

# Planning for Bushfire Protection



A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners





Produced by NSW Rural Fire Service in collaboration with planningNSW.  
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The NSW Rural Fire Service thanks the significant contribution to this document made by all those who submitted comments to the September 2000 Draft and in particular to the staff of planningNSW for their collaborative efforts in producing *Planning for Bushfire Protection*.

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Prepared by Planning & Environment Services, NSW Rural Fire Service in cooperation with planningNSW.

# FOREWORD



Bushfires represent an ever present risk to life, property and the environment in rural and urban interface areas within NSW. While the obvious answer would be to avoid development near bushfire hazards or to prevent bushfires from occurring, neither are realistic options due to the growing demands for residential land and our understanding of the ecological processes dependent upon bushfire.

One of the ways the NSW Rural Fire Service seeks to achieve its goal of managing risks to life, land, property and the environment is through appropriate residential planning strategies.

The 2001 revision of *Planning for Bushfire Protection* provides local government planners and decision makers, the building industry and the public with an effective guideline to these bushfire protection strategies. It also describes those provisions the NSW Rural Fire Service believes are necessary in protecting residential developments from the adverse effects of a bushfire event.

There have been many changes to the planning processes within NSW since the release of *Planning for Bushfire Protection* in 1991 and further changes to simplify the process are being implemented through the planningNSW's *Plan First* program. The *Environmental Planning and Assessment Act 1979* has been amended to include Section 79C replacing Section 90. The *Rural Fires Act 1997* has replaced the *Bush Fires Act 1949* and Australian Standard AS 3959 – 1999 better reflects advances in fire research on building materials. All these changes have pressed the need for a revision of *Planning for Bushfire Protection* to bring the document into line with supporting legislation and planning processes and have it reflect the advances in fire technology available today.

This revision of *Planning for Bushfire Protection* provides guidance on the planning and development control processes in relation to bushfire protection measures and a more flexible approach to subdivision design. This document also addresses the unique issues associated with Infill and Special Protection Developments that were not addressed in the earlier document.



*The Hon Bob Debus MP*  
Attorney General  
Minister for the Environment  
Minister for Emergency Services  
Minister Assisting the Premier on the Arts



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## GLOSSARY, ABBREVIATIONS, TERMS AND ACRONYMS

<b>AS 3959-1999</b>	Australian Standard AS 3959 <i>Construction of buildings in bushfire-prone areas</i> , Standards Australia, 1999, that outlines construction standards applicable to residential developments in bushfire-prone areas.
<b>Asset Protection Zone (APZ)</b>	Often referred to as a fire protection zone. Aims to protect human life, property and highly valued public assets and values. Comprises inner protection area (IPA) and outer protection area (OPA). An area surrounding a development managed to reduce the bushfire hazard to an acceptable level. The width of the APZ will vary with slope and construction level.
<b>Building Code of Australia (BCA)</b>	The Building Code of Australia means the document of that name published on behalf of the Australian Building Codes Board (ABCB) in October 1996, together with: <ul style="list-style-type: none"><li>a) such amendments made by the Board, and</li><li>b) such variations approved by the Board in relation to New South Wales, as are prescribed by the regulations</li></ul>
<b>Bushfire</b>	A fire involving grass, scrub or forest.
<b>Bushfire attack</b>	Arises from direct flame impingement, radiant heat or ember attack.
<b>Bushfire hazard</b>	The potential severity of a fire. Usually measured in terms of intensity (kW/m), the factors that influence a bushfire hazard include climate and weather patterns, vegetation (fuel quantity, distribution and moisture) and slope.
<b>Bushfire hazard reduction works</b>	<ul style="list-style-type: none"><li>a) the establishment or maintenance of fire breaks on land, and</li><li>b) the controlled application of appropriate fire regimes or other means for the reduction or modification of available fuels within a predetermined area to mitigate against the spread of a bush fire,</li></ul> but does not include construction of a track, trail or road.
<b>Bushfire-prone Area</b>	Is an area that can support a bushfire or is likely to be subject to bushfire attack. In general, a bushfire-prone area is an area occurring within or within 100m of a high or medium bushfire hazard, within or within 30m of a low bushfire hazard but are not existing urban areas or waterbodies (other than wetland vegetation) as identified by a bushfire hazard map produced under an approved Bush Fire Risk Management Plan, or such other map certified by the NSW Rural Fire Service for this purpose.
<b>Bushfire risk</b>	Is the chance of a bushfire igniting, spreading and causing damage to assets of value to the community. Risk may be rated as being extreme, major, moderate, minor or insignificant and is related to the vulnerability of the asset.
<b>Class 1, 2 and 3 buildings</b>	Are described within the Building Code of Australia.
<b>Development Control Plan (DCP)</b>	Development Control Plan is a detailed plan that illustrates the precise controls to apply to a particular type of development or in a particular area. A DCP refines or supplements a LEP.



