



# FIRE MANAGEMENT STRATEGY WOLLEMI NATIONAL PARK

*NSW National Parks & Wildlife Service (NPWS)  
Blue Mountains and Central Coast Hunter Range Regions*



Department of  
**Environment and Conservation (NSW)**  
NSW National Parks and Wildlife Service

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**FIRE MANAGEMENT STRATEGY  
WOLLEMI NATIONAL PARK**

NSW NPWS  
Central Coast Hunter Range and Blue Mountains Regions

## ACKNOWLEDGMENTS

This Fire Management Strategy was prepared by the Central Coast Hunter Range Region and the Blue Mountains Region of the NSW NPWS. The initial draft was completed in March 2003 by Donald MacDonald, Project Officer Central Coast Hunter Range Region with assistance from Lyndsay Holme BM Fire Technical Officer and was updated to November 2004 by Arthur Henry FMO Blue Mountains. It was placed on public exhibition in February 2005. Comments were collated and reviewed by Catherine Watt & Arthur Henry. The document was redrafted to Final in February 2006 by Arthur Henry, with amendments added by Lyndsay Holme in March 2006.

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## EXECUTIVE SUMMARY

### PLANNING AND CONSULTATIVE PROCESS

This Fire Management Strategy has been developed to provide direction for fire management activities, including bush fire suppression, in Wollemi National Park (NP). The Strategy will emphasise the protection of life and property as well as providing direction for land managers in the protection of the natural and cultural heritage of Wollemi NP.

Management guidelines have been determined by a combination of parameters including vegetation types, fuel types, fire history, appropriate access, fire's role in maintaining evolutionary processes and the potential risk to life, property and natural and cultural assets in the Wollemi NP area. Wollemi NP contains several plant species of conservation significance (including the Wollemi Pine) and a number of threatened fauna species. This Strategy will deal with the protection of these species through appropriate fire management regimes to preserve biodiversity.

This Strategy is the collation of information from NSW NPWS (NPWS) policies on fire management with ecological requirements to be taken into account in the fire planning for the Wollemi NP area.

In consultation with local BFMCS, volunteer Rural Fire Brigades, park neighbours and other stakeholders, areas have been prioritised for fuel management treatment by assessing bush fire threat to assets.

The co-operation of the community and implementation of *Community Fire Guard* will be important for the success of the Strategy. Neighbours will be encouraged to manage fuels near their own assets to complement work undertaken in the park.

Although every effort has been made to ensure accuracy of details from existing databases, additional information is continually being collected and management concepts and practices evolving. Therefore, it is proposed that this Strategy will have a shelf life of five years before a review is undertaken.

### FIRE MANAGEMENT OBJECTIVES AND PERFORMANCE INDICATORS

In accordance with Sections 63 & 64 and Part 1, Section 3 of the *Rural Fires Act (1997)* and with the *National Parks and Wildlife Act (1974)*; **the primary objectives for fire management in Wollemi NP are:**

***Objective 1: Protect persons and property, in, or adjacent to the Park from bush fires affecting the Park.***

***Indicators:***

- Number of significant injuries and property losses caused as a result of fire on or leaving the Park.
- Area (ha) of fire management activities undertaken (i.e. fuel monitoring, prescribed burns, mechanical fuel reduction).
- Length (km) of fire management access constructed or maintained.

***Objective 2: Manage fire regimes to protect water quality and the natural biodiversity of the Park and avoid the extinction of any species.***

***Indicators:***

- Proportion of Park managed for heritage, strategic and asset protection values.
- Proportion of Park managed within appropriate fire regime frequency tolerances.
- Population numbers and trends of endangered and other indicator species following post fire monitoring.

**Objective 3: Minimise the risk of arson in the Park.**

**Indicator:**

- Number and cause of ignitions

**Objective 4: Minimise the spread of unplanned fires within, from or into the Park.**

**Indicators:**

- Average area by tenure of individual unplanned fires affecting the Park.
- Number of unplanned fires affecting the Park with multiple tenures.

**Objective 5: Protect the Park's Aboriginal sites, historic places and culturally significant features from damage by bush fires.**

**Indicator:**

- Number of damaged Aboriginal sites, historic places and culturally significant features as a result of bush fires

## **TACTICS FOR FIRE MANAGEMENT**

Extensive remote areas in Wollemi NP contribute to suppression operations that are characterised by extended bush fire response times, campaign fires, poor radio communications, limited opportunities for vehicle access and a reliance on aircraft and remote area fire fighting teams in fire suppression operations. Furthermore extensive rural and urban interface areas require property protection when under threat from bush fires.

**Tactics for fire management include:**

- Prevent unplanned human related bush fires caused by arson, campers and Park visitors, illegal hazard reduction burns, powerlines and other miscellaneous sources.
- Maintain appropriate levels of fire preparedness and response capability in accordance with fire danger levels detailed in Regional Incident Procedures.
- Co-operate with fire management between the NPWS, the Upper Hunter, Mid Western, Hawkesbury and City of Lithgow Districts of the Rural Fire Service, Forests NSW, NSW Fire Brigades, other agencies and residents. This includes managing operations in accordance with Bush Fire Operations Plans, Risk Management Plans and the Wollemi NP Plan of Management.
- Manage suppression operations in accordance with the Incident Control System (ICS) to ensure a coordinated approach to the control, operations and logistics of suppression operations.
- Use helicopters and fixed wing aircraft for aerial surveillance of the Park following dry lightning storms; water bombing; aerial ignitions; and the insertion and extraction of RAFT teams.
- Use remote area fire fighting teams (RAFT) to suppress lightning strikes before the passage of severe fire weather and the development of campaign fires.
- Maintain of fire trails, other fire management utilities and equipment to enable rapid and effective suppression of ignitions.

- Use and maintain of bush fire intelligence systems including geographic information systems (GIS), weather and climatic data, FLIR, Line-scan and satellite imagery.
- Implement minimal impact operational guidelines for the construction of temporary control lines.
- Implement a strategic fuel management program that involves prescribed burning and mechanical fuel reduction within the guidelines identified by this Strategy.
- Rehabilitate significant impacts on natural and cultural heritage values that have been damaged as part of the suppression operations.
- Investigate arson related ignitions and pursue legal action where possible.
- Manage ignitions to achieve ecological advantages where possible.

## **TACTICS FOR LIFE AND PROPERTY PROTECTION**

The protection of life and property is a primary objective for NPWS fire management. During bush fire suppression operations and prescribed burns there is a high risk of injury or death to fire fighters, neighbours and visitors to the Park. Property and other assets that may be damaged or destroyed by bush fires include urban interface areas, rural properties, in- holdings, utilities such as powerlines, and timber production from neighbouring State forest.

### **Tactics for life and property protection include:**

- Promote Local Government to consider the need for fire radiation zones and fire trail access to be built into new development proposals in accordance with, "Planning for Bush Fire Protection" (NSW Rural Fire Service, 2001), and the Australian Standards, "Construction of Buildings in Bush fire-Prone Areas AS3959-1991".
- Maintain and develop asset registers for properties adjacent to the Park in conjunction with local Bush Fire Management Committees (local BFMCs) to enable the properties to be identified during suppression operations.
- Implement a strategic fuel management program that involves prescribed burning, and mechanical fuel reduction within Strategic Fire Management Zones (SFMZ) and Asset Protection Zones (APZ) adjacent to neighbours and Park facilities.
- Maintain and develop fuel monitoring programs at permanent fuel sampling sites in Asset Protection and Strategic Fire Management Zone areas.
- Detect and suppress bush fires posing a threat to life and property and other infrastructure assets early.
- Maintain a strategic network of fire trails and slash trails in preparedness for rapid response following detection.
- Supporting local BFMCs in the promotion of Community Fire Guard, fire wise education neighbourhood watch, and fuel management activities to ensure neighbours take appropriate measures to counter bush fire threats to their life and property.
- Promote fire safety to Park visitors through NPWS offices, interpretation facilities, media and NPWS Discovery (community education) programs.
- Closing the Park to visitors during periods of significant fire danger.
- Manage the impact of smoke from fire on sensitive areas such as hospitals, nursing homes, schools and transport infrastructure.

## **TACTICS FOR HERITAGE MANAGEMENT**

There are significant natural and cultural heritage values at a high risk of damage from bush fires and fire management operations within Wollemi NP.

### **Tactics for Heritage Management include:**

- Maintaining and updating Geographic Information System (GIS) databases of natural and cultural heritage information so that significant values can be identified and protected where possible during fire management operations.
- Undertake an appropriate assessment (where possible) and implement controls to minimise environmental impacts prior to fire management operations.
- Utilise minimal impact suppression techniques to prevent long term damage to heritage values.
- Manage fire suppression operations within the guidelines for threatened flora and fauna and vegetation communities identified in this Strategy.
- Identify areas where fire regimes have exceeded thresholds and promoting fire exclusion to enable regeneration of vegetation communities.
- Maintain a diversity of fire regimes for the purpose of creating a mosaic of communities with different ages and structures.
- Maintain and develop biodiversity monitoring programs in fire sensitive plant communities.
- Promote ecological research on the effects of fire on the natural resources of the park and disseminating findings to fire management authorities;

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## **INTRODUCTION**

### **Scope and Purpose**

Under the *Rural Fires Act 1997*, the NPWS is a prescribed fire organisation and is responsible for the control and suppression of all fires on areas that it manages.

This Strategy has been prepared in accordance with the policies and procedures detailed in the NPWS Fire Management Manual, NPWS Strategy for Fire Management and the Wollemi National Park Plan of Management. The Strategy has considered the bush fire environment, bush fire risks and management tactics, prescribed burning program and priorities identified in the Sydney Basin Fire Management Strategy, and cooperative fire fighting agreements outlined in the relevant District BFMC Risk Management and Operations Plans

Section 50 of the *Rural Fires Act 1997* sets up provisions for the establishment of local BFMCs with the task of developing and coordinating cooperative fire management between fire authorities across the State. NPWS is a member of these committees that are responsible for the development of both cooperative fire fighting and programs and strategies for the prevention, mitigation and suppression of bush fire hazards.

Within the scope of this Strategy NPWS is an active member of the following District BFMCs:

- Singleton District BFMC
- Muswellbrook District BFMC
- Rylstone District BFMC
- Hawkesbury District BFMC
- Greater Lithgow District BFMC

Under Section 52 of the *Rural Fires Act 1997*, each District BFMC is to prepare two kinds of bush fire management plans for the rural fire district or other part of the State for which it is constituted. These plans are:

- A plan of operations, and
- A bush fire risk management plan.

This Fire Management Strategy is a relevant plan for the purposes of Sections 38 s4 and 44 s3 of the *Rural Fires Act, 1997*, and should be implemented accordingly.

### **The Planning Environment**

#### **Legislation**

NPWS has statutory obligations under the *Rural Fires Act 1997* to protect life and property on its lands and to prevent fire from leaving its property. Under the *National Parks and Wildlife Act 1974* NPWS is responsible for the conservation of the natural and cultural heritage of NSW.

High frequency fires which result in the disruption of life cycle processes in plants and animals and the loss of vegetation structure and composition, has been listed as a key threatening process under this Act and has important implications for fire management. These obligations, though not mutually exclusive, require a flexible approach to fire management.

The NPWS must give appropriate consideration in its fire management planning to the requirements of protection for both human life and property as well as the protection of the environment. Thus, by its fire management policies the NPWS must not only safeguard the direct protection of human life, it must also ensure the protection, for future generations, of the natural and cultural values of NSW.

As a public authority and as a fire fighting authority under the *Rural Fires Act 1997* the NPWS has certain rights and responsibilities to undertake appropriate measures to prevent fire from entering or leaving its estate. As a prescribed organisation the NPWS is required to implement the provisions of Bush Fire Management Plans. The Service may act to suppress fires up to eight kilometres from its Park boundaries in collaboration with local brigades and park neighbours in accordance with provisions of local Bush fire Management Plans. Section 1.3.2 of the NPWS Fire Management Strategy details the role of the NPWS in fire management.

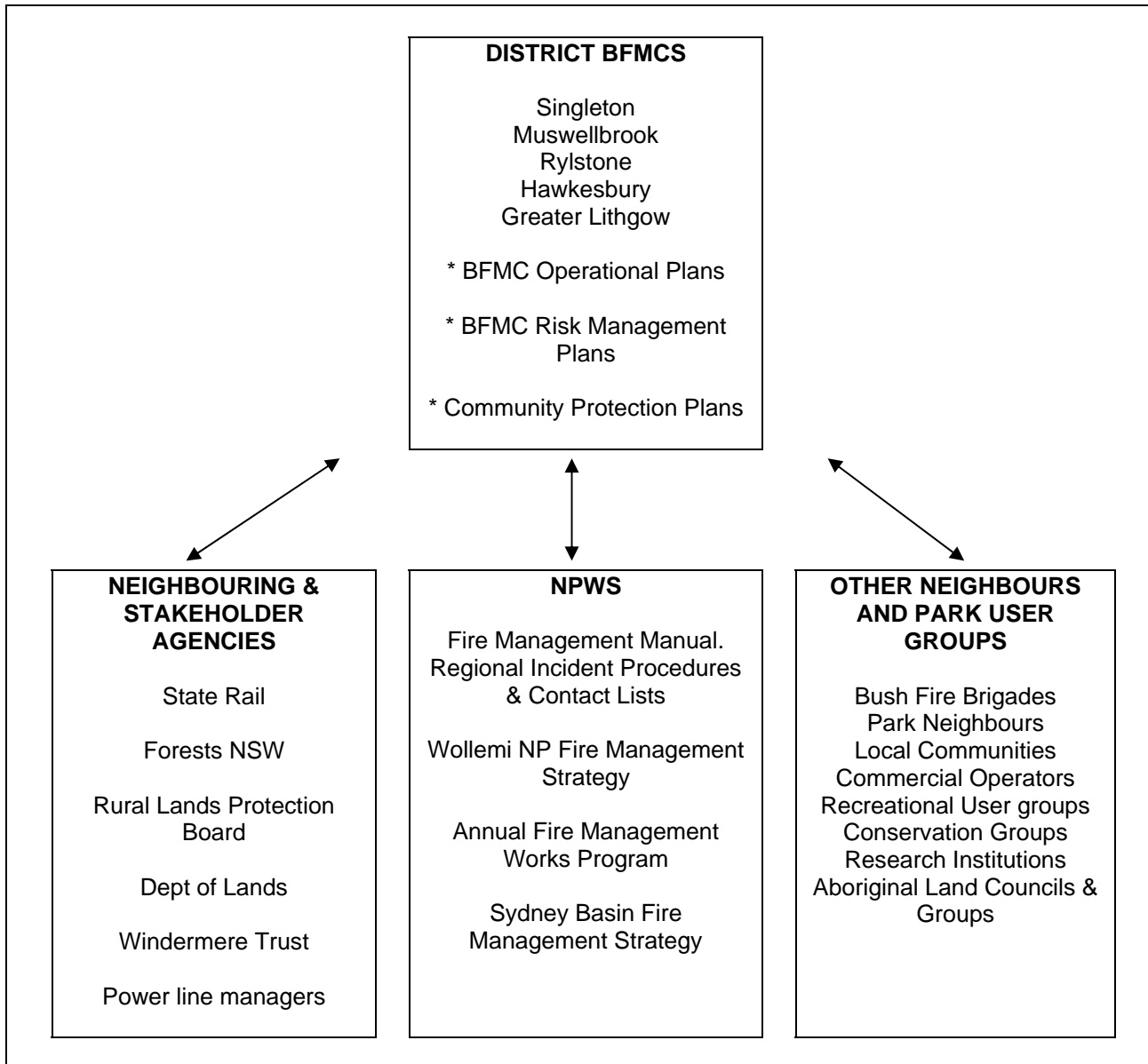
Other relevant legislation for fire management includes the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* as this park is managed as a World Heritage Area.

### **Management Objectives of the Park**

The management of the park is prescribed by objectives stated in the *National Parks and Wildlife Act 1974*. It is a requirement under that Act that no operations and actions are to be undertaken which are contrary to the Plan of Management. The *Wollemi NP Plan of Management (2001)* states the following general objectives:

- Protection and preservation of the scenic and natural features;
- Conservation of native plants and animals;
- Maintenance of natural processes;
- Protection and preservation of cultural resources;
- Provision of appropriate recreational opportunities;
- The encouragement of scientific and educational inquiry into environmental features and processes, prehistoric and historic features and into park use patterns.

**Figure 1: Planning Relationships and Responsibilities for Fire Management in Wollemi NP**



In addition, the *Wollemi NP Plan of Management* states the following specific management objectives for Wollemi NP

- To manage Wollemi NP in recognition of its role as a part of a contiguous system of parks, reserves and other protected lands;
- To maintain the Park's biodiversity with an emphasis on the protection of threatened species;
- To protect and where necessary restore areas to a wilderness condition within the Wollemi Wilderness;
- To protect the Park's catchment value;
- To provide and manage wilderness recreation opportunities;
- To provide developed recreation destinations at selected areas on the edges of the park with emphasis on:
  - wilderness values
  - natural and cultural heritage values
  - threatening processes and minimal impact use
  - community participation in Park management.

### **Wilderness**

In addition to the management requirements of a NP, the majority of the Park is also managed as part of the Wollemi Wilderness Area.

The *Wilderness Act 1987* defines wilderness as an area that together with its plant and animal communities, is in a state that has not been substantially modified by humans and their works, or is capable of being restored to such a state. The area must be of sufficient size to make its maintenance in such a state feasible and the area must be capable of providing opportunities for solitude and appropriate self-reliant recreation. Maintenance of these qualities must therefore be considered by this Fire Management Strategy.

The NPWS Wilderness Conservation Policy (NPWS, 1989) identifies five protection and management objectives for wilderness areas. These objectives apply to the Wollemi Wilderness Area and are as follows:

- The identification and subsequent management of large areas that clearly approach wilderness condition, or can be restored to that condition;
- The conservation of the natural features and processes of wilderness areas is a primary consideration, with minimum human interference;
- The conservation of significant cultural resources in the wilderness areas in accordance with the Burra Charter;
- The maintenance of opportunities for solitude and compatible self-reliant recreation and the exclusion of activities which conflict with or diminish these opportunities;
- The encouragement of public awareness and appropriate use of wilderness.

### **Fire management policies of NPWS**

NPWS policies concerning fire and fire management are detailed in the NPWS Fire Management Manual. They include the following:

- NPWS regards fire as a natural phenomenon - one of the continuing physical factors of the Australian environment;
- NPWS recognises the evolutionary adaptation of many native species of plants and animals to fire regimes;
- NPWS accepts that fire can be a useful management tool;
- Fire is and will be used as a fuel reducing agent where this does not conflict with management

objectives;

- Where life and property are directly threatened by fuel conditions, all steps will be taken to minimise risks, with other management needs regarded as secondary considerations.

All prevention and suppression works will, where possible, be pre-planned and coordinated with neighbour and other agencies likely to be affected by NPWS activities. The NPWS will undertake fire prevention programs, through public education and through local supervision and enforcement of the Acts and Regulations applying to fires.

### **Local-Regional Environmental Plans**

Wollemi NP lies within five Local Government Areas, specifically, Singleton Shire, Muswellbrook Shire, Mid Western Regional, Hawkesbury and City of Greater Lithgow.

The planning instruments that set the general direction for land use regulations are the *Local Environment Plan* and the *Development Control Plan (DCP)* pursuant to Section 72 of the *Environmental Planning and Assessment Act 1979*, for each of these local government areas.

As defined in the New South Wales Government Gazette No. 81: Part 8 (Environmental Protection and Nature Conservation), Wollemi NP is *Zone 8: National Parks and Nature Reserve Zone* in these plans. In *Zone 8* an activity can be carried out *without* development consent if it is authorised by or under the *National Parks and Wildlife Act 1974*. Any other development that does not come under this category is prohibited on land zoned *Zone 8*.

NPWS is permitted to carry out bush fire hazard reduction activities under SEPP 4, 11 D, under its current zoning.

### **State Environmental Planning Policies**

State Environmental Planning Policies (SEPPs) generally only apply when development consent is being sought from a council and does not apply to land dedicated or reserved under the *NP&W Act*. The NPWS has adopted a process of environmental assessment which is consistent with the principles for environmental protection outlined under various SEPPs.

SEPPs relevant to Wollemi NP include:

- SEPP 44, Koala Habitat Protection,

### **Fire management policies-regulations of involved organisations**

The *Rural Fires Act 1997* requires each local BFMC to prepare and submit a Bush Fire Risk Management Plan and Operational Plan, to co-ordinate the activities of organisations for the prevention, control and suppression of bush fires.

The Singleton, Muswellbrook, Rylstone, Hawkesbury and Greater Lithgow local BFMCs have adopted coordinated fire fighting policies based on the Policy Statement of the Bush Fire Co-ordinating Committee (BFCC) and the Manual of Procedures for Co-ordinated Fire Fighting.

The Wollemi NP Fire Management Strategy will form part of the NPWS input into the Plan of Operations and Bush fire Risk Management Plans for the Singleton, Muswellbrook, Rylstone, Hawkesbury and Greater Lithgow local BFMCs.

### **NSW Biodiversity Strategy**

The *NSW Biodiversity Strategy (1999)* was developed by the New South Wales Government and develops a collaborative approach to biodiversity conservation. This Strategy's over-riding goal is: "to protect the native biological diversity of NSW and maintain ecological processes and systems".

To this end, inappropriate fire regimes have been identified as one of the seven key threatening processes that is affecting the biological diversity of NSW. This issue is targeted within the Biodiversity Strategy through:

Action 43: manage fire in accordance with ecologically sustainable development principles

Action 44: improve the consideration of fire threat in land-use planning and incorporate the results of applied fire research, including the knowledge and experience of Aboriginal and local communities, inland management and land-use planning

Action 45: continue a research program to examine the effects of fire on biodiversity.



## **DESCRIPTION OF THE PARK**

### **Location**

Wollemi NP extends from near Windsor in the south to Denman in the north and west from the Putty Road to Glen Alice (**Figure** ). Wollemi NP covers over 501,376 hectares of rugged dissected plateaus in the Sydney Basin. It is part of a large unmodified area of sandstone landscapes that are substantially protected in the system of conservation areas surrounding Sydney.

The Park is contiguous with other major conservation areas within the Sydney Basin including Blue Mountains NP to the south, Yengo NP to the east and Goulburn River NP to the north.

### **Terrain**

Wollemi NP encompasses the western edge of the sedimentary Sydney Basin. The geology of the park is predominantly Narrabeen sandstone and claystones, characterised by a highly dissected landscape of deep valleys, clifflines and canyons.

The deeply dissected valleys of Wollemi NP with clifflines and watercourses can often provide natural barriers to bush fire and aid in the containment or suppression of these fires. Conversely these valleys provide few options for vehicle based fire fighting or the use of bulldozers and graders to construct fire breaks. There is consequently a heavy reliance on using fire-fighters who are trained for remote area work and that are able to contend with rugged, difficult to traverse terrain, supported by aircraft for access, backup safety, and water bucketing support if possible.

### **Biodiversity**

#### **Flora**

Preliminary broad-scale vegetation studies have been completed for the park at 1:100,000 and 1:25,000 scales. Systematic surveying of plant communities was conducted in the park in 1997 by Bell (1998). Various small scale surveys have been done over the last 5 years and the data included in the 1998 survey and analysis by Bell (1998). McRae and Cooper (1985) and Benson and Keith (1990) also provide an indication of the plant communities and species that occur in some parts of the park.

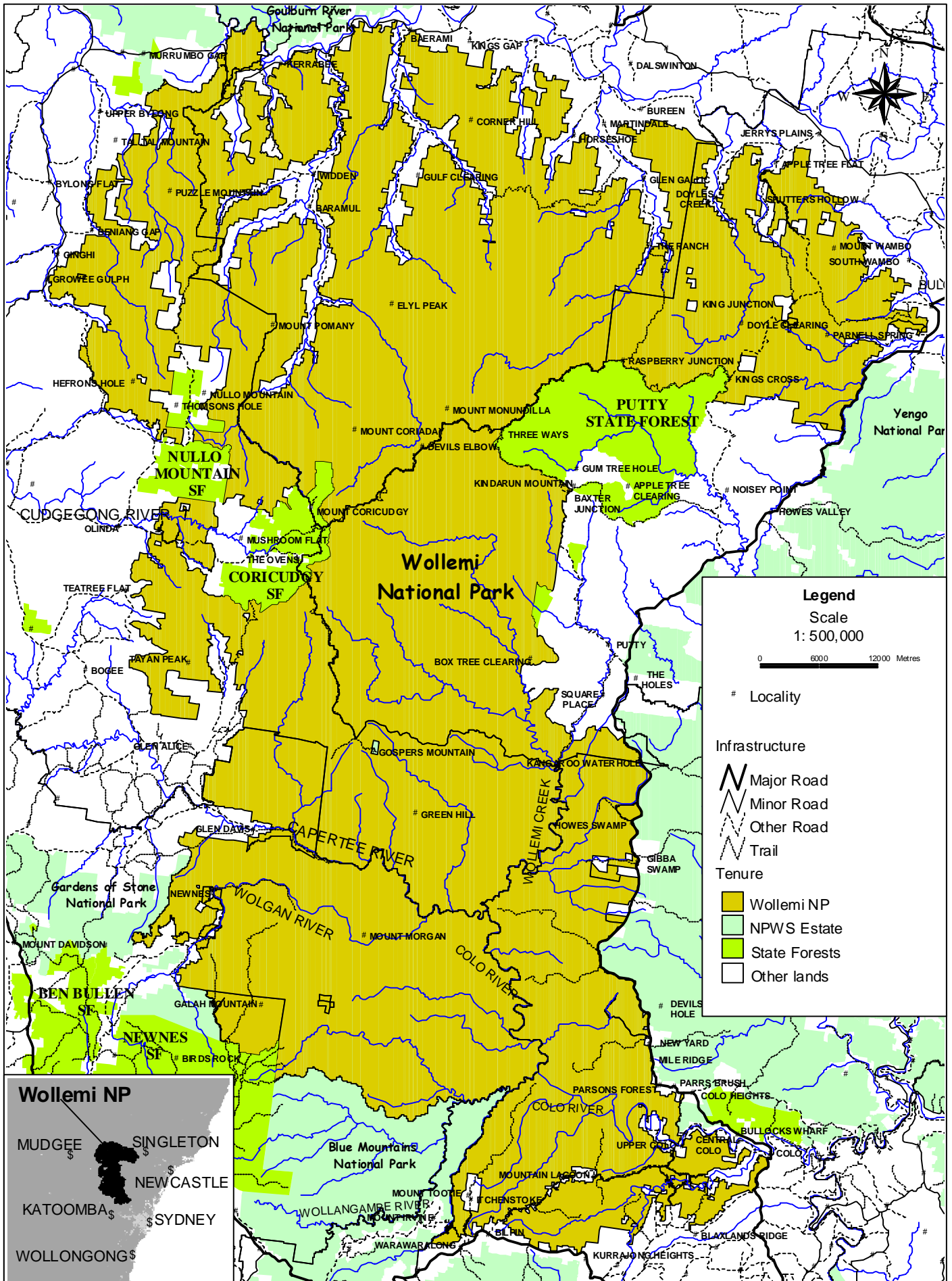
#### **Vegetation Communities**

Seventy eight vegetation communities have been identified within Wollemi NP (see Figure 3). Structural vegetation community types include rainforest, forest, woodland, heath, scrub, shrub-land, shrub-swamp, herb-field, bog, sedge-land, reed-land and grassland (Bell, 1998).

