorlie-Boulder. At each of these locations there is a highway that carries large quantities of traffic, buildings, important power and water infrastructure components and significant natural values. Elsewhere, Kambalda and Norseman stand out as high consequence locations for similar reasons. The highest total asset score that is not on one of the region’s highways is at Peak Charles. Here, catastrophic consequences would result from a fire affecting a popular recreation site with limited egress, rare flora and a secondary road. A number of minesites also fall into the catastrophic consequence category, including Koolyanobbing, Marvel Loch, Black Flag and Bulong.

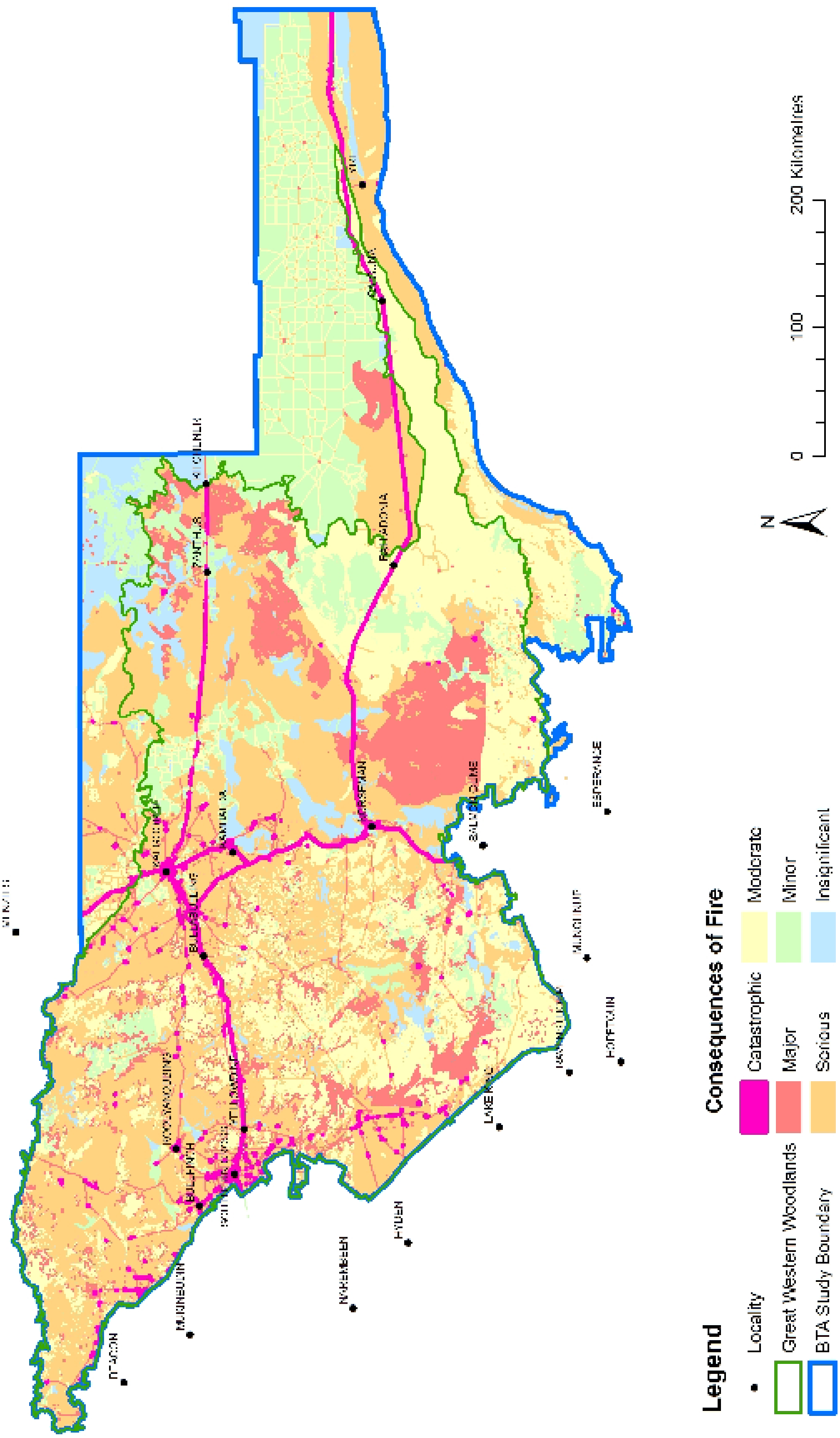

Figure 24: Categorisation of fire consequences in the Great Western Woodlands Bushfire Threat Analysis study area.

3.3. Conclusions of Threat Analysis

The usual approach to Bushfire Threat Analysis culminates in the four 'layers' being combined into a single index of bushfire threat. Areas where the threat score is high will feature valuable assets in locations where a fire is likely to occur and to burn with high intensity. The capacity to mount a rapid and effective suppression response at such locations may also be limited. These high threat areas should be targeted for pre-suppression activities designed to reduce the likelihood of a fire occurring or mitigate its impacts.

The disadvantage of relying on a total threat index is that it masks the constituent factors that contribute to the level of threat. As such, it can present a simplistic view of the issue and confound the identification of efficient risk treatment options. Furthermore, threat rankings will be strongly influenced by the weightings ascribed to the four component layers. These layers are usually weighted when combined, as they are not of equal importance to the threat from fire at a location. The assets at risk and headfire behaviour layers are very important, as they will determine the consequences of a fire. The suppression response layer, meanwhile, is highly speculative; it assumes that the prevailing conditions and available resources allow a fire to be combated. Suppression response is, therefore, usually weighted less heavily than the other layers. The likelihood of an ignition occurring is of some importance but, particularly where suppression capacity is limited, fires may spread to affect assets that are far removed from the origin point of the fire. The risk of ignition layer, therefore, also tends to be weighted less heavily than the asset and fire behaviour layers. Relatively small adjustments to the weighting of layers may significantly alter the final threat analysis and priorities for fire management.

For the reasons described above, a total threat index has not been included in the current project. Instead, the reader is advised to consider the maps that show the probability and consequences of fire. Contrasting these will allow the factors that elevate fire threat to be identified and priorities for pre-suppression activities determined. To facilitate this comparison, a summary of fire behaviour and consequence is presented in Figure 25, Figure 26, Figure 27, Figure 28, Figure 29 and Figure 30. The following text also describes some key locations where the probability and consequences of bushfire are simultaneously high.

The objectives for fire management in the study area are to prevent bushfires from threatening the well-being of people, damaging important infrastructure or permanently perturbing ecological function or biodiversity. To achieve these objectives, the size of bushfires must be minimised and fires must be prevented from affecting any of the area's major transport routes, townsites, service stations, populated minesites, infrastructure required for the supply of essential regional services or nodes of important fire-sensitive biodiversity. An occurrence of any of these assets within flammable fuels is a location where pre-suppression works are required.

The study area's major transport routes pass through several areas of highly flammable fuels. At these points, they are vulnerable to fire. They are also likely to provide a source of ignitions in these areas, further elevating the fire threat. The following are locations of particular concern:

- Great Eastern Highway for 3 kilometres west and 12 kilometres east from Ghooli, 8 kilometres west from Koorawalyee, 17 kilometres west from Boorabbin and 3 kilometres east from Benari. Infrastructure required for the delivery of electricity and water also follows the route of Great Eastern Highway and is vulnerable to fire at the same points that the highway is.
- Goldfields Highway and Kalgoorlie to Leonora railway for 2 kilometres south from Canegrass.
- Coolgardie-Esperance Highway for 4 kilometres north and 11 kilometres south from McPherson Rock.
- Eyre Highway for 11 west and 9 kilometres east from Fraser Range and 108 kilometres east from Moonera Tank Cave.
- Perth to Kalgoorlie railway for 20 kilometres east from Jaurdi siding.
- The Transcontiental railway for 20 kilometres west from Zanthus and for 4 kilometres approximately 9 kilometres west of Kitchener.

Other locations where the likelihood of intense fire behaviour and the consequences of a bushfire are simultaneously high include:

- Locations within and immediately adjoining Karroun Hill Nature Reserve including portions of Mouroubra, Adams and Emu Proof Fence roads; Three Sister's Soak, Billiburning Rock and Yarbu. High value assets in these locations include farm buildings, vegetation in a fire vulnerable seral stage, occurrences of rare and priority flora, roads and power lines. The area around Karroun Hill Nature Reserve also features large areas of young fuels that will regenerate to a highly flammable condition over the next several years. As this occurs, more high consequence locations will be placed at risk from fire.
- Locations within and surrounding Walyahmining Nature Reserve including Yanneymooning Hill and points between there and Hunter Road. There some buildings in this area within areas of flammable fuel and also some vegetation in a fire vulnerable seral stage and occurrences of rare and priority flora. Other assets at these locations include secondary roads and locally significant power infrastructure.
- Locations near Bullfinch and Southern Cross where farm and minesite buildings, vegetation in a fire vulnerable seral stage, priority flora, power transmission lines and minor roads are located within highly flammable vegetation.
- The area where the regional power transmission line crosses the Forrestania-Southern Cross Road to the north west of Mount Holland. This area features several occurrences of fire vulnerable rare and priority flora, vegetation in a fire vulnerable seral stage, a secondary road and power lines that supply local mining centres.
- The Holland Track where it passes through flammable fuels such as at Wattle Rocks. Track users may in danger if a fire occurs in these areas. There are also important natural assets along this track, such as occurrences of rare and priority flora and granite rock outcrops.
- Between Digger Rocks and South Ironcaps where vegetation in a fire vulnerable seral stage and priority flora co-occur with a secondary road and a number of minesites.
- Locations on the Hyden-Norseman road, particularly the recreation site at the Breakaways.
- Locations on the Lake King-Norseman Road including the area near its intersection with Cascades Road and near Ninety Mile tank. The assets in the area include the road, fibre optic cable uplinks, rare and priority flora, fire vulnerable vegetation, apiary sites and communication towers. This road also passes through extensive areas of recently burnt fuels that will need to be monitored as they regenerate.
- Peak Charles where natural assets include fire vulnerable rare flora, vegetation in a fire vulnerable seral stage and granite outcrops. There is also a popular recreation site here which draws visitors to this fire prone setting.
- Cundeelee Community which is largely surrounded by spinifex grasslands, including extensive areas that are currently long unburnt.
- Symons Hill where a station homestead lies alongside an Aboriginal heritage site, vegetation in a fire vulnerable seral stage and several minor infrastructure occurrences.
- Mt Heywood which is a granite outcrop that features the only known occurrence of a rare flora species that is vulnerable to fire.
- Eyre and two locations to its south where buildings, communications infrastructure, vegetation in a fire vulnerable seral stage and priority flora and fauna all occur.

Note that, at any of the above locations, localised fuel treatment may have been undertaken in order to provide site specific protection from fire. Such small scale works are difficult to incorporate into a BTA, which aims to provide strategic level direction. The advice of local fire managers should be sought before instituting actions to ameliorate fire threat at any of the locations described above or elsewhere in this report.

In addition to locating areas where the threat from fire is currently high, it is also important to identify locations where large areas of flammable fuels are regenerating from previous fires. These should be broken into management units as they become available to burn, in order to reduce the likelihood of landscape scale fires in the future. Notable instances of large cells of regenerating fuels include:

- The south west corner of the study area, approximately between the southern boundary of Frank Hann National Park and the northern boundary of Cheadanup Nature Reserve.
- Areas to the north and south of the Perth-Kalgoorlie railway immediately east of Jaurdi Siding.
- Much of the area between Boorabbin, Benari and the Holland Track.
- Most of Jilbadji Nature Reserve.
- West of 90 Mile Tank on the Lake King Norseman Road.
- An area extending northwards of Great Eastern Highway immediately west of Yellowdine.
- North east of Zanthus on the Transcontinental railway line
- Southeast of Karroun Hill Nature Reserve
- Southeast of Salmon Gums Nature Reserve
- Much of the coastal strip through Cape Arid Nature Reserve and Nuytsland Nature Reserve.