<b>Development Application (DA)</b>	An application for consent to carry out development such as building, subdivision, the use of a building or land. Applications are normally made to the local council.
<b>Ecologically Sustainable Development (ESD)</b>	As defined in the <i>Protection of the Environment Administration Act (NSW) 1991</i> , summarised as: the precautionary principle; inter-generational equity; conservation of biodiversity and ecological processes; the improved valuation and pricing of environmental resources.
<b>Fire Intensity</b>	The rate of heat release, per unit length of firefront. The primary unit is kilowatt per metre of firefront (kW/m). It is a function of the heat content of the fuel (H), the weight of the fuel consumed (W), and the rate of spread of the fire (r).
<b>Fire protection systems</b>	In this document, the term is used to refer to the use of sprinkler systems used to dispense water on to the walls, roof and other elements of a building.
<b>Habitable buildings</b>	Generally defined as buildings where people live or dwell. See also Class 1, 2 and 3 buildings.
<b>Inner Protection Area (IPA)</b>	The inner component of an asset protection zone, consisting of an area maintained to minimal fuel loads and comprising a combination of perimeter road, fire trail, rear yard or reserve, so that a fire path is not created between the hazard and the building.
<b>Local Environmental Plan (LEP)</b>	Local Environmental Plan prepared under Part 3 of the <i>Environmental Planning and Assessment Act 1979</i> . Plans prepared by a council that describe the planning status (zone) and/or development standards required for the future development of an area.
<b>Outer Protection Area (OPA)</b>	The outer component of an asset protection zone, where fuel loads are maintained at a level (usually less than 8 t/ha) where the intensity of an approaching bushfire would be significantly reduced.
<b>Precinct</b>	A place or space of definite or understood limits. An area of town, etc., whose use is in some way restricted.
<b>Setback</b>	The distance required through planning provisions to separate a building from the bushfire hazard, street frontage or from adjacent buildings.







## OVERVIEW OF PLANNING FOR BUSHFIRE PROTECTION

### 1.1 INTRODUCTION

This document, *Planning for Bushfire Protection*, has been developed by the NSW Rural Fire Service in close consultation and collaboration with planningNSW. This document replaces the *Planning for Bushfire Protection* discussion document originally released in May 1991 by the then Department of Bush Fire Services; and Circular C10 *Planning in Fire Prone Areas* issued by the Department of Urban Affairs and Planning in 1989.

This document is intended for use by councils, fire authorities, developers, planning consultants, building practitioners (including accredited certifiers), and home owners. It provides the necessary planning considerations when developing areas for residential use in residential, rural-residential, rural and urban areas when development sites are in close proximity to areas likely to be affected by bushfire events. The document is therefore applicable to Class 1, 2 & 3 residential development as defined within the Building Code of Australia (BCA). It also addresses development under State Environmental Planning Policy No.5 (SEPP 5) – Housing for Older People or People with a Disability. Its principles may be applied to the protection of other developments as councils deem appropriate (e.g. schools, hospitals, tourism developments). However, it must be recognised that these developments, due to the difficulty of preparing residents for bushfire events, may present difficulties at times of evacuation.

The document outlines the bushfire planning matters which need to be considered at various stages of the planning process. This includes those matters to be considered in the preparation of local environmental plans (LEPs), subdivision design, and building construction stages.

One of the key features of the document is the linkage of bushfire hazard for a site with the implementation of appropriate bushfire related planning and development controls. These controls include: land use planning, siting and access considerations, vegetation management, water supply provisions and building construction requirements. The document also identifies

strategies to be adopted in preparing for bushfire attack by residents and their responsibility in maintaining bushfire protection measures.