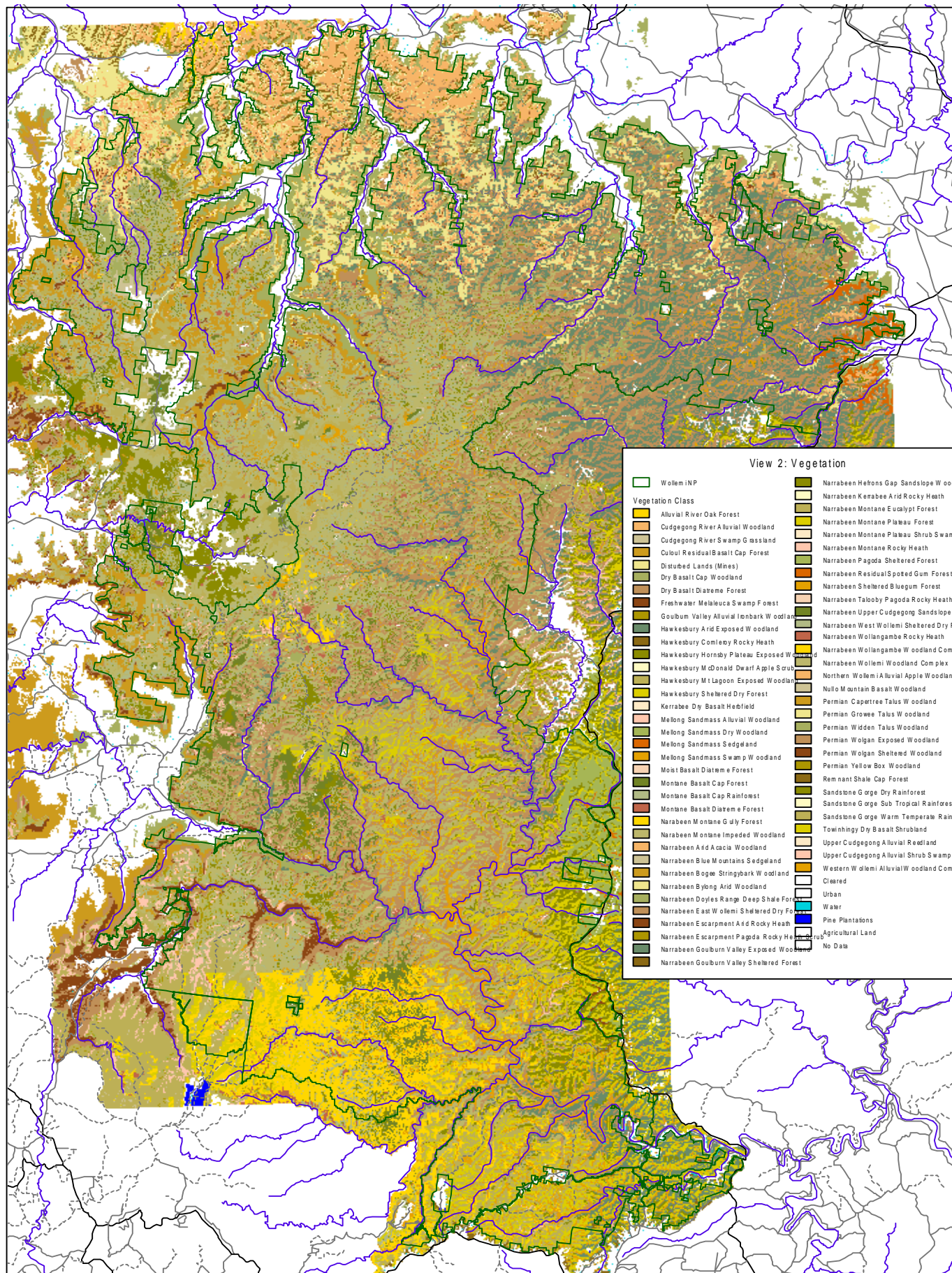
The predominant vegetation types within the park are the fire prone eucalypt dominated open forests on steep sandstone-shale terrain. These communities cover approximately 90% of the park. The pattern of eucalypt vegetation is largely mosaic with occasional distinctive communities such as rainforest, heath and grassy knolls.

Approximately 40% of the vegetation is composed of a Sheltered Dry Sandstone Forest. Other significant structural types include the Northern Escarpment Woodlands (9.1%), Exposed Hawkesbury Woodland (8.6%) and Grey Box Woodland (7.3%). Nearly 4% of the park is composed of rainforest types. 73 species of eucalypt have been recorded in the park.

Figure 2: Location of Wollemi NP



**Figure 3: Vegetation Communities of Wollemi NP**



The majority of the sandstone-based vegetation types are well conserved within the region, although several occur only in restricted locations and are therefore more sensitive to management decisions. Vegetation supported on enriched soils, such as the basalt caps and diatremes, and the residual shale caps in the south-east, are also restricted in occurrence, and historically have been subject to grazing or clearing. Alluvium-based vegetation also has a history of disturbance, and these are consequently less well conserved. (Bell 1998b)

### **Flora Species**

Over 1,360 vascular plant species have been recorded within Wollemi NP, with seventy species of conservation significance identified. Of this seventy species, 11 species are listed on Schedule 1 (Endangered) of the *NSW Threatened Species Conservation Act (1995)*; 24 species listed on Schedule 2 (Vulnerable) of this *Act* (see Appendix 4); and 41 species classified as Rare or Threatened (ROTAP) as listed in Briggs and Leigh (1996). An additional three species were collected during the 1998 survey which are likely to be described as new species at some time in the future (Bell 1998). Appendix 4 details flora species listed under the *Threatened Species Conservation Act, 1995*, that likely occur within the Park

The Wollemi Pine, *Wollemia nobilis* was discovered in late 1994 and is a local endemic species. It occurs in a remote section of Coachwood-Sassafras Warm Temperate Rainforest in a deep sheltered canyon of the park. It is assumed that hot fires will kill individuals and that catastrophic fire is a threat to the known populations, however, there is evidence of the site being exposed to a fire event in the past. An appropriate disturbance regime may be required to ensure the long-term viability of populations in the wild.

### **Fauna**

To date, over 90 reptiles and amphibians, 235 birds and 46 mammals have been recorded within Wollemi NP. In general, knowledge of the fire management requirements for animal species is not as advanced as that for plants. Despite this, NPWS fire management considers animals and plants to be interrelated. In implementing fire regime guidelines for vegetation communities, it is understood that vegetation cover and structure forms an important component of habitat and refuge for animals during fire events.

The varied topography and vegetation within the park provides a wide diversity of habitats for native animals. The habitats with the greatest diversity of native animals are the ecotones or areas where plant communities overlap. They add considerably to the overall biodiversity of the park. Other significant habitats occur as pocket-like environments such as basalt caps, alluvial gullies, heaths, rainforest and wet sclerophyll forests. The most widespread and abundant habitat types are the eucalypt dominated forest complex on Triassic sandstone.

This Strategy provides for minimising the occurrence and severity of large bush fires, and enhancing burn patchiness. Furthermore, it is understood that establishing a mosaic of burns, including recently burnt and long unburnt areas at different ages will enhance flora biodiversity of the Park. Appendix 3 details fauna species listed under the *Threatened Species Conservation Act, 1995*, that likely occur within the Park.

### **Reptiles and Amphibians**

Over 90 reptiles and amphibians have been recorded within Wollemi NP. A number of these species have been listed as threatened under the *Threatened Species Conservation Act 1995*, including the Broad-headed Snake (*Hoplocephalus bungaroides*) and Booroolong Frog (*Litoria booroolongensis*). Vulnerable species known to occur within the park include the Giant Burrowing Frog (*Heleioporus australiacus*), Stuttering Frog (*Mixophyes balbus*), Heath Monitor (*Varanus rosenbergi*) and Red-crowned Toadlet (*Pseudophryne australis*).

### **Birds**

Over 235 species of bird have been recorded within Wollemi NP, of which two are listed under Schedule 1 (Endangered) and 10 under Schedule 2 (Vulnerable) of the *NSW Threatened Species Conservation Act, 1995* (see Appendix 3). Endangered species known to occur within the park include the Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Xanthomyza phrygia*).

Vulnerable species include the Glossy Black-cockatoo (*Calyptorhynchus lathami*), Black Bittern (*Ixobrychus flavicollis*), Swift Parrot (*Lathamus discolor*), Square-tailed Kite (*Lophoictinia isura*), Turquoise Parrot (*Neophema pulchella*), Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*), Marbled Frogmouth (*Podargus ocellatus*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*).

The Regent Honeyeater (*Xanthomyza phrygia*) for example, occurs as a nomadic opportunist with very specific nesting requirements in mature Ironbark and Red-Yellow Box communities. This type of habitat is rare in the park. Their core nesting period is from the beginning of August to the end of November, and their primary food source is only available from mature trees. Under these circumstances a hot (high intensity) fire in this vegetation community can have a major impact on their breeding success over a number of years.

### **Mammals**

46 mammal species have been recorded within Wollemi NP. Of these, 12 species are listed as Vulnerable under Schedule 2 of the *Threatened Species Conservation Act, 1995* (see Appendix 3).

Seven vulnerable bat species have been recorded within the park. Species include the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Little Bent-wing Bat (*Miniopterus australis*), East Coast Freetail Bat (*Mormopterus norfolkensis*), Large-footed Myotis (*Myotis adversus*), Eastern Cave Bat (*Vespadelus troughtoni*), Large Pied Bat (*Chalinolobus dwyeri*) and the Greater Broad-Nose Bat (*Scoteanax rueppellii*).

The Brush-tailed Rock Wallaby (*Petrogale penicillata*), is also known to occur within the park in populations at both the northern and southern areas of the park where suitable rock habitats on exposed aspects are found. Wollemi NP plays a major regional and national role in the conservation of this species.

Reported sightings within the park of the threatened Squirrel Glider (*Petaurus norfolcensis*) and the Brush-Tailed Phascogale (*Phascogale tapoatafa*) require confirmation. Isolated sightings of other threatened species including the Koala (*Phascolarctos cinereus*) and Tiger Quoll (*Dasyurus maculatus*) and common sightings of the Yellow-bellied Glider (*Petaurus australis*) have also been reported. Koalas have been recorded from Colo Heights, Howes Valley, Newnes and the Mellong Swamps.

Other important animal species occurring within the park include the New Holland Mouse (*Pseudomys novaehollandiae*), the Northern Brown Bandicoot (*Isodon macrourus*) and the Platypus (*Ornithorhynchus anatinus*).

## **Cultural Heritage**

### **Aboriginal Heritage**

Wollemi NP lies within four Local Aboriginal Land Council Areas. Specifically, Wanaruah, Windradyne, Metropolitan and Deerubbin. There are also a number of other Aboriginal stakeholder groups that have a cultural connection to the Park.

Over 120 known and recorded Aboriginal sites lie within Wollemi NP. This includes the recently discovered 'Eagles Reach' site. It is likely that many more sites and places have not been re-discovered and registered.

Aboriginal people occupied the area now known as Wollemi NP for at least 12,000 years prior to European settlement. Evidence of occupation includes open campsites, occupation deposits in sandstone shelters, rock art, rock engravings, burials, scarred trees, ceremonial grounds, stone arrangements and grinding grooves.

Risks to these sites are from inadvertent destruction of grinding grooves, stone arrangements and campsites by heavy plant machinery and the exfoliation and blackening of art sites by smoke and heat.

### **Historic Heritage**

As a result of being agriculturally unproductive, large areas of the park remain largely unoccupied and undisturbed by Europeans. There was, however, some limited use of the area for agriculture, forestry and shale oil mining and in more recent times for defence force exercises.

Wollemi NP has 64 recorded historic places that contain physical evidence of past land-use. These relics include fences, huts, building foundations, stockyards, early roads and railways, shale oil mines and associated structures.

Shale oil at Newnes and Baerami was mined in the first half of this century and the remains of this activity constitute an important historic resource of the park.

Although most of the structures are now only ground level foundations, the sites and functions are well documented. Many historic features associated with the shale oil mines and railway still exist, such as the tunnels at Newnes and remnants of oil refining structures, rail and road systems and the Glen Davis-Newnes pipeline. The Baerami oil shale mines site in the Baerami Valley to the north of the park is a much smaller development than that at Newnes.

In addition, several stockman's huts are conserved within the Park (Ashley, 1992). These huts are examples of the simple, small shelters developed for rough bush winter grazing, commonly associated with grassy clearings. Pre-fire season maintenance around these huts is currently carried out and they are occasionally used as a base and refuge area for fire-fighting operations during bush fires.

### **Recreational Use and Facilities**

The rugged terrain of Wollemi NP and its relative inaccessibility have been strong determining factors on both the style and location of recreational use of the park. Most recreational activity has occurred around the edges although wilderness treks in remote areas have increased.

In recent years, recreation has expanded to include various types of day and overnight use of the more accessible parts of the park. Day use is currently concentrated in the Colo area because of its proximity to the Sydney metropolitan area and the availability of permanent water. Dunns Swamp, Glen Davis, Deep Pass and the Newnes/Glow Worm Tunnel precinct on the western side of the Park are also popular locations for picnicking and car-based camping.

The recreational use of Wollemi NP is predicted to increase as the metropolitan areas of Sydney and Newcastle expand and the demand for outdoor recreation, particularly self-reliant adventure activities in natural settings increases. Adventure activities such as canyoning and abseiling are growing in popularity in the Capertee, Wolgan and Wollangambe River valleys. This increases the risk of visitors starting fires in remote areas, but is a small risk when considering the small number of visitors, especially in summer. Of more concern is the possibility of visitors being overtaken by fires lit by lightning strikes during summer. Due to the deeply dissected nature of Wollemi NP visitors to the Wilderness Area may be unaware of an approaching fire. For this reason Wollemi NP may be closed during periods of significant fire danger.

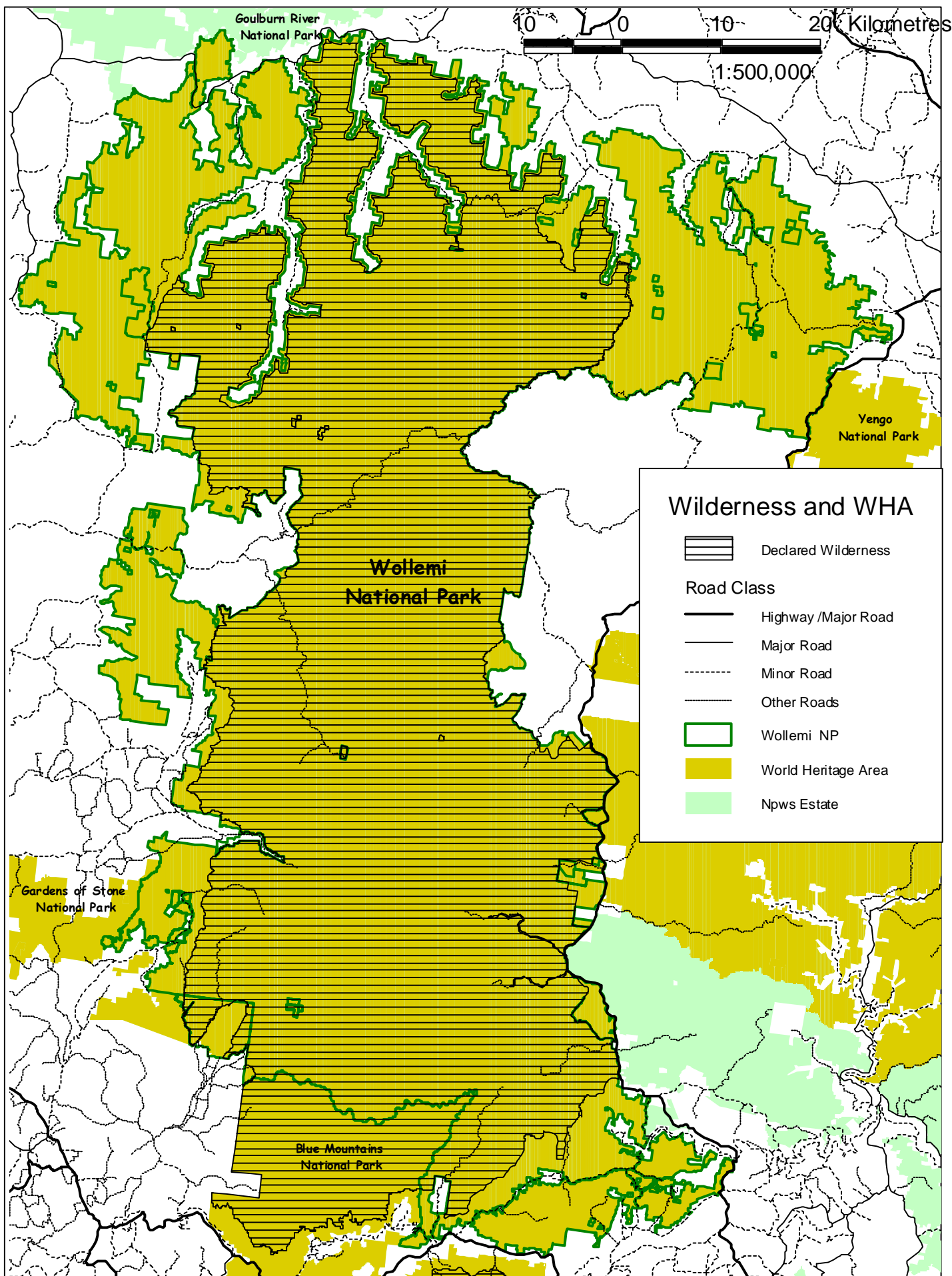
### **Wilderness and World Heritage Area**

#### **Wollemi Wilderness Area**

361,168ha of the Park has been declared wilderness under the *Wilderness Act 1997* as the Wollemi Wilderness (NPWS 1997). While the wilderness area requires particular management policies, it will continue to be actively managed for fire to meet the objectives of this fire Strategy. This includes the retention and maintenance of essential management trails, however, no new

roads, fire trails or signs will be constructed within the Wilderness Area. The boundary of the wilderness area in relation to the park is shown in Figure 4.

Figure 4 - Wollemi NP Wilderness and World Heritage Values





### **Greater Blue Mountains World Heritage Area**

The Park also forms a significant part of the Greater Blue Mountains WHA (James 1994; and NPWS and Environment Australia 1998a). WHA is considered a matter of National Environmental Significance (NES) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

### **In-holdings, Neighbours and Alien uses**

Neighbouring property tenure includes State forests, crown land and private property. Private property to the north of the Park consists mainly of large-scale rural holdings, with coal mines and small farms making up the balance, whilst to the south, neighbouring properties are considerably smaller. No substantial tourist facilities or tourism businesses adjoin the Park.

Five State forests adjoin Wollemi NP (Putty, Nullo Mountain, Coricudgy Comleroy and Newnes). There has always been close liaison between Forests NSW and NPWS on fire management matters to protect these community assets. Newnes State Forest pine plantation is located south-west of the Park. At their present age, the trees are a valuable resource to the local timber industry. Fires occurring in the south-western section of the Park could threaten the forest plantation as the logging debris is extremely flammable and trees are readily killed by fire.

The Park currently has over 30 in-holdings (private property completely surrounded by NP), ranging in size from a few hectares to grazing properties of over 2,000 ha. Over the years since gazettal of the Park in 1979 most of the permissive occupancies for grazing have been revoked or abandoned and together with them has gone the lighting of the bush for winter 'green pick' feed for cattle. Preventing bush fires from entering these in-holding properties is now the norm and where necessary co-operative fuel management burns are carried out to protect these property assets.

Another significant community asset running north to south through the eastern side of Wollemi NP is the 330 KV Bayswater Power Station to Sydney West power line. This line carries up to 75% of the electricity for Sydney. During the major bush fires of January 1994, 1997/8 and 2002/3 the heavy smoke and heat affected the power line as the fire passed under the line. Managers of the line need to be made aware of major fires that may potentially impact upon the transmission of electricity to Sydney so that alternative arrangements can be made.

Although it does not have a continuous maintenance road directly under it, the maintenance road and / or clearing under the power line has been used in the past as a control line for bush fires. Transgrid, managers of the line, do not consider there to be a significant risk to fire fighters in using these trails as control lines (pers. Comm. Andrew Power, Transgrid, 1998) however policy and procedures exist in the NPWS Fire Management Manual for operations close to powerlines.

## BUSH FIRE ENVIRONMENT

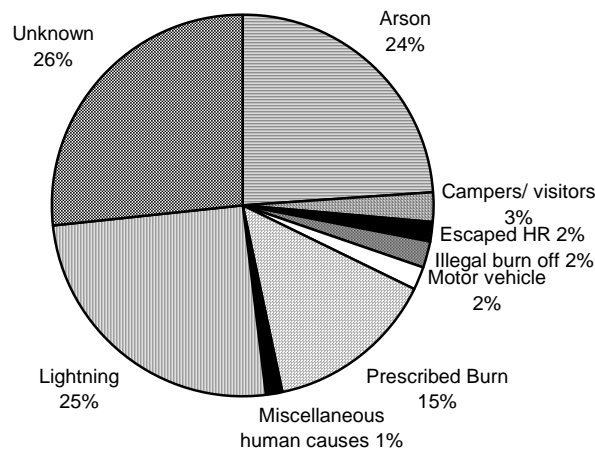
### Fire History and Frequency

Fire has long been a regular feature of the Park's environment. Fire history records for Wollemi NP date back to 1957. Little fire history information is available for the Park prior to major fires in 1957. Records have been compiled from NPWS original maps and incident reports, NSW Rural Fire Service, NSW State Forests and anecdotal evidence from NPWS staff, local fire brigade members, and Park neighbours. This data is stored in Geographic Information System (GIS) data bases and used in fire management planning and suppression operations.

### Bush fire Ignitions

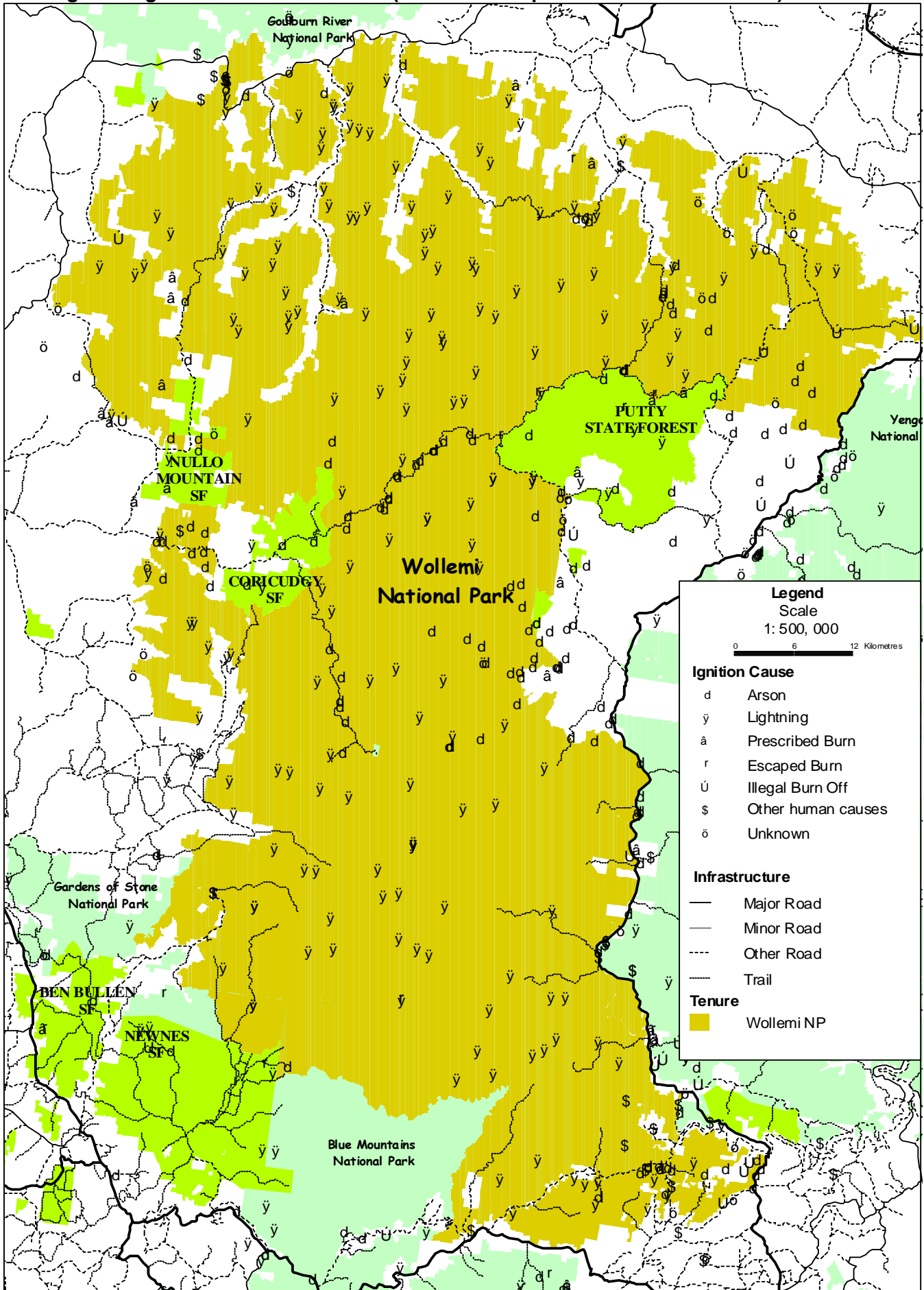
Wollemi NP generally has a high ignition potential (NSW BFCC, 1998) with an average of 20 fires per year. Figure 5 shows the break down of ignition causes in the vicinity of the Park. As can be seen from the chart human causes of bush fires (including prescribed burns) account for 49% of all known fires with the remainder of known causes attributed to lightning strikes. In the study area the cause of 26% of fires is unknown. This is in part due to limited information and a lack of post fire investigation and reporting particularly for older records. However it has been recognised over the last decade that the number of human caused bush fires is declining with statistics indicating that 66% of fires originate from lightning, 28% from human causes and 6% from unknown causes.

**Figure 5: Causes of Bush fire Ignitions in the vicinity of Wollemi NP (NPWS unpublished data 1974-2004)**



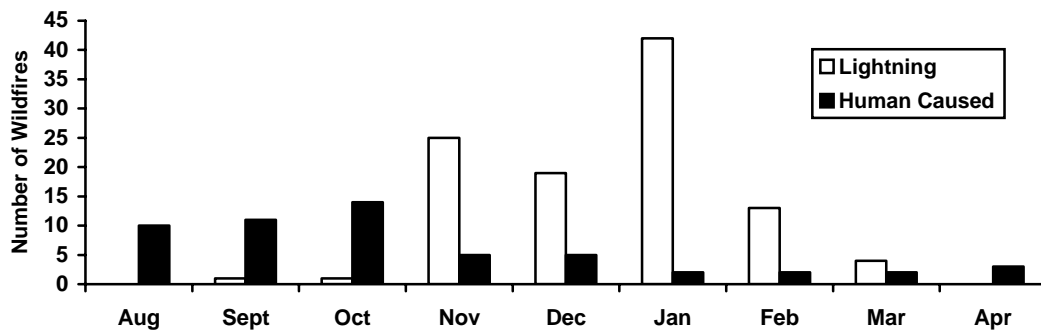
From the ignition point distribution map in Fig 6, it can be seen that human caused fires are generally concentrated in clusters on the Park boundary and along Park roads indicating the current "black spots" for arson activity and illegal burning off into the Park. The distribution of lightning ignitions demonstrates the need for fire detection flights after late spring and summer thunderstorms over the whole of the Park. Experience has shown that fires caused by lightning may not be visible for up to three to four weeks after the passing of a storm cell.

Figure 6: Ignition Points and Cause (NPWS GIS Unpublished Data 1974-2004)



Ignitions from lightning strikes are mainly in the November to February period with a peak in January; whilst human caused unplanned fires occur mainly in the spring and autumn months (see Figure 7).

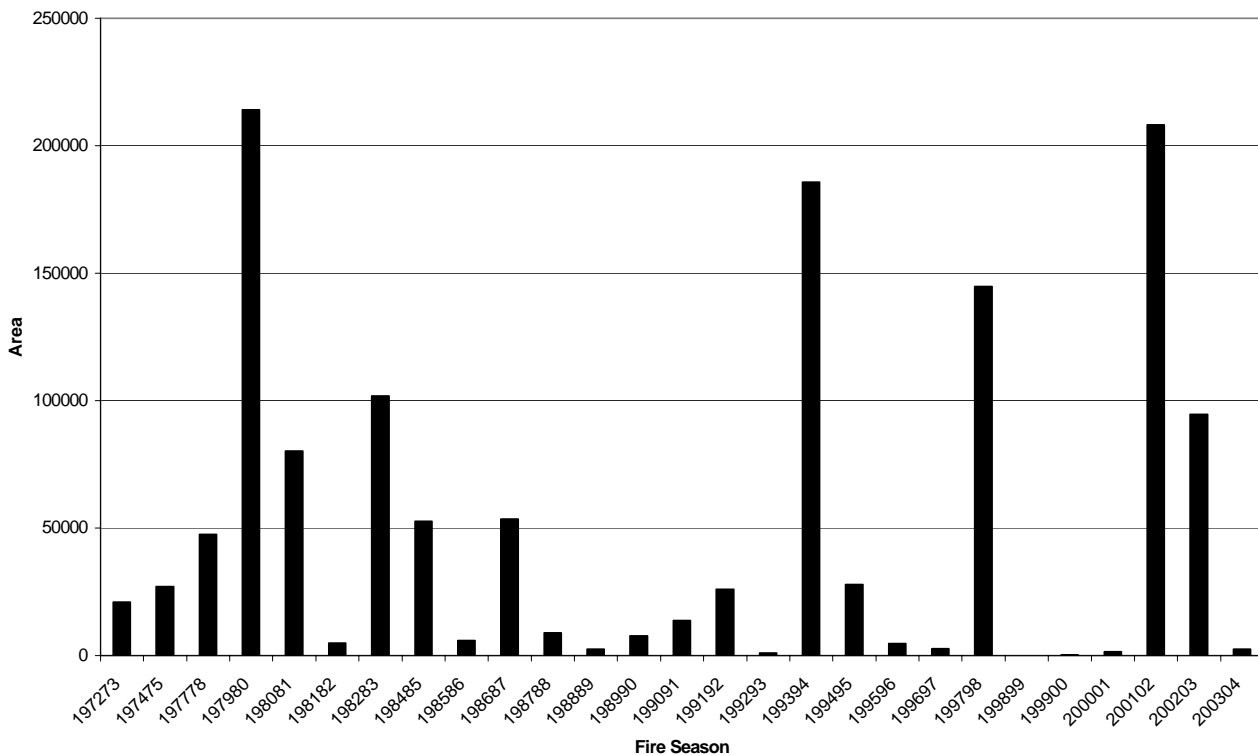
**Figure 7: Month of ignition for bush fires**



**Bush fire History**

Based on NPWS records (Figure 8), anecdotal evidence and known long term climatic trends, a major fire affects somewhere within the Wollemi NP every 3 to 10 years. Major fires are generally caused by multiple lightning strikes in remote areas of the Park. While the majority of bush fires are contained within the Park, it is acknowledged that large, difficult to control fires may escape the Park under extreme weather conditions. It is large fire or multiple small fires burning on blow up days that present the greatest threat to life and property.