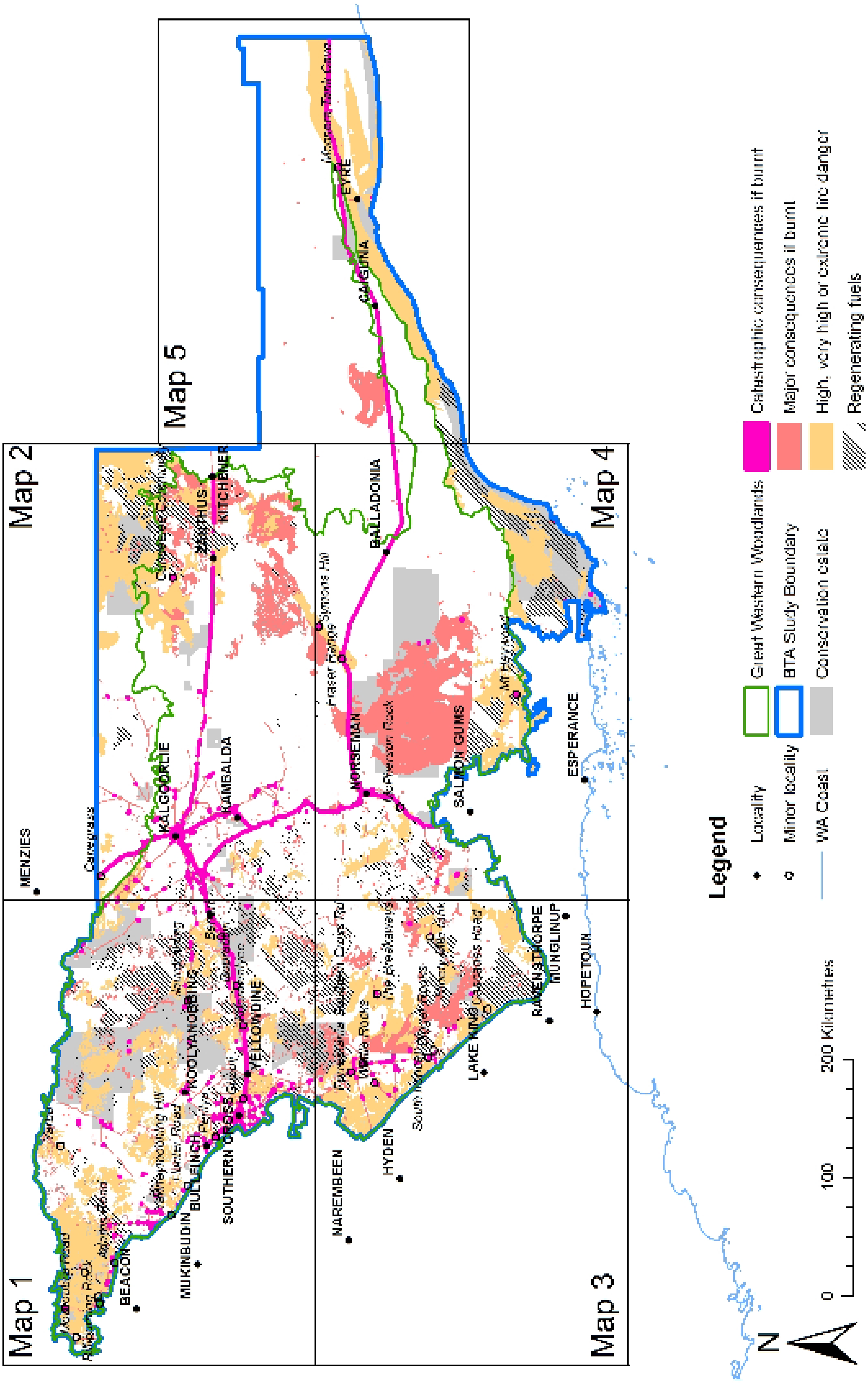

Figure 25: A summary of the threat analysis in the Great Western Woodlands Bushfire Threat Analysis study area. Highlighted are large areas of highly flammable fuel (> 5000 ha of contiguous fuel in high to extreme fire danger classes), high value assets (major and catastrophic consequence classes) and areas of depleted fuel that will become available to burn over the next several years. The grid overlay relates to the more detailed maps that follow.

The following legend describes the symbology used on Figure 26, Figure 27, Figure 28, Figure 29 and Figure 30. Those maps show the assets of the study area, as well as providing the information presented on Figure 25 at a smaller scale.

Legend

- Locality
- Minor locality
- Declared Rare Flora
- Priority 1 Flora
- Communications infrastructure
- Apiary site
- Recreation site
- Mine site
- European heritage site
- Principal road
- Secondary road
- Minor road
- Track
- Rail line
- Water supply infrastructure
- Power line
- BTA Study Boundary
- Great Western Woodlands
- Aboriginal heritage site
- Conservation estate
- Catastrophic consequences if burnt
- Major consequences if burnt
- High, very high or extreme fire danger
- Regenerating fuels

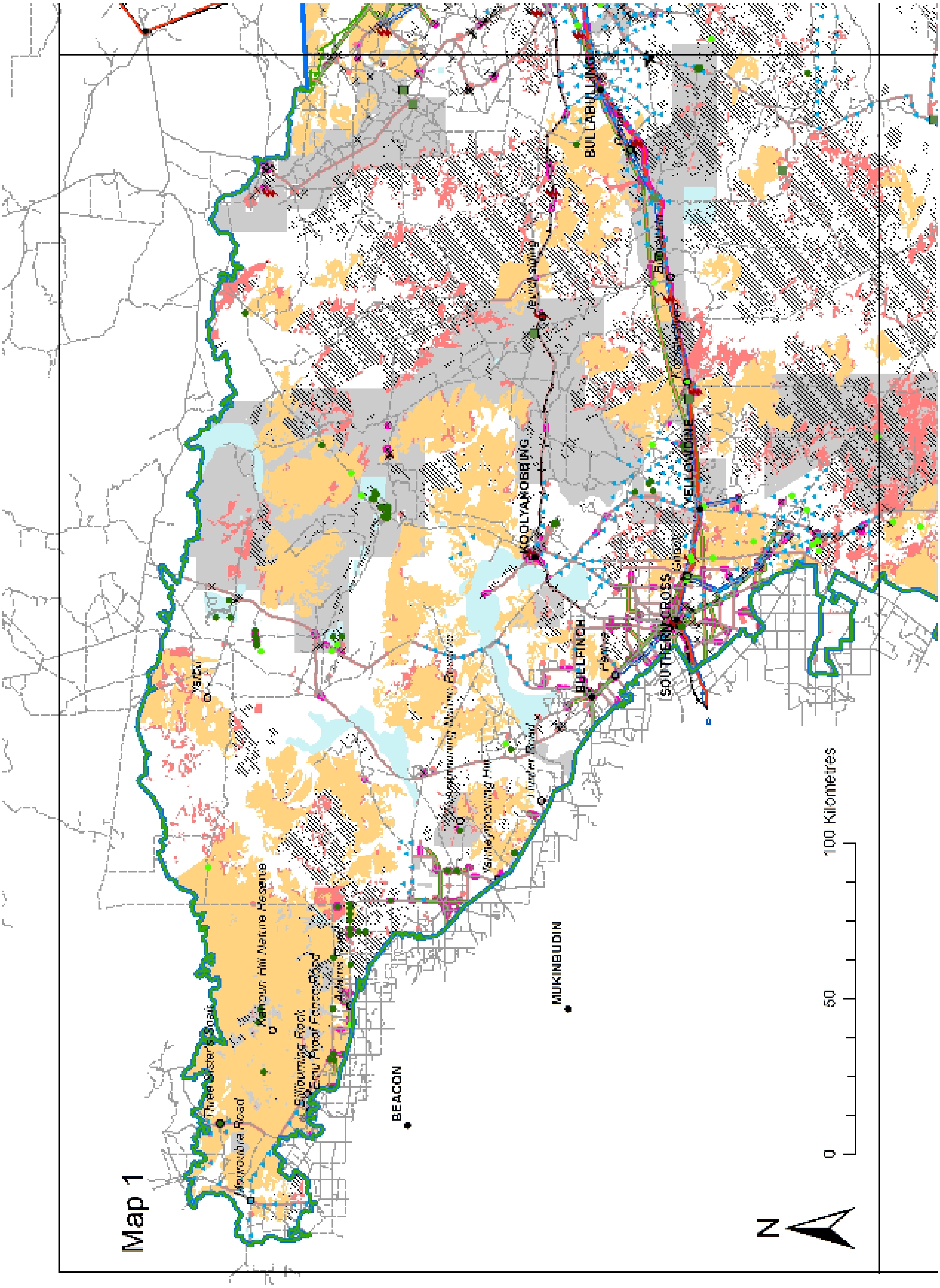

Figure 26: Analysis of bushfire threat in the Great Western Woodlands; Detailed Map 1.

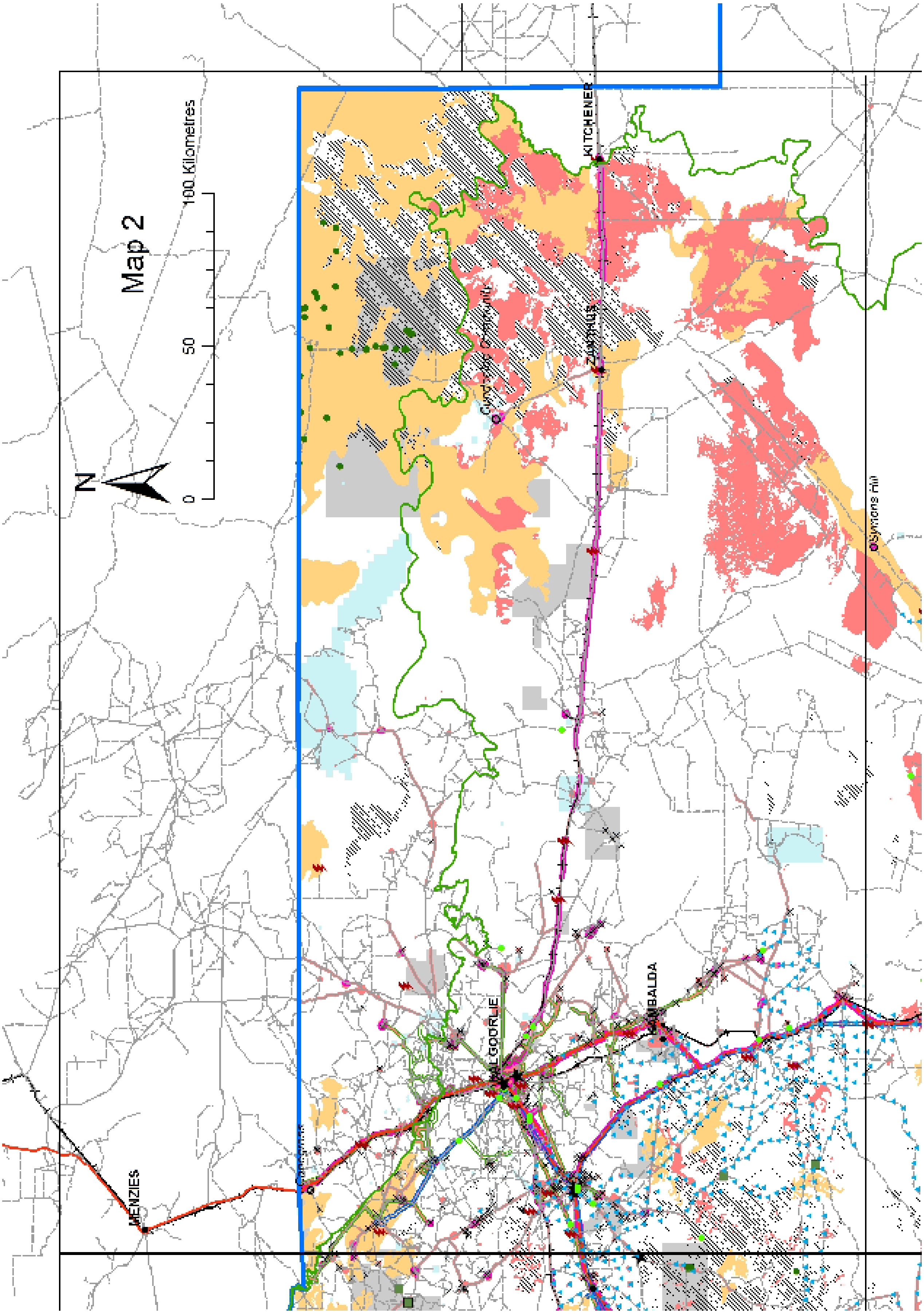

Figure 27: Analysis of bushfire threat in the Great Western Woodlands; Map 2.