The incorporation of appropriate bushfire protection measures into a development is one of a number of strategies developed to address bushfire attack. There are five main ways of protecting life and property from bushfire:

1. The planning and implementation of bushfire hazard reduction activities such as prescribed burning;
2. Incorporation of bushfire protection measures into subdivision design and housing development;
3. Incorporation of construction standards into building design;
4. Ongoing maintenance of bushfire protection measures by land-owners; and
5. Emergency firefighting and evacuation.

In producing this document, the principal consideration has been to provide for the protection of human life (including the safety of firefighters suppressing bushfire events) and property.

This document therefore addresses the following issues:

- how LEPs can strategically map bushfire-prone areas using bushfire hazard mapping;
- how bushfire hazard is assessed and applied at each stage of the planning/development control process;
- the provisions applicable to a LEP which relate to land which could pose or be affected by a bushfire threat;
- how subdivision designs should take into account bushfire hazard and provide appropriate setbacks for buildings, emergency water supplies and access during a fire;
- how infill development should be considered in areas that are bushfire-prone;
- how Australian Standard 3959 is to be applied in NSW; and





- strategies to be adopted by residents in preparing for bushfire attack and their responsibility in maintaining bushfire protection measures.

General principles applied in the document include:

- the need for, and types of, protection measures are governed by the degree of threat posed to a development;
- the need to meet a minimum setback from the hazard;
- the greater the setback from the hazard, the lower the bushfire protection construction standards needed;
- the smaller the perimeter of the development fronting the threat, the less the opportunity for bushfire to threaten the development;
- requirements needed to protect the development are to be kept within the site of the development and not adjoining lands (NB. Infill development may need to take account of protection measures implemented at subdivision stage).

## 1.1.1 Objectives for Bushfire Protection

The objectives adopted by *Planning for Bushfire Protection* to meet the overall purpose of bushfire protection of human life (including firefighters) and property, include the following:

1. consider bushfire protection and management issues in land use planning and development decisions, to provide a safe environment for the community



*Photograph 1.1 Some past planning practices have provided little real protection to life and property in the event of a severe bushfire.*

2. manage vegetation to reduce potential bushfire attack in the vicinity of habitable buildings
3. design and siting of habitable buildings to improve the survivability of the building and the protection of life during the passage of the firefront
4. provide safe access for emergency and other vehicles at all times
5. ensure water is available to landholders and emergency services to enable the defence of habitable buildings against bushfire attack
6. establish a maintenance regime for fire protection for the life of the habitable building

## 1.1.2 Assumptions

Although residential development is the main focus of the document, adequate provisions are required to ensure the safety of the community and emergency personnel, and the protection of property, for all development in bushfire-prone areas.

The provisions of this document are designed not only to assist building survival during a bushfire, but also to provide for the relative safety of members of the community who may be occupying or trying to leave buildings during a bushfire or who could assist in defending a property during a bushfire. It is also designed to provide for the safety of firefighters suppressing the fire.

Protection of development from the impacts of bushfires is required for the entire life of the development. Determination of the protection measures required is based on estimation of the maximum hazard which in turn is based on maximum possible fuel loads likely to occur on and adjacent to the development site (rather than fuel loads which may currently be present).

Protection measures are designed to provide protection to the development based on the maximum hazard likely to be encountered. Inherent to maintaining this protection over the life of the development is the ongoing maintenance of the protection measures to the recommended standards.

Implementation of planning and construction provisions for developments in bushfire-prone areas provides the most effective way of minimising the



effects of bushfire on a development and the people occupying that development. However, no development in a bushfire-prone area can be guaranteed to be entirely safe from bushfires. Providing an acceptable level of protection is to some extent a compromise between the level of threat and the costs (such as financial and environmental) involved in providing the protection.

### 1.1.3 Strategies for Bushfire Protection

An acceptable level of protection from bushfires is achieved through a combination of strategies:

- Controlling the type of developments permissible in bushfire-prone areas
- Minimising the impact of radiant heat and direct flame contact by separating the development from the bushfire hazard
- Reducing the rate of heat output (intensity) of a bushfire close to a development through control of fuel levels
- Minimising the vulnerability of buildings to ignition from radiation and ember attack
- Access provisions which enable relatively safe access/egress for the public and facilitate firefighting operations
- Provision of adequate water supplies for bushfire suppression operations
- Community education focusing on property preparedness including planning for and maintenance requirements
- Maintenance of Asset Protection Zones, fire trails, access for firefighting and on-site equipment for fire suppression.