**Figure 8: Annual area burnt by bush fires from 1972 - 2004**



As a result of bush fires within the Park, the current 'time since last fire' age classes for Wollemi NP show that over half of the Park was burnt in the last 10 years. In contrast less than 13% of the Park is in the over 20 years since last fire age class, with most of this being in the north west of the Park.

## Prescribed burning

The aim of NPWS is for prescribed burning to be strategically concentrated on Park boundaries to protect assets, whilst meeting biodiversity and nature conservation goals.

The “window of opportunity” for implementing prescribed burns within Wollemi NP is limited. There is the risk of the burn escaping the prescribed boundary, mainly due to adverse weather conditions not forecasted. There are also times when nothing will burn. For example, during the spring and autumn periods between 1986 and 1989, a succession of wet periods were encountered in the northern area of the Park which hampered prescribed burning operations.

Conversely, major escapes from prescribed burns occurred in 1991 and 1995 into the adjacent Putty State Forest, and private property. With the limited vehicle access to the Park, and most prescription burns requiring aerial incendiary ignition the operation must be approached with caution and careful planning. The area of recorded prescribed burns carried out since the gazettal of the Park is shown in Figure 9. The majority of the prescribed burns are adjacent to neighbouring property assets.

**Figure 9: Area treated by Prescribed burns each year from 1979 to 2004.**

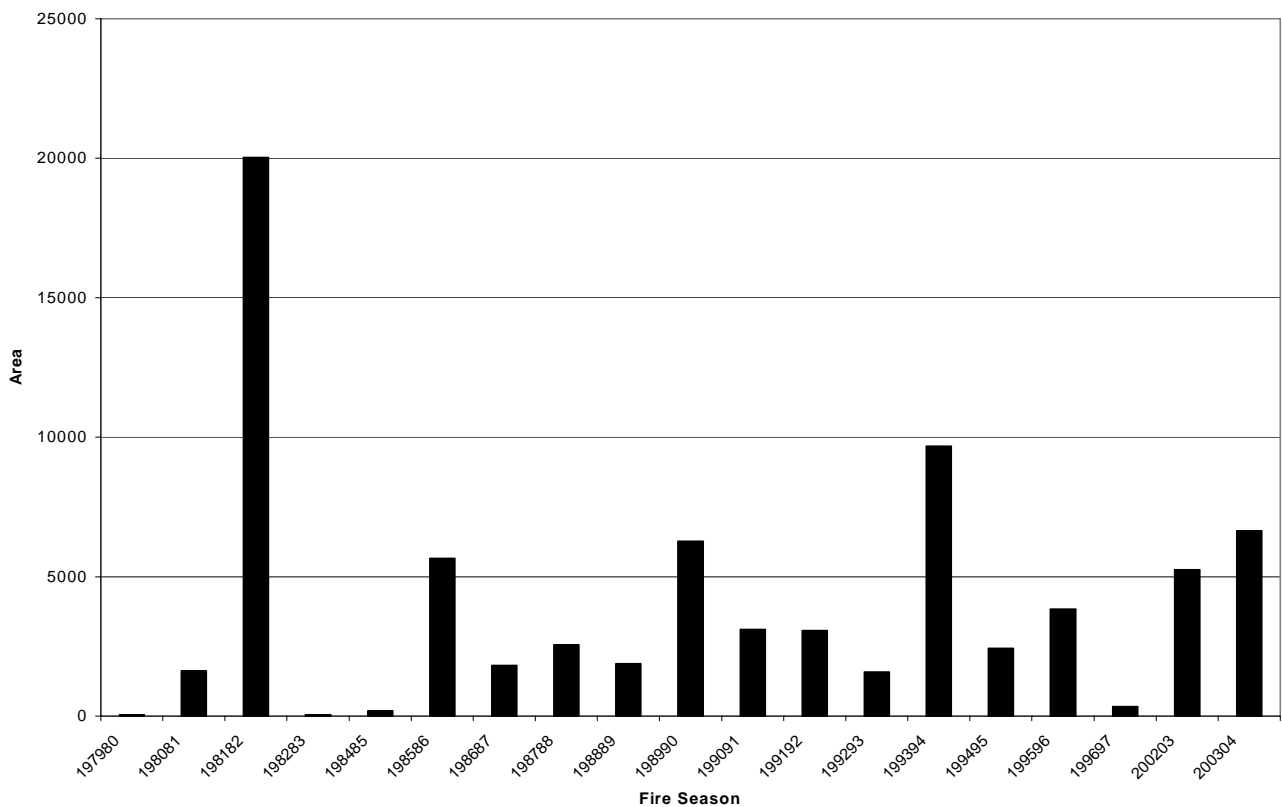
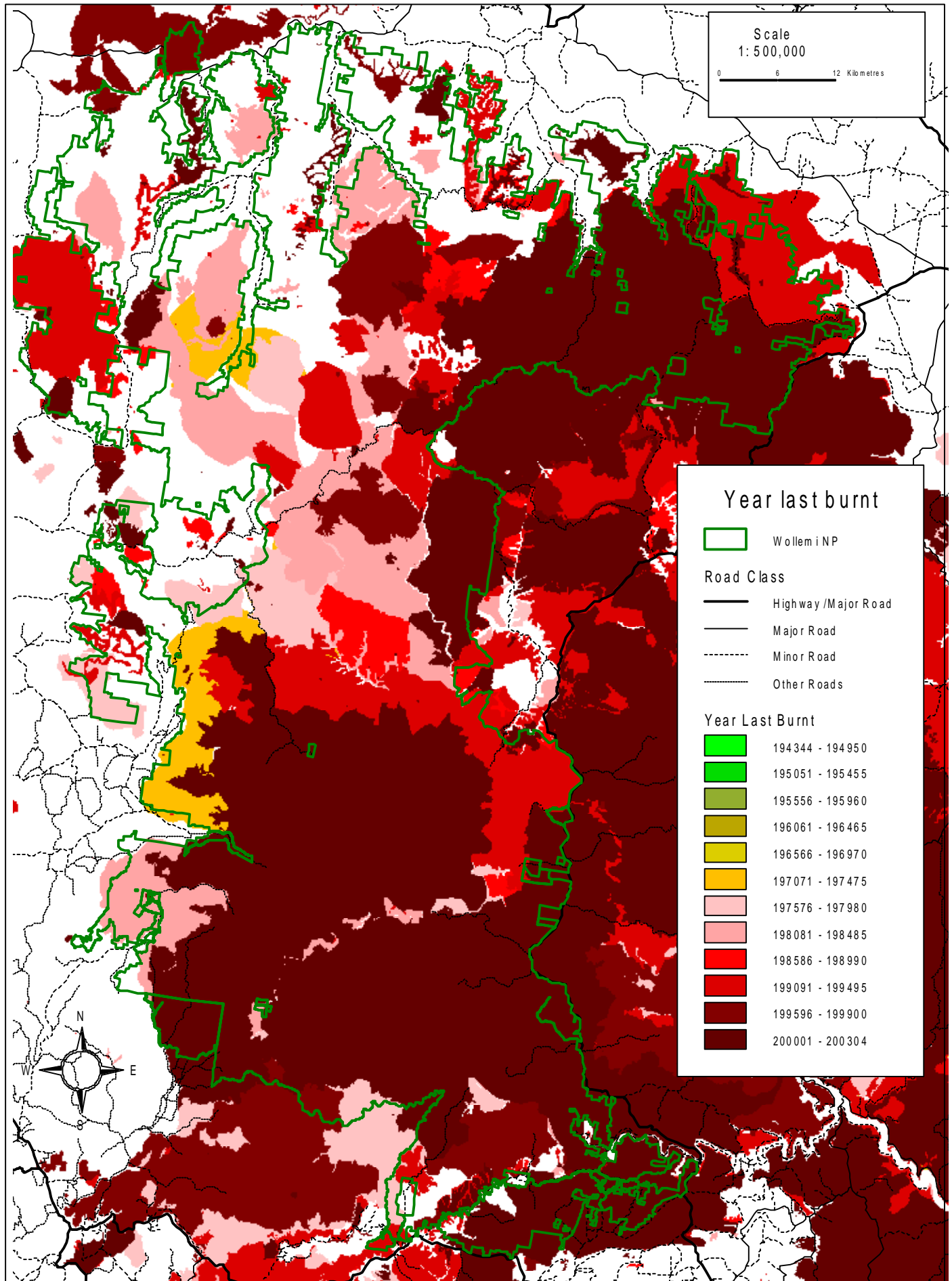


Figure 10 shows the 5 year interval when parts of the Park were last burnt either by hazard reduction or bush fire.

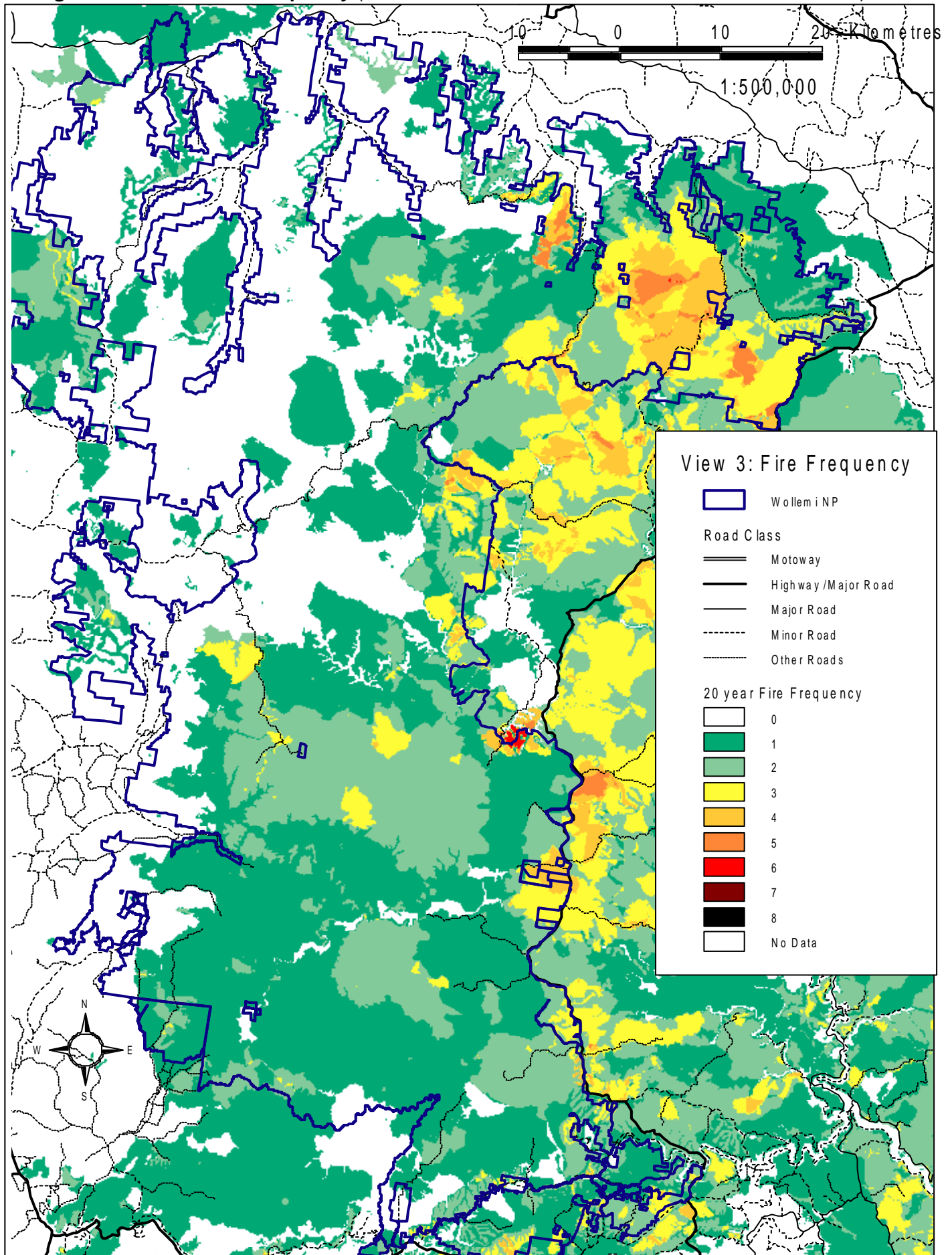
## Fire frequency

Fire frequency is in part a measure of the number of times an area is burnt within a given period of time. Using records from 1983/4 to 2003/4 (20 years) **Figure 11** has details the current fire frequency within the Park.

Figure 10: Year of Last Burn (5 year range)



**Figure 11: 20 Year Fire Frequency** (i.e. the number of fires that has occurred from 1984-2004)



## FIRE WEATHER

### Climate

Climatic conditions vary throughout the Park due to differences in elevation, topography and proximity to coastal influences. The Park can be divided into two broad 'climatic areas' along its north-south axis. The western section being higher in elevation (500-1000m ASL) experiences a greater climatic influence from westerly moving continental air masses. The eastern section ranges in elevation from 100-500m ASL and is influenced more by coastal air masses.

The highest monthly mean temperatures for the area are experienced between November and February, with the period of lowest relative humidity in December and January. The period of strongest wind is between July and December. Rainfall varies considerably throughout the Park, with the southern portion receiving significantly more than the northern. A summary of a typical yearly weather pattern cycle for Wollemi National Park is summarised in Table 1. Negative Southern Oscillation Index (SOI associated with *El Nino* years) are generally associated with below average rainfall along the east coast of Australia and prolonged drought. Monitoring the index can assist in the early prediction of severe fire seasons. The implication of SOI on bush fire conditions is for major fire seasons to occur at intervals between 5 and 11 years (BOM, 1999).

**Table 1: Typical Weather Patterns in Wollemi NP**

Season	Conditions
<i>July - August</i>	There is a winter pattern of cool to cold dry westerly air-streams. Weekly passages of cold fronts produce rain and occasional snow above 1000 metres. Frosts are common at all elevations. Severe fires unlikely during this period.
<i>September - January</i>	This period of the fire season is an unstable transition between spring and early summer. Rapidly changing weather systems produce either warm or hot dry north-west weather before cold fronts and cool south-west to southerly conditions after the fronts. Campaign fires tend to occur during this period if vegetation and soils incur drought stress. Dry lightning storms occur during late November / December and multiple lightning strike fires may occur. There is potential for fire storm events.
<i>February - April</i>	The late summer period has warm to hot conditions at lower elevations. These warm periods are interspersed with periods of drizzle and rain. These rain events are more likely to occur as moist south east, or easterly air streams move in from the coast. Thunderstorms are more frequent and can produce heavy rain. Bush fires due to lightning strikes are common during this period, however are generally followed by rain. Bush fires during this time may become campaign fires but generally there is less potential for a fire storm event. Numerous lightning strike fires in the order of 15 to 30 ignitions in one event can cause problems with getting sufficient personnel and equipment resources.
<i>May - June</i>	Moist mild weather occurs during this period of the year. Large fires are unlikely.

### Conditions associated with bush fires

Conditions associated with serious bush fire seasons and events include:

- Occurrence of an extended drought period (KBDI >100) and lower than average rainfall through winter drying fuel for the spring;
- Summer rainfall is lower than average (Negative SOI), extending the fire season into autumn;
- Prolific fuel accumulation from strong growing seasons the previous summer(s), followed by point a);
- Spring / summer thunderstorm activity in dry years.
- Occurrence of particular synoptic patterns that bring persistent west to north west winds in late winter / early spring and are followed by strong cold fronts or southerly changes (high FFDI).

The official bush fire season in New South Wales starts on the 1st of October and finishes on the 31st of March. However, the fire season in Wollemi NP usually extends beyond the declared fire



season and occurs between August and April of the following year. The majority of the Park can experience Very High to Extreme Fire Danger.

### **Conditions suitable for prescribed burns**

Prescribed burning operations are carried out in accordance with the Hawkesbury, Singleton, Muswellbrook, Rylstone and Greater Lithgow local BFMCs' Risk Management Plans. The primary objectives of these Plans are to minimise the risk of bush fire to life, property, natural and cultural heritage values.

Fuel management generally would occur outside the bush fire danger period between 1<sup>st</sup> April and 30<sup>th</sup> September. During this time a number of factors allow for a specific prescription to be achieved. These include:

- Dry surface fuels;
- A high level of moisture recovery in fine fuels at night; and
- A low probability of dry north-westerly winds.

With the onset of rain in late February, leading on to moist mild weather in May, the most suitable period for undertaking prescribed burns is usually between rain events in late February, March and April. During this time, there are usually 10 to 12 days between rain events, with rain being light enough to allow more than one burn over 6 to 8 weeks and heavy enough to extinguish a burn.

Past experience with prescribed burns escaping the intended boundary and becoming large fires in late spring and early summer has shown that prescribed burning in spring is inherently risky. This is primarily due to the unpredictable nature of both temperature and wind speed when the fire is in the smouldering stage.

### **Bush fire behaviour potential**

Fire behaviour is the manner in which a fire reacts to the variables of fuel, weather and topography.

The bush fire behaviour potential model for the Park has been developed using the applied methodology of the Southern Regional Fire Association (Dovey, 1994). The model is based on the probability of vegetation communities in specific terrain categories sustaining fire during a fire season (excluding extreme fire behaviour conditions).

Bush fire behaviour potential classes are calculated from terrain variables (aspect, slope and elevation), in conjunction with vegetation / fuel groups. The resultant model can be used for planning eg. fuel reduction, asset protection and during bush fires eg. to warn of areas of potential high intensity.

### **Elevation**

The western section of Wollemi NP (part of The Great Dividing Range) is considerably higher than the eastern portion and ranges in elevation between 500 and 1000 metres ASL. The eastern portion ranges in elevation between 100 and 500 metres ASL.

For the bush fire behaviour modelling, elevation has been grouped into four categories. (0-300m, 300-600m, 600-900m, 900-1200m).

### **Slope**

Slope has a significant effect on bush fire behaviour. Increases in slope generally increase bush fire intensity and rate of spread, and conversely decreases in slope reduce fire intensity and rate of spread. Table 2 identifies the three slope classes used in calculating the bush fire behaviour potential model – flat and level, hilly, steep.

**Table 2: Slope Classes for Wollemi NP**

Slope	Class	% of Park
0 - 5 degrees	Flat & Level	8
5 - 15	Hilly	28
Over 15	Steep	64

The Slope Classes show the majority of the Park is either over 15 degrees slope (Steep) or hilly (5 to 15 degrees), indicating that under severe bush fire weather conditions large bush fires have the potential to develop quickly in the Park. Slope in the Park has a significant effect on fire behaviour and needs to be a prime consideration in determining fire management tactics for any fire in the Park.

### Aspect

Estimates of the McArthur Forest Fire Danger Index (FFDI) for all combinations of slope and aspect were conducted by Bradstock *et al* (1997) for the Sydney region. Summaries showed that high FFDI values occurred on western and to a lesser degree southern aspects (Bradstock *et al*, (1997). In general, fire intensity and rate of spread tends to increase with drier aspects.

Table 3 identifies the aspect classes used for modelling bush fire behaviour potential. Aspect categories used rank from zero (0), which has the least effect on fire behaviour, to 3, which has the most effect upon fire behaviour.

**Table 3: Aspect Classes for Wollemi NP**

Aspect Ranking	Aspect	Degrees	% of Park
0	North east to south	27 - 180	44
1	South to south west	180 - 227	12
2	North to north east	0 - 27	7
3	South West to North	227 - 360	37

### Fuel

Vegetation communities within the Park have been grouped into structural vegetation types that behave in a similar way in a bush fire. For modelling of bush fire behaviour potential the vegetation communities have been grouped into nine fire vegetation groups, based on fuel characteristics such as fuel structure, arrangement, amount and type. The highest rating is for continuous fuels with a higher quantity of fuel and available to burn during average seasons, for example - dry open forests. Zero value is for fuels unlikely to burn, for example - rainforest.

A fuel assessment which accurately determines these fuel characteristics and their resultant effects on fire behaviour potential is yet to be undertaken within the Park. Nevertheless, fuel loadings in vegetation communities within the Park could be expected to range from 5 to 40 tonnes per hectare in areas long unburnt.

### Analysis of likely fire behaviour

Bush fire behaviour potential within the Park varies considerably due to the steep elevation gradient over short distances. High winds on exposed tops create the conditions for bush fires to rapidly crown from ridge to ridge and reach firestorm proportions. Conversely, the extensive cliff lines and rocky outcrops provide natural breaks and control lines that are often used to assist containment when weather conditions are suitable.

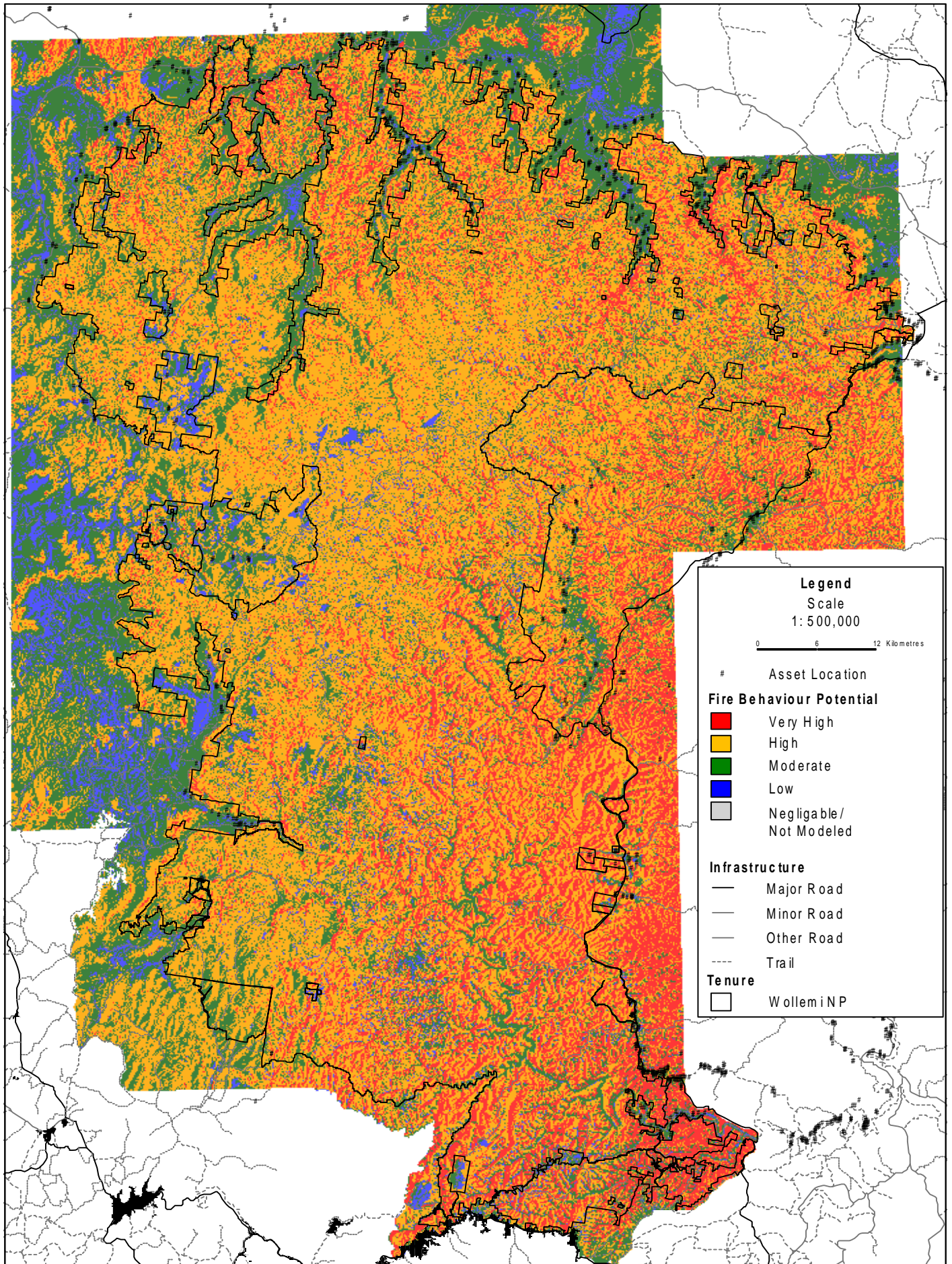
Figure 11 shows the result of the bush fire behaviour potential analysis, with the highest values indicating the greatest potential to carry fire. The model is independent of fire weather but takes into consideration local changes in climatic zones (elevation, aspect) and the effects of slope. The map reflects the fire history of the Park over the last 25 years. The model indicates the highest potential for bush fires occurring on the eastern side of the Park with increased potential in the south-eastern corner of the Park and around the Putty area.

## **Damage potential**

Damage potential is the chance of a fire igniting, spreading and causing damage to assets of value to the community (such as property, natural and cultural heritage items) as a result of direct flame contact, radiant heat, burning debris carried by wind and smoke.

Fires within Wollemi NP have the potential to become high intensity fires on days of high, very high and extreme bush fire weather conditions. In addition to the potential for high intensity fire, the Park's ignition history places it in a high ignition potential class.

**Figure 12: Bush fire behaviour potential**



## **Historical damage**

Wollemi NP has a long history of fires exiting the Park and causing property damage. Anecdotal evidence suggests the recent damage history of the last 20 years is comparable to the damage history before declaration of the Park in 1979. The fires of 1957 were of similar size and intensity to January 1994 and 2001, and a number of houses were lost during those fires.

To plan for future fire events it is useful to examine the types of fire damage sustained in the past. Examples of damages and costs to the community have included:

- Loss of and significant damage to houses: 2001/2 - 22 houses in the Hawkesbury Council Area; 1994 – 2 houses; 1991 – 1 house, and also loss of houses in previous fires during the 1950s
- Loss of property assets i.e. (sheds, fencing, vehicles, caravans, tractors, etc) in 2001/2 (79 reports various damage, 1997/8 and 1993/4.
- Loss of livelihood (1994 – complete loss of orchards, loss of grazing, stored fodder and fencing. 1995/6 – pasture buried by silt washed from the burn area onto adjacent grazing lands).
- Loss of productivity (Putty State Forest experienced severe fires in 1993/4 and 1997/8. Coal mining production adjacent to the Park was affected by fire operations in 1994. 1500 hectares of pine plantation in Newnes State Forest was lost between 1942 and 1980. The 1952 fire led to the abandonment of 800 hectares of the '15 mile pine plantation' in Newnes State Forest, located between the existing pine and the Wollemi NP boundary.)
- Federal, State and Local Government bush fire-fighting costs. (Suppression costs, loss of property assets, loss of productivity whilst engaged in suppression activity).
- Significant soil erosion events (such as after the 1993/4 and 1995/6 fires in the northern Wollemi area that closed roads, damaged bridges, buried fencing and fouled domestic and stock water supplies).
- Fish kills in streams from high concentrations of ash and tannins (1993/4).
- Damage to roads and infrastructure. (Jan 1994 – closure of the Putty Road for four weeks due to falling trees, significant damage to Bulga Bridge, damage to the guard rails and signs).

Other damage to the Park has included:

- Possible loss of biodiversity due mainly to the frequency of fires in the Park;
- Significant damage to Park signs, roads and trails.

## **Life and property Risks**

There are many community assets within close proximity to the Park that could potentially be damaged by fire, including buildings, houses, coal mine infrastructure, orchards, State forest timber production, livestock, grazing pastures and fencing.

### **Buildings**

The majority of buildings adjacent to the Park are located on cleared, grazing properties with suitable access for local Rural Fire Service brigades. However, many buildings and homes within close proximity to the Park are situated within a bushland setting and are considered to be at a higher risk of exposure to all forms of bush fire attack. Many of these properties do not have suitable access and egress routes and are considered unsafe for firefighters to defend in the event of a bush fire. Villages such as Putty, Colo Heights, Bulga and Jerrys Plains are also potentially at risk of damage by burning embers from a fire.

### **Rural Lands**

A significant proportion of the Park bounds onto grazing properties and for many of these neighbours there is a major risk of losing valuable grazing for cattle. Bush fires that escape Wollemi NP can have a pronounced and prolonged effect on the livelihoods of these neighbours and it may take neighbouring properties years to recover from the economic loss sustained.

Wollemi NP also has neighbouring properties where there is high value livestock that potentially would not survive a fire or could be injured so as to lower their value considerably. The Widden and Baerami Valleys in the north of Wollemi NP have high value thoroughbred horses and breeding deer. Up to 150 seasonal workers can be working in these valleys during spring and early summer and both of these valleys have only a single lane road leading in and out of the valley. These problems have been addressed by Muswellbrook local BFMC in their Risk Management Plan.

### **State Forests**

There are also large areas of NSW State Forests adjacent to the Park including Putty, Nullo Mountain, Coricudgy, Newnes and Comleroy State Forest. Native timber production and its silviculture may be compromised by fires originating from the Park. In addition, Newnes State Forest pine plantations are located south-west of Wollemi NP. At its present age, the trees are a valuable resource to the local timber industry and fire can cause considerable damage to pine plantations.

### **Natural Heritage Risks**

#### **Wilderness area**

Inappropriate fire regimes and fire management activities have the potential to degrade the Wollemi Wilderness area values. Activities that are incompatible with wilderness values include the construction of dozer lines and helipads and general damage.