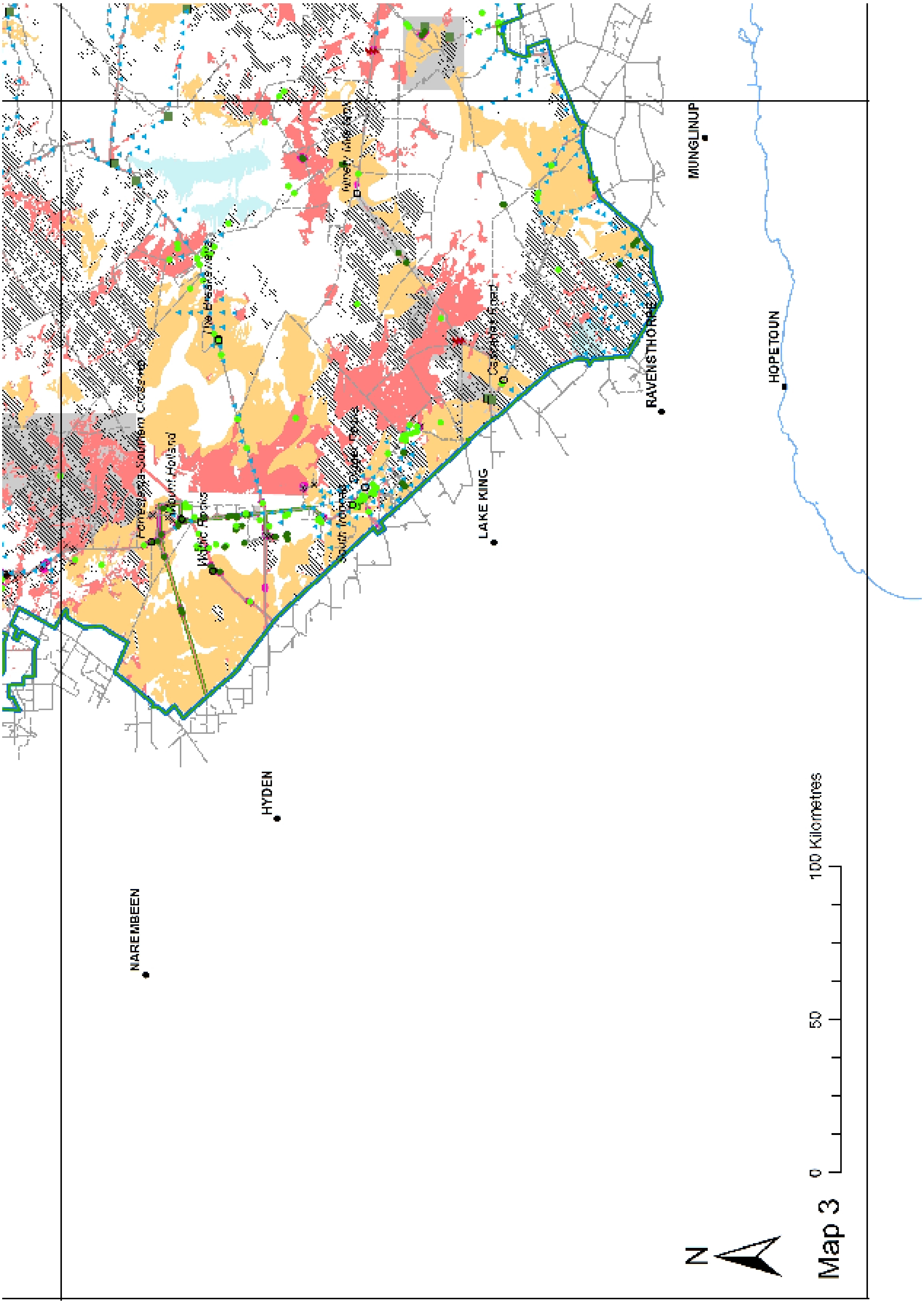

Figure 28: Analysis of bushfire threat in the Great Western Woodlands; Map 3.

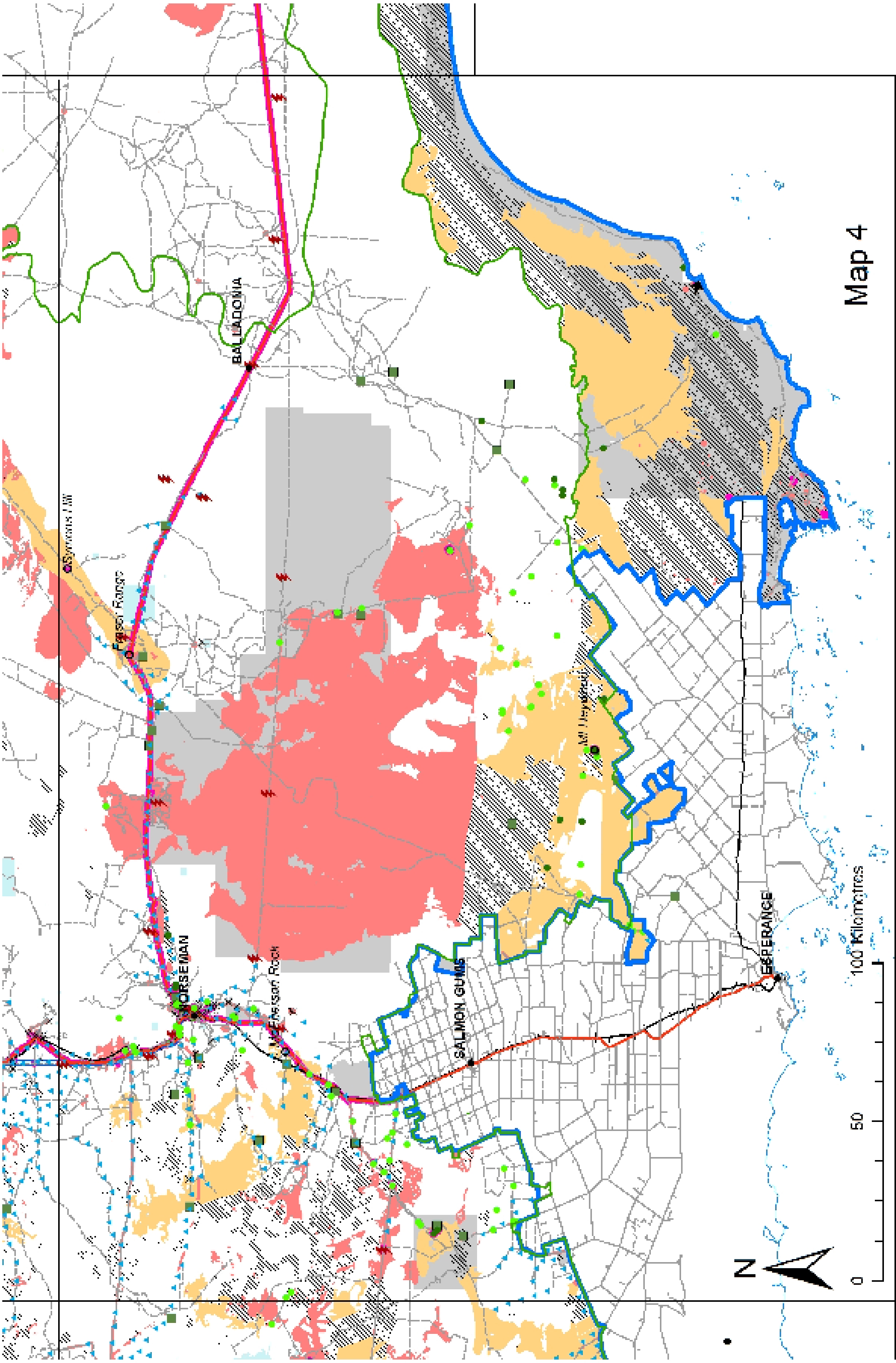

Figure 29: Analysis of bushfire threat in the Great Western Woodlands; Map 4.

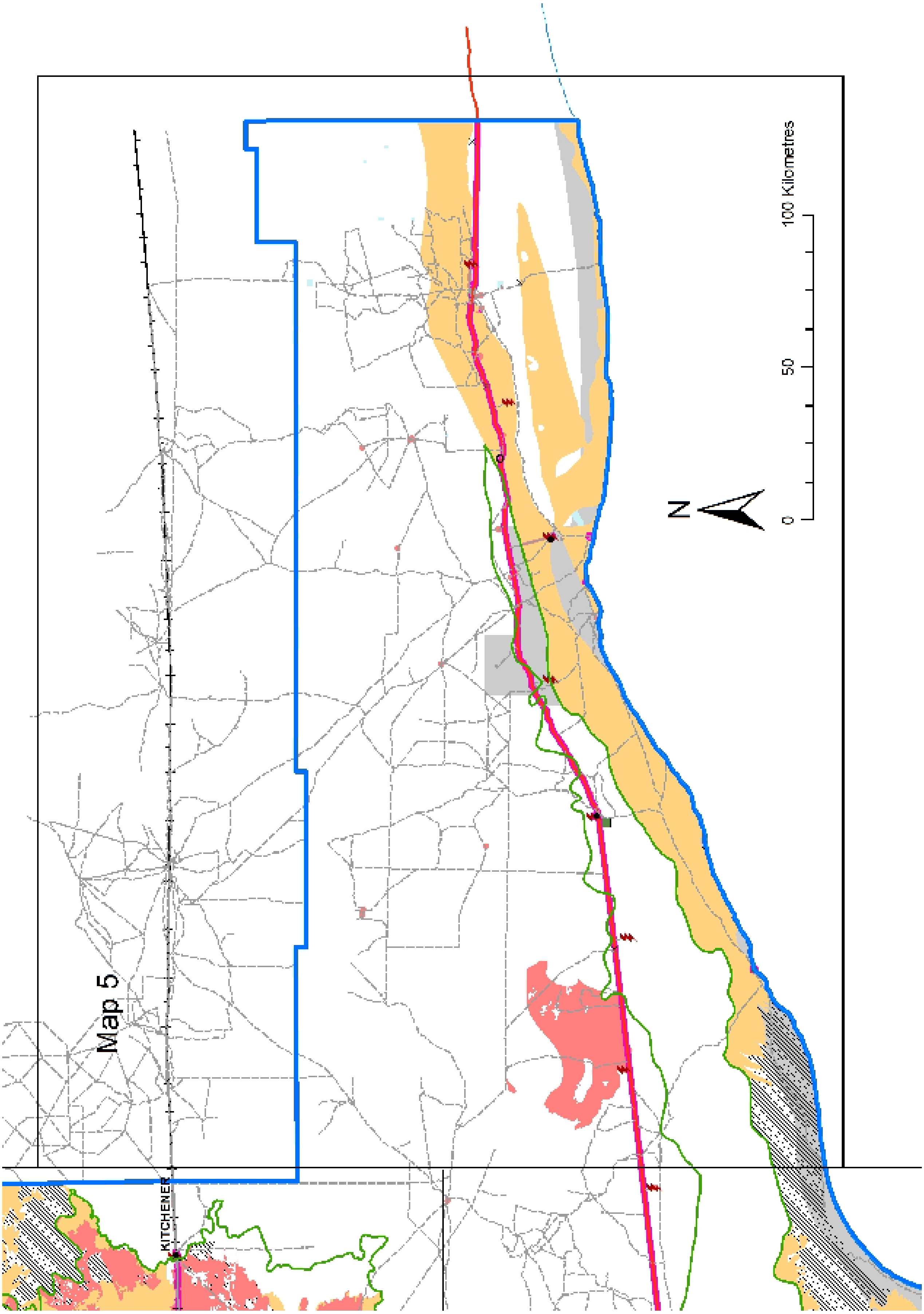

Figure 30: Analysis of bushfire threat in the Great Western Woodlands; Map 5.

Appendix 1: Beard's Vegetation Associations of the Great Western Woodlands Bushfire Threat Analysis Study Area

Beards Vegetation Association Description	Area (ha)	% of Study Area
Bare areas; claypans	890	0.0
Bare areas; drift sand	10892	0.0
Bare areas; rock outcrops	211971	1.0
Bare areas; salt lakes	671701	3.0
Total Bare Areas	**895455**	**4.0**
Hummock grasslands, mallee steppe; red mallee over spinifex, *Triodia scariosa*	56354	0.3
Hummock grasslands, mixed sandplain - red mallee & mixed sparse dwarf shrubs over *Triodia basedowii*	164	0.0
Hummock grasslands, marble gum & mallee (*Eucalyptus youngiana*) over hard spinifex on sandplain	272272	1.2
Hummock grasslands, marble gum & mallee (*Eucalyptus youngiana*) over hard spinifex Triodia basedowii between sandhills	169245	0.8
Hummock grasslands, shrub steppe; *Eucalyptus youngiana* over hard spinifex	454339	2.1
Hummock grasslands, shrub steppe; red mallee over spinifex, *Triodia scariosa*	34516	0.2
Total Hummock Grassland	**986890**	**4.5**
Low forest; moort (*Eucalytpus platypus*)	4414	0.0
Low woodland over scrub; *Allocasuarina cristata* over bowgada scrub	1019	0.0
Low woodland; *Allocasuarina cristata*	22469	0.1
Low woodland; *Allocasuarina cristata* & eucalypts	7841	0.0
Low woodland; *Allocasuarina huegeliana* & York gum	4694	0.0
Low woodland; mulga & *Allocasuarina cristata*	25	0.0
Low woodland; mulga & red mallee	40157	0.2
Low woodland; mulga (*Acacia aneura*)	44253	0.2
Low woodland; mulga between sandridges	10322	0.0
Low woodland; mulga mixed with *Allocasuarina cristata* & Eucalyptus sp.	728875	3.3
Low woodland; mulga mixed with cypress pine & york gum	51	0.0
Low woodland; York gum, and cypress pine.	3981	0.0
Total Low Woodland	**868102**	**3.9**
Medium woodland over scrub; York gum over bowgada & jam (*Acacia acuminata*)	2	0.0
Medium woodland; *Allocasuarina cristata* & goldfields blackbutt	916	0.0
Medium woodland; coral gum	6295	0.0
Medium woodland; coral gum (*Eucalyptus torquata*) & goldfields blackbutt (*E. le soufii*).	240408	1.1
Medium woodland; Dundas blackbutt & red mallee	347325	1.6
Medium woodland; gimlet	321	0.0
Medium woodland; goldfields blackbutt	43913	0.2
Medium woodland; goldfields blackbutt & red mallee	32778	0.1
Medium woodland; merrit & red mallee	1609071	7.3
Medium woodland; morrel & Dundas blackbutt (*E. dundasii*)	67198	0.3
Medium woodland; morrel (*Eucalyptus longicornis*)	703	0.0
Medium woodland; morrell & rough fruited mallee (*Eucalyptus corrugata*)	2011	0.0
Medium woodland; red mallee group	140217	0.6
Medium woodland; redwood & goldfields blackbutt	7059	0.0
Medium woodland; redwood & red mallee (*Eucalyptus oleosa*)	498233	2.2
Medium woodland; redwood (*Eucalyptus transcontinentalis*) & merrit (*E. flocktoniae*)	709798	3.2
Medium woodland; rough fruited mallee on greenstone hills	24415	0.1
Medium woodland; salmon gum	633956	2.9
Medium woodland; salmon gum & Dundas blackbutt	52630	0.2
Medium woodland; salmon gum & gimlet	296082	1.3
Medium woodland; salmon gum & goldfields blackbutt	585409	2.6
Medium woodland; salmon gum & morrel	488827	2.2
Medium woodland; salmon gum & red mallee	113278	0.5