### 1.1.4 Limitations

The measures recommended in this document are derived from both scientific theory and practical experience. They are not necessarily universally applicable and consideration of individual cases may warrant modification of the recommendation. Before any modifications are made, however, it should be remembered that these measures are safety related and demand a conservative stand.

Continued innovation in LEP development and regular Court decisions make it difficult to detail all

considerations that can be applied when considering development applications. From time to time and depending on the circumstances, other considerations may be relevant, in particular any provision designed to reduce the entry of embers.

Councils should not avoid placing additional controls on developments where such controls are warranted.

In the final analysis, it is the local council that bears the responsibility for the provision of bushfire protection. Where aspects of the approach required by the legislation are considered insufficient for the local area, then amendments may be required at a local level (such as through Development Control Plans).

Any departure from recommendations set out in this document is at council's discretion. In all cases, local firefighting authorities (NSW Fire Brigades or RFS) should be the ultimate arbiter of what restrictions are applicable to the situation in question. However, councils must be prepared to justify any departures to avoid action being taken in the Land and Environment Court.

Notwithstanding the precautions adopted, it should always be remembered that bushfires burn under a wide range of conditions and an element of risk, no matter how small, always remains.

## 1.2 HOW THIS DOCUMENT RELATES TO BUSHFIRE RISK MANAGEMENT PLANNING UNDER THE RURAL FIRES ACT

The *Rural Fires Act 1997* requires Bush Fire Management Committees to prepare Bush Fire Risk Management Plans (BFRMPs). These plans seek to identify the level of bushfire risk across a Bush Fire Management Committee's area (usually a local government area), and the strategies which need to be implemented by the responsible land managers (including local government) to manage the bushfire risks that have been identified.

The Bush Fire Management Committees responsible for preparing the plan are formed in all local government areas that have a bushfire risk. Membership of the committee includes representatives of the major fire and land





management agencies within the local government area, as well as other community interest groups such as the Nature Conservation Council and the NSW Farmers Association. Local councils have a major role to play in these committees and are represented through a councillor and a council staff member with expertise in environmental matters.

## 1.2.1 Strategic Use of Bushfire Hazard Mapping for Local Government Areas

The bushfire hazard maps produced as part of the bushfire risk management planning process identify those areas of low, moderate and high bushfire hazard based on vegetation and slope classes. They can be used by councils to assess where potential rural residential and urban release areas should be located and the potential hazard posed to these locations. They can also be used to give a broad assessment of subdivision proposals. The maps can be used to identify those areas that are bushfire-prone and thus determine when and where the requirements of AS 3959 should apply. This is discussed in section 3.2.2.

In some cases, councils may have already developed adequate measures for the identification of bushfire-prone areas. In these circumstances, council should make use of these more accurate assessment processes rather than relying solely on the bushfire hazard maps within the local BFRMP.

Until bushfire hazard maps are produced for a particular local government area, councils that need bushfire hazard mapping for individual development proposals are advised to consult with the local Rural Fire Service office.



*Photograph 1.2 Lack of separation places many properties in peril during a bushfire event. Fire fighters are not provided with adequate access to the hazard/development interface.*



## BUSHFIRE PROTECTION AND THE PLANNING SYSTEM

This section of the document provides an overview and guidance on the NSW planning system and how it relates to bushfire protection. It does this by outlining the various stages of the planning and development process and how these relate to bushfire protection.

In addition to the application of planning controls, the owners of land are also responsible for ongoing vegetation management and maintenance of the property and its services. This is to ensure that the effectiveness of the relevant bushfire protection measures is maintained.

### 2.1 THE PLANNING PROCESS – OVERVIEW

Planning and development in NSW is regulated by the *Environmental Planning and Assessment Act 1979* (EP&A Act). In planning any development in a rural area or on the fringes of urban areas, whether a new development or an addition to existing development, it is necessary to take into account the potential threat from bushfires.