#### **Greater Blue Mountains World Heritage Area**

The primary risks to WHA values of the Park include:

- The impact of altered fire regimes on the ecological, biological and evolutionary processes within the eucalypt dominated ecosystems, and ;
- The impact of altered fire regimes on the quality of habitats for the in-situ conservation of biological diversity, particularly eucalypt dominated communities, primitive species with Gondwanan affinities and a diversity of rare and threatened plants and animals of conservation significance.

#### **Threatened Species Populations and Communities**

Wollemi NP contains many valuable and unique species of flora and fauna listed under the *Threatened Species Conservation Act, 1995*. Large areas of the Park are in the 'moderate' level of risk category (due to frequent fires) leading to populations of threatened species possibly being under threat of depletion if current fire regimes are continued (see Appendix 3 and Appendix 4).

The loss of Wollemi Pine *Wollemia nobilis* individuals would mean the loss of the only population of that species living in the wild.

#### **Water Catchments**

Significant long-term damage to water catchment values are probable if current fire regimes continue. High intensity uncontrolled bush fires can burn extensive areas within catchments and destabilise hydrological characteristics. Major impacts include large amounts of sediment, ash and other pollutants being washed or leached into Parks water ways by subsequent rains. This may have a short term impact on the water quality and quantity that comes from the water supplies.

#### **Soil erosion**

Many of the soil landscapes within the Park are prone to erosion as a result of high intensity fires, track and trail maintenance and construction, and other fire management works. Specific impacts may include alteration of landforms, the smothering of vegetation, increased sedimentation of drainage lines and water bodies, and alteration of aquatic habitat. Increased run-off from disturbed areas may increase the pollutant load entering the Park and assist in the invasion of weeds. Of particular concern are extreme erosion events following high intensity bush fires as they produce massive sediment loads, and reduce the regenerative capacity of ecosystems through the removal of seed banks and nutrients.

#### **Pest / Exotic species invasion**

Fire disturbance has the potential to advantage introduced species and may disadvantage native species due to an increase in destruction and predation by foxes, pigs, cattle, cats and dogs (Catling, 1991) and the colonisation by non-indigenous plant and weed species. Predator and weed control programs may be opportunistically implemented after fire to reduce the impact by feral animals and weeds on native populations.

### Cultural heritage risks

Wollemi NP contains many Aboriginal and European heritage sites which may be damaged by operational activities such as the use of heavy firefighting and earthmoving equipment. During fire operations, all potential impacts are taken into consideration, based on mapped and registered records listed in the Aboriginal and Historic Sites Registers. In addition, NPWS field staff are trained to recognise Aboriginal and historic sites that may not have been previously recorded. Areas where particular care needs to be taken are in the Appletree Creek area (north-eastern Wollemi NP), Tollagong Range, Baerami and Newnes Oil shale mining areas, Bylong - Widden Trails area.

### Aboriginal heritage

Table 4: defines the level of vulnerability of different site types to fire and summarises the predicted impacts of fires, foams and wetting agents, retardants and vehicles including dozers on Aboriginal archaeological sites. Site locations are accurately mapped on the NPWS GIS.

**Table 4: Impact of Fire Types and Suppression Activities on Aboriginal Heritage**

Site Type	Bush fire	Low Intensity Prescribed Burn	Slashing / Mowing	Dozer Lines
Open Camp Site	Post fire soil erosion may cause artefact movement and damage archaeological deposits	Probably low impact except if damaged by vehicle traffic	Moderate to high impact if driven over	High impact
Scarred Tree	Depending on intensity may cause tree death, erode tree stability or damage scar Fire may also lead to decline in tree health and promote rot May destroy dead tree	Low impact if site is protected from fire using buffer zone If not protected, may damage tree health May destroy dead trees High impact if struck by vehicles	High impact if struck by slasher or vehicle	High impact
Axe Grinding Groove	High intensity fire may cause spalling of sandstone and damage engraving Post fire soil erosion may cause build up of soil on site which can lead to chemical weathering	Low impact if site is protected from fire using buffer zone High impact if struck by vehicles	High impact if struck by slasher or vehicle	High impact
Rock Art Site	High intensity fire may cause spalling of sandstone and damage grooves Post fire soil erosion may cause build up of soil on site which can lead to chemical weathering	Low impact, especially if protected by buffer zone If not protected may still lead to smoke damage and removal of protective vegetation	Low to no impact if protective vegetation is not damaged High impact if vehicle enters shelter	High impact
Shelter with deposit	Post fire soil erosion may lead to artefact movement and damage to archaeological deposits	Low impact	Low to no impact if protective vegetation is not damaged High impact if vehicle enters shelter	High impact
Midden	May remove protective vegetation and promote post fire erosion	Low impact if protected with buffer Low impact generally if post fire soil erosion is not caused High impact if driven over	Moderate to high impact if driven over	High impact
Burial	May promote post fire erosion which can expose remains, especially in sandy soils	May be offensive to local people High impact if it damages grave features such as headstones High impact if it causes	Possible high impact from vehicles where burial is exposed or close to surface May be offensive to local people	High impact

		post fire erosion or damage headstones or other grave features.	May damage grave features	
Stone arrangement	May cause spalling of stones in an arrangement Post fire soil erosion may lead to displacement of stones	Low impact if post fire erosion is not caused. High impact if driven over	High impact if driven over	High impact

### European Heritage

Within the Park there are 64 historic sites listed on the NPWS register. Several walking tracks within the Park have been identified as items of State heritage significance. Table 5 classes high risk cultural heritage sites within the Park.

**Table 5: High Risk Historic Cultural Heritage Sites**

Site Type	Impacts of bush fires and fire management operations
Constructions, foundations, building remains	Fire may directly remove combustible material such as timber structures. Post fire soil erosion may lead to displacement of foundations. High impact if struck by vehicle or dozer.
Artefacts	Post fire soil erosion may lead to artefact movement and damage to archaeological deposits.
Wells, mines and quarries	Low impact except where post-fire erosion causes artefact movement or changes to site. High impact if driven over especially with earth moving equipment.
Earthworks, drainage lines, retaining walls etc	High intensity fires may cause spalling of rock constructions. Removal of protective vegetation may promote erosion especially along drainage lines. Earth moving equipment may alter historic earthworks.
Gardens and exotic vegetation	Depending on the intensity, fire may cause vegetation death and erode stability; may also lead to decline in vegetation health.
Stone arrangements	May cause spalling of stones in an arrangement. Post fire soil erosion may lead to displacement of stones.

### Natural Area Fire Management

Details of bush fire management in natural areas are included in a section with the NPWS Fire Management Manual. This includes the ideology behind allowing fires to burn without human interference where they occur under suitable weather conditions.



## **FIRE MANAGEMENT**

### **Bush fire Management Zones**

Fire Management Zones are used by the NSW NPWS to facilitate broad and specific fire management objectives within its conservation Parks.

Fire Management Zones (FMZ) define operational activities to best protect life, property, natural and cultural heritage. Three major categories of fire management zones are used in the Strategy, these are:

- Strategic Fire Management Zones
- Asset Protection Zones
- Heritage Management Zones

Each zone has fire management objectives, tactics, actions and performance criteria specific to the area within its boundary. For example, zones with fire sensitive communities such as rainforest will have fire exclusion objectives, on the other hand, a zone on the fire prone side of a residential development will have objectives that specifically provide for protection of assets.

The objectives and tactics for each zone are complementary and allow the objectives of the Strategy to be met. Although each zone has a management prescription reflecting its emphasis, a site-specific variation of the prescription may be necessary due to the occurrence of unusual features.

Fire Management Zones developed for the Park were created following consultation with each of the local BFMCs and are consistent with the appropriate Fuel Management Zones of the NSW BFCC (1998).

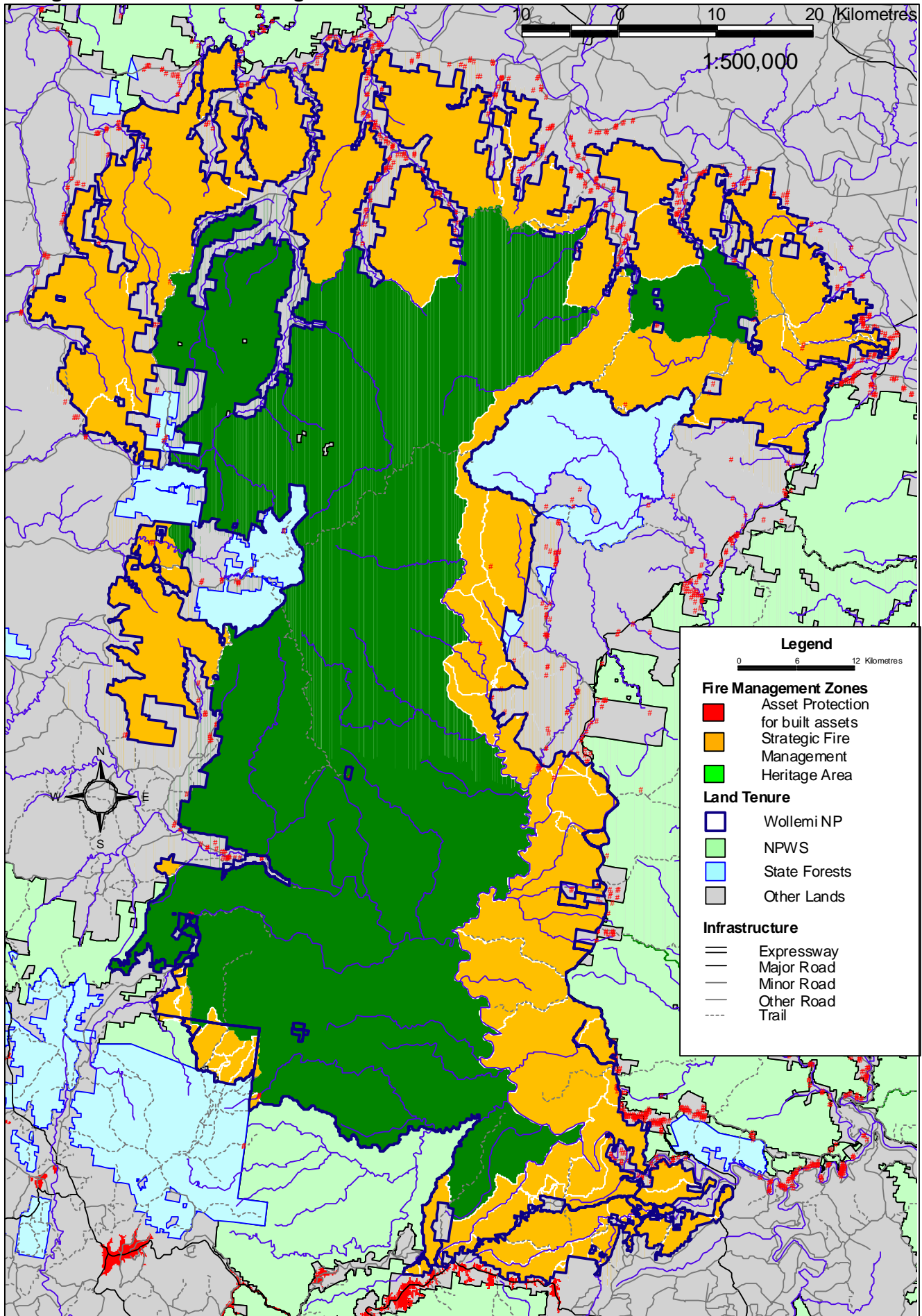
The Fire Management Zones in this Strategy form the fundamental operational management area of the Strategy for which fire management prescriptions will be applied.

### **Asset Protection Zones**

The establishment of asset protection zones is regarded as one of the single most beneficial tactics for the protection of buildings (Bush fire and Environmental Services 2001; Bradstock and Gill, 2001; NSW Rural Fire Service, 2001). The required width and fuel loading for individual Assets Protection Zones are detailed in '*Planning for Bush Fire Protection*' (NSW Rural Fire Service (2001). The construction and maintenance of Asset Protection Zones (APZ) is primarily the responsibility of the landholder or manager adjacent the asset. Wollemi NP has very few adjacent private property assets that require APZs within the Park.

Figure 13 illustrates Asset Protection Zones within and in the proximity of Wollemi NP.

**Figure 13: Bush Fire Management Zones**



## Strategic Fire Management Zones

Strategic Fire Management Zones (SFMZ) within the Park (Figure 12) are designed to reduce the risk of damage to life and property within and adjacent to the Park. SFMZs provide for the strategic containment and management of high intensity bush fire events.

Strategic Fire Management Zones also provide protection for a wide range of assets including roads, residential areas, camping and picnic areas. SFMZs are useful in creating buffers to reduce the spread of fire into and from Parks and across whole landscapes.

Strategic FMZ boundaries align with the closest natural or trail advantage where proposed fuel reduction operations can feasibly be contained.

## Heritage Area Fire Management Zones

Heritage Area Fire Management Zones (HAMZ) within the Park (Figure 12) are areas where assets are not at risk from bush fire and management can concentrate on the ecological values of the area. The purpose of HAMZs is to prevent / limit the damage of bush fire events on sensitive areas within and adjacent to the Park. This Strategy identifies HAMZs through a combination of natural and cultural heritage features.

Natural heritage encompasses the biodiversity of the Park and can be defined at specific levels, often focusing on the conservation of individual species, populations and communities

Cultural heritage encompasses the anthropogenic characteristics of the Park and includes Aboriginal and Historic Heritage.

Heritage items are often irreversibly damaged or lost to inappropriate fire management. The management of HAMZs is often undertaken in accordance with other previously determined conditions for the conservation of heritage items, including Recovery Plans, Plans of Management and Conservation Plans.

## Summary Table of Zones

Three categories of Fire Management Zones have been identified within and adjacent to the Park. The objectives and tactics for each zone type are outlined in Table 6.

**Table 6: Summary of Fire Management Zones**

Zone	Suppression objective	Prevention & mitigation objectives	Tactics (Methods)
Asset Protection	To protect residential areas, crops, plantations, utilities, camping areas, day use areas, urban interface, cultural heritage assets etc.	To encourage community education and community fireguard programs. To construct APZs and maintain where appropriate on NP.	Fuel managed by strip burning, slashing, selective shrub clearing, construction of radiation barriers or trail construction.
Strategic Fire Management	To assist in the strategic control and containment of bush fires. To reduce bush fire and spotting intensity.	Promotion of the NPWS fire management and fuel management activities.	Fuels actively managed mainly by burning. Where possible fire suppression or containment tactics will be consistent with the fire regime prescription.
Heritage Area Fire Management	To apply fire prescriptions consistent with broad area objectives or relevant statutes.	Promotion of awareness of the special values requiring protection in these areas.	Burning, suppression or containment tactics will be consistent with the fire regime prescription.

## **Protection of neighbours, visitors and facilities**

Based on the Fire Management Zones areas for prescribed burning are identified for the annual prescribed burn program submitted to the local BFMCs. Protection works conducted by private property owners may be supplemented with prescribed burning within the Park boundary, however, no prescribed fire is acceptable in rainforest.

Fuel management works will be concentrated in areas:

- ◆ where there is high likelihood of bush fire ignition;
- ◆ having a medium or high fire potential, and;
- ◆ that are in close proximity to an identified asset.

The extent, frequency and application of fuel management by burning within each zone will be consistent with the objectives of the Bush Fire Management Zones in Table 6. All completed prescribed burns will be assessed to determine their degree of success and to compare the result against the objectives of the burn.

Any future NPWS facilities and infrastructure will be protected with the establishment and maintenance of fire radiation zones with annual activities to reduce structure ignition by embers.

Early detection of bush fires, with a response aim of quick suppression or containment, will continue to be a high priority for this Park due to the high potential for the development of large, difficult to control bush fires that can threaten life and property. Aerial and ground detection activities are routinely carried out in summer, particularly after dry lightning storms. Local lookout and vantage points are also used for detection of bush fires, with crews held on standby on days of extreme fire danger or Total Fire Ban days.

The Park, or part of the Park, may be closed to the public due to conditions that create an extreme fire danger or during fire fighting operations.

## **Biodiversity conservation**

In practical terms, conservation is about the prevention of the extinction of species, especially extinctions brought about by the action of humans. The nature conservation objective of this Strategy is to manage fire to retain (avoid extinction of) all native species known to occur within the Park.

Therefore, a primary aim of fire management is to maintain the species and community biodiversity of the Park by maintaining appropriate fire regime “thresholds”. A fire regime is essentially the combination of fire frequency, fire intensity and season of fire occurrence.

## **Principles and thresholds**

Contemporary ecological research in fire-prone ecosystems of the kind represented in the Park has established some general principles in relation to the fire regimes required to conserve biodiversity. Management of fire for conservation in the Park will be guided by the following general principles:

1. Groups of flora and fauna species respond similarly to fire according to characteristics of their life history. Therefore, it is not necessary to individually specify fire regimes for the conservation of every species. Rather an overview is needed of the requirements for broad groups of species. Requirements for most plant species can be summarised on the basis of a small number of groups. The knowledge of requirements for groups of animals is less advanced.
2. Flora and fauna are interrelated. Flora forms an important component of habitat for fauna. Fire management must consider this important interaction.
3. A diversity of fire regimes may be required in order to maintain native biodiversity. This means that over time, there may be a need to implement fires of high, moderate and low intensity,

frequency and size throughout the Park. Extinctions may be likely when fire regimes of relatively fixed intensity, frequency and extent prevail without interruption.

4. Bradstock *et al.* (1995) contended that there is a threshold in fire regime variability that marks a critical change from high species diversity to low species diversity. For some groups of biota these thresholds separating desirable and undesirable fire regimes can be defined. Management should therefore be targeted toward desirable fire regimes using these thresholds as a guide.
5. Management tactics involve the manipulation of fire regimes. While information may be lacking about important elements in this tactic, fire management using this framework can progress while further knowledge is accumulated. Assessment of fire regimes through mapping of the locality and characteristics of all fire will be ongoing so that tactics can be regularly reviewed, refined and adjusted. Depending on the circumstances (a function of community type and prevailing fire regimes) there may be a role for both prescribed fire and / or fire-exclusion in parts of a given Park in the future.

Knowledge of fire ecology on resident animal species is currently insufficient to formulate comprehensive fire regime thresholds for the management of fauna species as outlined for plant communities. Maintenance of vegetation cover and structure within flora communities in the Park is essential for conserving viable fauna populations.

It is important that any individual fire not completely burn the whole of a particular community type or the whole of the Park. Unburnt areas act as a refuge for fauna species that suffer habitat loss during and soon after fire. These areas then become extremely important for the recolonisation and protection of species. However, it is not possible at present to define and quantify guidelines concerning the size of unburnt areas required for critical fauna habitat.

The guidelines provided for the management of species within this Strategy will be subject to the *Threatened Species Conservation Act, 1995*. This Act provides the framework to protect and encourage the recovery of threatened species, populations and ecological communities. Table 7 and figure 14 provide suitable fire regimes for conservation of biodiversity based on current knowledge of vegetation communities within the Park.

### **Evaluation of current fire regimes**

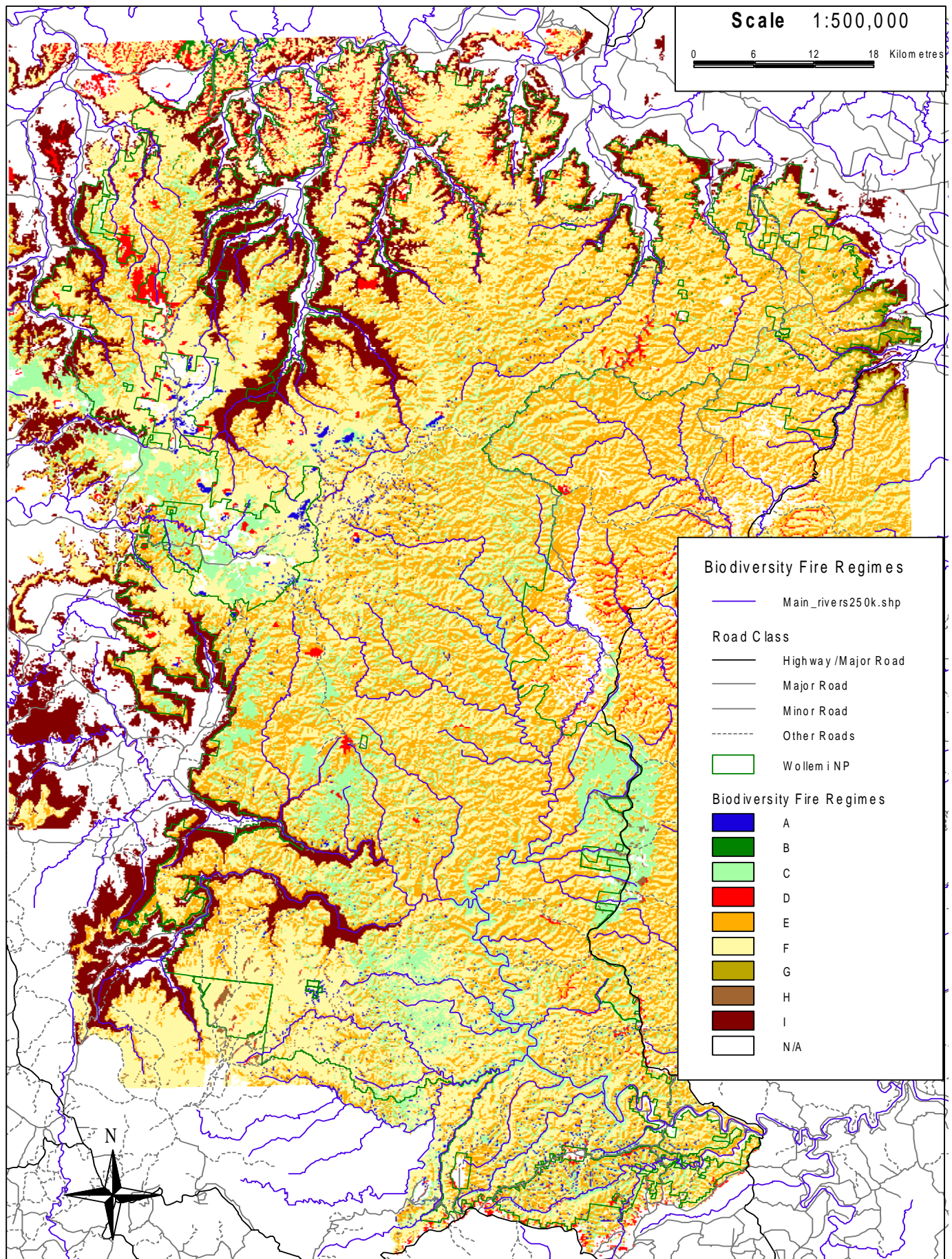
An analysis of current fire regimes shows an undesirable frequency of fire has occurred over approximately 17,500 hectares (3.5%) of the Park. A further 172,000 hectares (34%) has also experienced undesirable fire frequencies, where biodiversity may be compromised if a second fire occurs within the next 5 years. For the remainder of the Park (over 300,000 hectares) the occasional bush fire may be providing an appropriate fire frequency.

**Table 7: Fire Regime Guidelines<sup>1</sup>**

<b>Fire Community (Bell 1998)</b>	<b>Vegetation Community (Bell 1998)</b>	<b>Plant species decline possible if the following fire regime thresholds are exceeded</b>	<b>Regime Code</b>
Moist Rainforest Complex. Bog (Sphagnum)	RF2, RF3, RF4. B1.	Any fire	A
Dry Rainforest. Fire Sensitive Vegetation.	RF1. F4, F19, F20, W5, H3.	Two or more successive fires each less than 25 years apart. No fire for more than 100 years.	B
Enriched Moist Forests. Mellong Woodlands. Cudgegong Woodlands	F11, F14. W18, W19, F21. W8, W9.	Two or more successive fires each less than 10 years apart. No fire for more than 40 years. Two or more successive fires with 100% canopy scorch.	C
Enriched Dry Forests Dry Basalt Forests & Woodlands. Alluvial Woodlands. Basalt Heaths & Shrublands. Alluvial Shrub Swamps	F3, F13. F18, W21, W22. W14, W15, W16, W17, W20. H8, SH2, HF1. SS1, SS2, SC3.	Two or more successive fires each less than 5 years apart. No fire for more than 20 years. Two or more successive fires with 100% canopy scorch.	D
Sandstone Sheltered Forests. Sandstone Rocky Heath.	F8, F9, F10, F12. H1, H2, H4, H5, H6, H7, H9, H10, SH1.	Two or more successive fires each less than 10 years apart. No fire for more than 30 years. Two or more successive fires with 100% canopy scorch.	E
Major Sandstone Plateau Forests & Woodlands. Arid Sandstone Plateau Forests & Woodlands Moist Basalt Forests & Woodlands	F6, F7, W6, W7, W11, W12, W13, SC1. W1, W2, W3, W4, F5. F15, F16, F17, F22.	Two or more successive fires each less than 10 years apart. No fire for more than 25 years. Two or more successive fires with 100% canopy scorch.	F
Narrabeen Residual Shale Forests	F1, F2.	Two or more successive fires each less than 8 years apart. No fire for more than 20 years. Two or more successive fires with 100% canopy scorch.	G
Impeded Woodlands Sedge & Reedlands.	W10, SG1. SE1, SE2, SE3, RL1.	Two or more successive fires each less than 5 years apart. No fire for more than 40 years. Two or more successive fires with 100% canopy scorch.	H
Permian Talus Woodland	W23, W24, W25, W26, W27, W28.	Two or more successive fires each less than 15 years apart. No fire for more than 25 years. Two or more successive fires with 100% canopy scorch.	I
Rocky Riparian	SC2	Two or more successive fires each less than 40 years apart. No fire for more than 100 years.	J

<sup>1</sup> It is generally recognised that vegetation communities whose fire regimes are outside these frequency guidelines also contribute to overall biodiversity and its research. This includes over burnt and long unburnt areas which are valued for their role as fauna refuges and sources of propagules.

Figure 14: Biodiversity Fire Regime Thresholds



### Effects of management for human protection and strategic bush fire control on biodiversity

The effects of fire management in Strategic Fire Management Zones (SFMZ) on biodiversity need to be considered and factored into planning for biodiversity conservation.

Within the SFMZs, there exists the opportunity to manipulate fire prescriptions so as to cause the least amount of undesirable impact to these communities. Achieving this will require burns of a patchy low intensity nature.

The potential impacts of fire management activities for strategic fire management have been summarised in Table 8.

**Table 8: Impacts of fire management activities on flora**

Management Activity	Effect on Biodiversity
Prescribed burning after long non-fire periods and of a low intensity	- Moderate to negligible impact on fire sensitive species - Beneficial to some fire dependent species
Slashing	- Moderate to high impact on most vegetation species, reduction of habitat
Trail Construction	- Moderate to high impact on most vegetation species, reduction of habitat; increased access by predators
Use of fire fighting equipment, particularly heavy earth moving equipment	- Moderate to high impact on most vegetation species, reduction of habitat; increased access by predators

The major long-term impact of fire on fauna is the reduction of population size through changes in vegetation structure and floristics. Fire can diminish shelter or breeding sites and reduce or eliminate natural foraging resources for some species.

Of additional importance is the post-fire period. This is when individuals are under the greatest threat from predators and a lack of food. Opportunistic predator control programs may be implemented following a fire event to reduce the impact of feral animals upon native species. The key characteristics of fire regimes which impact on animals are frequency, season and extent or patchiness. These characteristics are listed in Table 9 below.

**Table 9: Key Characteristics of Fire Regimes which Impact Upon Fauna**

Fire regime	Impacts
<b>Frequency</b>	The frequency of fires will determine the complexity and therefore the habitat value of the understorey, with frequent fires increasing exposure to predation and climatic influences, and promoting the potential loss of food and shelter resources.
<b>Season</b>	Fires occurring during the breeding season could adversely affect some species by killing offspring or preventing breeding. Reduction of vegetation density may increase the exposure of the young of some species to predation.
<b>Size/ Patchiness</b>	Burns which are limited or patchy will provide a range of ages and vegetation which will provide a greater variety of food and shelter sources, enabling utilisation of an area by a greater number of animal species. Areas not burnt also act as important refuges for wildlife to congregate in, providing shelter and food sources for survivors, from which re-colonisation of the burnt areas can occur.

### Fire regime tactics for biodiversity conservation

The vegetation map for Wollemi NP forms the planning foundation for the preparation of the tactics for biodiversity conservation. The basis of this approach is the concept of 'fire regime thresholds' defining desirable and undesirable fire regimes for conservation of biodiversity.

Due to the high occurrence of lightning strike fires, tactics will be regularly reviewed, refined and adjusted. Given that a diversity of fire regimes is required to maintain biodiversity, the assessment of fire regimes showed that there might be a role for both prescribed fire and /or fire exclusion in parts of the Park at different times in the future. Over time, fires of high, low and moderate intensity, frequency and size will be required to avoid local extinctions.



## **Vegetation communities**

Fire management tactics for vegetation communities is based on the principle of maintaining appropriate fire regimes for the purpose of creating a mosaic of patches with different ages and structures. Furthermore, suppression tactics during bush fire will attempt to minimise burn area by strategically containing fire using existing control lines within the Park to protect fire sensitive plant communities and where possible be consistent with the vegetation types appropriate fire regimes.