Beards Vegetation Association Description	Area (ha)	% of Study Area
Medium woodland; salmon gum mixed with merrit & desert bloodwood (Eucalyptus sp.)	2577	0.0
Medium woodland; salmon gum mixed with merrit & red mallee	19503	0.1
Medium woodland; Salmon gum, goldfield balckbutt, gimlet & *Allocasuarina cristata*	27630	0.1
Medium woodland; salmon gum, morrel, gimlet & *Eucalyptus sheathiana*	227415	1.0
Medium woodland; salmon gum, morrel, gimlet & rough fruited mallee	9401	0.0
Medium woodland; salmon gum, redwood, merrit, gimlet & *Eucalyptus sheathiana*	758	0.0
Medium woodland; wandoo	788	0.0
Medium woodland; wandoo, salmon gum, morrel, gimlet & rough fruited mallee	3997	0.0
Medium woodland; yate	690	0.0
Medium woodland; York gum	513	0.0
Medium woodland; York gum & salmon gum	136885	0.6
Medium woodland; York gum, salmon gum & gimlet	884859	4.0
Medium-Low woodland; York gum & cypress pine (*Callitris columellaris*)	172132	0.8
Total Medium Woodland	**7387993**	**33.3**
Mosaic: Medium woodland; Allocasuarina cristata & goldfields blackbutt Shrublands; *Acacia quadrimarginea* thicket	36014	0.2
Mosaic: Medium woodland; gimlet / Shrublands; mallee scrub, *Eucalyptus eremophila*	37964	0.2
Mosaic: Medium woodland; goldfield eucalypts / Succulent steppe with open low woodland; myoporum over saltbush	505318	2.3
Mosaic: Medium woodland; goldfields blackbutt & Dundas blackbutt / Shrublands; Dodonaea scrub	78542	0.4
Mosaic: Medium woodland; merrit & coral gum / Shrublands; mallee scrub *Eucalyptus eremophila*	658143	3.0
Mosaic: Medium woodland; merrit & red mallee / Shrublands; Dodonaea scrub	98863	0.4
Mosaic: Medium woodland; salmon gum & Dundas blackbutt / Shrublands; mallee scrub *Eucalyptus eremophila*	15874	0.1
Mosaic: Medium woodland; salmon gum & gimlet / Hummock grasslands, mallee steppe; red mallee over spinifex, Triodia scariosa	282215	1.3
Mosaic: Medium woodland; salmon gum & gimlet / Medium woodland; merrit & red mallee	236214	1.1
Mosaic: Medium woodland; salmon gum & morrel / Shrublands; mallee scrub, redwood	10839	0.0
Mosaic: Medium woodland; salmon gum & red mallee / Hummock grasslands, mallee steppe; red mallee over spinifex *Triodia scariosa*	809083	3.7
Mosaic: Medium woodland; salmon gum & red mallee / Shrublands; mallee scrub *Eucalyptus eremophila*	235715	1.1
Mosaic: Medium woodland; salmon gum / Shrublands; mallee scrub, redwood & black marlock	8575	0.0
Total Mosaic	**3013359**	**13.6**
Shrublands; *Acacia brachystachya* scrub	128568	0.6
Shrublands; *Acacia neurophylla* & A. species thicket	1351	0.0
Shrublands; *Acacia neurophylla, A. beauverdiana* & *A. resinimarginea* thicket	739141	3.3
Shrublands; *Acacia quadrimarginea* thicket	37594	0.2
Shrublands; acacia scrub, various species	1676	0.0
Shrublands; acacia, Casuarina & melaleuca thicket	1138654	5.1
Shrublands; *Allocasuarina campestris* thicket	31818	0.1
Shrublands; banksia scrub-heath on coastal plain in the Esperance Plains Region	67143	0.3
Shrublands; bowgada & jam scrub	205	0.0
Shrublands; bowgada & jam scrub with scattered York gum	35	0.0
Shrublands; *Casuarina acutivalvis* & Calothamnus (also melaleuca) thicket on greenstone hills	30353	0.1
Shrublands; *Eucalyptus incrassata* mallee-heath	184061	0.8
Shrublands; heath with scattered *Nuytsia floribunda* on sandplain	2223	0.0
Shrublands; jam thicket	1255	0.0
Shrublands; mallee & acacia scrub on south coastal dunes	210858	1.0
Shrublands; mallee & Casuarina thicket	21200	0.1
Shrublands; mallee scrub *Eucalyptus gracilis*	125392	0.6
Shrublands; mallee scrub marble gum (*Eucalyptus gongylocarpa*)	4886	0.0
Shrublands; mallee scrub, black marlock	87081	0.4
Shrublands; mallee scrub, black marlock & Forrest's marlock	44093	0.2

Beards Vegetation Association Description	**Area (ha)**	**% of Study Area**
Shrublands; mallee scrub, blue mallee (*Eucalyptus socialis*)	523282	2.4
Shrublands; mallee scrub, *Eucalyptus eremophila*	1084859	4.9
Shrublands; mallee scrub, *Eucalyptus eremophila* & banksia	3288	0.0
Shrublands; mallee scrub, *Eucalyptus eremophila* & Forrest's marlock (*E. forrestiana*)	34583	0.2
Shrublands; mallee scrub, *Eucalyptus eremophila* & red mallee	48468	0.2
Shrublands; mallee scrub, red mallee	3687	0.0
Shrublands; mallee scrub, white mallee (*Eucalyptus cooperiana*)	143883	0.6
Shrublands; mallee-heath (Nuytsland)	56419	0.3
Shrublands; Mixed acacia thicket on sandplain	313482	1.4
Shrublands; mixed Acacia thickets in thickets of Acacia-Casuarina-Melaleuca alliance	1060	0.0
Shrublands; Mt Ragged heath	3247	0.0
Shrublands; mulga & *Acacia quadrimarginea* scrub	6127	0.0
Shrublands; mulga scrub	139	0.0
Shrublands; scrub-heath	881	0.0
Shrublands; scrub-heath in the Coolgardie Region	260645	1.2
Shrublands; scrub-heath in the Esperance Plains including Mt Ragged scrub-heath	11072	0.0
Shrublands; scrub-heath in the Mallee Region	115512	0.5
Shrublands; tallerack mallee-heath	20722	0.1
Shrublands; teatree scrub	127	0.0
Shrublands; thicket, Acacia-Casuarina alliance	870	0.0
Shrublands; York gum & *Eucalyptus sheathiana* mallee scrub	82	0.0
Total Shrublands	**5490025**	**24.8**
Succulent steppe with open low woodland; *Acacia papyrocarpa* over bluebush	559279	2.5
Succulent steppe with open low woodland; *Acacia papyrocarpa* over saltbush & bluebush,	433053	2.0
Succulent steppe with open low woodland; mulga & sheoak over bluebush	208042	0.9
Succulent steppe with open low woodland; mulga & sheoak over salt bush	77305	0.3
Succulent steppe with open low woodland; mulga over bluebush	12300	0.1
Succulent steppe with open low woodland; mulga over saltbush	1444	0.0
Succulent steppe with open low woodland; sheoak over saltbush	146119	0.7
Succulent steppe with open low woodland; sheoak over saltbush & bluebush	9088	0.0
Succulent steppe with open scrub; scattered mulga over saltbush	18563	0.1
Succulent steppe with open scrub; scattered wattles over saltbush	2	0.0
Succulent steppe with open woodland; salmon gum & gimlet over bluebush	154059	0.7
Succulent steppe with open woodland; york gum over saltbush	6430	0.0
Succulent steppe with scrub; acacia species over saltbush	31348	0.1
Succulent steppe with scrub; acacia species over saltbush & bluebush	763	0.0
Succulent steppe with woodland; gimlet & saltbush	145481	0.7
Succulent steppe with woodland; salmon gum & bluebush	98126	0.4
Succulent steppe with woodland; salmon gum & saltbush	9403	0.0
Succulent steppe; bluebush	10473	0.0
Succulent steppe; bluebush with grassy depressions	534806	2.4
Succulent steppe; bluebush with saltbush in depressions	915568	4.1
Succulent steppe; saltbush	20496	0.1
Succulent steppe; saltbush & samphire	791	0.0
Succulent steppe; samphire	121154	0.5
Total Succulent Steppe	**3514094**	**15.9**

Appendix 2: NVIS Level 5 Associations of the Great Western Woodlands Bushfire Threat Analysis Study Area

Code	Fuel Category	NVIS Level 5 (Vegetation Association) Description	Area (ha)	% of GWW BTA
47.30	B	-9999	1005	0.00
125.00	B	-9999	671701	3.03
128.00	B	-9999	211971	0.96
129.00	B	-9999	10892	0.05
221.00	B	G^Atriplex sp.\chenopod\2\i	12656	0.06
325.10	B	G^^Atriplex sp.,Arthrocnemum bidens,Halosarcia halocnemoides\chenopod,samphire\2\i	791	0.00
449.00	B	G^Maireana sp.\chenopod\2\i	534806	2.41
460.00	B	G^Maireana sp., Atriplex sp.\chenopod\2\i	915568	4.13
508.00	B	U Acacia aneura\shrub\6\biG^Atriplex sp.\chenopod\2\c	18563	0.08
676.00	B	G^Halosarcia sp.\samphire\2\i	121129	0.55
676.50	B	G^Arthrocnemum bidens,^Halosarcia halocnemoides,^Halosarcia lepidosperma\samphire\2\i	25	0.00
1271.00	B	-9999	890	0.00
		Total Non Fuel	**2499997**	**11.28**
84.00	H1	U Eucalyptus gongylocarpa, Eucalyptus youngiana\tree,mallee\6\biG^Triodia basedowii\hummock grass\2\i	169245	0.76
109.00	H1	U Eucalyptus youngiana\mallee\5\rG^Triodia sp.\hummock grass\2\i	454339	2.05
110.00	H1	U Eucalyptus sp.\mallee\5\rG^Triodia scariosa\hummock grass\2\i	34467	0.16
110.30	H1	U^Eucalyptus oleosa, Eucalyptus transcontinentalis, Eucalyptus platycorys\mallee\6\r;M Acacia leptoneura, Acacia sp. cf. coolgardiensis, Acacia porphyrochila\shrub\4\r;G Triodia scariosa, Helichrysum apiculatum, Brachysema chambersii\hummock grass,forb,s	48	0.00
467.10	H1	U^Eucalyptus salmonophloia,^Eucalyptus salubris, Eucalyptus leptophylla\tree,mallee\7\i;M Eremophila scoparia, Eremophila dempsteri\shrub\4\i;G Triodia sp.\hummock grass\2\i	280070	1.26
483.10	H1	U^Eucalyptus oleosa\mallee\5\r;M Acacia ramulosa, Acacia sp. aff. ramulosa, Allocasuarina acutivalvis\shrub\4\r;G Triodia scariosa, Triodia sp., Baeckea floribunda\hummock grass,shrub,forb\2\i	164	0.00
555.00	H1	U^Eucalyptus oleosa\mallee\5\iG Triodia scariosa\hummock grass\2\i	24991	0.11
555.10	H1	U^Eucalyptus oleosa\mallee\5\iG Triodia scariosa, Triodia rigidissima\hummock grass\2\i	15422	0.07
555.20	H1	U^Eucalyptus oleosa, Eucalyptus loxophleba, Eucalyptus sheathiana\mallee,tree\5\i;M Acacia sp.\shrub\4\r;G Trioda scariosa\hummock grass\2\i	2693	0.01
555.30	H1	U^Eucalyptus oleosa, Eucalyptus griffithsii, Eucalyptus gracilis\mallee\5\iG Triodia scariosa\hummock grass\2\i	13248	0.06
85.00	H2	U Eucalyptus gongylocarpa, Eucalyptus youngiana\tree,mallee\6\biG^Triodia sp.\hummock grass\2\c	272272	1.23
		Total Hummock Grass Fuels	**1266960**	**5.72**