Developments are the end product of a planning process that involves the following steps.

#### 2.1.1 Environmental Studies

Before any change in land-use zoning occurs, some form of study is usually carried out to determine what types of development are appropriate for each area. A number of separate studies may be carried out including transport, land capability, and, if the area is prone to bushfires, a bushfire assessment report. These studies examine the state of the land as it exists and the potential impact of and on the development.

Bushfire assessment reports need to focus on the level of hazard posed to the development by the land or adjacent land, and how that hazard may change as a result of the development.

#### 2.1.2 Local Environmental Plans

Most councils have a Local Environmental Plan (LEP) covering all of the local government area. These LGA-wide LEPs are termed 'principal' LEPs. Such principal LEPs will usually contain:

1. a land use table which sets out the types of development allowed in each zone;
2. a set of written development standards which place conditions on particular types of developments;
3. an accompanying map which shows the area of land included in each zone.

From time to time councils may prepare a new principal LEP for their LGA.

Before a development can occur, it must first be permissible under the LEP. Subdivisions and other new developments may require the preparation of an accompanying 'amending' LEP to provide for a change in land-use zoning in the principal plan. This is in order for the new development to be permissible under the principal LEP.

#### 2.1.3 Development Control Plans

A LEP may allow for the preparation of a more detailed Development Control Plan (DCP). DCPs can be used to spell out in more detail the provisions of the LEP.

DCPs for subdivision and urban release areas can be used to control:

1. the staging of the development
2. the subdivision pattern
3. the road network
4. building envelopes
5. setbacks
6. buffer zones

#### 2.1.4 Development Approval

##### a) Permissible development

LEPs should identify all development categories likely to be affected by, or which will increase the risk of bushfire and require consent for these developments. Because of the complexity of bushfire behaviour, whether this consent is given or not will depend on an assessment of the nature of the development and the adjacent hazard. A judgement must be made as to whether the





proposed development should be approved and, if so, what conditions should apply.

A development can comprise a subdivision or construction of a building or other work on land. In determining a development application, a consent authority is to take into consideration those matters listed in Section 79C of the *Environmental Planning and Assessment Act 1979* (EP&A Act) that are of relevance to the application. Section 79C requires that, among other things, consideration be given to:

- the provisions of any environmental planning instrument (such as a LEP);
- the provisions of any draft environmental planning instrument;
- any development control plan;
- the likely impacts of the development, including impacts on both the natural and built environment;
- the suitability of the site for the development; and,
- the public interest.

The provisions of LEPs and DCPs therefore largely influence development decisions. Also, an assessment of bushfire hazard and protection of life and property are pertinent to the consideration of impacts on the environment, the suitability of the site for the development, and the public interest.

In 1998, the Department of Urban Affairs and Planning issued a *Guide to section 79C* to assist councils, applicants and the community identify those issues that need to be covered when preparing and assessing development applications. The Guide includes a specific reference to bushfire risk and the document *Planning for Bushfire Protection* as a potential matter for consideration under section 79C(1)(b) – the likely impacts of that development.

### **b) Exempt and complying development**

There are two new categories of development; exempt and complying development. These ensure that a suitable level of assessment is assigned to different types of development. Exempt development is that which is of minimal environmental impact and needs no consent under the EP&A Act. Complying development is intended to be routine development that must meet preset

requirements and conditions. Both must be introduced through an environmental planning instrument (EPI).

Section 76A (6)(g) of the EP&A Act provides that complying development is excluded from land that is identified as environmentally sensitive in a planning instrument that makes provision for the complying development.

State Environmental Planning Policy No.60 (SEPP 60) – Exempt and Complying Development, lists a number of areas as environmentally sensitive and excludes both exempt and complying development from these. The State Policy excludes exempt and complying development from State parks, National Parks, areas with a slope of greater than 18 degrees, SEPP 14 coastal wetlands and SEPP 26 littoral rainforests. The State Policy also makes provision for councils to exclude areas that they consider are unsuitable for exempt and/or complying development by mapping these as environmentally sensitive areas on maps held in their offices. In general those areas identified as being environmentally sensitive due to the nature of the vegetation present will also represent areas of bushfire hazard.