## **Threatened flora**

Research has shown that groups of plant species respond in a similar way to fire, according to characteristics of their life history. Therefore, fire regime guidelines for each individual species within a community are not necessary. This Strategy provides for individual species to be conserved according to the fire regime guidelines applied to the communities in which they occur. Appendix 4 outlines the fire regime guidelines for particular endangered and vulnerable flora species. In addition, any relevant Recovery Plan must be considered when planning for fire management.

## **Threatened fauna**

Knowledge of the fire ecology on resident fauna species within the Park is limited. Therefore it is difficult to confidently predict appropriate fire frequency thresholds for the conservation of specific fauna.

The basic management for all fauna is to ensure maintenance of vegetation cover and structure. It is desirable that any individual fire should not completely burn the entire representation of a particular community type or the entire Park.

Appendix 3 lists the fire management guidelines for threatened fauna that are known or likely to occur within the Park. These guidelines are subject to the *Threatened Species Conservation Act, 1995*. This Act provides the framework to protect and encourage the recovery of threatened species, populations and ecological communities. In addition, any relevant Recovery Plan must be considered when planning for fire management.

## **Aboriginal Heritage**

Aboriginal sites can be damaged through the use of heavy machinery, fire fighting efforts and inappropriate fire regimes. Current knowledge on the potential impact on Aboriginal heritage from fire management activities is listed in section 3.4.4 and Table 4.

Damage to sites can be avoided by adhering to procedures outlined in the NPWS Fire Management Manual and by applying operational guidelines. Consultation with Windrayne, Wanaruah, Darkinjung and Dharuk Local Aboriginal Land Councils and other stakeholder groups should occur where appropriate.

## **Historic heritage**

It is considered that operational activities should not adversely affect historic sites within the Park. In the event of a bush fire, suppression or prescribed burning operation within sites containing historic heritage, the following management tactics should be followed:

- No access trail, management trail or helicopter pad will be constructed over any known sites of historic value
- Any known cultural heritage site that exists within a prescribed burn area will be assessed and protection measures taken to minimise any possible adverse effects from fire
- During bush fire suppression operations, any trail or helipad construction activity will be assessed by a NPWS Officer, and the Incident Management Team will be made aware of any

cultural site within close proximity to the construction area

- Operations staff on ground at any construction area, whether a trail or helipad, will be instructed to avoid damaging the cultural heritage site
- Continuation of the regular, yearly pre-fire season fuel reduction programs around California, Sheepskin and Putty Creek Huts.

### **Special purpose management**

The Wollemi Pine (*Wollemia nobilis*) is a recently discovered species and new genus of ancient origins. The Wollemi Pine occurs in small isolated populations only within Wollemi NP.

A species recovery plan has been prepared to identify ways of reducing processes that may threaten the existing natural populations, such as fire, which has been identified as a major threat.

The locations of this species are confidential and therefore fire fighting authorities, personnel and NPWS officers may not be aware of them. However, where possible, fire management for the conservation of the two known *Wollemia nobilis* populations within the Park will follow the following policies.

- Fire retardants (including foam) and surfactants will not be used within 500 metres of any known *W. nobilis* location.
- Earthmoving equipment will not be used within the upper catchment of the Wollemi Pine sites or within 500 metres of the known populations.
- NPWS will attempt to ensure that average fire frequency in areas known to contain *W. nobilis* will be > 40 years, pending further research.
- NPWS will manage fuel and fire ignitions within the catchment of the known *W. nobilis* populations to minimise the risk of high intensity fire within 500 metres of the known sites, pending further research.
- Fire regimes will be managed to minimise the risk of more than 50% of the upper catchment of the known *W. nobilis* sites being burnt in any five year period.

### **Smoke management**

The generation of smoke from fire can cause impacts on the community and the environment. It is intended that all controlled fires should endeavour to reduce the exposure of the community to smoke.

Hazard reductions should be undertaken during climatically favourable periods to allow for the swift dispersal of smoke from the vicinity of the fire. NPWS Operational Guidelines for smoke management are detailed in the NPWS Fire Management Manual. These guidelines are based on the Environmental Protection Authority (EPA) requirements for smoke management.

### **Summary of operational guidelines**

The NPWS operational framework for fire incident management, fire fighting and hazard reduction burning is reviewed annually. At the time of review it includes:

- The NPWS Fire Management Manual – a 160 page document that details all corporate policies and procedures relating to fire.
- Regional Incident Procedures 2005 – a 120 page document that details Region specific procedures for managing incidents.
- Regional Contact Lists 2005 – a 40 page document that details equipment, contact and competency information for NPWS staff, contractors and providers of equipment and services.

These documents are used to maintain RFS local BFMC Operations Plans which detail the cooperative arrangements for the management of fires.

In summary these documents provide the operational guidelines for preparedness, detection, incident management, visitor safety and rehabilitation. They include policy on: readiness levels for initial response and response procedures, the duty officer role, crew standby arrangements, lists of available resources, out-of-area support procedures and guidelines, remote area fire fighting team (RAFT) use, aerial surveillance and standby guidelines, park closure and fire bans, visitor evacuation, natural area fire management, post fire pest and weed invasion, monitoring and rehabilitation, chemical use, accountability and responsibility, training and fitness requirements amongst a lot of other policies, guidelines and procedures that are not specific to Wollemi NP.

## FIRE MANAGEMENT ASSETS

### Fire management access

Fire management access includes roads and trails (mainly vehicular) that can be used for fire management and control operations. The major fire trails are illustrated in Figure 15.

The NPWS provides assistance and in some cases maintains fire trails on private property for those trails that contribute to the fire management of the Park. Existing fire trails within the Wollemi Wilderness Area will be maintained for fire management purposes however, no new trails are to be constructed.

These roads are maintained to access facilities such as lookouts, picnic and camping areas, walking track heads, and for uses such as vehicle touring, cycling and horse riding. The Park includes vehicle tracks which are not available for general public access but provide strategic access for fire fighting or other management works.

In 2003, the Bush Fire Coordinating Committee (BFCC) released a policy on classification and standards of fire trails. The Policy, classification guidelines document and NPWS Policy are detailed in Appendix 4.

Local BFMCs are required to maintain a Strategic Fire Trails Register of such trails within the District. The review of the Fire Trails Register against classification standards is an ongoing consultative process within the local BFMCs and is current for major areas within the Park. The maintenance and/or upgrade of registered trails to these specified standards is NPWS's responsibility but subject to available funding and resources.

As at the time of printing the following trails and information is current.

**Table 10: List of Trails within Wollemi NP and their classification.**

NPWS Name	Current Road Status (using BFCC Classifications) <sup>2</sup>	NPWS Proposed BFCC Class for FT Register <sup>2</sup>	Local BFMC Agreed Fire Trail Register Class <sup>2</sup>	Comment
Hunter Main	Secondary	Secondary		
California	Secondary	Secondary	Secondary	
Bulga	Dormant	Dormant		
Commission Road	Secondary/Primary	Primary	Primary	
Martindale	Secondary	Secondary		
Myrtle (Widden)	Secondary/Dormant	Secondary		
Bakers Road	Primary	Primary		mostly not WNP
Mellong Range	Secondary/Dormant	Secondary		From Baxters Junction to 3ways
Old Coach Road (public access)	Primary	Primary		
Old Coach Road (carpark to Wolgan River)	Dormant	Secondary		
Glow Worm Tunnel Road	Primary	Primary		public access with last 200m secondary

<sup>2</sup> Trails contained within each District BFMC Fire Trail Register may not now, or at any stage in the future, necessarily conform to the BFCC Guidelines in Appendix 4. The Region has classified current status based upon the historical use of the trail and current levels of maintenance.

Mt Cameron (natural Bridge to Mt Cameron)	Closed	Closed		As per POM
Mt Cameron (to Natural Bridge)	Primary	Primary		public access
Grassy Hill	Secondary	Secondary		
Culoul Range	Secondary	Secondary		
Mellong Swamp (Kings Water Hole public access)	N/a	N/a		neighbour access not NP
Mellong Swamp (Kings Water Hole extension)	Dormant	Dormant		
Glen Gallic	Secondary	Secondary		
Yarrowa	Secondary	Secondary		
Reubens West	Secondary/Dormant	Secondary		
Reubens East	Dormant	Dormant		
Kerrabee	Secondary/Dormant	Secondary		
Mailmans Gap	Secondary/Dormant	Secondary		
St Helena	Secondary/Dormant	Secondary		
Mycumbene	Secondary/Dormant	Secondary		
Never Never	Secondary/Dormant	Secondary		
Spring Log	Secondary/Dormant	Secondary		
Nullo (East)	Secondary/Dormant	Secondary		
Nullo (West)	Secondary/Dormant	Secondary		
Cox's Creek	Secondary/Dormant	Secondary		
Growee (Widden)	Secondary/Dormant	Secondary		
Bylong	Secondary/Dormant	Secondary		
Park boundary (Bulga)	Dormant	Dormant	Dormant	
Park boundary (Jerrys Plains)	Dormant	Dormant	Dormant	
Canobla Gap	Primary	Primary		
Capertee Creek	Primary	Primary		
Little Capertee Creek	Secondary	Secondary		
D'Arcy Range	Dormant	Secondary		
Tootie Creek	Secondary	Secondary		
Cabbage Tree Creek	Dormant	Dormant		
Gospers Ridge	Secondary	Secondary		
Gees Arm (South)	N/a	N/a		neighbour access not NP
Wheeney Gap (North)	Secondary	Secondary		
Wheeney Gap (South)	Secondary/Dormant	Secondary		
McMahons Road Trail	Secondary	Secondary		
High Ground				
Bowan Hill	Dormant	Dormant		
Drip Rock	Secondary	Secondary		
Wirraba (Putty Rd to Putty Creek)	Closed	Closed		
Wirraba (Army Rd to Putty Ck)	Closed	Closed		As per POM
Melaleuca	Dormant	Dormant	Dormant	
Army Road	Secondary/Dormant	Secondary		

T3	Secondary	Secondary		
Cora Ck	Dormant	Secondary		
Long Ridge	Dormant	Secondary		
Boongarri	Secondary	Secondary		
Bucketts	Secondary	Secondary		
Blue Gum	Dormant/Closed	Closed		
Angorawa	Dormant	Dormant		part neighbour access not NP
Bob Turners	Secondary	Secondary		
Ladder	Dormant	Dormant		Powerline Access
Upper Colo Powerline Access	Secondary	Secondary		Powerline Access
Gospers Lookout	Dormant	Dormant		
Gees Arm North	Secondary	Secondary		
Ferrari	N/a	N/a		neighbour access not NP
Weatherboard	N/a	N/a		neighbour access not NP
Cerone's	Secondary	Secondary		
Warrigal	Dormant	Secondary		
Ironbark Ridge	N/a	N/a		neighbour access not NP
Irwins Swamp	N/a	N/a		not Wollemi
Eternity Corner	N/a	N/a		neighbour access not NP
Males	N/a	N/a		not Wollemi
Turnbull North	N/a	N/a		not Wollemi
Mid Turnbull	N/a	N/a		not Wollemi
Ruins	Dormant	Dormant		
Tinda Ck	Secondary	Secondary		
Blue Gum Ridge East	Dormant	Dormant		
Brenden	Dormant	Dormant		
Green Scrub	Dormant	Dormant		
Pine	N/a	N/a		neighbour access not NP
Deep Pass North	Primary	Primary		public access
Deep Pass South	Primary	Primary		public access
Mt Budgary	Closed	Closed		from barrier
Galah Mt Rd	Primary	Primary		last 100m dormant
Deans Lookout	Dormant	Dormant		to Gd 459 188
Deans Siding	Dormant	Dormant		
Wolgan River South Public Access	Secondary	Secondary		
Wolgan River South Extension	Dormant	Dormant		
Capertee River Road	Primary	Primary		public access
Capertee River Road Extension	Dormant	Dormant		
Dunns Swamp Public Access	Primary/Secondary	Primary		public access
Glen Alice Perimeter	Dormant	Dormant		
Bylong Perimeter	Dormant	Dormant		
Blackwater Creek	Dormant	Dormant		

Dunns Swamp Powerline Access	Dormant	Dormant		
Kandos Wier	Dormant	Dormant		

<sup>2</sup> Trails contained within each District BFMC Fire Trail Register may not now, or at any stage in the future, necessarily conform to the BFCC Guidelines in Appendix 4. The Region has classified current status based upon the historical use of the trail and current levels of maintenance.

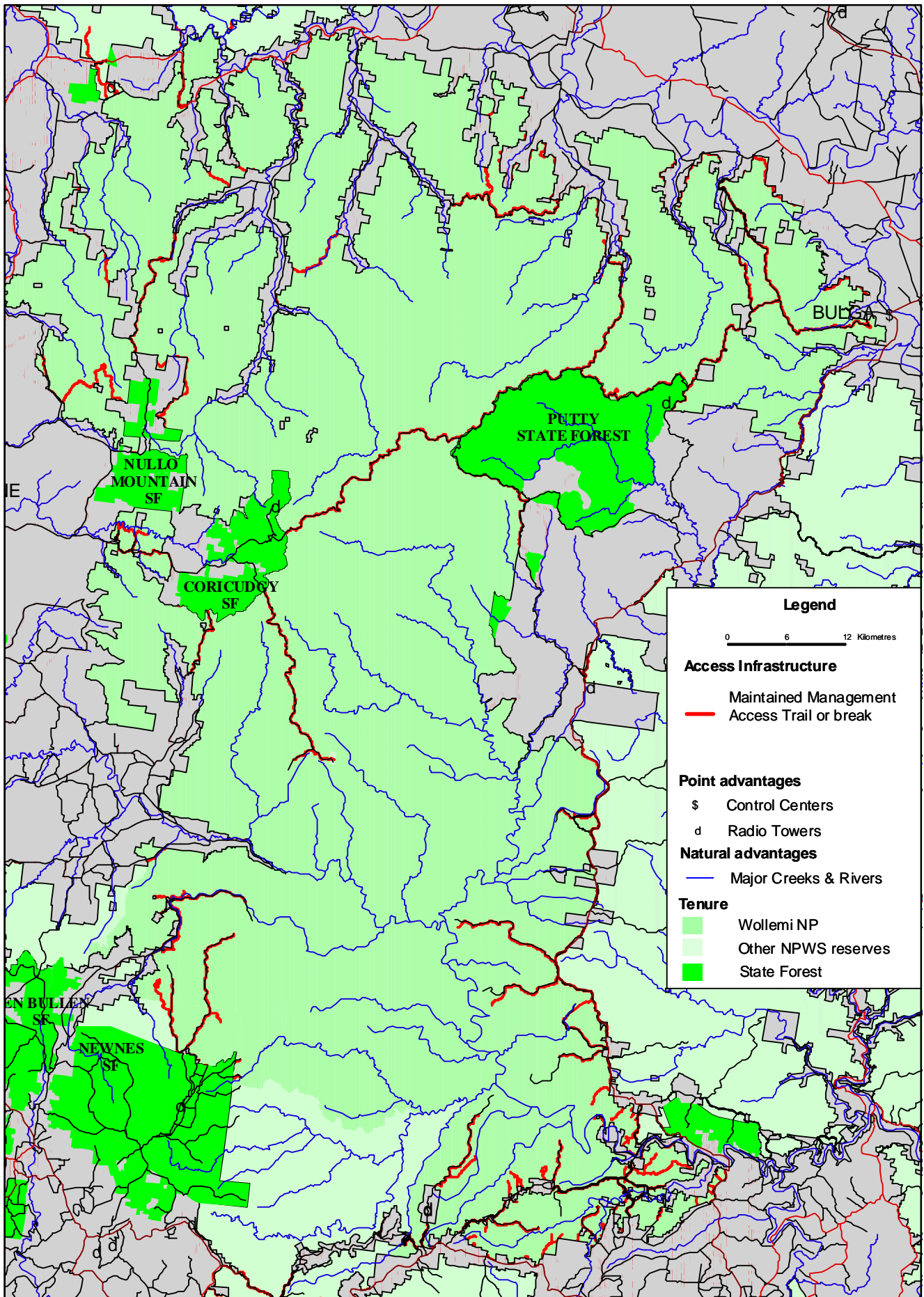
### **Fire Management Utilities & Resources**

Fire management utilities include infrastructure that assists in the detection and control of bush fire and assists in fire management operations. Utilities include fire towers, vantage points, dams and maintained watering points, forward control bases and helipads. No fire towers are maintained for fire detection in Wollemi NP.

NPWS fire equipment is a shared resource across the State and additional NPWS equipment and staff are routinely sourced from across the State at short notice.

A number of workshops and facilities on private land have in the past been set up to permit scaling up of the location as a forward control centre and / or helicopter bases. DISPLN telephone lines are installed at Bulga NPWS Depot, Baerami Hall (northern Wollemi NP on the Bylong Road) and the Halfway Cafe on the Putty Road. Water and electricity supplies are also on hand for immediate connection.

Figure 15: Fire Management Advantages within Wollemi NP





Weather information for Wollemi NP is obtained from the following:

- The Australian Bureau of Meteorology provide a range of historical data collected from remote weather stations and collated by the Bureau. (Relevant information for Wollemi NP is from the Jerrys Plains, Nullo Mountain, Richmond Automatic Weather Stations).
- Daily forecasting services from Australian Bureau of Meteorology. Accessible via the Internet.
- A weather system owned and operated by NPWS. The system currently consists of weather stations located at Mudgee, Muswellbrook, Bulga offices / depots, Colo Heights Depot and remote stations at Mt Poppong and Kerrabee. They display real-time weather information and store the historic data.

NPWS will continue to improve the local weather monitoring system in cooperation with RFS to provide real-time weather information for fire management. An additional station is planned for Staircase Hill (Putty) to provide advance warning of thunderstorm and frontal weather system activity. This will complete the NPWS network of a weather station at approximately every 50 kilometres in and around the Park.

A fire retardant mixing unit has been established at Scone Airport in cooperation with Scone RFS.

### **Fire management facilities**

The NPWS has dedicated equipped fire operations rooms at the Bulga and Blackheath offices, as do the five relevant RFS Fire Control Centres. Other NPWS depots at Rylstone, Colo Heights, Richmond and Mudgee have also been used as control centres. These are equipped with radio, remote weather monitoring equipment, telecommunications and mapping facilities. Other infrastructure available for this purpose is outlined in the local BFMC Fire Management Plans and annual Regional Incident Procedure documents.

## **WORKS SCHEDULE**

### **Biodiversity works schedule**

Management of biodiversity within the Park aims to maintain appropriate fire regimes and to create a mosaic of age classes and structures within vegetation communities. Fire frequency, years since last fire and the inter-fire period are all used to determine fire thresholds within the Park. Incomplete fire records could give a false indication of areas exceeding thresholds.

### **Fire management research**

At present, there is varied information available on the fire ecology and fire behaviour of flora and fauna within the Park. Ongoing research is required where major deficiencies occur in understanding how to manage and conserve biodiversity.

Specific areas of research requiring attention are:

- The responses of fauna to fire. (NB: Research is especially needed within the realm of invertebrates and lower vertebrates, especially in relation to their habitat requirements.)
- A basis for predicting the long-term responses of animal populations to fire regimes, not just a single fire.
- A better understanding of the requirements for refuge, post-fire dispersal and re-colonisation of animal species which may have been depleted by a fire in the short term, with an outcome of creating fire thresholds of fire size and shape they may require for conservation purposes.

Other fire management research and monitoring requirements for the Park, include:

- Establishment of permanent sites for the monitoring of the response of biota and landscape

processes to the fire regimes of the Park. The program should include the monitoring of ecotones so as to measure the rate of expansion or reduction of the size of vegetation communities.

- The re-mapping of broad vegetation classes prior to each 5 yearly review of the Fire Management Strategy, using aerial photographs or remote sensing. Maps are to be digitised and a comparison with previous vegetation layers made using GIS technology. A consistent standard of mapping accuracy and vegetation classification is required.
- On-going analysis of trends shown by fire ignition point data and bush fire paths to determine further site specific fire prevention and mitigation tactics.
- Compilation of locally prepared fuel accumulation curves for the major vegetation communities of the study area.
- Investigate the need to burn those areas that are currently not within the biodiversity thresholds of that area
- More detailed evaluation of the fire regime and recovery plan requirements of the threatened species identified within the Park.
- Improvement in knowledge of propagule longevity for plants especially obligate seed regenerators.
- Effects of fire fighting foam and retardants on water quality of creeks and invertebrates.
- Test the flexible approach model to fire management (Bradstock *et al.*1995).
- Temporal vegetation regeneration following prescribed burns.
- Soil erosion following fires.
- Correlation of weather and fire behaviour.

### **Fire mapping and database management**

Fire history data for the Park will be stored in the NPWS Geographical Information System (Arcview) maintained by Central Branch, RFS databases such as their Bushfire Risk Information Management System (BRIMS), and the NPWS Incident Database (EXCEL spread sheet) maintained at the Central Coast Hunter Range and Blue Mountains Regional Offices of the NSW NPWS.

### **Monitoring fuel**

Fuel sampling will be required to occur pre and post fuel reduction activities and recorded into a database for future reference. Fuel sampling will be carried out according to the current method used by the Service. Objectives of the fuel monitoring program will be to:

- Measure and record the effectiveness of prescribed burns
- Allow for prioritisation of prescribed burns
- Determine the accumulation rate and distribution of fuels within different fuel groups

Fuel sampling techniques are to be reviewed as new research is undertaken within this area of fire management.

### **Monitoring fire regimes and changes to biodiversity**

Mapping of all fires, both planned and unplanned, will be required to ensure that information is available for effective analysis. The involvement of research agencies other than the NPWS may be required due to resource deficiencies. The cooperation of universities should be encouraged for their capability to contribute to the research and analysis of fire regimes and / or changes to biodiversity.

## **Operations Works Schedule**

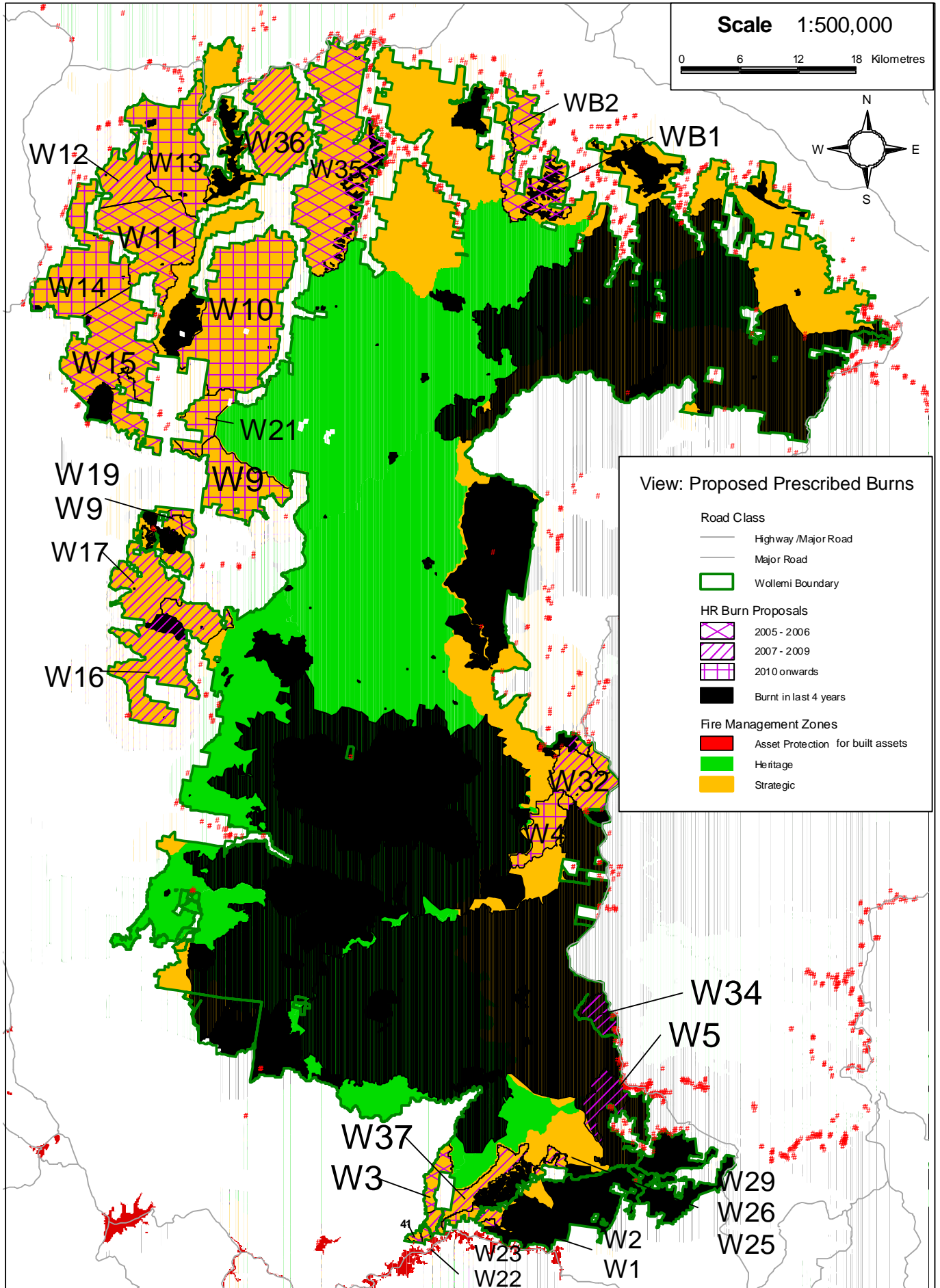
### **Prescribed Fuel Reduction Burning**

Table 11 and Figure 16 detail the proposed strategic fire management zones (SFMZ) to be considered for prescribed fuel reduction burning during the term of this Strategy.

Areas are based on fire history (including year since last fire), proximity to assets, bush fire behaviour potential and biodiversity thresholds as at November 2004. These areas are subject to annual endorsement by local BFMCs, where priorities could alter according to bush fire occurrences and unfavourable weather patterns. It is recommended that an annual review of the schedule be undertaken in light of changing circumstances.

The Strategy has mapped SFMZ at a broad scale and it is not intended that the entire zone will be treated at any one time. As part of the preparation of annual works schedules, fire managers will identify suitable sections of zones defined by appropriate control lines for prescribed burning. The timing and success of each prescribed burn will be dependent on the prevailing climatic conditions within the region, outbreaks of bush fire, resource issues and the accumulation of fuel. An assessment of fuel loads will be conducted before and after burning. A detailed Prescribed Burn Operations Plan will be prepared for each prescribed burn. These identify suitable weather conditions.

Figure 16: Proposed prescribed fuel reduction burns within these broad areas.



**Table 11: Proposed Prescribed Burning Works**

<b>ZONE_ID</b>	<b>ZONE_NAMES</b>	<b>AREA_HA*</b>	<b>Years scheduled for treatment</b>
W2	Wheeny	107	2005-6
W2	Wheeny	86	2005-6
W3	Mount Tootie	1214	2005-6
W11	Puzzle Mountain	7467	2005-6
W15	Nullo West	9101	2005-6
W19	The Molle	373	2005-6
W20	The Molle	710	2005-6
W22	Wolka East	231	2005-6
W23	Warawaralong	322	2005-6
W25	Cooramill	174	2005-6
W6	Talamba Hill	3234	2005-6
WB 1 & 2	Martindale West & Horseshoe	7028	2005-6
W35	Baerami Valley West	15994	2005-6
W1	Wheeny Creek North	482	2007-9
W17	Durambang	5484	2007-9
W36	Widden Valley West	7651	2007-9
W37	Tooti Creek North	1847	2007-9
W18	Ganjudd1	656	2007-9
W26	Sunny Dell	172	2007-9
W29	Cora Creek	138	2007-9
W3	Mount Tootie	373	2007-9
W30	High Wollemi	535	2007-9
W31	Kangaroo Waterhole	390	2007-9
W32	Gospers Creek	2887	2007-9
W12	Bylong Creek	5432	2007-9
W16	Tayan	2515	2007-9
W16	Tayan	13893	2007-9
W27	The Mill Paddock	97	2007-9
W28	Outer Mill Paddock	108	2007-9
W34	Meroo Pines West	1071	2007-9
W5	New Yard Ck	1821	2007-9
W13	Cox's Gap West	8335	2010+
W24	Bilpin	639	2010+
W33	Mellong Creek	198	2010+
W9	Mt Wilworrell	9294	2010+
W14	Oz Mountain	8825	2010+
W10	Mount Pomany	16139	2010+
W21	Nullo East	2166	2010+

\* This is the total area of Strategic Fire Management Zone. The actual area of proposed prescribed burn within this area and its boundaries will be resolved with local BFMCs.

## **Infrastructure Works Schedule**

The annual works schedule specifies the proposed activities primarily involved with access and management. The ability of the Service and assisting organisations to implement each activity will be predominantly influenced by seasonal conditions, bush fire events, research and finance.

### **Fire management access**

Annual works schedules will identify the priorities for fire management access maintenance and construction works including grading, slashing, selective shrub removal and rehabilitation. Priorities for works will be based on an evaluation of the strategic value of access routes including previous success in fire containment and significance at regional level. Tracks and trails on Service estate will be maintained by NPWS plant crew or by contractors. Finally, access routes should be monitored for soil erosion and weed invasion.

### **Fire management utilities and equipment**

Prior to the fire season each year, NPWS staff will ensure that access to watering points is suitable for fast extraction by vehicles or helicopters.