Code	Fuel Category	NVIS Level 5 (Vegetation Association) Description	Area (ha)	% of GWW BTA
10.10	S1	U^Eucalyptus oleosa, Eucalyptus flocktoniae, Eucalyptus transcontinentalis\mallee\6\i;M Acacia ancistrophylla, Melaleuca acuminata, Eremophila calorhabdos\shrub\4\i	38719	0.17
18.15	S1	U^Acacia aneura, Acacia pruinocarpa, Acacia ramulosa var. linophylla\shrub\4\i;M Eremophila latrobei, Senna sp., Acacia aciphylla\shrub\3\r;G Schoenia cassiniana, Podolepis canescens, Waitzia acuminata\forb,tussock grass\1\r	5674	0.03
39.00	S1	U^Acacia aneura\shrub\4\i	139	0.00
41.00	S1	U^Melaleuca cuticularis, Melaleuca sp.\shrub\4\i	127	0.00
42.10	S1	U^Eucalyptus angulosa,^Acacia cyclops, Agonis flexuosa\mallee,shrub\4\i;M Melaleuca pentagona, Melaleuca sclerophylla, Melaleuca pubescens\shrub\4\i	52456	0.24
48.00	S1	U Agonis flexuosa, Acacia rostellifera, Acacia saligna\shrub\4\i	881	0.00
147.00	S1	U^Acacia sp.\shrub\4\iG Atriplex sp.\chenopod\2\i	9284	0.04
147.10	S1	U Acacia linophylla, Acacia tetragonophylla, Callitris huegelii\shrub\4\i;M Atriplex paludosa, Atriplex nummularia, Calytrix brachyphylla\chenopod,shrub\3\i;G Carpobrotus edulis, Dichymanthus roei, Disphyma australe\samphire,chenopod,forb\1\i	22064	0.10
202.00	S1	U^Acacia aneura,^Acacia quadrimarginea\shrub\4\i	6082	0.03
202.40	S1	U^Acacia aneura,^Acacia quadrimarginea, Scaevola spinescens\shrub\4\iG Ptilotus obovatus\forb\2\r	45	0.00
221.10	S1	U Myoporum sp., Westringia sp.\shrub\4\rG^Atriplex vesicaria, Frankenia sp., Cratystylis conocephala\chenopod,forb,tussock grass\2\i	130	0.00
221.30	S1	U Grevillea sarissa, Eremophila oldfieldii, Acacia sp. cf. leptoneura\shrub\3\rG^Atriplex vesicaria, Rhagodia spinescens, Maireana pyramidata\chenopod\2\i	7710	0.03
385.00	S1	U Eucalyptus loxophleba\tree\6\bi;M^Acacia ramulosa,^Acacia acuminata\shrub\4\i	35	0.00
461.00	S1	U^Acacia papyrocarpa\shrub\6\rG Maireana sp.\chenopod\2\i	559279	2.52
479.00	S1	U Eucalyptus sp.\mallee\5\r;M Banskia sp., Grevillea sp.\shrub\4\i	27088	0.12
500.10	S1	U Eucalyptus sp.\mallee\5\i;M Dodonaea sp., Acacia sp.\shrub\4\i;G Maireana sedifolia, Triodia sp., Stipa nitida\chenopod,hummock grass\,tussock grass2\r	98863	0.45
516.10	S1	U^Eucalyptus uncinata,^Eucalyptus redunca, Eucalyptus goniantha\mallee\5\i;M Banksia media, Callitris sp., Phymatocarpus maxwellii\shrub\4\r	3684	0.02
519.50	S1	U Eucalyptus eremophila, Eucalyptus transcontinentalis, Eucalyptus sp. (JSB.6325)\mallee\5\i;M Acacia merrallii, Boronia leptophylla, Olearia muelleri\shrub\4\i	13017	0.06
538.00	S1	U^Acacia brachystachya\shrub\4\i	27448	0.12
924.20	S1	U^Eucalyptus eremophila,^Eucalyptus oleosa, Eucalyptus conglobata\mallee\5\i;M Melaleuca sp.\shrub\4\i	43602	0.20
1071.00	S1	U^Acacia sp.\shrub\4\iG Atriplex sp., Maireana sp.\chenopod\2\I	401	0.00
1071.10	S1	U Callitris columellaris, Acacia acuminata, Pittosporum phylliraeoides\tree\6\i;M Atriplex hymenotheca, Melaleuca lateriflora\chenopod,shrub\4\I;G^Halosarcia halocnemoides, Rhagodia spinescens\chenopod,shrub\2\i	362	0.00
1148.20	S1	U Eucalyptus eremophila, Eucalyptus flocktoniae, Grevillea excelsior\mallee,shrub\5\r;M^^Banksia elderiana, Callitris preissii subsp. verrucosa, Calothamnus quadrifidus\shrub\4\i	78045	0.35

Code	Fuel Category	NVIS Level 5 (Vegetation Association) Description	Area (ha)	% of GWW BTA
1241.10	S1	U Acacia burkittii, Acacia oswaldii, Acacia tetragonophylla\shrub,chenopod\3\iG^Maireana sedifolia, Stipa nitida, Zygophyllum ovatum\chenopod,forb,tussock grass\1\i	5070	0.02
1413.40	S1	U Eucalyptus loxophleba^Allocasuarina dielsiana, Senna chatelaineana\mallee,shrub\5\rG Boronia inornata, Westringia dampieri, Halgania lavandulacea\shrub\3\r	9628	0.04
1413.50	S1	U Allocasuarina acutivalvis, Eucalyptus burracoppinensis,^^Acacia signata\shrub,mallee\5\rG Acacia brachyphylla, Adenanthos argyreus, Astroloma serratifolium\shrub,forb,sedge,hummock grass\2\i	40865	0.18
1515.10	S1	U^Eucalyptus gracilis, Eucalyptus conglobata, Callitris verrucosa\mallee,tree\6\i;M Melaleuca lanceolata, Acacia cochlearis\shrub\4\i;G Atriplex sp., Cratystylis sp.\chenopod\3\i	125392	0.57
42.40	S2	U^Eucalyptus gracilis, Eucalyptus oleosa\mallee\5\i;M Exocarpos aphyllus, Rhagodia preissii\shrub,chenopod\4\i;G Atriplex hastata, Stipa hemipogon, Dianella revoluta\chenopod,tussock grass,forb\2\i	158403	0.71
512.10	S2	U^Eucalyptus eremophila, Eucalyptus forrestiana, Eucalyptus uncinata\mallee\5\i;M Melaleuca pungens, Melaleuca cliffortioides, Melaleuca scabra\shrub\4\i;G Halgania integerrima, Microcybe multiflora, Pimelea imbricata\shrub\2\i	34583	0.16
519.10	S2	U^Eucalyptus eremophila, Eucalyptus oleosa, Eucalyptus calycogona\mallee\5\i;M Melaleuca sp.\shrub\4\i;G Triodia sp.\hummock grass\2\r	105287	0.48
538.10	S2	U Casuarina cristata, Brachychiton gregorii, Callitris columellaris\tree\6\bi;M^Acacia brachystachya, Bossiaea walkeri, Dodonaea attenuata\shrub\4\i;G Helichrysum davenportii\forb\1\i	101121	0.46
1063.10	S2	U^Eucalyptus loxophleba,^Callitris columellaris\mallee,tree\6\i;M Acacia acuminata, Acacia obtecta, Acacia prainii\shrub\4\i;G Helichrysum lindleyi\forb\1\i	171795	0.78
1413.11	S2	U^^Acacia sp., Allocasuarina acutivalvis, Melaleuca eleutherostachya\shrub,mallee\4\iG Baeckea sp., Phebalium sp., Thryptomene urceolaris\shrub\2\i	18502	0.08
36.00	S3	U Acacia sp., Leptopspermum erubescens\shrub\4\i;M^Allocasuarina campestris,^Melaleuca sp.\shrub\3\c	870	0.00
40.00	S3	U^Acacia sp.\shrub\4\c	1676	0.01
413.00	S3	U^Acacia neurophylla, Acacia sp.\shrub\4\c	1351	0.01
435.00	S3	U^Acacia neurophylla,^Acacia beauverdiana,^Acacia resinomarginea\shrub\4\c	58020	0.26
436.00	S3	U^Acacia sp.\shrub\4\c	1060	0.00
437.00	S3	U^Acacia sp.\shrub\4\c	224643	1.01
484.00	S3	U^Acacia acuminata\shrub\4\c	1255	0.01
510.00	S3	U Callitris preissii, Calothamnus quadrifidus\shrub\4\i;M^^Kunzea baxteri, Dillwynia pungens, Agonis linearifolia\shrub\3\c	3247	0.01
514.00	S3	U^Eucalyptus cooperiana, Eucalyptus sp.\mallee\5\i;M Callitris roei, Templetonia retusa, Acacia sp.\shrub\4\c	143883	0.65
515.00	S3	U^Eucalyptus socialis, Eucalyptus sp.\mallee\5\i;M Melaleuca sp., Allocasuarina helmsii, Exocarpos aphyllus\shrub\4\c	523282	2.36
516.00	S3	U^Eucalyptus redunca, Eucalyptus sp.\mallee\5\i;M Banksia sp., Melaleuca spathulata, Grevillea sp.\shrub\4\c	3663	0.02
516.30	S3	U^Eucalyptus uncinata, Eucalyptus redunca, Eucalyptus flocktiniae\mallee\6\i;M Banksia calyei, Hakea laurina, Hakea crassifolia\shrub\4\c	0	0.00
519.00	S3	U^Eucalyptus eremophila, Eucalyptus sp.\mallee\5\i;M Melaleuca sp.\shrub\3\c	719261	3.25

Code	Fuel Category	NVIS Level 5 (Vegetation Association) Description	Area (ha)	% of GWW BTA
520.00	S3	U^Acacia quadrimarginea\shrub\4\c	31177	0.14
520.20	S3	U Brachychiton gregorii, Casuarina cristata, Dryandra arborea\tree\6\bi;M^Acacia quadrimarginea, Dodonaea larraeoides, Eremophila sp. aff. goodwinii\shrub\4\d	3268	0.01
520.30	S3	U^Acacia quadrimarginea, Acacia tetragonophylla, Allocasuarina campestris\shrub\4\dG Atriplex nummularia, Maireana sp., Scaevola spinescens\chenopod,shrub,forb\2\i	1970	0.01
520.50	S3	U^Acacia quadrimarginea, Acacia acuminata, Allocasuarina campestris\shrub,mallee\4\c	1180	0.01
551.00	S3	U^Allocasuarina campestris\shrub\4\d	31339	0.14
551.60	S3	U Actinostrobus arenarius, Allocasuarina acutivalvis, Eucalyptus pyriformis\tree,mallee\6\r;M^Allocasuarina campestris, Acacia juncea, Calothamnus sp.\shrub\4\d	480	0.00
552.00	S3	U^Allocasuarina acutivalvis,^Calothamnus sp., Melaleuca sp.\shrub\4\c	18724	0.08
1024.00	S3	U^Allocasuarina sp., Eucalyptus sp.\shrub,mallee\4\c	21200	0.10
1148.00	S3	U Eucalyptus sp., Grevillea sp.\mallee,shrub\4\r;M^^Acacia sp., Allocasuarina sp., Dryandra sp.\shrub\4\c	9421	0.04
1148.30	S3	U^^Acacia beauverdiana, Banksia audax, Eucalyptus leptopoda\shrub\4\i;M Anthotium rubriflorum, Baeckea leptophylla, Burtonia hendersonii\shrub,xanthorrhoea\3\c	5285	0.02
1413.00	S3	U^Acacia sp.,^Allocasuarina campestris,^Melaleuca uncinata\shrub\4\c	326893	1.48
1413.10	S3	U Eucalyptus grossa, Callitris preissii\mallee,shrub\5\r;M^Allocasuarina campestris, Acacia fragilis, Melaleuca uncinata\shrub\4\c	1856	0.01
1413.20	S3	U Eucalyptus merrickiae\mallee\5\r;M^Acacia acuminata, Melaleuca acuminata, Grevillea acuaria\shrub\4\c	1802	0.01
1519.10	S3	U^Eucalyptus eremophila, Eucalyptus gonian tha\mallee\5\i;M Banksia media, Phymatocarpus maxwellii, Phebalium sp.\shrub\4\c;G Baeckea sp., Calytrix stipulosa\shrub\2\c	3288	0.01
2048.00	S3	U Acacia sp., Allocasuarina acutivalvis, Adenanthos argyreus\shrub\4\r;M^^Acacia sp., Allocasuarina campestris, Melaleuca sp.\shrub\4\c	11755	0.05
2048.20	S3	U Eucalyptus leptopoda, Eucalyptus burracoppinensis, Allocasuarina acutivalvis\mallee,shrub\5\r;M^^Acacia beauverdiana, Banksia audax, Grevillea excelsior\shrub\4\c	62303	0.28
2901.10	S3	U^Acacia quadrimarginea, Acacia acuminata, Allocasuarina campestris\shrub\4\d	36014	0.16
4801.10	S3	U Eucalyptus sp., Nuytsia floribunda\mallee,tree\5\r;M^Lambertia inermis, Hakea sp., Xanthorrhoea preissii\shrub\4\c	2223	0.01
7048.00	S3	U^Banksia speciosa, Acacia cyclops\shrub\4\i;M Melaleuca sp.\shrub\2\c	67143	0.30
47.00	S4	U^Eucalyptus tetragona, Eucalyptus sp.\mallee\5\i;M Banksia sp., Calothamnus sp., Lambertia inermis\shrub,mallee\4\i;G Andersonia sp., Conospermum sp., Conostylis sp.\shrub\1\c	17418	0.08
435.10	S4	U^^Acacia resinomarginea, Melaleuca uncinata, Allocasuarina corniculata\shrub\4\dG Thryptomene kochii, Baeckea maidenii, Balaustion pulcherrimum\shrub,sedge,forb,hummock grass,xanthorrhoea\2\r	250031	1.13
435.30	S4	U^Acacia neurophylla, Calothamnus quadrifidus, Grevillea excelsior\shrub\3\dG Astroloma serratifolium, Baeckea ochropetala, Brachysema chambersii\shrub,forb\2\r	311041	1.40
435.40	S4	U^Acacia resinomarginea, Acacia sp., Eucalyptus leptopoda\shrub,mallee\4\cG Thryptomene kochii, Baeckea sp., Thryptomene urceolaris\shrub,hummock grass\2\i	120049	0.54