The Rural Fire Service can assist councils with a base map and advice for the mapping of bushfire hazards. The advice can assist councils to map areas that are known to be bushfire-prone or where bushfire threat is likely to exist. These areas that are mapped will therefore be excluded from exempt and complying development provisions.

SEPP 60 identifies some fences and minor developments related to a permissible use as exempt development. However, for these works to be exempt development, the SEPP requires that they must be constructed of non-combustible materials if located in a fire protection zone or an Asset Protection Zone as identified in a Bush Fire Risk Management Plan.

When councils prepare their own LEP, they have some latitude in excluding exempt and complying development from land that they identify as environmentally sensitive areas. PlanningNSW encourages councils to identify bushfire-prone areas in their LEPs for their exclusion from exempt (except those made from non-combustible materials) and complying development.



## 2.1.5 The Building Code of Australia and AS 3959

The Building Code of Australia (BCA) is a fully performance based code which obtains its statutory power through the EP&A Act 1979 and EP&A Regulation 2000. The EP&A Regulation requires a certifying authority to be satisfied that the relevant requirements of the BCA will be met prior to issuing a construction certificate or complying development certificate. The EP&A Regulation also states that it is a prescribed condition of development consent that building work must comply with the BCA, and complying development certificates must be issued with a condition to this effect.

The BCA contains both Performance Requirements and Deemed-to-Satisfy Provisions relating to the construction of buildings in bushfire-prone areas. These provisions apply to Class 1, 2 and 3 buildings that are proposed for construction in “designated bushfire-prone areas”.

AS 3959 *Construction of buildings in bushfire-prone areas* is referenced by the BCA as the Deemed-to-Satisfy construction standard for buildings in designated bushfire-prone areas. Application of AS 3959 therefore relies on the identification of “designated bushfire-prone areas”.

New South Wales varies the BCA’s national definition for this term to read:

**Designated bushfire-prone area** means land that:

- (a) has been designated under legislation; or
- (b) has been identified under an environmental planning instrument, development control plan or in the course of processing and determining a development application,

as land that can support a bushfire or is likely to be subject to bushfire attack.

The methodology for determining broad area hazard mapping is described in the *Bush Fire Risk Management Plans – Guidelines* (page 8) produced by RFS.

At this point in time, bushfire-prone areas are not designated under legislation in NSW. NSW relies on the means described in paragraph (b) of this definition for identification of designated bushfire-prone areas.

Paragraph (b) formally recognises the actions some councils have taken through their LEPs and DCPs and enables all councils to designate what is a bushfire-prone area through the same means. Although paragraph (b) also allows the identification of bushfire-prone areas on a case-by-case basis, it is recommended (but not mandatory) that a more strategic approach be conducted involving bushfire hazard mapping for the entire local government area (i.e. via broad area mapping) and use this to identify bushfire-prone areas.

To strategically identify bushfire-prone areas across a LGA, this document recommends use of the BFRMP hazard maps, so that, bushfire-prone areas are defined as those areas:

- within or within 100m of high or medium bushfire hazards; or
- within or within 30m of low bushfire hazards; but are not existing urban areas or waterbodies (other than wetland vegetation).

In a practical sense, areas identified by council as being predominantly grasslands can be readily managed and as such are also not to be considered to be bushfire-prone.

Whilst not all developments within a bushfire-prone area will require bushfire construction standards applied to habitable buildings, all developments will, at a minimum, require fuel management.

## 2.1.6 Planning Certificate (section 149 certificates)

Planning certificates provide information on the development potential of a parcel of land including any planning restrictions that apply.

A landowner can apply to a council for a Planning Certificate under section 149 of the EP&A Act in respect to any land within the area of the council. The certificate will detail matters relating to the land as listed in schedule 4 of the EP&A Regulation 2000. This list will include identifying all relevant SEPPs, REPs, LEPs, DCPs (including drafts on public exhibition), zoning, land use, contribution



# CHAPTER 2



plans, hazard risk policies and any other relevant matters.

The NSW Rural Fire Service and planning NSW advise that, as per schedule 4, 7(b) of the EP&A Regulation, areas designated as bushfire-prone should be notified as being a relevant matter within the section 149 Planning Certificate.

## 2.2 SUMMARY

In summary, the protection of life (including firefighters and emergency services personnel) and property from bushfire is considered under the planning system through a number of provisions.