Radio communication equipment will be checked prior to the fire season and attention paid to the adequacy of portable units including batteries and chargers. The availability of fire suppression equipment kits will be checked, and shortcomings attended to prior to each fire season as part of standard operational procedures.

Plant equipment and personal kits are to be checked prior to the commencement of each fire season, to ensure that they are ready for service or updated where necessary.

All equipment will be checked and, where required, repaired or replaced immediately following its use at a fire.

### **Fire management facilities**

Prior to each fire season, the incident management facility will be reviewed. The logistics and planning response box contents will be checked. Staff will be required to participate in training exercises to ensure that all staff and personnel are familiar with the current incident procedures and facilities.

Pre-planning procedures will continually be improved, including the identification and establishment of temporary aircraft facilities and forward control centres with rapid deployment capability.

## **STRATEGY ADMINISTRATION**

### **Management of works**

The works programmed for the next five years will be identified in the NPWS Regional Operations Plan and Hazard Reduction schedules. This lists all management works to be conducted in all conservation reserves within the NPWS Blue Mountains and Central Coast Hunter Range Regions.

Work performance will be monitored and reported on by the Blue Mountains and Central Coast Hunter Range Regions.

### **Environmental assessment of scheduled works**

Environmental assessments for all scheduled works will be undertaken by NPWS. For asset protection and strategic fire management zones this will comply with the RFS Bush fire Environmental Assessment Code, July 2003. Otherwise, NPWS will conduct a full Review of Environmental Factors (REF) for each activity.

### **Strategy Review**

This Strategy has been placed on public display for a period of one month for community comment. During its life, there may be need to review the fire management tactics as further information and research into flora and fauna develops. To ensure that regular reviews are undertaken, this fire Strategy has an operational life span of 5 years. At the completion of this period, the Strategy will be reviewed according to prevailing policy.

### **Implementation and Evaluation**

The monitoring of the issues outlined below will determine the level of success of implementation of this Strategy. It will also prove how effectively the recommended actions have been to reduce the impact of adverse events and improve fire management. The issues which will govern this Strategy's success are:

- The protection of life and property from adverse fire effects
- The maintenance of biodiversity through the appropriate management of fire regimes
- Increased surveillance on days of very high to extreme fire danger either through patrols, neighbourhood assistance or other direct methods
- The need to promulgate suppression policies that can be implemented by the local fire fighting organisation in the absence of Service staff
- The maintenance of appropriate fuel levels in strategic locations associated with the residential settlements
- The management of existing fire trails as strategic fire breaks. It is recognised that these trails may be unable to stop medium to high intensity fires or high wind driven fires.

Factors beyond the control of fire management include:

- Adverse weather conditions leading to a period of extreme fire weather
- Inability to complete trail maintenance, slashing or prescribed burning operations due to prolonged periods of wet weather during the non-fire danger period
- The carelessness of some individuals in use of fire for campfires and burning of vegetation and refuse, thereby allowing fire to escape into the Park
- Ongoing information is required to judge whether management tactics based on the guidelines contained in this Strategy are successful in terms of achieving conservation objectives. The conservation guidelines are a summation of current knowledge relevant to the biodiversity contained within the Park

### **Life and property**

The achievement of these objectives will be evaluated by:

- The provision of public education on fire prevention, preparedness and response for residents adjacent to the Park in cooperation with each local BFMC.
- The collection and maintenance of accurate fire history records and an evaluation of trends
- The upgrading and maintenance of fire trails within the Park to the identified standard

### **Maintenance of biodiversity**

The achievement of these objectives will be evaluated by:

- The accurate recording of all planned and unplanned fires
- The comparison of fire history with fire regimes identified within each zone to determine the adherence to the prescription
- Ongoing research into the appropriateness of prescriptions
- The incidence of fire in the fire sensitive vegetation and / or locations
- The recovery of other recently burned vegetation communities
- The success of neighbourhood relations and in particular the incidence of arson activities or accidental fire ignitions that impact upon the Park

As the knowledge-base evolves, the above guidelines could change. Performance evaluation must be an exercise in scrutiny of these guidelines, aimed at pinpointing where they are invalid and are in need of improvement. It is vital that performance evaluation is not solely directed at describing the State of fire regimes within the Park.

Thorough performance evaluation must be directed at assessing changes in species populations in relation to fire regimes so that the predictions implicit in the guidelines are tested and verified. The Service is committed to performance evaluation of its conservation guidelines and tactics and will seek whatever assistance is required to develop and implement a program that takes account of species dynamics and fire regimes.



## REFERENCES

- Australian Fire Authorities Council (1996) 'Glossary of Rural Fire Terminology'. Information handout for Fire Managers, produced by AFAC. Mount Waverly, Vic.
- Banffy, C (2002) *Blue Mountains Region Pest Management Plan*. Katoomba, NSW.
- Barker, J., Grigg, G.C. and Tyler, M.J. (1995) *A Field Guide to Australian Frogs*. Surrey Beatty and Sons, Norton, NSW
- Bell, S (1998) *Wollemi NP vegetation survey: a fire management document*. Report to NSW NPWS, Upper Hunter District.
- Benson, D. and Howell, J. (1994) Ecology of the Sydney plant species part 2: Dicotyledon families Asteraceae to Buddlejaceae. *Cunninghamia*. 3(4):789-986
- Benson, D and Keith, D (1990) The natural vegetation of the Wallerawang 1;100 000 map sheet. *Cunninghamia* 2(2): 223-262.
- Benson, D. and McDougall, L. (1993) Ecology of Sydney plant species part 1: Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. *Cunninghamia*. 3(2):257-422.
- Benson, D. and McDougall, L. (1996) Ecology of the Sydney plant species part 4: Fabaceae: Peas and Wattles. *Cunninghamia*. 4(4):553 -747
- Benson, D. and McDougall, L. (1997). Ecology of Sydney plant species part 5: Dicotyledon families Flacourtiaceae to Myrsinaceae. *Cunninghamia* 5(2):330-544.
- Benson, D. and McDougall, L (1998) Ecology of Sydney plant species Part 6: Dicotyledon family Myrtaceae. *Cunninghamia*. 5(4):808- 984.
- Benson, D. and McDougall, L (1999a) Ecology of Sydney plant species Part 7b: Dicotyledon families Proteaceae to Rubiaciaceae. *Cunninghamia*. 6(4):1017 – 1202.
- Benson, D. and McDougall, L (1999b) Ecology of Sydney plant species Part 7a: Dicotyledon families Nyctaginaceae to Primulaceae. *Cunninghamia*. 6(2):402-506.
- Benson, D. and McDougall, L (1999c) Ecology of Sydney plant species Part 3: Dicotyledon families Cabomaceae to Eupomatiaceae. *Cunninghamia*. 4(2): 217-425.
- Binns, D. (1996) *Flora Survey, Morisset Forestry District, Central Region, New South Wales: Morisset Forestry District EIS Supporting Document No. 3*. Research Division, State Forests of New South Wales, Sydney.
- Bishop, A. (1996) *Field Guide to the Orchids of New South Wales and Victoria*. University of New South Wales Press.
- Bradstock, R.A., Auld, T.D., Keith, D.A., Kingsford, R., Lunney, D. and Sivertsen, D. eds. (1995) *Conserving biodiversity: threats and solutions*. Surrey Beatty & Sons, Sydney.
- Bradstock, R.A., Tozer, M.G., and Keith D.A. (1997) Effects of High Frequency fire on Floristic composition and Abundance in a fire prone heathland near Sydney, Australian Journal Of Botany 45, pp.641 – 655.
- Bradstock, R.A. and Gill, A.M. (2001) Living with fire and biodiversity at the urban edge: in search of a sustainable solution to the human protection problem in southern Australia. *Journal of Mediterranean Ecology*, 2:179-195.
- Brindle, N (1999) *Threatened Biodiversity of the Central Coast District in Relation to Fire Management; Report Submitted to the Department of Geography and Environmental Science*. The University of Newcastle and NSW NPWS.
- Bush Fire Coordinating Committee (2003) *Policy No. 01/03: Guidelines for the Classification of Fire Trails*. NSW Rural Fire Service, Rosehill, NSW.

- Catling, P (1991) Ecological effects of prescribed burning practices on the mammals of south east Australia. In Lunney, D. (ed) (1991) Conservation of Australia's forest Fauna. Royal Zoological Society, NSW, Sydney.
- Cheney, P. et al (1992) *A Prescribed Burning Guide for Young Eucalyptus Forests of Silvertop Ash*, Forestry Research paper No. 16 NSW Forestry Commission
- Cheney, P and Sullivan, A. (1998) *Comment on Risk Analysis Process for New South Wales* CSIRO Forestry and Forest Products
- Cogger, H. G. (2000) Reptiles and Amphibians of Australia. (Ed) P. Hutton. Reed New Holland.
- Ecotone Ecological Consultants (1995) *Survey of Non-Flying Mammals and Owls and Impact Assessment of Forestry Practices in Morisset Forestry District*. Forestry Commission of NSW.
- Conroy, R.J. (1993) *Fuel Dynamics in the Sydney Region* NSW NPWS
- Cultural Heritage Division, NSW NPWS (2002) *Blue Mountains Region Interim Cultural Heritage Management Strategy*. Unpublished.
- Debus, SJ and Chafer, CJ, 1994. The Powerful Owl, *Ninox strenua* in New South Wales. *Aust. Birds*. 28:S20-S38.
- Department of Environment and Conservation (NSW) (2005) *Fire Management Manual*. Department of Environment and Conservation (NSW), Hurstville, NSW.
- Department of Environment & Conservation (NSW) (2004) *The role of the NPWS in managing fire*. <http://www.nationalparks.nsw.gov.au/npws.nsf/Content/The+role+of+the+NPWS+in+managing+fire>
- Dovey, S. (1996) *Analysing Bush fire Threat in Southern New South Wales*. NSW NPWS.
- Dowden, H (1985) *Preliminary fine fuel curves for a dry forest site in the Blue Mountains*. Report to Forestry Commission of NSW, Sydney.
- Ecotone Ecological Consultants (1995) *Survey of Non-Flying Mammals and Owls and Impact Assessment of Forestry Practices in Morisset Forestry District*. Forestry Commission of NSW
- Fox, BJ, Fox, MD and McKay, GM (1979) Litter accumulation after a fire in a eucalypt forest. *Aust J Bot*, 27, 157-65.
- Gellie, N.J. (1994) Blue Mountains Bush fire (41A) Management plan, Blue Mountains Local BFMC, Katoomba.
- Gellie, NJG and Holme, L (1991) *NSW Fuel Tables*. Internal NPWS report, NPWS Blackheath.
- Gill, A. M. and Bradstock, R. A. (1992) A national register for the fire response of plant species. *Cunninghamia*. 2:653-660.
- Harden, G. J. (ed) (2000) *Flora of New South Wales*. Volume 1 (2<sup>nd</sup> Edition). Royal Botanic Gardens, Sydney.
- Harden, G. J. (ed.) (1991) *Flora of New South Wales*. Volumes 1-4. Royal Botanic Gardens, Sydney.
- Hoye, G.A. (1995) *A Bat Survey of the Morisset Forestry District*. G.A. Hoye, FBN Bat Surveys and the Forestry Commission of NSW.
- Jelinek, AJ (1983) *A frequent burning study in the Blue Mountains NSW*. Internal NPWS report, Blackheath, NSW.
- Kerr, J.S. (1985) *The Conservation Plan*. A guide to the preparation of conservation plans for places of European cultural significance. The National Trust of Australia (NSW)
- Leigh, J. and Briggs, J. (1996) *Rare or Threatened Australian Plants*. Australian NPWS
- Lewis, B. (2000) Record of the Green-thighed frog (*Litoria brevipalmata*) from North-east New South Wales. *Herpetofauna* 30(2): 7-8
- McRae, R.H. and Cooper, M.G. (1985) Vegetation of the Merriwa area, New South Wales. *Cunninghamia* 1 (3): 351-369.

- Murphy M. J and Turbill, J. (1999) A new locality for the threatened Green-thighed Frog *Litoria brevipalmata* in coastal north-east New South Wales. *Australian Zoologist*. 31(1):225-229.
- NPWS (1989) NPWS Wilderness Conservation Policy, Strategic Policy Division, NSW NPWS Hurstville.
- NPWS (1997) *Assessment Report on the Wollemi Wilderness Area*. NSW NPWS.
- NPWS (1999) *Threatened Species Management – Species Information*. NSW NPWS, Hurstville.
- NPWS (2000) *Threatened Species of the Lower North Coast of New South Wales*. NSW NPWS, Hurstville.
- NSW NPWS (2001) *Wollemi NP Plan of Management*. NSW NPWS, Hurstville, NSW.
- NSW NPWS (2003a) *Fire Interval Guidelines for Broad Vegetation Types*. Unpublished.
- NSW NPWS (2003b) *Fire Management Planning*. NSW NPWS, Hurstville, NSW.
- NPWS (2005) *Fire Management Manual*. NSW NPWS, Hurstville.
- NSW Rural Fire Service & Planning NSW (2001), *Planning for Bush Fire Protection: a guide for Councils, Planners, Fire authorities, Developers and Home Owners*, NSW Rural Fire Service, Sydney.
- NSW Soil Conservation Service (1994) *Guidelines for the Planning, Construction and Maintenance of tracks*. Maitland, NSW. (This document has also been reproduced under the auspices of Conservation and Land Management, and Department of Land and Water Conservation).
- Payne, R. J. (1991) 'New findings of the rare tree *Syzygium paniculatum* (Myrtaceae) in the Wyong area, New South Wales.' *Cunninghamia* 2: 495-498.
- Pizzey, G. and Knight, F. (1997) *The Graham Pizzey and Frank Knight Field Guide to the Birds of Australia*. Angus and Robertson.
- Raison, R.J., Woods, P.V., Khanna, P.K. *Dynamics of Fine Fuels in Recurrently Burnt Eucalypt Forests*. Australian Forestry, Vol 46. No 4 pp.294 - 302, CSIRO Divn. For. Res., Canberra, Act.
- Read, D.G. and Fox, B.J. (1991) *Assessing the Habitat of the Parma Wallaby, Macropus parma* (Marsupialia; Macropodidae). *Australian Wildlife Research*, 18, 469-78.
- Robinson, M. (2000) *A Field Guide to Frogs of Australia – From Port Augusta to Fraser Island Including Tasmania*. Australian Museum / Reed New Holland.
- Rummery, C., Alison, C. and Lunney, D. (1995) *The Brush-tailed Rock Wallaby Petrogale penicillate in Yengo NP and Parr State Recreation Area*. NSW NPWS.
- Read, D.G. and Fox, B.J. (1991) *Assessing the Habitat of the Parma Wallaby, Macropus parma* (Marsupialia; Macropodidae). *Australian Wildlife Research*, 18, 469-78.
- State Forests of NSW (1995) *Morisset Forestry District Environmental Impact Statement*. Australian Forestry Commission.
- Strahan, R. (1995) *The Mammals of Australia*. Australian Museum and Reed New Holland.
- Slater, P., Slater, P. and Slater, R (1999) *The Slater Field Guide to Australian Birds*. Lansdown Publishing.
- State Forests of NSW (1995) *Morisset Forestry District Environmental Impact Statement*. Australian Forestry Commission.
- Tanton, M. (1996) *Northern Region Threatened Fauna Species Profiles*. State Forests of New South Wales.
- TFB Ecovision (1996) *Spotted-tailed Quoll (Dasyurus maculatus) Survey of Popran NP, NSW*.
- Van Loon, AP (1977) *Bushland fuel quantities in the Blue Mountains - litter and understorey*. Forestry Commission of NSW Research Note No 33, Sydney.
- Webster, R. (1995) *Fauna Survey of the Morisset Forestry District, Central Region, Diurnal Birds*. Forestry Commission of NSW.
- White A. M., Whitford, R. W., and Mahoney, M. J (1994) *A New Species of Litoria (Anura:Hylidae)*

*from Eastern Australia. Proc. Linn. Soc. NSW. 114(1): 2-9*

Willis, M (2004) *Bushfire arson: a review of the literature*. Australian Institute of Criminology, Canberra.

## Appendix 1: Definitions, Abbreviations and Principles

Most definitions described below come from the Australian Fire Authorities Council (AFAC) *Glossary of Rural Fire Terminology* (March 1996).

<b>Aerial Detection</b>	The discovering, locating and reporting of fires from aircraft.
<b>Aerial Fuels</b>	The standing and supporting combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, bark and creepers.
<b>ASL</b>	Above sea level
<b>Aspect</b>	The direction towards which a slope faces, eg north-east. Slopes on a west to north-westerly aspect are the most hazardous during fire fighting operations.
<b>Assets at Risk</b>	The natural resources or improvements that may be jeopardised if a fire occurs. Examples include: threatened species habitat, rainforests, forestry coupes, human built structures or infrastructures, Park information signs, transmission poles etc. and may also include scenic values. For the fire manager it may also include natural values that may be threatened by a fire (e.g. water catchment quality).
<b>Backburning</b>	A fire started intentionally along the inner edge of a fire line to consume the fuel in the path of a bush fire.
<b>Buffer</b>	A strip or block of land on which the fuels are reduced to provide protection to surrounding lands.
<b>Burning Program</b>	All the prescribed burns scheduled for a designated area over a nominated period of time.
<b>Bushfire</b>	An unplanned fire. A generic term that includes grass fires, forest fires and scrub fires.
<b>Bush Fire Management Zone</b>	Management areas where a specified fire management operational objective, tactic and performance indicator has been developed to mitigate against the threat of a bush fire.
<b>Coarse Fuels</b>	Dead woody material, greater than 25mm in diameter, in contact with the soil surface (fallen trees and branches).
<b>Controlled Burning</b>	<i>see Prescribed Burning.</i>
<b>Crown Fire</b>	A fire burning in the crowns of trees and usually supported by fire in ground fuels. It is a fast travelling fire that usually consumes all available fuels in its path.
<b>Drought Index</b>	A numerical value, such as the Keetch Byram Drought Index, reflecting the dryness of soils, deep forest litter, logs and living vegetation.
<b>Ecosystem</b>	The interacting system of a biological community, both plant and animal, and its non living surroundings
<b>Edge Burning</b>	A term used to describe perimeter burning of an area in mild conditions. May be done prior to large scale prescribed burning. This practice is used to strengthen buffers and control lines; and to reduce mop-up operations.
<b>Fine Fuels</b>	Grass, leaves, bark and twigs less than 6mm in diameter.
<b>Fire</b>	The chemical reaction between fuel, oxygen and heat. Heat is necessary to start the reaction and once ignited, fire produces its own heat and becomes self-supporting.

Removal of any one of the three elements of fuel, oxygen and heat will extinguish a fire.

<b>Fire Behaviour</b>	The manner in which a fire reacts to the variables of fuel, weather and topography. Changes in any of these variables will result in a change in the fire behaviour.
<b>Fire Break</b>	Any natural or constructed discontinuity in a fuel bed used to segregate, stop and control the spread of a bush fire, or to provide a fireline from which to suppress a fire.
<b>Fire Extent</b>	The area burnt by a bush fire, measured in hectares. Within that area there will be "islands" of unburnt vegetation (these islands are generally included in the total fire extent). <i>NB: it is preferable that fire affect only part of a vegetation community at any one time so that nearby areas of more mature plants may provide a seed source for re-colonisation and animals will have suitable unburnt habitat in order to seek shelter and forage.</i>
<b>Fire Front</b>	The part of a fire where the rate of spread, flame height and intensity is greatest, usually when burning downwind or upslope.
<b>Fire Intensity</b>	The rate of energy released per unit length of fire front. This is usually expressed as kilowatts per metre (kW/m).
<b>Fire Management</b>	All activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives.
<b>Fire Perimeter</b>	The entire outer boundary of a fire area.
<b>Fire Regime</b>	The history of fire in a particular vegetation type or area including the frequency, intensity and season of burning (season in this context refers to the time of the year in which the fire occurred). It may also include proposals for the use of fire in a given area.
<b>Fire Season</b>	The period(s) of the year during which fires are likely to occur, spread and do sufficient damage to warrant organised fire control. In New South Wales the core fire season is from 1st October to the 31st March of the following year. <i>At the regional scale, the season may be introduced or extended, by one month, dependant upon the prevailing weather conditions, drought indexes and number of bush fires that may already be burning within that area.</i>
<b>Fire Storm</b>	Violent convection caused by a large continuous area of intense fire; often characterised by destructively violent surface indrafts, a towering convection column, long distance spotting, and sometimes by tornado-like whirlwinds.
<b>Flame Height</b>	The vertical distance between the tip of the flame and ground level, excluding higher flame flashes. Expressed in vertical metres.
<b>Fuel</b>	Any material such as grass, bark, leaf litter and living vegetation which can be ignited and sustains a fire. Fuel is usually measured in tonnes per hectare of dry weight.
<b>Fuel Arrangement</b>	A general term referring to the spacing and arrangement of fuel in a given area.
<b>Fuel Load</b>	The oven dry weight of fuel per unit area. Commonly expressed as tonnes per hectare.
<b>Fuel Bed</b>	The arrangement and vertical profile of all readily combustible materials lying on the ground.
<b>Fuel Management</b>	Modification of fuels by prescribed burning, manual removal, slashing, grazing, or other means. The objective is to reduce the fuel thereby reducing the risk posed by bush fires.

<b>Fuel Type</b>	An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause predictable rate of spread or difficulty of control under specified weather conditions.
<b>Habitat</b>	A physical portion of the environment that is inhabited by an organism or population of organisms. A habitat is characterised by a relative uniformity of the physical environment and fairly close interaction of all the biological species involved. <i>Organisms within a given habitat will express a level of co-dependancy upon one-another. The loss of the physical characteristics of a given habitat can have severe and long term detrimental effects upon the organisms living in that habitat.</i>
<b>Hazard Reduction</b>	<i>see Fuel Management</i>
<b>Island</b>	An unburnt area within a fire perimeter. Islands are critical for species survival and recruitment after a bush fire event.
<b>Keetch- Byram Drought Index (KBDI)</b>	A numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation, and expressed as a scale from 0 - 200 points. When 100 points has been reached in an area, that area is said to be in drought.
<b>NPWS</b>	National Parks and Wildlife Service of New South Wales.
<b>NSWFB</b>	New South Wales Fire Brigades.
<b>Prescribed Burning</b>	The controlled application of fire under specified environmental and weather conditions to a predetermined area and at the time, intensity, and rate of spread required to attain planned resource management objectives.
<b>RFS</b>	Rural Fire Service.
<b>Rate of Spread</b>	The forward progress per unit time of the head of the fire or another specified part of the fire perimeter.
<b>SF</b>	State Forests of New South Wales.
<b>Scorch Height</b>	The height above ground level up to where foliage has been browned by a fire. This height is roughly ten times the actual flame height of the fire.
<b>Slip-on Unit</b>	A fire fighting unit that can be placed on to the back of a four wheel drive vehicle to convert it to a fire tanker. <i>Depending upon the units water carrying capacity, a four wheel drive tray top vehicle could be converted to Category 2,7 or 9 fire tanker in a very short period of time.</i>
<b>SOI</b>	Southern Oscillation Index
<b>Spot Fire</b>	Isolated fires started ahead of the main fire by sparks, embers or other ignited material, sometimes to a distance of several kilometres.
<b>Striker</b>	A small four wheel drive fire tanker capable of carrying from 400 to 600 litres of water for fire fighting purposes. Also known as a Category 9 Fire Tanker.
<b>Structure Fire</b>	A fire burning part, or all of any building, shelter, or other human made construction.
<b>Tanker</b>	A mobile fire-fighting vehicle equipped with a water tank, pump, and the necessary equipment for spraying water and/or foam on bush fires. <i>Under NSW Department of Rural Fire Service guidelines, bush fire fighting tankers have been designated into nine 'Categories' delineating water carrying capacity and whether the unit is two or four wheel drive capable.</i>
<b>Topography</b>	The surface features of a particular area or region, i.e. the lay of the land, and includes mountains, rivers etc.
<b>Unplanned Fire</b>	<i>see Bushfire</i>

**Urban/Rural Interface** The line, area, or zone where structures and other human development adjoin or overlaps with undeveloped bushland. Also known as the urban/bush interface, urban interface or just the interface.



## Appendix 2: Vegetation Communities & Fire Behaviour Categories of Wollemi NP

Code	Vegetation Community	Fire Regime
	Urban	0
	Water	0
RF1	Sandstone Gorge Dry Rainforest	0
RF2	Sandstone Gorge Warm Temperate Rainforest	0
RF3	Sandstone Gorge Sub-tropical Rainforest	0
F11a	Narrabeen Sheltered Bluegum Forest	1
F16	Montane Basalt Diatreme Forest	1
F17	Moist Basalt Diatreme Forest	1
RF4a	Montane Basalt Cap Rainforest	1
SE3	Upper Cudgegong Alluvial Sedgeland	1
Ag	Agricultural	2
C	Cleared	2
Dist	Disturbed lands	2
HF1	Kerrabee Dry Basalt Herbfield	2
RL1	Upper Cudgegong Alluvial Reedland	2
SC2	Rocky Alluvial Riparian Scrub	2
SG1	Cudgegong River Swamp Grassland	2
F14a	Culoul Residual Basalt Cap Forest	3
F20	Alluvial River Oak Forest	3
H1	Narrabeen Escarpment Arid Rocky Heath	3
SE2	Mellong Sandmass Sedgeland	3
SS2	Upper Cudgegong Alluvial Shrub-swamp	3
W15	Northern Wollemi Alluvial Apple Woodland	3
W19	Mellong Sandmass Swamp Woodland	3
W2a	Narrabeen Goulburn Valley Exposed Woodland	3
W8	Narrabeen Upper Cudgegong Sandslope Woodland	3
F22b	Narrabeen Montane Eucalypt Forest (Nullo)	4
F4	Narrabeen Goulburn Valley Callitris Forest	4
W20a	Mellong Sandmass Alluvial Woodland	4
W21	Dry Basalt Cap Woodland	4
W22	Nullo Mountain Basalt Woodland	4
W23	Permian Widden Talus Woodland	4
W25	Permian Capertee Talus Woodland	4
W27a	Permian Wolgan Sheltered Woodland	4
W28	Permian Yellow Box Woodland	4
W5a	Narrabeen Arid Acacia Woodland	4
F13	Remnant Shale Cap Forest	5
F2	Narrabeen Residual Grey Box Forest	5
H4	Narrabeen Montane Rocky Heath	5
H5	Narrabeen Montane Mallee Heath	5
W14	Goulburn Valley Alluvial Ironbark Woodland	5
W9	Narrabeen Hefrons Gap Sandslope Woodland	5
SE1	Narrabeen Blue Mountains Sedgeland	6
SH2	Towinhyngy Dry Basalt Shrubland	6
SS1	Narrabeen Montane Plateau Shrub-swamp	6
W26	Permian Wolgan Exposed Woodland	6
W6a	Narrabeen Wollemi Woodland Complex	6
F1	Narrabeen Residual Spotted Gum Forest	7
F10	Narrabeen Pagoda Sheltered Forest	7
F15a	Montane Basalt Cap Forest	7
F18	Dry Basalt Diatreme Forest	7
F21	Freshwater Melaleuca Swamp Forest	7
F22a	Narrabeen Montane Eucalypt Forest (Nullo)	7

<b>Code</b>	<b>Vegetation Community</b>	<b>Fire Regime</b>
F6a	Narrabeen Montane Plateau Forest	7
F7	Narrabeen Montane Gully Forest	7
W1	Narrabeen Goulburn Valley Ironbark Woodland	7
W10	Narrabeen Montane Impeded Woodland	7
W24	Permian Growee Talus Woodland	7
W29	Permian Grey Box Woodland	7
W3a	Narrabeen Bylong Arid Woodland	7
W4b	Narrabeen Bogee Stringybark Woodland	7
F12	Hawkesbury Sheltered Dry Forest	8
F3	Narrabeen Doyles Range Deep Shale Forest	8
F5a	Narrabeen Goulburn Valley Sheltered Forest	8
F8a	Narrabeen East-Wollemi Sheltered Dry Forest	8
F9a	Narrabeen West-Wollemi Sheltered Dry Forest	8
H6	Narrabeen Wollangambe Rocky Heath	8
H7	Hawkesbury Comleroy Rocky Heath	8
H9	Narrabeen Kerrabee Arid Rocky Heath	8
SC1	Hawkesbury McDonald Dwarf Apple Scrub	8
SH1	Narrabeen Wollemi Mallee Shrubland	8
W11a	Hawkesbury Hornsby Plateau Exposed Woodland	8
W12	Hawkesbury Arid Exposed Woodland	8
W13a	Hawkesbury Mt Lagoon Exposed Woodland	8
W16	Western Wollemi Alluvial Woodland Complex	8
W17	Cudgegong River Alluvial Woodland	8
W18a	Mellong Sandmass Dry Woodland	8
W7e	Narrabeen Wollangambe Woodland Complex	8
	Pine Plantation	9
H10	Narrabeen Taloby Pagoda Rocky Heath-Scrub	9
H2	Narrabeen Escarpment Pagoda Rocky Heath-Scrub	9
H3	Narrabeen Newnes Plateau Callitris Heath	9
H8	Yarrawa Residual Basalt Heath	9