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479.10	S4	U Eucalyptus angulosa, Eucalyptus cooperiana, Eucalyptus diversifolia\mallee\5\rG^Melaleuca pentagona, Banksia media, Banksia speciosa\shrub\2\c	29331	0.13
489.10	S4	U Allocasuarina huegeliana, Pittosporum phylliraeoides\tree\6\i;M Acacia acuminata, Eucalyptus sp. aff. salubris^Dodonaea microzyga\shrub,tree\4\I;G Aristida arenaria, Microseris scapigera, Ptilotus obovatus\forb,tussock grass\1\c	77018	0.35
519.40	S4	U^Eucalyptus eremophila, Eucalyptus sp.\mallee\5\i;M Acacia acuminata, Allocasuarina acutivalvis, Alyxia buxifolia\shrub,liana\4\c;G Astroloma serratifolium, Baeckea heteranthera, Bassia diacantha\shrub,chenopod,forb,sedge,tussock grass,\2\i	123423	0.56
552.20	S4	U Eucalyptus gardneri, Eucalyptus redunca, Eucalyptus loxophleba\mallee\5\r;M^Acacia beauverdiana,^Acacia neurophylla, Allocasuarina campestris\shrub\4\d;G Triodia scariosa\hummock grass\2\bi	11629	0.05
1148.10	S4	U Eucalyptus burracoppinensis, Eucalyptus foecunda, Eucalyptus incrassata\mallee,shrub\5\r;M Acacia beauverdiana, Banksia audax,^^Adenanthos flavidiflorus\shrub\4\c;G Triodia rigidissima, Waitzia acuminata\hummock grass,forb\1\i	167894	0.76
1413.12	S4	U^Allocasuarina acutivalvis,^Allocasuarina campestris,^Acacia sp.\shrub\4\cG Triodia rigidissima\hummock grass\2\r	8339	0.04
1413.60	S4	U Callitris canescens, Eucalyptus leptopoda, Eucalyptus burracoppinensis\shrub,mallee\4\r;M^^Acacia jutsonii, Allocasuarina corniculata, Melaleuca uncinata\shrub\4\d;G Thryptomene kochii, Baeckea maidenii, Balaustion pulcherrimum\shrub,sedge,forb,hummock	513173	2.32
1413.70	S4	U^Allocasuarina acutivalvis,^Allocasuarina corniculata, Acacia beauverdiana\shrub\4\dG Anthotium rubriflorum, Baeckea leptophylla, Burtonia hendersonii\shrub,xanthorrhoea\2\i	13575	0.06
1413.80	S4	U^Acacia resinomarginea, Acacia stereophylla\shrub\4\dG Ecdeiocolea monostachya\sedge\2\r	153	0.00
1413.90	S4	U^Acacia resinomarginea, Allocasuarina acutivalvis, Melaleuca uncinata\shrub\4\dG Ecdeiocolea monostachya\sedge\2\i	203869	0.92
47.10	S5	U^Eucalyptus tetragona,^Eucalyptus incrassata\mallee\5\i;M Lambertia inermis, Banksia baueri, Calothamnus quadrifidus, Eucalyptus tetraptera\shrub,mallee\4\c;G Andersonia parvifolia, Banksia repens, Calytrix decandra\shrub,forb\2\c	47	0.00
47.20	S5	U^Eucalyptus tetragona, Eucalyptus leptopoda, Eucalyptus forrestiana\mallee\5\i;M Grevillea excelsior, Banksia elderiana, Grevillea incrassata\shrub\4\c;G Micromyrtus imbricata\shrub\2\c	2252	0.01
516.20	S5	U^Eucalyptus redunca,^Eucalyptus uncinata, Eucalyptus dielsii\mallee\5\i;M Banksia media, Callitris preissii, Hakea laurina\shrub\4\c;G Conostephium roei, Baeckea sp. aff. ambigua, Daviesia juncea\shrub,forb\2\c	79734	0.36
519.30	S5	U Eucalyptus falcata, Eucalyptus gardneri^Eucalyptus eremophila\tree\6\bi;M Banksia media, Callitris roei, Hakea multilineata\shrub\4\c;G Grevillea huegelii, Grevillea pectinata, Boronia inconspicua\shrub\2\c	123870	0.56
1047.10	S5	U^Eucalyptus incrassata, Eucalyptus uncinata, Eucalyptus redunca\mallee\5\i;M Grevillea hookeriana, Lambertia inermis,^^Agonis linearifolia\shrub\4\c;G Goodenia strophiolata, Lechenaultia formosa\forb\1\c	184061	0.83
1516.10	S5	U^Eucalyptus redunca,^Eucalyptus uncinata, Eucalyptus forrestiana\mallee\5\i;M Banksia media, Callitris preissii,^^Acacia glaucoptera\shrub\4\c;G Conostephium roei, Baeckea sp. aff. ambigua, Daviesia juncea\shrub,forb\2\c	44093	0.20
2048.10	S5	U Acacia fragilis, Acacia multispicata, Grevillea excelsior\shrub\4\c;M^^Adenanthos argyreus, Acacia fragilis, Banksia sphaerocarpa\shrub\3\c;G Acacia acanthoclada, Baeckea grandibracteata, Boronia caerulescens\shrub,xanthorrhoea\3\c	41454	0.19
4048.10	S5	U Eucalyptus incrassata, Eucalyptus conglobata, Nuytsia floribunda\mallee,tree,shrub\5\i;M Dryandra quercifolia, Lambertia inermis,^^Allocasuarina humilis\shrub,mallee,cycad\5\c;G Acacia gonophylla, Adenanthos dobsonii, Agonis	11072	0.05

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		spathulata\shrub,forb\1\c		
		Total Shrub Fuels	**6418838**	**28.97**
8.00	W1	U^Eucalyptus salmonophloia, Eucalyptus salubris\tree\7\i	132947	0.60
141.00	W1	U^Eucalyptus salmonophloia, Eucalyptus loxophleba, Eucalyptus salubris\tree\7\i	239935	1.08
142.00	W1	U Eucalyptus salmonophloia\tree\7\i	18036	0.08
144.00	W1	U^Eucalyptus capillosa,^Eucalyptus salmonophloia, Eucalyptus longicornis\tree\7\i	3997	0.02
148.20	W1	U Eucalyptus salmonophloia^Eucalyptus salubris, Eucalyptus loxophleba\tree\7\IG Atriplex bunburyana\chenopod\2\i	321	0.00
214.00	W1	U^Eucalyptus dundasii,^Eucalyptus transcontinentalis, Eucalyptus sp.\tree\7\i	15710	0.07
214.10	W1	U^Eucalyptus oleosa,^Eucalyptus flocktoniae\tree\7\i;M Atriplex sp., Cratystylis sp., Eremophila dempsteri\chenopod,shrub\4\r	489609	2.21
314.00	W1	U Eucalyptus loxophleba\tree\7\rG^Atriplex sp.\chenopod\2\i	6430	0.03
352.00	W1	U^Eucalyptus loxophleba, Allocasuarina huegeliana\tree\7\i	513	0.00
389.20	W1	U Acacia victoriae\shrub\4\rG^Maireana pyramidata\chenopod\2\i	1444	0.01
417.00	W1	U Acacia sp.\shrub\4\biG^Atriplex sp.\chenopod\2\i	2	0.00
437.20	W1	U Acacia aneura, Acacia linophylla, Acacia acuminata\shrub\4\r	88839	0.40
467.00	W1	U^Eucalyptus salmonophloia, Eucalyptus salubris\tree\7\i	2145	0.01
468.00	W1	U^Eucalyptus salmonophloia, Eucalyptus dundasii\tree\7\i	435610	1.97
481.00	W1	U^Eucalyptus salmonophloia, Eucalyptus sp.\tree,mallee\7\i	9469	0.04
482.00	W1	U^Eucalyptus flocktoniae, Eucalyptus oleosa\tree,mallee\7\i	1362377	6.15
486.00	W1	U^Eucalyptus salmonophloia, Eucalyptus sp.\tree,mallee\7\i	235715	1.06
489.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus dundasii\tree\7\i	1525	0.01
491.00	W1	U^Eucalyptus longicornis,^Eucalyptus dundasii\tree\7\i	67198	0.30
493.00	W1	U^Eucalyptus salmonophloia, Eucalyptus flocktoniae, Eucalyptus sp.\tree,mallee\7\i	19503	0.09
494.00	W1	U^Eucalyptus salmonophloia, Eucalyptus flocktoniae, Eucalyptus sp.\tree\7\i	2577	0.01
501.00	W1	U^Eucalyptus lesouefii\tree\7\i	32444	0.15
506.00	W1	U Eucalyptus salmonophloia\tree\7\rG Maireana sp.\chenopod\2\i	5567	0.03
506.10	W1	U Eucalyptus salmonophloia, Casuarina cristata\tree\7\biG^Maireana sp., Lycium australe\chenopod\2\i	84281	0.38
506.20	W1	U^Eucalyptus salmonophloia, Eucalyptus le souefii, Eucalyptus oleosa\tree\7\i;M Maireana sedifolia, Atriplex sp., Eremophila scoparia\chenopod,shrub\3\i	8278	0.04
507.00	W1	U Eucalyptus salmonophloia\tree\7\rG Atriplex sp.\chenopod\2\i	3616	0.02
507.10	W1	U^Eucalyptus salmonophloia, Eucalyptus le souefii, Eucalyptus oleosa\tree\7\i;M Atriplex sp.\chenopod\3\i	5787	0.03
511.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus longicornis\tree\7\i	122823	0.55

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511.30	W1	U^Eucalyptus salmonophloia, Eucalyptus longicornis, Eucalyptus salubris\tree\7\iG Atriplex hymenotheca, Atriplex nummularia\chenopod\2\i	176853	0.80
513.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus dundasii\tree\7\i	15874	0.07
518.00	W1	U^Eucalyptus flocktoniae,^Eucalyptus torquata\tree\7\i	658143	2.97
521.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus sp.\tree,mallee\7\i	23315	0.11
522.00	W1	U^Eucalyptus transcontinentalis,^Eucalyptus flocktoniae\tree\7\i	356066	1.61
522.10	W1	U^Eucalyptus transcontinentalis,^Eucalyptus flocktoniae, Eucalyptus loxophleba\tree\7\i	178020	0.80
524.00	W1	U^Eucalyptus dundasii, Eucalyptus sp.\tree,mallee\7\i	21745	0.10
525.00	W1	U^Eucalyptus salmonophloia, Eucalyptus salubris\tree\7\i	236214	1.07
529.10	W1	U^Acacia aneura,^Casuarina cristata, Eucalyptus salmonophloia\tree\6\r	40349	0.18
536.00	W1	U^Eucalyptus longicornis, Eucalyptus corrugata\tree\7\i	459	0.00
540.00	W1	U^Allocasuarina sp.\tree\6\rG Atriplex sp.\chenopod\2\c	94465	0.43
931.00	W1	U^Eucalyptus occidentalis\tree\7\i	690	0.00
936.00	W1	U^Eucalyptus salmonophloia\tree\7\i	150611	0.68
936.60	W1	U^Eucalyptus salmonophloia, Eucalyptus le souefii, Eucalyptus transcontinentalis\tree\7\iG Atriplex sp.\chenopod\2\i	57822	0.26
941.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus longicornis\tree\7\i	10839	0.05
945.00	W1	U^Eucalyptus salmonophloia\tree\7\i	8575	0.04
946.00	W1	U^Eucalyptus wandoo\tree\7\i	788	0.00
1067.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus longicornis, Eucalyptus salubris\tree\7\i	9401	0.04
1068.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus longicornis, Eucalyptus salubris\tree\7\i	93089	0.42
1078.00	W1	U^Eucalyptus salmonophloia,^Eucalyptus transcontinentalis, Eucalyptus flocktoniae\tree\7\i	758	0.00
1241.20	W1	U Acacia aneura, Casuarina cristata, Eucalyptus salmonophloia\tree\6\r	5403	0.02
2903.00	W1	U^Eucalyptus salmonophloia, Eucalyptus lesouefii, Eucalyptus salubris\tree\7\i	27630	0.12
3106.00	W1	U^Eucalyptus salmonophloia, Eucalyptus dundasii\tree\7\i	52630	0.24
9.00	W2	U^Eucalyptus torquata,^Eucalyptus le souefii, Eucalyptus clelandii\tree\6\i;M Eremophila scoparia, Eremophila glabra, Eremophila oldfieldii\shrub,chenopod\4\r	240408	1.09
10.00	W2	U^Eucalyptus flocktoniae,^Eucalyptus transcontinentalis, Eucalyptus sp.\mallee\5\i	96104	0.43
19.00	W2	U^Acacia aneura\tree\6\i	10322	0.05
20.00	W2	U^Acacia aneura, Allocasuarina cristata, Eucalyptus sp.\tree\6\i	12065	0.05
24.00	W2	U^Allocasuarina cristata\tree\6\i	12553	0.06
25.00	W2	U^Allocasuarina huegeliana,^Eucalyptus loxophleba\tree\6\i	4694	0.02
122.10	W2	U Acacia papyrocarpa, Myoporum platycarpum, Pittosporum phylliraeoides\tree\6\rG^Atriplex vesicaria,^Atriplex acutibractea subsp. whyallensis,^Atriplex cryptocarpa\chenopod\2\i	312456	1.41
122.20	W2	U Acacia papyrocarpa, Melaleuca lanceolata, Acacia oswaldii\tree\6\rG^Atriplex sp., Cratystylis sp., Nitraria sp.\chenopod,shrub\3\i	120597	0.54