These include:

- LEP provisions
- DCP provisions
- Subdivision planning and development control
- Control of construction standards
- Change of use considerations

Vegetation management and property maintenance are also important in ensuring that life and property are adequately protected. This, however, is largely the responsibility of individual landholders.

These matters are illustrated in Figure 2.1 and discussed in detail in the following chapters.

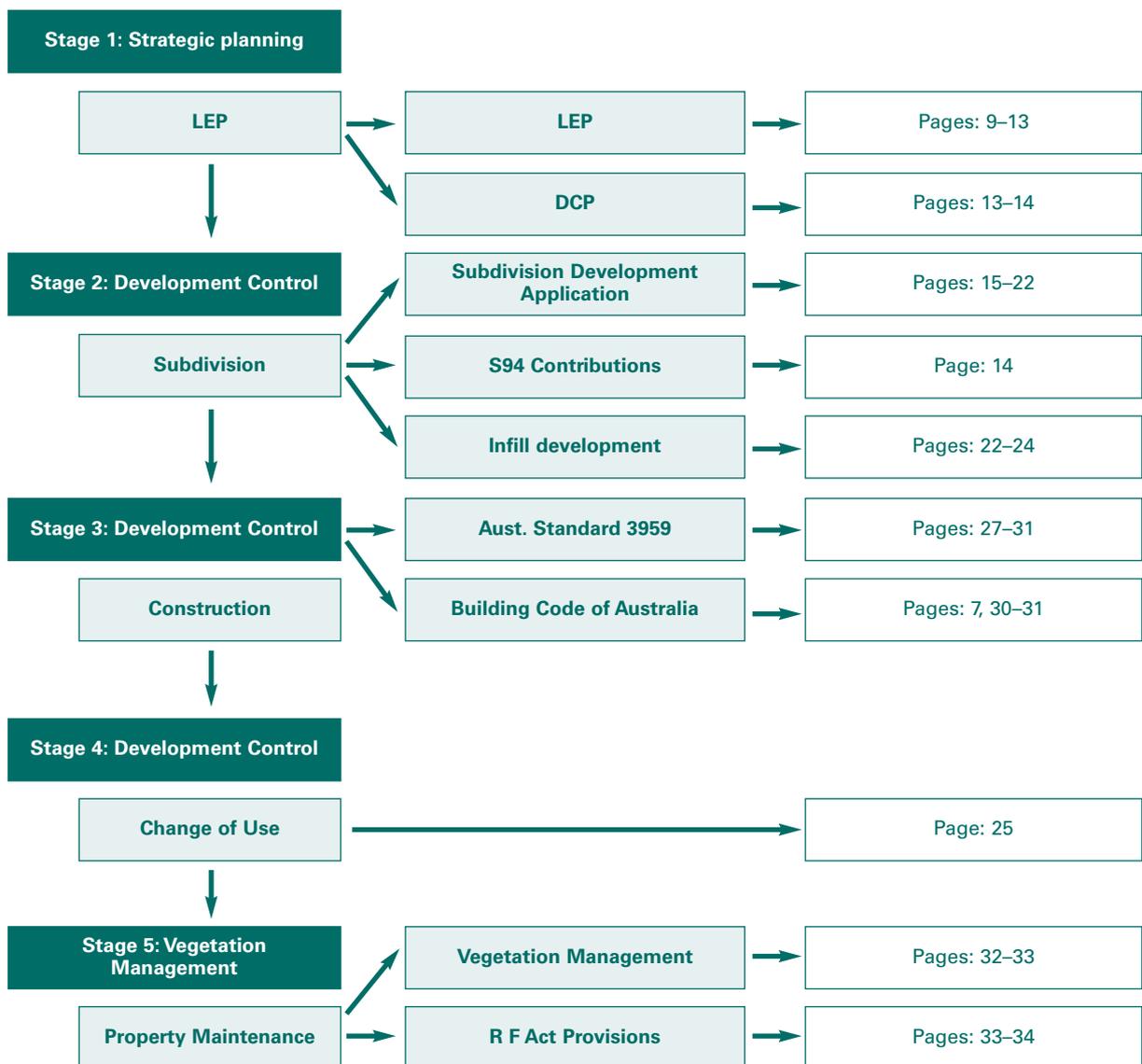


Figure 2.1 Quick reference guide to document



## ADDRESSING BUSHFIRE ISSUES IN LOCAL ENVIRONMENTAL PLANS AND DEVELOPMENT CONTROL PLANS

### 3.1 INTRODUCTION

The use of Local Environmental Plans (LEPs) and Development Control Plans (DCPs) presents the best way of strategically achieving bushfire protection objectives. This chapter details how LEPs and DCPs can be used to achieve bushfire protection and how the bushfire assessment methods described in Appendix 2 relate to planning controls in LEPs and DCPs.

### 3.2 LOCAL ENVIRONMENTAL PLANS

LEPs provide the mechanism by which:

1. bushfire objectives and protection measures can be achieved across a LGA
2. bushfire-prone areas can be identified and criteria specified to ensure that developments within those areas are appropriate to the potential level of hazard.

Inclusion of bushfire planning provisions in the LEP is fundamental to the adequate management of development in bushfire-prone areas for the following reasons:

- The LEP gives weight to bushfire management planning principles, and ensures they are considered at subdivision and development application including construction stages;
- The LEP can allow for sufficient space to be incorporated into land use zones to accommodate asset protection zones and adequate access; and
- The LEP can allow for the control of inappropriate land uses in bushfire-prone areas.

#### 3.2.1 Bushfire Protection Objectives in LEPs

Council areas deemed to have a level of risk arising from bushfires are required to prepare BFRMPs under the RF Act.

Councils are encouraged to include objectives and criteria within their LEPs to ensure that developments are adequately protected from bushfire and that impacts from protection measures

The following extract from Shoalhaven Council LEP, 1985 demonstrates how bushfire protection provisions can be incorporated into LEPs:

#### Clause 28(1)

In deciding whether to grant consent to any development on land which in its opinion is likely to be affected by bushfire, the Council must take into account whether:

- a) the development is likely to have a significant adverse effect on the implementation of any strategies for bushfire control and fuel management adopted by council;