### Appendix 3: Fire Management Guidelines for Threatened Fauna Species Likely to Occur in Wollemi NP

Species / Status	Habitat / Ecology	Fire Management Guidelines
<i>Calyptorhynchus lathamii</i> (Glossy Black-Cockatoo) Status - Vulnerable	Habitat: She Oaks (mostly <i>Allocasuarina spp</i> ) in forests, woodlands, timbered watercourses Breeds: March to August Diet: <i>Allocasuarina</i> cones Nest Site: High, large tree hollows Home Range:	<ul style="list-style-type: none"> <li>* Fire likely to impact upon adults</li> <li>* Avoid high intensity fires within potential habitat, to prevent damage to nesting sites (tree hollows)</li> <li>* Avoid implementing large area prescribed burns within habitat (<i>Allocasuarina spp</i> present) to avoid loss of sole food source – mosaic burn</li> <li>* Protect known nest sites by a 50-200 metre buffer strip</li> <li>* Maintain diversity of age structure over wide areas</li> <li>* Low intensity mosaic burn</li> </ul>
<i>Chalinolobus dwyeri</i> (Large-eared Pied Bat) Status - Vulnerable	Habitat: Warm temperate to subtropical dry sclerophyll forest to woodland Breeds: Early winter to Spring Diet: Small flying insects below tree canopy Den Site: Caves, mine tunnels, Fairy Martin nests, culverts Home Range:	<ul style="list-style-type: none"> <li>* Avoid high intensity fire in known roost locations</li> <li>* Fire should be low intensity for preservation of den sites</li> <li>* Avoid fire during the breeding season</li> <li>* Avoid fire during the summer months, to minimise impact on actively foraging species</li> <li>* High intensity fires may decrease the density of important foraging habitat – potentially affecting the diversity and abundance of prey species</li> </ul>
<i>Charadrius mongolus</i> (Lesser Sand Plover) Status - Vulnerable	Habitat: Mudflats, wide sandy beaches, estuaries and tidal areas in mangroves Breeds: Northern Hemisphere Diet: Crustaceans, molluscs, insects and marine worms, sometimes seeds Nest Site: On sandy beaches or rocky shores at high tide Home Range:	<ul style="list-style-type: none"> <li>* Avoid fire management activities within and adjacent to known habitat</li> <li>* Avoid high intensity, frequent fires adjacent to known habitat and nesting sites</li> </ul>
<i>Dasyurus maculatus</i> (Spotted-tailed Quoll) Status - Vulnerable	Habitat: Rainforest, open forest, woodland, coastal heathland and inland riparian forest. Dry and moist open forest containing rock caves, hollow logs or trees Breeds: April to August Diet: Insects to small wallabies Den Site: Hollow logs Home Range: large, 800 ha	<ul style="list-style-type: none"> <li>* Individuals likely to escape low to moderate intensity fire</li> <li>* Potential for inappropriate fire regimes to reduce habitat and prey diversity</li> <li>* Avoid high intensity fires over areas larger than 800 ha</li> <li>* Avoid burning during the breeding season</li> <li>* Protect all potential den sites from all fire activities</li> <li>* Low to moderate intensity burns may encourage the growth of dense understorey favouring this species</li> <li>* Maintain a mosaic of age classes within habitat to encourage prey diversity and tree hollow regeneration</li> <li>* Monitor population demography of this species, especially in relation to fire</li> <li>* Highest populations known from long unburnt sites</li> </ul>
<i>Falsistrellus tasmaniensis</i> (Eastern False Pipistrel) Status - Vulnerable	Habitat: Moist and dry eucalypt forest and rainforest, particularly at high elevations in the northern part of its range Breeds: Late spring to early summer Diet: Den Site: Tree hollows Home Range: 7-12 km	<ul style="list-style-type: none"> <li>* Avoid high intensity fire within known roost locations</li> <li>* Felling of known roost trees / potential roost trees should be avoided during mop-up operations</li> <li>* Implement low intensity fires, with a low flame height to preserve roost sites</li> <li>* Fire of moderate intensity may encourage formation of tree hollows however, could be detrimental in breeding season</li> </ul>
<i>Heleioporus australiacus</i> (Giant Burrowing Frog) Status - Vulnerable	Habitat: Forest margins adjacent to creeks with pools Breeds: Summer and Autumn Diet: Nest Site: Burrows into creek banks. Tadpoles require pools in creek	<ul style="list-style-type: none"> <li>* Avoid fire regimes that reduce or encroach on rainforest boundaries in known habitat</li> <li>* Avoid burning 100m either side of creek lines to avoid sedimentation into creeks and ponds</li> <li>* Implement low intensity mosaic burns to ensure refuge areas are available</li> <li>* Avoid high intensity, frequent fires adjacent to known habitat – may cause sedimentation and potentially simplify the structure and species composition of the surrounding habitat</li> </ul>
<i>Hoplocephalus bungaroides</i> (Broad-headed Snake) Status - Endangered	Habitat: Confined to sandstone outcrops and associated tree hollows. Shelters under exfoliated rock slabs on rocky ridges Breeds: January to March Fecundity: 4-12 live young	<ul style="list-style-type: none"> <li>* Avoid unnecessary clearing of bush rock during fire management activities</li> <li>* Avoid moderate to high and frequent fire regimes which may reduce the number of fallen logs and tree hollows (which are suitable retreats for reptiles) as well as decreasing prey</li> </ul>

Species / Status	Habitat / Ecology	Fire Management Guidelines
	Juvenile period: 4 – 6 years Diet: Lizards, particularly Lesueurs Velvet Geckos and small mammals in summer Den Site: Trees with hollows in summer, rock crevices on north to westerly slopes in cooler months	diversity * Implement low intensity, mosaic burns to retain ground refuge areas
<i>Ixobrychus flavicollis</i> (Black Bittern)  Status - Vulnerable	Habitat: Leafy riverside, creekside or swampside trees, mangroves, occasionally in willows on margins of rivers, swamps, tidal creeks and mudflats Breeds: September to April Diet: Fish, molluscs, crustaceans and insects Nest Site: On branch over water	* Fire unlikely to impact on individuals * Nests on branch over water, therefore no impact on breeding by fire expected * Low to moderate intensity fires will have little impact upon this species unless frequent fires impact upon suitable breeding habitat * Avoid high intensity fires within habitat during breeding season
<i>Lathamus discolor</i> (Swift Parrot)  Status - Endangered	Habitat: Eucalypt forest and woodland, especially where eucalypts are flowering profusely and an abundance of psyllids is available Breeds: September to December Diet: Flowering eucalypts and an abundance of psyllids Nest Site: Mature eucalypts with tree hollows	* Unsuitable fire regimes may reduce the abundance of food available for this species * Burns should be of low intensity so as not to reduce the abundance of winter flowering eucalypts or reduce the flowers available for this species. * Maintain a mosaic of age classes within habitat * Avoid frequent, high intensity burns in known habitat areas * Avoid high intensity fires within habitat during the breeding season * During trail construction, avoid removing any winter flowering eucalypts
<i>Litoria booroolongensis</i> (Booroolong Frog)  Status - Endangered	Habitat: Almost always associated with rocky flowing streams in mountainous areas Breeds: Males start calling from May, eggs laid amongst rocks Diet: Nest Site:	* Buffer potential or known habitat (100m) from all fire management activities * Fire may remove critical habitat (ground and canopy cover) therefore, mosaic burn to ensure refuge areas are available * Avoid high frequency fires – may lead to a build up of sediments in small ponds used for breeding; may also simplify the structure and alter species composition of habitat * Avoid fire during the breeding season
<i>Lophoictinia isura</i> (Square-tailed Kite)  Status - Vulnerable	Habitat: Coastal forest and woodland of tropical and temperate Australia Breeds: March to June Diet: Honeyeater and insects Nest Site: Near watercourse in fork or limb of Angophora or Eucalyptus species	* Low intensity, mosaic burns may be an advantage to this species by maintaining a variety of age classes in the understorey vegetation and ensuring the survival of sufficient prey * Avoid fire management activities near breeding sites, especially during the breeding season * Avoid moderate to high intensity, frequent fires which may reduce nesting and feeding resources * Protect all known or potential nesting trees (by placing a buffer around each tree) from all fire management activities
<i>Miniopterus australis</i> (Little Bent-wing Bat)  Status - Vulnerable	Habitat: Usually found in well timbered habitats including rainforests, dry sclerophyll forests and <i>Melaleuca</i> swamps Breeds: July Diet: Flying insects Nursery / Roosting Sites: Within caves, old mine tunnels, buildings and stormwater channels	* frequent fire near nursery cave may impact upon breeding success * forages for small, flying insects beneath the tree canopy, therefore, potential for inappropriate fire regimes to reduce prey diversity * avoid frequent fires within heathland habitat * low to moderate intensity fires within woodland communities may promote invertebrate density, however, too frequent fire will decrease the invertebrate density significantly * avoid fire around known nesting sites, especially during the mating (July) and birth (December) and weaning (February) periods
<i>Miniopterus schreibersii</i> (Common Bent-wing Bat)  Status - Vulnerable	Habitat: Cool to tropical wet and dry sclerophyll forest Breeds: May to June Diet: Small insects above tree canopy Den Site: Caves, old mines, stormwater channels, occasionally buildings	* Frequent fire near nursery caves may impact upon breeding success * Potential for inappropriate fire regimes to reduce habitat and prey diversity * Maintain a mosaic of age classes within habitat * Avoid fire management activities within close proximity (<100m) to known roosting caves / trees / mines especially during the breeding (May to June), birth (November to

Species / Status	Habitat / Ecology	Fire Management Guidelines
		December) and weaning (February) periods * Fire should be low intensity with low flame heights for preservation of roost sites
<i>Mixophyes balbus</i> (Stuttering Frog)  Status - Vulnerable	Habitat: Highly terrestrial, occupies dense wet sclerophyll forest as well as dry forest, adults occupy leaf litter Breeds: Summer Juvenile Period: Larval stage approximately 15 months Diet: Insects and small frogs Nest Site: Lay eggs in riffle zones between pools or amongst rocks	* Buffer potential or known habitat (100m) from all fire management activities * Fire may remove critical habitat (ground and canopy cover) therefore, mosaic burn to ensure refuge areas are available * Avoid high frequency fires – may lead to a build up of sediments in small ponds used for breeding. May also simplify the structure and alter species composition of habitat * Avoid fire during the breeding season
<i>Mormopterus norfolkensis</i> (East Coast Freetail Bat)  Status - Vulnerable	Habitat: Dry sclerophyll forest and woodland in subtropical areas (Tanton, 1996) Breeds: Diet: Den Site: Hollow bearing trees and loose bark (Tanton, 1996)	* High intensity fire may decrease the availability of loose bark and hollow bearing trees used for roosting * Avoid moderate to high intensity, frequent fires which fragment important foraging and breeding habitat * Prevent habitat from being burnt more than once every 10 years.
<i>Myotis adversus</i> (Large-footed Myotis)  Status - Vulnerable	Habitat: Low dense foliage Breeds: November to December Diet: Invertebrates Den Site: Caves, mine shafts and buildings	* Unlikely to be adversely affected by inappropriate fire regimes, as it hibernates in winter and can utilise a wide range of forest types * Avoid high intensity fire around known roosting sites during the breeding season * Maintain a mosaic of age classes within habitat * Avoid high frequency fire in habitats as this will decrease prey diversity
<i>Neophema pulchella</i> (Turquoise Parrot)  Status - Vulnerable	Habitat: Eucalypt woodlands and open forests with a ground cover of grasses and low understorey of shrubs Breeds: August to January Diet: Seeds from bearded heath, barley grass, wild mustard wallaby grass, stinging nettle, saffron thistle, flowers, nectar, fruits, leaves and sometimes scale insects Nest Site: Hollows of small trees dead <i>Eucalyptus</i> or in holes or stumps, fence posts or even logs lying on ground	* Maintain a mosaic of age classes within habitat * Avoid high intensity fires around known nesting sites during the breeding season * Avoid high intensity, frequent fire within habitat over large areas * Alter prescribed burning regimes to ensure the enhancement and maintenance of floristic and structural diversity * Low intensity mosaic burn within known habitat. Avoid total clearance of nesting sites and food sources (especially in eucalypt woodland) * Avoid removal of nesting trees and stumps. Protect known and potential nesting areas from disturbance
<i>Ninox connivens</i> (Barking Owl)  Status - Vulnerable	Habitat: Forest and woodland and is most common in eucalypt savanna woodland. It prefers well-forested hills and flats, trees along watercourses and in gorges  Breeds: July to November Diet: Nest Site: Tree hollow, sometimes in rabbit burrow	* Low intensity, mosaic burn within habitat containing rivergums and paperbarks of semiarid mulga and spinifex country as these areas are important habitat for hunting and breeding * Low intensity burns will ensure that sufficient prey resource remains for the short-term survival of this species * Physically protect (reduce fuels from base of tree) known nesting trees from burning activities * Potential for high intensity, frequent burns to reduce habitat and prey diversity (Norris ?)
<i>Ninox strenua</i> (Powerful Owl)  Status - Vulnerable	Habitat: <i>Eucalyptus</i> forests / woodland with large old trees. Breeds: June and September Diet: Arboreal marsupials, terrestrial mammals and birds Nest Site: 8-20m high in tree foliage	* Fire unlikely to impact on adults * Potential for inappropriate fire regimes to reduce habitat and prey diversity * Potential for moderate to high intensity fire to impact on reproduction during breeding season * Maintain a mosaic of age classes within habitat * Physically protect (reduce fuels from base of tree) known nesting trees from burning activities * encourage low to moderate intensity fuel reduction burns
<i>Petaurus australis</i> (Yellow-bellied Glider)  Status - Vulnerable	Habitat: Tall mature forests Breeds: May to September Diet: Plant and insect exudes, insects, spiders, pollen Den Site: Hollow branch, usually in a	* Alteration of prescribed burning regimes to ensure the enhancement and maintenance of floristic and structural diversity * Avoid high intensity fires over large areas, should be less than half of home range

Species / Status	Habitat / Ecology	Fire Management Guidelines
	living, smooth-barked eucalypt Home Range: 35 ha	<ul style="list-style-type: none"> <li>* During mop-up avoid felling potential habitat trees, sap site trees and winter flowering eucalypts</li> <li>* Time prescribed burns in areas to avoid breeding season of known populations</li> <li>* Should not be adversely affected by low-medium intensity fire</li> <li>* On going monitoring of population demography in relation to fire</li> </ul>
<i>Petaurus norfolcensis</i> (Squirrel Glider)  Status - Vulnerable	Habitat: Littoral dry sclerophyll forest and woodland Breeds: All year, depending on availability of resources Diet: Insects, gum produced by acacias, the sap of certain eucalypts, nectar and pollen Den Site: Bowl-shaped, leaf lined nest in a tree hollow	<ul style="list-style-type: none"> <li>* Species should not be adversely affected by low to moderate intensity fires</li> <li>* Avoid large scale, high intensity fires which may fragment habitat – potentially isolating populations and affecting breeding success</li> <li>* Maintain a mosaic of fire frequencies to ensure the maintenance and enhancement of floristic and structural diversity</li> <li>* Avoid disturbing breeding sites and feeding trees (buffer known locations) during fire management activities, especially during the breeding season</li> <li>* Monitor population demography of this species, especially in relation to fire</li> </ul>
<i>Petrogale penicillata</i> (Brush-tailed Rock-wallaby)  Status - Vulnerable	Habitat: Rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops, mostly sites with a northerly aspect Breeds All year round: Diet: Grasses and herbs Den Site: Ledges, caves and crevices	<ul style="list-style-type: none"> <li>* Individuals likely to escape low to moderate intensity fire</li> <li>* Protect refuge areas from high intensity fires</li> <li>* No prescribed burning during the breeding season</li> <li>* Maintain a variety of age classes in understorey vegetation by implementing a mosaic of fire intensities and frequencies</li> <li>* Monitor population demography of this species, especially in relation to fire</li> </ul>
<i>Phascolarctos cinereus</i> (Koala)  Status - Vulnerable	Habitat: Wet and dry Eucalypt forest on high nutrient soils containing preferred feed trees Breeds: Summer Diet: Eucalypt leaves Den Site: Branch of eucalyptus tree	<ul style="list-style-type: none"> <li>* Individuals likely to be unaffected by low to medium (small scale, &lt;10ha) intensity fires, however dense smoke from such fires may be detrimental</li> <li>* Koalas prefer new growth for food (Tanton, 1996), therefore, implementing a variety of fire regimes may be beneficial to this species</li> <li>* High intensity, crown fires have the potential to kill individuals and directly reduce habitat</li> <li>* Protect known populations from fire, especially during the breeding season</li> <li>* Monitor population demography of this species, especially in relation to fire</li> </ul>
<i>Podargus ocellatus</i> (Marbled Frogmouth)  Status – Vulnerable	Habitat: Rainforests with palms Breeds: September to December Juvenile Period: Diet: Arthropods, snails, small vertebrates Nest Site: Vertical trunks in deep forks (Simpson, 1999)	<ul style="list-style-type: none"> <li>* Avoid fire within known habitat, especially during the breeding season</li> <li>* Infrequent, low intensity fires may be tolerated by this species, however, fire within the rainforest community may significantly impact upon prey diversity</li> </ul>
<i>Pseudophryne australis</i> (Red-crowned Toadlet)  Status – Vulnerable	Habitat: Talus slopes below sandstone outcrops. Can be found besides temporary creeks, gutters and soaks, under rocks and logs Breeds: Juvenile Period: 3 months to completion of metamorphosis Diet: Breeding Site: Near non-perennial creek beds in damp leaf litter. Forms colonies of > 20 frogs	<ul style="list-style-type: none"> <li>* Buffer potential or known habitat (100m) from all fire management activities</li> <li>* Fire may remove critical habitat (ground and canopy cover) therefore, mosaic burn to ensure refuge areas are available</li> <li>* Avoid high frequency fires – may lead to a build up of sediments in small ponds used for breeding. May also simplify the structure and alter species composition of habitat</li> <li>* Avoid fire during the breeding season</li> </ul>
<i>Scoteanax rueppellii</i> (Greater Broad-nosed Bat)  Status – Vulnerable	Habitat: Prefer moist gullies in mature coastal forest or rainforest, lying between the Great Dividing Range and the coast. Also in gullies associated with open woodland, wet and dry sclerophyll forests Breeds: April Diet: Beetles and other slow flying insects, sometimes other bats	<ul style="list-style-type: none"> <li>* Adults likely to escape fire</li> <li>* Potential for moderate to high intensity fires, near maternity sites to impact on breeding success</li> <li>* Maintain a mosaic of age classes within habitat to encourage prey diversity and tree hollow regeneration</li> <li>* Avoid fire management activities within close proximity (&lt;100m) to known roosting trees</li> <li>* Felling of known / potential roost trees should be avoided</li> </ul>

Species / Status	Habitat / Ecology	Fire Management Guidelines
	Den Site: Tree hollows and often in roof spaces of old buildings	<ul style="list-style-type: none"> <li>during mop up operations</li> <li>* Fire should be low intensity for preservation of roost sites</li> <li>* Avoid fire during the breeding season</li> </ul>
<p><i>Tyto novaehollandiae</i> (Masked Owl)</p> <p>Status – Vulnerable</p>	<p>Habitat: Forest margins in dry forest</p> <p>Breeds: Autumn / Winter</p> <p>Diet: Terrestrial mammals</p> <p>Nest Site: Tree hollows</p>	<ul style="list-style-type: none"> <li>* Fire may be detrimental to this species if there is a loss of large trees for nesting and loss of key habitat for prey species</li> <li>* Burning at low to moderate intensity may encourage the formation of hollows for nesting, however, it would be detrimental during the breeding season</li> <li>* Avoid impacting hollow bearing trees during fire management activities</li> <li>* Maintain a mosaic of age classes within habitat to encourage prey diversity and to prevent habitat fragmentation</li> </ul>
<p><i>Tyto tenebricosa</i> (Sooty Owl)</p> <p>Status – Vulnerable</p>	<p>Habitat: Tall, wet forests in sheltered east and south-east facing mountain gullies</p> <p>Breeds: April to June</p> <p>Diet: Generalist predator</p> <p>Nest Site: Nests on tree trunks up to 30m high</p>	<ul style="list-style-type: none"> <li>* Fire unlikely to impact on adults</li> <li>* Potential for inappropriate fire regimes to reduce habitat and prey diversity</li> <li>* Potential for moderate to high intensity fires to impact on reproduction</li> <li>* Clearing by fire likely to increase foraging potential</li> <li>* Maintain a mosaic of age classes within habitat</li> <li>* Avoid impacting hollow bearing trees during activities</li> <li>* Avoid burning within known nesting habitats during the breeding season</li> </ul>
<p><i>Varanus rosenbergi</i> (Heath Monitor)</p> <p>Status – Vulnerable</p>	<p>Habitat: Coastal heaths, humid woodlands and wet and dry sclerophyll forests (Cogger, 2000)</p> <p>Breeds: Summer</p> <p>Diet: Insects, mammals and reptiles (Norris, ?)</p> <p>Den Site: Burrows in soil, hollow logs and rock crevices</p>	<ul style="list-style-type: none"> <li>* High intensity, widespread burns may significantly impact this species by decreasing prey availability</li> <li>* Avoid high intensity fire, especially during the breeding season</li> </ul>
<p><i>Vespadelus troughtoni</i> (Eastern Cave Bat)</p> <p>Status – Vulnerable</p>	<p>Habitat: Dry forests and tropical woodlands</p> <p>Breeds:</p> <p>Diet:</p> <p>Den Site: Sandstone overhangs and mine tunnels, occasionally in buildings</p>	<ul style="list-style-type: none"> <li>* Avoid high intensity fire in known roost locations</li> <li>* Fire should be low intensity for preservation of den sites</li> <li>* Avoid fire during the breeding season</li> <li>* High intensity fires may decrease the density of important foraging habitat – potentially affecting the diversity and abundance of prey</li> </ul>
<p><i>Xanthomyza phrygia</i> (Regent Honeyeater)</p> <p>Status – Endangered</p>	<p>Habitat: Dry eucalypt woodland and dry sclerophyll forest with mature flowering trees, and riparian vegetation for breeding</p> <p>Breeds: July to November</p> <p>Diet: Nectar (mainly Red Ironbark, White Box and Yellow Box) and arthropods</p> <p>Nest Site: In Red Ironbark, Red River Gum, also other eucalypts and mistletoe clumps and casuarinas</p>	<ul style="list-style-type: none"> <li>* High intensity fire may decrease the suitability of mature feeding trees and destroy nests (possibly containing eggs)</li> <li>* Avoid burning within suitable habitat during the breeding season</li> <li>* Avoid removing suitable feeding and nesting trees from potential or known habitat as part of fire management activities (Norris ?)</li> </ul>

## Appendix 4 Fire Management Guidelines for Threatened Flora Species Likely to Occur in Wollemi NP

Significant Species	Status	Distribution and Abundance	Ecology	Fire Management Guidelines
<i>Acacia bynoeana</i>	E1	<p>Endemic to central eastern NSW and occurs in an area from the Hunter District on the Central Coast South to Berrima in the Southern Highlands.</p> <p>Recorded in Blue Mountains NP, Yengo NP and Royal NP.</p>	<p>Life Form: Low prostrate shrub to 50cm across</p> <p>Habitat: Open sometimes slightly disturbed sites in Eucalypt woodland, shrubland and open forest. Shrubs associated with this species are : <i>Banksia spinulosa</i>, <i>Acacia oxycedrus</i>, <i>Acacia myrtifolia</i>.</p> <p>Flowering Period: November till January</p> <p>Fire Response: Survives 100% scorch (Gill and Bradstock, 1992). Seeds shed at maturity. Apparently there is little dispersal of seed. Has long term soil-stored seed bank.</p> <p>Primary Juvenile Period: Unknown</p>	<ul style="list-style-type: none"> <li>- High frequency fire and inappropriate fire regimes have been identified as a threat to this species by the NSW Scientific Community. Avoid fires less than 8 – 12 years apart (Binns 1996). Fire every 5 years or less would be likely to diminish ability to resprout and deplete the seed bank.</li> <li>- Avoid high intensity fires to habitat and known locations of this species.</li> <li>- Avoid fires near species locations in Summer.</li> <li>- Take care during trail maintenance operations, hazard reduction burning and mechanical fuel reduction activities to prevent damage to threatened species which may occur along trails.</li> </ul>
<i>Acacia flocktoniae</i>	V	<p>Grows in the Blue Mountains from Mt Wilson south to the Picton district</p>	<p>Life Form: Erect or spreading shrub, 2-3m high</p> <p>Habitat: Dry sclerophyll forest on sandstone</p> <p>Flowering Period: June to August</p> <p>Fire Response:</p> <p>Primary Juvenile Period:</p>	<ul style="list-style-type: none"> <li>-</li> </ul>
<i>Acacia gordonii</i>	E1	<p>Found in the Sydney Region, chiefly in the Blue Mountains from Bilpin to Faulconbridge.</p> <p>Recorded plants are in the Blue Mountains NP only.</p>	<p>Life Form: Erect of spreading shrub, 0.5 – 1.5 m high, bark smooth, grey, branchlets densely hairy.</p> <p>Habitat: Dry sclerophyll forest and heath on sandstone outcrops</p> <p>Flowering Period: August to September, and fruiting period is October to February</p> <p>Fire Response: Resprouts and germinates prolifically after high intensity fire, soil stored seed.</p>	<ul style="list-style-type: none"> <li>- This species should be surveyed to ascertain whether a significant proportion of the population is mature. If not, do not allow any fire. Research to ascertain the primary juvenile periods and long term viability of soil-stored seed will enable minimum and maximum fire intervals to be set for the species.</li> <li>- Avoid repeated low intensity fires – may be to cool for seeds to germinate.</li> <li>- Avoid burning in habitat and known locations of this species in Spring and Summer to ensure seed bank reserves are replenished.</li> <li>- If possible trail maintenance, bush fire suppression, mop up operations and mechanical fuel reduction and should be avoided in known species locations.</li> </ul>
<i>Acacia pubescens</i>	V	<p>Found from the Sydney bio region to the north coast. Mainly from Canterbury to Liverpool in Sydney. Inadequately conserved.</p>	<p>Life Form: Spreading, hairy shrub 1-4 m high, with bipinnate leaves.</p> <p>Habitat: Hillsides and flat areas in Open-forest with <i>Eucalyptus fibrosa</i>, and in full sun.</p> <p>Flowering Period: August to December fruits appear October to December</p> <p>Fire Response: Resprouts from root suckers. Can form dense patches by suckering. Soil stored seed.</p>	<ul style="list-style-type: none"> <li>- Even though this species will survive fire if sufficiently developed, the tolerated range of fire intervals are unknown.</li> <li>- Monitoring and research required to ascertain primary juvenile period, survival of seeds after fire and time taken for the seed bank to become sufficient for stand replacement.</li> <li>- Avoid burning in potential habitat and known locations of this species in Spring</li> </ul>



Significant Species	Status	Distribution and Abundance	Ecology	Fire Management Guidelines
				and Summer to ensure seed bank reserves are replenished.
<i>Acrophyllum australe</i>	V		Life Form: Small shrub 1-2m high Habitat: Grows in damp crevices in sandstone, usually near waterfalls Flowering Period: November to December Fire Response: Survives 100% scorch (Gill and Bradstock, 1992). Regenerative mechanism unknown	-
<i>Apatophyllum constablei</i>	E1		Life Form: Diffuse many-branched shrub to 40cm high Habitat: Rocky hillsides at the base of sandstone cliffs Flowering Period: September to October Fire Response: 100% scorch kills the plant (Gill and Bradstock, 1992). Unknown regenerative mechanism	-
<i>Baeckea kandos</i>	E1		Life Form: Habitat: Flowering Period: Fire Response:	-
<i>Boronia deanei</i>	V		Life Form: Erect shrub 0.2-1.5m high Habitat: Wet Heath Flowering Period: September to November Fire Response:	-
<i>Cynanchum elegans</i>	E1	Scattered coastal localities from north coast to Wollongong.	Life Form: Small climbing plant with twining stems to one metre long. White clustered flowers grow from a joint on the leaf stalk. Habitat: Dry littoral or subtropical rainforest, and occasionally in scrub or woodland. Fire Response: 100% scorch kills.	- High frequency fire and inappropriate fire regimes have been identified as a threat to this species by the NSW Scientific Community. Frequent burning may encourage weed species to compete.  - If encountered in the field, all attempts should be made to determine if the species has matured, and response to fire frequency and intensity noted through fire history of the site and species growth habit. If insufficient numbers of the population have matured, then fire should be excluded until the population has produced enough seed for stand replacement. Knowledge of long term viability of seed required to determine maximum fire interval for the species. Ongoing monitoring required.  - If possible, trail maintenance, bush fire suppression, mop up operations and mechanical fuel reduction should be avoided in known species locations.
<i>Darwinia peduncularis</i>	V	Local abundance: rare. Found in Central Coast Region and Central Tablelands. Recorded in Marramorra NP, Wollemi NP, Blue Mountains NP and Berowra Valley Regional Park.	Life Form: Divariacate shrub to 1.5 m high. Habitat: Rocky hillside, open forest Flowering Period: May to November, fruits in October Fire Response: Probably killed	- Appears to be vulnerable to fire and disturbance little is known of recovery from each. If encountered in the field, all attempts should be made to determine if the species has matured, and response to fire frequency and intensity noted through fire history of the site and species growth habit. If insufficient numbers of the population have matured, then fire should be excluded until the population has produced enough seed for stand replacement. Knowledge of long term viability of seed required to determine maximum fire interval for the species. Ongoing monitoring required.  - Seasonally, sensitive to Winter and Spring

Significant Species	Status	Distribution and Abundance	Ecology	Fire Management Guidelines
				fires - the flowering and fruiting season.
<i>Eucalyptus cannonii</i>	V	Local abundance: rare. Distributed from Rylstone to Lithgow	Life Form: Tree to 15m high Habitat: Sclerophyll woodland on shallow soil on rises Flowering Period: January to April Fire Response: Resprouts from epicormic buds	-
<i>Grammitis stenophylla</i>	E1		Life Form: Habitat: Flowering Period: Fire Response:	-
<i>Grevillea evansiana</i>	V		Life Form: Low dense spreading shrub rarely more than 0.5m high Habitat: Eucalypt open forest to woodland on ridges, rocky areas Flowering Period: August to December Fire Response: Probably killed, regenerates from soil-stored seed	-
<i>Haloragodendron lucasii</i>	E1		Life Form: Stragglng shrub mostly 1-1.5m high Habitat: Dry sclerophyll forest on sheltered slopes near creeks on sandstone Flowering Period: October Fire Response:	-
<i>Homoranthus darwinioides</i>	V		Life Form: Habitat: Flowering Period: Fire Response:	-
<i>Kennedia retrorsa</i>	V	Recorded in Colo Heights area, Parr State recreation Area. Northern limit is Mount Dangar and southern is Dingo Creek.	Life Form: Vigorous climbing perennial herb sometimes forming dense mounds to 4 m high or appearing prostrate in the absence of support. Habitat: Mountain sides, riparian zones, sheltered forests and exposed ridges Fire Response: Likely to be fire sensitive. Adult plants killed by fire. Likely to regenerate from soil-stored seed after moderate to high intensity fire (Binns 1996). Juvenile Period: Plants reach maturity at approximately 3 years following germination. Peak maturity may not be reached until 4 – 6 years.	- Two or more fire intervals of less than 10 – 15 years is likely to result in sub-population declines. Fire intervals of less than 3-4 years are likely to result in extinction. - Fire intensity should be medium to high to allow germination of seed. - If possible, trail maintenance, bush fire suppression, mop up operations and mechanical fuel reduction should be avoided in known species locations.
<i>Leionema sympetalum</i>	V		Life Form: Habitat: Flowering Period: Fire Response:	-
<i>Melaleuca deanei</i>	V	Extremely fragmented populations, total population estimated between 1000 – 3000 individuals. Occurs as scattered clumps. Found in Coastal districts from Berowra to Nowra.	Life Form: Shrub to 3 m high with fibrous flaky bark. Leaves alternate, narrow-elliptic. Sometimes with massy woody lignotuber. Habitat: Wet heath on sandstone, woodland. Flowering Period: December Fire Response: Resprouts from epicormic buds, coppicing and suckering. No flowering observed in absence of fire, may require fire to stimulate flowering.	- High frequency fire and inappropriate fire regimes have been identified as a threat to this species by the NSW Scientific Community. - Sensitive to localised extinction from fire, due to fragmented populations. Little or no seedlings observed at sites and not much seed observed on adults. Thus, species could be sensitive to a maximum fire interval. Monitoring required. - Individuals have been recorded on trail edges. Care must be taken during trail maintenance, bush fire suppression, mop up operations and mechanical fuel reduction as to preserve individual plants.