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256.00	W2	U^Eucalyptus loxophleba,^Callitris glaucophylla\tree\6\i	3981	0.02
400.00	W2	U^Acacia aneura\tree\6\rG Maireana sp.\chenopod\2\i	12300	0.06
480.00	W2	U^Acacia aneura,^Allocasuarina sp.\tree\6\rG Atriplex sp.\chenopod\2\i	39645	0.18
481.10	W2	U^Eucalyptus oleosa\mallee\6\i	87	0.00
487.00	W2	U^Eucalyptus transcontinentalis, Eucalyptus sp.\tree,mallee\6\i	498233	2.25
488.00	W2	U^Eucalyptus salubris\tree\6\i	37964	0.17
502.00	W2	U^Eucalyptus lesouefii, Eucalyptus sp\tree\,mallee7\i	32778	0.15
504.00	W2	U^Acacia aneura, Eucalyptus sp.\tree,mallee\6\i	40157	0.18
535.20	W2	U^Eucalyptus corrugata\tree\6\i	24415	0.11
542.00	W2	U^Eucalyptus gongylocarpa\mallee\5\i	4886	0.02
924.00	W2	U^Eucalyptus eremophila,^Eucalyptus oleosa\mallee\5\i	4866	0.02
925.00	W2	U^Eucalyptus sp.\mallee\5\i	3687	0.02
929.00	W2	U^Eucalyptus platypus,^Eucalyptus annulata\tree\6\c	4414	0.02
1055.00	W2	U^Eucalyptus loxophleba,^Eucalyptus sheathiana\mallee\5\i	82	0.00
1063.00	W2	U^Eucalyptus loxophleba,^Callitris sp.\tree\6\i	338	0.00
1294.00	W2	U^Eucalyptus torquata\tree\6\i	6295	0.03
2009.00	W2	U^Eucalyptus lesouefii\tree\7\i	7059	0.03
8.30	W3	U^Eucalyptus salmonophloia, Eucalyptus salubris\tree\7\i;M Acacia acuminata, Exocarpos aphyllus, Santalum acuminatum\shrub\4\i;G Bassia diacantha, Dianella revoluta, Enchylaena tomentosa\chenopod,sedge,forb,shrub,tussock grass,\2\i	9280	0.04
8.60	W3	U^Eucalyptus salmonophloia,^Eucalyptus salubris\tree\7\i;M Eremophila scoparia, Eremophila interstans, Exocarpos aphyllus\shrub\4\r;G Atriplex vesicaria, Maireana sedifolia, Maireana pyramidata\chenopod,shrub,samphire\2\i	30731	0.14
10.30	W3	U^Eucalyptus oleosa, Eucalyptus flocktoniae, Eucalyptus le souefii\mallee,tree\5\i;M Eremophila scoparia, Eremophila interstans, Exocarpos aphyllus\shrub\4\r;G Atriplex vesicaria, Maireana sedifolia, Maireana pyramidata\chenopod,shrub,samphire\2\i	5395	0.02
18.10	W3	U^Acacia aneura, Casuarina cristata\tree\6\i;M Acacia brachystachya\shrub\4\r	16009	0.07
20.20	W3	U^Acacia aneura,^Callitris columellaris,^Eucalyptus oleosa\tree\6\i;M Acacia hemiteles, Senna artemisioides subsp. petiolaris, Eremophila decipiens\shrub\3\r;G Maireana sedifolia, Ptilotus obovatus\chenopod,forb\2\i	716810	3.24
123.10	W3	U Casuarina cristata, Myoporum platycarpum, Callitris columellaris\tree\6\r;M Eremophila miniata, Grevillea sarissa\shrub\4\r;G^Atriplex hymenotheca,^Maireana sp.\chenopod\2\i	9088	0.04
357.00	W3	U Eucalyptus loxophleba\tree\7\i;M Acacia ramulosa, Acacia acuminata\shrub\4\i	2	0.00
420.60	W3	U^Acacia acuminata,^Acacia ramulosa, Eucalyptus sp.\tree\6\i;M Acacia hemiteles, Senna artemisioides subsp. petiolaris, Eremophila decipiens\shrub\3\r;G Maireana sedifolia, Ptilotus obovatus\chenopod,forb\2\i	205	0.00
441.10	W3	U^Acacia aneura, Casuarina cristata\tree\6\i;M Acacia papyrocarpa, Myoporum platycarpum, Eucalyptus oleosa\shrub,mallee\4\bi;G Maireana sedifolia\chenopod\2\i	125909	0.57

Code	Fuel Category	NVIS Level 5 (Vegetation Association) Description	Area (ha)	% of GWW BTA
468.10	W3	U^Eucalyptus le souefii, Eucalyptus salmonophloia, Eucalyptus transcontinentalis\tree\7\i;M Eremophila scoparia, Eremophila alternifolia, Eremophila decipiens\shrub\4\i	66457	0.30
480.10	W3	U Casuarina cristata, Eucalyptus torquata, Eucalyptus transcontinentalis\tree\6\r;M Acacia oswaldii, Grevillea nematophylla, Dodonaea lobulata\shrub\4\r;G Atriplex hymenotheca, Maireana sp.\chenopod\2\i	37660	0.17
482.10	W3	U Eucalyptus salmonophloia^Eucalyptus oleosa,^Eucalyptus flocktoniae\tree,mallee\7\I;M Melaleuca uncinata, Acacia sp., Eremophila sp.\shrub\4\i	246694	1.11
501.10	W3	U^Eucalyptus le souefii, Eucalyptus oleosa, Eucalyptus flocktoniae\tree,mallee\7\i;M Eremophila scoparia, Eremophila interstans, Exocarpos aphyllus\shrub\4\r;G Atriplex vesicaria, Maireana sedifolia, Maireana pyramidata\chenopod,shrub,samphire\2\i	11469	0.05
509.10	W3	U^Eucalyptus salubris\tree\7\i;M Eremophila scoparia, Eremophila interstans, Exocarpos aphyllus\shrub\4\r;G Atriplex vesicaria, Maireana sedifolia, Maireana pyramidata\chenopod,shrub,samphire\2\i	77482	0.35
509.20	W3	U^Eucalyptus salubris, Eucalyptus dundasii, Eucalyptus oleosa\tree,mallee\7\i;M Eremophila scoparia, Eremophila interstans, Exocarpos aphyllus\shrub\4\r;G Atriplex vesicaria, Maireana sedifolia, Maireana pyramidata\chenopod,shrub,samphire\2\i	67999	0.31
511.20	W3	U^Eucalyptus salmonophloia,^Eucalyptus longicornis, Eucalyptus salubris\tree\7\i;M Dodonaea stenozyga, Eremophila saligna, Daviesia nematophylla\shrub\3\i	164155	0.74
511.40	W3	U^Eucalyptus salmonophloia,^Eucalyptus longicornis, Casuarina cristata\tree\7\i;M Acacia tetragonophylla, Acacia brachystachya, Santalum spicatum\shrub\4\i;G Atriplex hymenotheca, Atriplex nummularia\chenopod\2\i	24997	0.11
521.10	W3	U^Eucalyptus salmonophloia, Eucalyptus oleosa\tree,mallee\7\i;M Eremophila scoparia, Eremophila interstans, Exocarpos aphyllus\shrub\4\r;G Atriplex vesicaria, Maireana sedifolia, Maireana pyramidata\chenopod,shrub,samphire\2\i	89964	0.41
522.20	W3	U^Eucalyptus transcontinentalis,^Eucalyptus flocktoniae, Eucalyptus gracilis\tree\7\i;M Melaleuca sp.\shrub\4\r;G Atriplex sp.\chenopod\2\r	175713	0.79
524.10	W3	U^Eucalyptus dundasii,^Eucalyptus oleosa, Eucalyptus flocktoniae\tree,mallee\7\i;M Eremophila scoparia, Eremophila interstans, Exocarpos aphyllus\shrub\4\r;G Atriplex vesicaria, Maireana sedifolia, Maireana pyramidata\chenopod,shrub,samphire\2\i	325580	1.47
529.20	W3	U Casuarina cristata\tree\6\r;M^Maireana sedifolia, Maireana pyramidata, Lycium australe\chenopod,shrub\3\i;G Austrostipa variabilis, Rhodanthe charsleyae, Cephalipterum drummondii\tussock grass,forb\2\i	41785	0.19
536.10	W3	U^Eucalyptus longicornis,^Eucalyptus salmonophloia, Eucalyptus corrugata\tree\7\i;M Melaleuca lateriflora, Melaleuca pauperiflora\shrub\4\i	1551	0.01
540.10	W3	U Casuarina cristata, Myoporum platycarpum, Callitris columellaris\tree\6\r;M Eremophila miniata, Grevillea sarissa\shrub\4\r;G^Atriplex hymenotheca\chenopod\2\i	51654	0.23
554.00	W3	U^Allocasuarina cristata\tree\6\i;M Acacia ramulosa\shrub\4\i	1019	0.00
936.20	W3	U^Eucalyptus salmonophloia, Eucalyptus salubris\tree\7\i;M Melaleuca pauperiflora, Melaleuca uncinata, Melaleuca pungens\shrub\4\i	395	0.00
936.30	W3	U^Eucalyptus salmonophloia, Eucalyptus redunca\tree,mallee\7\i;M Santalum acuminatum, Melaleuca lateriflora\shrub\3\r;G Gahnia ancistrophylla, Grevillea huegelii, Olearia muelleri\sedge,shrub\2\r	3479	0.02

Code	Fuel Category	NVIS Level 5 (Vegetation Association) Description	Area (ha)	% of GWW BTA
936.70	W3	U^Eucalyptus salmonophloia, Eucalyptus salubris, Eucalyptus longicornis\tree\7\i;M Melaleuca sp.\shrub\4\r;G Atriplex sp.\chenopod\2\r	157665	0.71
936.90	W3	U^Eucalyptus salmonophloia\tree\7\i;M Melaleuca pauperiflora\shrub\4\r	199091	0.90
1068.10	W3	U^Eucalyptus longicornis,^Eucalyptus salmonophloia, Eucalyptus salubris\tree\7\i;M Melaleuca lateriflora, Melaleuca pauperiflora\shrub\4\i	68813	0.31
1068.20	W3	U^Eucalyptus longicornis,^Eucalyptus salmonophloia, Eucalyptus salubris\tree\7\i;M Melaleuca lateriflora, Melaleuca pauperiflora\shrub\4\i	65512	0.30
2902.10	W3	U^Casuarina cristata,^Eucalyptus le souefii, Eucalyptus transcontinentalis\tree,mallee\6\i;M Acacia quadrimarginea, Acacia acuminata, Allocasuarina campestris\shrub\4\i	916	0.00
4641.10	W3	U^Eucalyptus salmonophloia,^Eucalyptus salubris\tree\6\i;M Acacia sowdenii, Myoporum platycarpum\shrub\3\r;G Maireana sedifolia\chenopod\2\r	154059	0.70
8.40	W4	U^Eucalyptus salmonophloia, Eucalyptus longicornis, Eucalyptus salubris\tree\7\i;M Acacia acuminata, Acacia tetragonophylla, Pittosporum philyraeoides\shrub\4\i;G Olearia muelleri, Olearia ramosissima\shrub\2\i	115062	0.52
8.50	W4	U^Eucalyptus salmonophloia, Eucalyptus longicornis, Eucalyptus salubris\tree\7\i;M Acacia aciphylla, Acacia acuminata, Acacia brachystachya\shrub\4\i;G Angianthus tomentosus, Anguillaria dioica, Podolepis gnaphalioides\forb\1\i	8061	0.04
18.40	W4	U^Acacia aneura, Eucalyptus oleosa, Eucalyptus loxophleba\tree\6\i;M Acacia ramulosa, Acacia acuminata, Acacia grasbyi\shrub\4\r;G Eragrostis sp., Stipa variabilis\tussock grass\1\i	22570	0.10
24.10	W4	U^Allocasuarina cristata, Myoporum platycarpum\tree\6\i;M Eremophila oldfieldii, Dodonaea lobulata, Olearia muelleri\shrub,chenopod\4\r;G Stipa nitida\tussock grass\1\i	690	0.00
24.20	W4	U^Casuarina sp.\tree\6\i;M Acacia acuminata, Senna sp., Dodonaea sp.\shrub\3\r;G Ptilotus obovatus\forb\2\i	9227	0.04
141.30	W4	U Eucalyptus salmonophloia^Eucalyptus loxophleba,^Eucalyptus salubris\tree\7\I;M Acacia acuminata, Alyxia buxifolia, Choretrum sp.\shrub\4\i;G Cephalipterum drummondii, Helichrysum davenportii, Podolepis canescens\forb\1\i	644924	2.91
142.11	W4	U Eucalyptus salmonophloia^Eucalyptus loxophleba, Eucalyptus salubris\tree\7\I;M Acacia acuminata, Alyxia buxifolia, Choretrum sp.\shrub\4\i;G Cephalipterum drummondii, Helichrysum davenportii, Podolepis canescens\forb\1\i	11137	0.05
142.12	W4	U Eucalyptus salmonophloia^Eucalyptus loxophleba, Eucalyptus salubris\tree\7\i;M Acacia acuminata, Alyxia buxifolia, Choretrum sp.\shrub\4\i;G Cephalipterum drummondii, Helichrysum davenportii, Podolepis canescens\forb\1\i	86768	0.39
142.80	W4	U^Eucalyptus salmonophloia, Eucalyptus salubris, Eucalyptus oleosa\tree,mallee\7\i;M Acacia acuminata, Acacia ramulosa, Santalum spicatum\shrub\4\i;G Olearia muelleri, Ptilotus obovatus, Schoenia cassiniana\shrub,forb\2\i	20945	0.09
251.10	W4	U^Acacia aneura,^Casuarina cristata\tree\6\i;M Acacia acuminata, Senna sp., Dodonaea sp.\shrub\3\r;G Ptilotus obovatus\forb\2\i	25	0.00
416.10	W4	U^Acacia aneura,^Callitris columellaris\tree\6\i;M Acacia hemiteles, Senna artemisioides subsp. petiolaris, Eremophila decipiens\shrub\3\r;G Maireana sedifolia, Ptilotus obovatus\chenopod,forb\2\i	51	0.00
468.20	W4	U^Eucalyptus le souefii,^Eucalyptus salmonophloia, Eucalyptus leptophylla\tree,mallee\7\iG Cratystylis conocephala\shrub\2\i	83341	0.38
481.20	W4	U^Eucalyptus salmonophloia,^Eucalyptus oleosa, Eucalyptus leptophylla\tree,mallee\7\iG Cratystylis conocephala\shrub\2\i	799527	3.61

Code	Fuel Category	NVIS Level 5 (Vegetation Association) Description	Area (ha)	% of GWW BTA
505.10	W4	U^Allocasuarina cristata, Eucalyptus le souefii, Eucalyptus transcontinentalis\tree\6\i;M Eremophila oldfieldii, Dodonaea lobulata, Olearia muelleri\shrub,chenopod\4\r;G Stipa nitida\tussock grass\1\i	7841	0.04
537.10	W4	U Eucalyptus salmonophloia,^Eucalyptus longicornis, Eucalyptus salubris\tree\7\i;M Acacia aciphylla, Acacia acuminata, Acacia brachystachya\shrub\4\i;G Angianthus tomentosus, Anguillaria dioica, Podolepis gnaphalioides\forb\1\i	703	0.00
936.10	W4	U^Eucalyptus salmonophloia, Eucalyptus sp.\tree,mallee\7\i;M Melaleuca pauperiflora, Eremophila calorhabdos, Grevillea oncogyne\shrub\4\i;G Helichrysum adnatum\forb\1\i	130	0.00
936.80	W4	U^Eucalyptus salmonophloia,^Eucalyptus leptophylla,^Eucalyptus celastroides\tree,mallee\7\iG Cratystylis conocephala\shrub\2\i	64763	0.29
		Total Woodland Fuels	**11970121**	**54.03**

Explanation of codes for NVIS strata height descriptions.

Height		Growth Form				
Height Class	**Height Range**	Tree, vine, palm (single stemmed)	Shrub, heath shrub, chenopod shrub, fern, samphire shrub, cycad, tree-fern, grass tree, palm (multi-stemmed)	Tree mallee, mallee shrub	Tussock grass, hummock grass, other grass, sedge, rush, forb, vine	Bryophyte, lichen, seagrass, aquatic
8	>30	Tall				
7	10 – 30	Medium		Tall		
6	<10	Low		Medium		
5	<3			Low		
4	>2		Tall		Tall	
3	1 – 2		Medium		Tall	
2	0.5 – 1		Low		Medium	Tall
1	<0.5		Low		Low	Low

Explanation of codes for NVIS strata density descriptions.

Cover Code	**d**	**c**	**i**	**r**	**bi**
% Cover	>80	50 - 80	20 - 50	0.25 - 20	<0.25
Cover Descriptor	Dense	Dense	Moderate	Sparse	Sparse

Appendix 3: Declared Rare and Priority Flora of the Great Western Woodlands Bushfire Threat Analysis study area

Asset Category A (Declared Rare Flora)	
Adenanthos eyrei	Drummondita longifolia
Darwinia calothamnoides	Eremophila ciliata
Asset Category B (Declared Rare Flora)	
Acacia denticulosa	Gastrolobium graniticum
Acacia lanuginophylla	Isopogon robustus
Acacia lobulata	Leucopogon spectabilis
Anigozanthos bicolor subsp. minor	Marianthus aquilonaris
Banksia sphaerocarpa var. dolichostyla	Marianthus mollis
Boronia adamsiana	Melaleuca sciotostyla
Boronia revoluta	Muelleranthus crenulatus
Conospermum toddii	Myriophyllum lapidicola
Conostylis lepidospermoides	Rhizanthella gardneri
Daviesia microcarpa	Ricinocarpos brevis
Eremophila denticulata subsp. denticulata	Ricinocarpos trichophorus
Eremophila denticulata subsp. trisulca	Stylidium merrallii
Eucalyptus articulata	Tetratheca aphylla subsp. aphylla
Eucalyptus brevipes	Tetratheca aphylla subsp. megacarpa
Eucalyptus merrickiae	Tetratheca erubescens
Eucalyptus platydisca	Tetratheca harperi
Eucalyptus steedmanii	Tetratheca paynterae subsp. cremnobates
Eucalyptus synandra	Tetratheca paynterae subsp. paynterae
Frankenia parvula	
Asset Category B (Priority 1 Flora)	
Acacia diaphana	Darwinia sp. Mt Ney
Acacia dorsenna	Drummondita wilsonii
Acacia hystrix subsp. continua	Eremophila glabra subsp. Scaddan
Aotus prosacris	Eucalyptus jimberlanica
Astus duomilius	Euryomyrtus sp. Parker Range
Baeckea sp. Blue Haze Mine	Gastrolobium hians
Baeckea sp. Crossroads	Gastrolobium involutum
Baeckea sp. Lake Cronin	Goodenia heatheriana
Baeckea sp. Sheoaks Rocks	Grammosolen sp. Mt Ridley
Boronia baeckeacea subsp. patula	Hydrocotyle sp. Truslove
Bossiaea arcuata	Lepidosperma amentifera
Bossiaea aurantiaca	Lepidosperma ferriculmen
Bossiaea saxosa	Leptospermum macgillivrayi
Brachyloma sp. Forrestiana White	Leucopogon validus
Caesia sp. Ennuin	Micromyrtus papillosa
Darwinia sp. Gibson	Thryptomene sp. Mt Clara

Asset Category C (Priority 1 Flora)	
Acacia desertorum var. nudipes	Grevillea marriottii
Acacia tetraneura	Grevillea phillipsiana
Acacia websteri	Guichenotia anota
Allocasuarina globosa	Hibbertia axillibarba
Aotus lanea	Hibbertia carinata
Astartea sp. Esperance	Keraudrenia cacaobrunnea subsp. undulata
Baeckea grandibracteata subsp. Parker Range	Labichea eremaea
Baeckea sp. Exclamation Lake	Lepidosperma diurnum
Beyeria rostellata	Leucopogon remotus
Bossiaea simulata	Leucopogon rugulosus
Brachyloma nguba	Leucopogon sp. Bonnie Hill
Chorizema circinale	Melaleuca agathosmoides
Cryptandra exserta	Mirbelia taxifolia
Cyathostemon sp. Dowak	Myoporum velutinum
Dampiera scaevolina	Persoonia baeckeoides
Dicrastylis archeri	Persoonia leucopogon
Dicrastylis capitellata	Philotheca gardneri subsp. globosa
Eremophila lucida	Philotheca nutans
Eremophila praecox	Scaevola archeriana
Eucalyptus misella	Scaevola tortuosa
Eucalyptus myriadena subsp. parviflora	Stenanthemum liberum
Eucalyptus sp. Esperance	Stylidium validum
Eucalyptus websteriana subsp. norsemanica	Tecticornia flabelliformis
Eutaxia andocada	Teucrium sp. dwarf
Gastrolobium tenue	Verticordia roei subsp. meiogona
Gnephosis intonsa	Verticordia sieberi var. pachyphylla
Grevillea lullfitzii	
Asset Category C (Priority 2 Flora)	
Angianthus newbeyi	Darwinia luehmannii
Asteridea archeri	Gastrolobium pycnostachyum
Baeckea sp. North Ironcap	Gastrolobium tergiversum
Banksia prolata subsp. archeos	Goodenia corralina
Boronia coriacea	Gunniopsis sp. Nuytsland
Bossiaea laxa	Verticordia dasystylis subsp. dasystylis

Asset Category D (Priority 2 Flora)	
Acacia amyctica	Elachanthus pusillus
Acacia asepala	Eucalyptus fraseri subsp. melanobasis
Acacia concolorans	Eucalyptus litorea
Acacia heterochroa subsp. robertii	Eucalyptus surgens
Acacia kerryana	Eutaxia lasiocalyx
Acacia nitidula	Frankenia brachyphylla
Acacia subrigida	Gastrolobium acrocaroli
Andersonia carinata	Goodenia quadrilocularis
Angasomyrtus salina	Goodenia scapigera subsp. graniticola
Astartea sp. Jyndabinbin Rocks	Goodenia varia
Astus wittweri	Gratiola pedunculata
Baeckea sp. Mt Gibbs	Hakea pendens
Banksia epica	Hakea rigida
Banksia epimicta	Halgania sp. Peak Eleanora
Bentleya diminuta	Harperia eyreana
Boronia corynophylla	Hibbertia charlesii
Boronia westringioides	Lepidium merrallii
Caesia viscida	Lepidobolus spiralis
Chthonocephalus multiceps	Lissanthe scabra
Conospermum sigmoideum	Logania exilis
Conostephium uncinatum	Olearia laciniifolia
Could not fetch Species	Pimelea halophila
Cyathostemon sp. Lake King	Stenanthemum poicilum
Dampiera orchardii	Stylidium sejunctum
Darwinia sp. Mt Ragged	Stylidium thylax
Daviesia newbeyi	Verticordia multiflora subsp. solox
Dicrastylis obovata	Verticordia pulchella
Drosera salina	

Asset Category E (Priority 3 Flora)	
Acacia ancistrophylla var. perarcuata	Goodenia trichophylla
Acacia crenulata	Grevillea eriobotrya
Acacia cylindrica	Grevillea insignis subsp. elliotii
Acacia dissona var. indoloria	Grevillea pilosa subsp. redacta
Acacia filifolia	Gunniopsis rubra
Acacia formidabilis	Hibbertia pachyphylla
Acacia repanda	Isoetes brevicula
Acacia singula	Isolepis australiensis
Acacia undosa	Keraudrenia adenogyna
Austrostipa blackii	Lepidium genistoides
Baeckea sp. Elsewhere Road	Leucopogon florulentus
Baeckea sp. Hatter Hill	Leucopogon rotundifolius
Baeckea sp. Merredin	Leucopogon sp. Ironcaps
Baeckea sp. Parker Range	Menkea draboides
Banksia lullfitzii	Microcybe pauciflora subsp. grandis
Banksia rufa subsp. flavescens	Microseris scapigera
Banksia viscida	Mirbelia densiflora
Calytrix nematoclada	Parmeliopsis macrospora
Comesperma calcicola	Persoonia cymbifolia
Conostephium marchantiorum	Phebalium brachycalyx
Cryptandra polyclada subsp. polyclada	Pityrodia sp. Yilgarn
Daviesia elongata subsp. implexa	Prostanthera nanophylla
Dillwynia acerosa	Pseudactinia sp. Bungalbin Hill
Eucalyptus exigua	Pultenaea daena
Eucalyptus frenchiana	Schoenus benthamii
Euryomyrtus leptospermoides	Spartothamnella sp. Helena & Aurora Range
Eutaxia acanthoclada	Stenanthemum bremerense
Eutaxia actinophylla	Stenanthemum newbeyi
Eutaxia nanophylla	Stylidium choreanthum
Frankenia drummondii	Stylidium pulviniforme
Frankenia glomerata	Synaphea tripartita
Galium leptogonium	Tricoryne sp. Morawa
Gastrolobium semiteres	Verticordia gracilis
Gnephosis sp. Norseman	Verticordia mitodes
Gompholobium cinereum	Verticordia stenopetala
Gonocarpus pycnostachyus	
Asset Category F (Priority 4 Flora)	
Acacia merrickiae	Eucalyptus rhomboidea
Adenanthos ileticos	Grevillea prostrata
Allocasuarina hystricosa	Haegiela tatei
Banksia shanklandiorum	Kennedia beckxiana
Calamphoreus inflatus	Leucopogon compactus
Daviesia purpurascens	Microcorys sp.Forrestania
Eremophila biserrata	Myriophyllum petraeum
Eremophila caerulea subsp. merrallii	Prostanthera carrickiana
Eremophila racemosa	Pterostylis sp.Ongerup
Eremophila serpens	Sowerbaea multicaulis
Eucalyptus cerasiformis	Stachystemon vinosus

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