Significant Species	Status	Distribution and Abundance	Ecology	Fire Management Guidelines
				<ul style="list-style-type: none"> <li>- Avoid burning in Summer in flowering period.</li> </ul>
<i>Melaleuca groveana</i>	V	<p>Widespread scattered populations in coastal districts north of Port Stephens, extending into south-eastern QLD.</p> <p>Recorded in Yengo NP.</p>	<p>Life Form: Shrub or small tree usually 2 to 5 m high, with firm fibrous-papery bark. Narrow curled leaves. Fluffy white flowers form on short spikes 2 to 3 cm long.</p> <p>Habitat: Heath and shrubland, often in exposed sites at high elevations on rocky outcrops and cliffs. It occurs in dry woodlands also.</p> <p>Flowering Period: Spring</p> <p>Fire Response: Will resprout from epicormic buds insulated by relatively thick bark. Mature plants have been observed to recover after severe fires (Binns 1996).</p>	<ul style="list-style-type: none"> <li>- Tolerant of successive fires but at unknown intervals. Intervals should be guided by the age that plants develop resprouting characteristics as well as time taken for sufficient seed to build up for stand replacement. Ongoing monitoring required.</li> <li>- Avoid burning during Spring.</li> <li>- Knowledge of long term viability of seed required to determine maximum fire interval for the species. Ongoing monitoring required.</li> <li>- Research into primary juvenile periods and time taken for seed bank to build up for stand replacement required before minimum fire interval thresholds can be determined.</li> <li>- Trail maintenance, bush fire suppression, mop up operations and mechanical fuel reduction should be avoided in known species locations.</li> </ul>
<i>Olearia cordata</i>	V	<p>Restricted to south western Hunter Plateau and the eastern Colo Plateau.</p> <p>Recorded in Yengo NP and Wollemi NP.</p>	<p>Life Form: Aromatic slender shrub to 2 m high with leaves alternately scattered along stem. Flowers are daisy like and mauve to blue. Life span – 15 – 20 years.</p> <p>Habitat: Woodland on Hawkesbury sandstone ridges. Prefers sheltered easterly aspects. Found along trail edges.</p> <p>Fire Response: Resprouts from basal stem buds or underground root buds.</p> <p>Juvenile Period: Minimum time to produce seed is 1- 2 years.</p> <p>Flowering Period: November to May. Seeds germinate immediately after rain. No dormancy period.</p>	<ul style="list-style-type: none"> <li>- Fire intervals less than 12 – 15 years will kill plants, rootstock will not yet be fire resistant. A minimum fire interval of 8 – 12 years may be acceptable if had good flowering years.</li> <li>- Fires in February to May must be avoided in order to ensure successful seasonal seed production.</li> <li>- Trail maintenance is a significant threat as species occur along trail edges. Other threatening activities include bush fire suppression, mop up operations and hazard reduction burning.</li> </ul>
<i>Persoonia hirsuta</i> <i>subsp hirsuta</i>	E1	<p>Very rare, no known conservation sites and now found as single plants or groups &lt; 10. From Gosford to Royal NP.</p>	<p>Life Form: Spreading to decumbent; shrub, with hairy young branchlets.</p> <p>Habitat: Sides of ridges and disturbed sites such as quarries. Also found along trail edges.</p> <p>Fire Response: Probably killed by fire. Has some soil stored seed although unknown if germinate after fire.</p>	<ul style="list-style-type: none"> <li>- Frequent fire is a particular threat as populations are very small i.e. only a few plants at one site. The population could possibly become extinct after two undesirable fire intervals.</li> <li>- If encountered in the field all attempts should be made to determine if the species has matured, and response to fire frequency and intensity noted through fire history of the site and species growth habit. Ongoing monitoring required.</li> <li>- Since species occurs along trail edges, fire operations along trails are a significant threat. Fire trail maintenance, mechanical fuel reduction, bush fire suppression and mop up operations should be avoided near known locations of this species.</li> </ul>

Significant Species	Status	Distribution and Abundance	Ecology	Fire Management Guidelines
<i>Persoonia hirsuta</i> <i>subsp. evoluta</i>	E1	Yengo NP	Life Form: Spreading to decumbent, shrub, with hairy young branchlets. Habitat: Ridges and sides of ridges. Fire Response: Probably killed by fire, with soil stored seed bank. Unknown if seeds are killed or germinated following fire.	<ul style="list-style-type: none"> <li>- If encountered in the field all attempts should be made to determine if the species has matured, and response to fire frequency and intensity noted through fire history of the site and species growth habit. Ongoing monitoring required.</li> <li>- Fire trail maintenance (some plants are located along tracks), mechanical fuel reduction, bush fire suppression and mop up operations should be avoided near known locations of this species.</li> </ul>
<i>Persoonia marginata</i>	V	Restricted local endemic, confined to Capertree district. Rare to occasional local abundance.	Life Form: Spreading shrub to 50 cm high, 1 m across. Young branches are hairy (Geebung). Habitat: Open-forest on ridges and slopes with <i>Eucalyptus rossii</i> , <i>E. beyeriana</i> , <i>E. tenella</i> with grassy/shrubby understorey. Fire Response: Resprouter Juvenile Period: Unknown Flowering Period: December, fruit shed at maturity, two seeds enclosed in woody stone. Possibly dispersed by mammals and birds. Soil-stored seed bank, germination triggers unknown.	<ul style="list-style-type: none"> <li>- Monitoring needed ascertain intensities of fire that the species can withstand. If encountered in the field all attempts should be made to determine if the species has matured, and if not implement fire free areas in known species locations. This will ensure that seed bank has sufficient time to build to allow stand replacement.</li> <li>- Avoid fires during summer.</li> <li>- Fire trail maintenance, mechanical fuel reduction, bush fire suppression and mop up operations should be avoided near known locations of this species.</li> </ul>
<i>Promaderris brunnea</i>	V	Wollemi NP and Yengo NP	Life Form: Medium sized shrub 1.3m tall. Stems covered with long brownish hairs. Habitat: Open Forests Flowering Period: Fire Response: 100% scorch kills, soil stored seed.	<ul style="list-style-type: none"> <li>- If encountered in the field all attempts should be made to determine if the species has matured, and response to fire frequency and intensity noted through fire history of the site and species growth habit.</li> <li>- If population small, maintain a fire refuge around plants until sufficient numbers have matured.</li> </ul>
<i>Pomaderris sericea</i>	E1		Life Form: Low shrub Habitat: Flowering Period: Fire Response:	-
<i>Prostanthera cryptandroides</i>	V	Restricted; known at two disjunct occurrences, Wollomi NP and Goulburn River NP.	Life Form: Low spreading shrub with aroma growing 0.5 – 1m high up to 1m wide. Branches are moderately dense and are often black or obscured due to “sooty mould”. Habitat: Open-forest dominated by <i>Eucalyptus fibrosa</i> . Also found in Low Open-scrub-heath. Fire Response: Obligate seeder. Adult plants killed by 100% scorch Flowering Period: September to May Juvenile Period: Reproductive maturity likely to occur after 3 years	<ul style="list-style-type: none"> <li>- Fire intervals should be greater than 8 years. Intervals of 3-5 years likely to result in extinction. Fire free areas should also be maintained to allow sufficient Reserves of the seed bank for stand replacement.</li> <li>- Fire trail maintenance, mechanical fuel reduction, bush fire suppression and mop up operations should be avoided near known locations of this species.</li> <li>- Monitoring required to determine how seed germination is impacted by fire events of differing intensity.</li> </ul>
<i>Prostanthera cryptandroides</i> <i>subsp. cryptandroides</i>	V		Life Form: Low divaricate, strongly aromatic, sticky shrub 0.5-2m high Habitat: Dry sclerophyll forest, often in rocky sites Flowering Period: September to April Fire Response:	-
<i>Prostanthera discolor</i>	V		Life Form: Open, erect shrub 0.6-3m high Habitat: Dry sclerophyll forest in rocky gullies Flowering Period: September to October Fire Response:	-

Significant Species	Status	Distribution and Abundance	Ecology	Fire Management Guidelines
<i>Prostanthera stricta</i>	V	Mount Vincent and Central Western Tablelands and Slopes Botanical Regions.	Life Form: Erect, bushy aromatic shrub (Mint Bush) commonly growing 1-2 m wide. Habitat: High rainfall areas and fertile soils. Steep rocky side slopes, cliff lines and sandstone platforms – forest to scrub communities. Flowering Period: Winter-Spring Fire Response: Seeder, does not appear to reproduce vegetatively. Adults killed by fire. Primary Juvenile Period: Likely to be 3 – 5 years, and peak maturity at 5 – 8 years.	<ul style="list-style-type: none"> <li>- Fire frequency of 2 intervals less than 8 years apart will be detrimental. It may be important to maintain unburnt “refuge” areas containing large numbers of <i>P stricta</i> for long periods of time to assist in assuring the survival of the yet unknown specific pollination vector.</li> <li>- A repeated fire interval of 3 – 5 years is likely to result in extinction.</li> <li>- Avoid trail construction, maintenance and bush fire suppression activities through known species locations.</li> </ul>
<i>Pultenaea glabra</i>	V		Life Form: Erect shrub Habitat: Dry sclerophyll forest on sandstone Flowering Period: Fire Response:	-
<i>Pultenaea sp. olinda</i>	E1		Life Form: Habitat: Flowering Period: Fire Response:	-
<i>Syzygium paniculatum</i>	V	Found between Jervis Bay and Buladelah in Eastern NSW.  Recorded in Towra Point NR, Wamberal Lagoon, Myall Lakes NP, Wyrribalong NP, Booderee NP, and Jervis Bay NP.	Life Form: Tall shrub or tree with flaky bark. Leaves are shiny and pointed, 5 to 9 cm long. Small fluffy white flowers in summer followed by globular fleshy magenta coloured fruit.  Flowering Period: December to March  Habitat: Subtropical and littoral rainforest on sandy soils at low altitudes.  Fire Response: Payne (1991) notes that the tree coppices readily after fire.	<ul style="list-style-type: none"> <li>- Mature individuals tolerate fire, but at unknown frequencies and intensities. Since this species has been recorded in fire sensitive vegetation communities, fire should be avoided in known species locations.</li> <li>- If encountered in the field all attempts should be made to determine if the species has matured, and response to fire frequency and intensity noted through fire history of the site and species growth habit.</li> <li>- Research needed as to what fire intensities can be tolerated of this species.</li> <li>- Avoid trail construction and maintenance through known species locations.</li> <li>- Avoid fire during summer in flowering period.</li> </ul>
<i>Tetratheca glandulosa</i>	V	Highly fragmented population. Occurs on Central Coast and in the Sydney region. The North south range is approximately 65 km. Found in Yengo NP, Dharug NP, Brisbane Water NP, Popran NP, Parr SRA, Lane Cove NP and Wollemi NP. There were once populations in Manly, Willoughby and Mosman, but are now extinct.	Life Form: Small spreading shrub which grows 20 cm to 50 cm height. The plant has a woody tuberous root, with sprawling stems branching close to the base. Habitat: Strongly associated with areas of shale-sandstone transition habitat. Vegetation varies from heath to woodland and forest. Occurs close to trail edges. Flowering Period: July to November Fire Response: Resprouts from woody root. Can withstand a high intensity fire (Binns 1996).. recruitment not dependent on soil stored seed.	<ul style="list-style-type: none"> <li>- Species is vulnerable to fire management operations due to being located near trail edges. Fire trail maintenance, bush fire suppression and mop up operations should be avoided near known locations of this species.</li> <li>- Resprouters generally thought to survive fire before mature. May not to be able to tolerate frequent fire if woody root not developed sufficiently for resprouting. Thus, prescribed burning a significant threat.</li> <li>- Tentative guidelines: More than 2 fire intervals less than 5 years apart and absence of fire for greater than 20 years may reduce the abundance of the species. After long intervals, this species can be outcompeted by Banksia thickets as well as lose chance to regenerate through fire.</li> <li>- Monitoring required to determine juvenile</li> </ul>

Significant Species	Status	Distribution and Abundance	Ecology	Fire Management Guidelines
				period and survival after fire, as well as maximum fire interval threshold.
<i>Velleia perfoliata</i>	V	Found in Wollombi to Colo Area. Recorded in Yengo NP, Wollemi NP.	Life Form: Small perennial herb with short thick rootstock and light green spoon-shaped leaves.  Habitat: Heath on infertile, shallow sandy soil over sandstone. Prefers disturbed areas i.e. near trail edges.  Fire Response: Probably killed by fire, regenerate from soil-stored seed.  Flowering Period: Spring  Primary Juvenile Period: Less than one year.	<ul style="list-style-type: none"> <li>- High frequency fire and inappropriate fire regimes have been identified as a threat to this species by the NSW Scientific Community. This could be due to a small number of individuals recorded at each site.</li> <li>- Even though species can reach maturity after one year of growth, abundance is so small that there may be insufficient soil-stored seed for population replacement. More research required. Not known if seeds require fire to germinate.</li> <li>- Maximum fire interval should be guided by the maximum time that soil-stored seed is viable. Further research needed.</li> <li>- Species is vulnerable to fire management operations due to being located near trail edges. Fire trail maintenance, bush fire suppression and mop up operations should be avoided near known locations of this species.</li> <li>- Avoid fire in Spring during flowering period.</li> </ul>
<i>Zieria involuocrata</i>	V	Rare, occurs on the central coast, and chiefly in the Blue Mountains.  Recorded in Yengo NP.	Life Form: Shrub to small tree  Habitat: Wet sclerophyll forests. Individuals have been located on regularly maintained fire trails.  Flowering Period: Spring. Has been found flowering in April also.  Fire Response: Soil stored seed (Bell <i>et. al.</i> , 1993).	<ul style="list-style-type: none"> <li>- High frequency fire and inappropriate fire regimes have been identified as a threat to this species by the NSW Scientific Community.</li> <li>- If encountered in the field all attempts should be made to determine if the species has matured, and response to fire frequency and intensity noted through fire history of the site and species growth habit.</li> <li>- Appears to tolerate disturbance from some activities such as fire trail maintenance. Care should be taken during trail maintenance, mop up operations and mechanical fuel reduction to prevent damage to individuals.</li> </ul>

## Appendix 5: Roads & Trails Policies

### Bush Fire Coordinating Committee POLICY NO. #/03

#### Fire Trails

#### 1.0 Rationale

1.1 Fire trails may serve as a firebreak as well as a physical platform from which fire suppression and mitigation related activities may be undertaken by fire fighting agencies. A knowledge of the location, condition and accessibility of fire trails is essential in the planning and management of suppression operations and mitigation activities. Fire trails can play a critical role in providing rapid response and close access to fires, allowing fire fighting authorities the opportunity to undertake initial attack and early containment of fires. They therefore can provide an opportunity to contain fires often before they escalate into major fires that would otherwise incur significant costs of suppression and potentially significant losses to community and environmental assets.

1.2 Fire trails are important resources in the facilitation of prevention and mitigation works. An effective fire trail network increases options available in implementing hazard reduction to protect communities and their social, cultural environmental and economic assets.

1.3 Fire trails will have an impact on environmental, social and economic values. These impacts may include:

- a) Illegal activities such as arson, dumping, trespassing, bush rock/soil or vegetation removal.
- b) Degradation of native vegetation (including weed invasion) and wildlife habitat.
- c) Soil erosion and degradation of catchment values including water quality (eg. siltation) and quantity (eg. increased surface runoff).

1.4 Fire trails can be costly to construct and maintain and hence, their strategic value for fire management purposes needs to be understood by the community and balanced with environmental and other significant values of the area.

1.5 Trails constructed for other purposes such as timber production, land management, recreational/tourism activities, access to public and private property, and stock movement may also be important for fire management and should be identified where they are important and recognised as part of the fire trail system.

1.6 While fire trails provide a platform for fire mitigation and suppression works, it is recognised that in remote or undeveloped landscapes with rugged topography, fire trail densities may be low. In these areas remote fire fighting techniques typically provide an alternative method of accessing fires.

#### 2.0 Policy

- 2.1 To ensure consistency and suitable standards are applied, Bush Fire Coordinating Committee Guidelines should be adopted by land managers in the identification, construction, maintenance and recording of fire trails. This policy recognises the need to be progressively implemented over time, and consistent with national standards.

### **3.0 Classification**

- 3.1 Fire trails need to be identified and identifiable in a consistent way so as to convey to fire management personnel the condition, purpose and accessibility of the fire trail.

- 3.2 Three categories of fire trails are identified as:

- (a) Primary Fire Trail: a fire trail of strategic importance for the protection of assets and/or is a primary feeder route to a network of secondary trails.
- (b) Secondary Fire Trail: a fire trail that can be used for fire control, suppression and mitigation purposes.
- (c) Dormant Fire Trail: a fire trail that has been closed but has been identified as suitable for reopening with minimal works.

- 3.3 This trail classification system applies to trails that have been identified in a local bush fire risk management plan as primary or secondary trails and are listed on the register.

- 3.4 The Bush Fire Coordinating Committee's *Guidelines for the Classification of Fire Trails* provides a basis for the standardisation and condition of fire trail identification.

### **4.0 Construction and Maintenance**

- 4.1 Fire trails should be constructed and maintained to a standard to allow effective bush fire mitigation and suppression activities while ensuring a safe working environment and ameliorating social, economic, and environmental impacts. It is recognised that some land management agencies have developed standards for the construction and maintenance of fire trails; "*Guidelines for the Planning, Construction and Maintenance of tracks* (C&LM, 1994) provides a minimum standard.

- 4.2 Effective management of fire trails requires selection of the best option from a suite that includes: reconstruction to required standard, realignment and relocation from sensitive areas through to closure and rehabilitation.

- 4.3 Where subdivision of land in bush fire prone areas is proposed, construction and maintenance of new fire trails should be considered as part of subdivision release of land to provide strategic protection benefits to the community. Fire trails of this nature should be constructed within the confines of the proposed subdivision development. Reference should be made to "*Planning for Bush Fire Protection – A Guide for Land Use Planners, Fire Authorities, Developers and Home Owners*" (NSW Rural Fire Service, 2001).

- 4.4 Fire trails should only be constructed or maintained where they provide a clear strategic benefit and their financial and environmental costs do not outweigh the benefits for fire management.



## **5.0 Fire Trail Registers**

5.1 Bush Fire Management Committees need to regularly maintain and update a Local Fire Trail Register linked to the Bush Fire Management Plans for its area of responsibility.

5.2 The Fire Trail Register should record necessary information for administrative, planning and operational purposes including location, condition and accessibility and should conform to the Bush Fire Co-ordinating Committee *Guidelines for Fire Trail Register*, when available.

## **6.0 Funding**

6.1 Adequate funding is required for a safe and effective fire trail network. Land management agencies are responsible for funding and maintaining fire trails for the proper management and protection of their lands. In the case of new developments the cost of fire trail establishment needs to be met by the developer.

6.2 Limited funding is available for fire trail works through the Fire Mitigation Works Fund. The Bush Fire Coordinating Committee *Annual Fire Mitigation Works Fund Policy and Guideline for the Roles and Responsibilities in the Distribution of the Annual Fire Mitigation Works Fund* has been established to regulate the distribution of these funds to Bush Fire Management Committees across New South Wales (refer to BFCC Policy No. 02/01). Where funding is provided through the Bush Fire Mitigation Fund to construct new fire trails it should be conditional upon the use of BFCC approved identification signage, when available.

# Bush Fire Coordinating Committee **Guidelines for the Classification of Fire Trails**

## **1. Introduction.**

1.1 These guidelines provide the basis for the standardisation for identifying and mapping of fire trails across the State. Fire trails need to be identified and identifiable in a consistent manner so as to convey to fire management personnel the condition, purpose and accessibility of the fire trail. Fire trail identification and mapping needs to be effectively undertaken in the most efficient and effective means possible, recognising the need to minimise the cost of implementation.

1.2 It is recognised that local conditions may necessitate variations from these guidelines. Where this is the case variations should be noted in the Local Operations Plan. Trails may need to be closed for a period of time due to wet weather or other management requirements. In these instances the temporary closures will be notified to the Executive Officer of the Bush Fire Management Committee.

## **2. Classification of Fire Trails**

There are three categories of fire trails identified in these guidelines:

2.1 Primary Fire Trail – **This is a fire trail of strategic importance and/or is a primary feeder route to a network of secondary trails.**

Primary fire trails should:

- avoid steep grades which may prevent passage of Category 1 fire tankers;
- avoid sharp bends which may prevent the passage of Category 1 fire tankers without the need for three point turns;
- be of a general carriageway width  $\geq 4$  metres.
- have provision to pass every 250 metres or where topography allows.

Turnaround Areas – Dead ends should be avoided as far as possible. Where dead ends exist, a turnaround of sufficient radius for a full lock by a Category 1 fire tanker should be constructed (radius  $\geq 12$  metres). If there is insufficient space for such a turnaround due to the topography, provision should be made to allow a maximum three-point turn (radius  $\geq 10$  metres).

Clearing - Consideration must be given to adjacent vegetation along the length of the trail. The minimum clearance for heavy tankers is 4 metres.

Maintenance – Primary trails are maintained to provide safe four wheel drive access for fire fighting vehicles.

## **2.2 Secondary Fire Trail** – This is a fire trail that can be used for control in both fire suppression and mitigation operations.

*It is recognised that there are some secondary trails that only provide for Category 7/9 light fire tankers and some secondary/dormant trails that are known as Prepared Fire Lines (P.F.L.) – hand tool lines.*

This is a trail of moderate standard and the following is recommended.

Width - generally single lane 3.7 metres wide with provision for vehicles to pass where the topography allows.

Turnaround Areas - Where dead ends exist a turnaround of sufficient radius for a full lock by a Category 1 fire tanker should be constructed (radius  $\geq 12$  metres). If there is insufficient space for such a turnaround due to the topography, provision should be made to allow a maximum three-point turn (radius  $\geq 10$  metres).

Clearing - Consideration must be given to adjacent vegetation along the length of the trail. A minimum clearance for heavy tankers is 4 metres.

Maintenance – Secondary trails are maintained to provide safe four wheel drive access for fire fighting vehicles.

## **2.3 Dormant** – Is a previously existing fire trail or temporary trail used for previous fire suppression (or other) operations that is now closed. Minimum work is required to reopen the trail.

*It is recognised that there are some secondary trails that only provide for Category 7/9 light fire tankers and some secondary/dormant trails that are known as Prepared Fire Lines (P.F.L.) – hand tool lines.*

Condition assessment of dormant trails should be carried out annually. Where dormant trails revert to a condition requiring significant work to reopen (for example heavy regrowth), then the BFMC should review if the trail is to remain classified as a dormant trail.

Other transport routes that may or may not be used for fire fighting purposes may be subject to wet weather or management provisions.

### **3. Fire Trail Marking**

- 3.1 The purpose of marking fire trails is to convey sufficient information to fire crews on the identification of the trail for fire fighting purposes.
- 3.2 As such, the marking of fire trails should provide information that is visible, flexible and identifiable by fire crews.
- 3.3 Visibility can be achieved by ensuring signs are of a distinctive colour, reflective for night vision, are not obscured by vegetation, suitably located and at a height to be noticed. Markers should be placed at a height above the ground, free of obscuring vegetation. Markers should be located in such a way as to clearly indicate the direction of the trail and be placed in advance of entering that section of the trail.
- 3.4 Flexibility may be important for local conditions to indicate watering points, staging areas or other operational information. Where local conditions dictate the need for such information, identification measures should not be confusing or mistaken for essential fire trail information.

Where additional information is required, such information should be in accordance with the Bush Fire Coordinating Committee *Guidelines for Standard Incident Control Documentation* (6.08.01 Bush Fire Mapping Symbols). Where additional information signs are co-located with fire trail identifiers, they should be positioned adjacent to the fire trail identifier and separated by at least 5 cm.

- 3.5 Symbols need to be clearly identifiable, logical and readily recognised with minimal training.

## 2.2 Fire Roads and Trails

### Introduction

1. This policy applies to permanent roads and trails in NPWS-managed lands.
2. Issues relating to trails can be divided into five categories:
  - use of trails during incidents — use of a trail during an incident will depend on the outcomes of an appreciation of the incident.
  - classification of fire access — classification of reserves roads and trails that are strategically important for fire management.
  - specifications for development/maintenance of trails — trails are developed and maintained to a consistent standard.
  - use of signs to identify roads and trails, fire control advantages and warnings.
  - use by fire authorities — other fire authorities may require access to reserves for a variety of reasons.

### Policies

#### Access for incidents

3. The NPWS will maintain a fire access system for reserves to support fire suppression and prevention operations.
4. The NPWS will facilitate the appropriate use of trails for fire authorities, including the use for training, reconnaissance, fire management activities and fire control.
5. Remote area firefighting provides a legitimate alternative method of accessing fires in rugged, undeveloped or difficult to access landscapes.

#### Classification of fire access

6. Roads and management trails that are strategically important for fire management are classified as *primary* or *secondary* fire access, in accordance with Bush Fire Coordinating Committee (BFCC) policy.
7. Primary and secondary fire access routes will be identified in reserve plans of management and/or reserve fire management strategies.

#### Construction and maintenance of fire trails and signage

8. Trail construction and maintenance may have social, environmental and economic implications, so new trail proposals should proceed only where the benefit is not outweighed by the impact.
9. Environmental impact assessment procedures will be carried out before the construction of non-emergency access trails or major upgrade activities.
10. Construction and maintenance of fire trails will be in accordance with NPWS specifications.
11. NPWS and BFCC standards for fire trails and safety signage are implemented where appropriate and according to assessed risk.
12. The decision as whether or not to erect signage on NPWS-managed lands and the dimensions of signs is the responsibility of the NPWS and is based on assessed risk and need.
13. The provision of signage or otherwise in no way diminishes the responsibility of a fire fighter to inspect the condition of a trail before use, drive within their capacities, and be able to read a map.

*for PWD lands (NPWS Intranet).*





Wolgan Valley Photo: L Holme



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**NATIONAL  
PARKS AND  
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