- b) a significant threat to the lives of residents, visitors or emergency services personnel may be created or increased as a result of the development or the access arrangements to and from the development;
- c) the increased demand for emergency services during bushfire events created by the development would lead to a significant decrease in the ability of the emergency services personnel to effectively control major bushfires; and;
- d) the measures adopted to avoid or mitigate the threat from bushfire, including siting of the development, design of structures and materials used, clearing of vegetation, fuel free and fuel reduced areas and landscaping and fire control aids such as roads and water supplies are inadequate for the locality or would result in unacceptable environmental impacts.

The following sub-clause is also recommended:

- (2) In exercising its consideration of sub-clause (1), the council shall have regard to, and as much as possible, be satisfied that the provisions of *Planning for Bushfire Protection*, as produced by the NSW Rural Fire Service, have been met.





do not cause unreasonable environmental damage. LEP provisions can include:

- Objectives such as protection of life and property including emergency personnel,
- Minimum development protection requirements: e.g. access during times of emergency;
- Heads of consideration that council must take into account when determining a development application, e.g.
  - whether the development will place an increased demand for emergency services;
  - whether the development will adversely affect other bushfire protection strategies or place other developments at risk; and
  - whether the bushfire protection measures will adversely affect the environment.

### 3.2.2 Identification of Bushfire-prone Areas

For each council area, the respective Bush Fire Management Committee is required to produce a Bush Fire Risk Management Plan (BFMRP) under the *Rural Fires Act*. This requires the production of a bushfire hazard map that shows areas of high, medium, low, and no hazard. The bushfire hazard map can be used by councils to designate bushfire-prone areas in their LEPs.

This document recommends that bushfire-prone areas be defined in the following way:

bushfire-prone areas are defined as those areas:

- within or within 100m of high or medium bushfire hazards; or
- within or within 30m of low bushfire hazards;

but are not existing urban areas or waterbodies (other than wetland vegetation) as identified by a bushfire hazard map produced under a BFRMP.

In a practical sense, areas identified by council as being predominantly grasslands can be readily managed and as such are also not to be considered to be bushfire-prone.

The designation of bushfire-prone areas is required to:

- a) identify those areas for which bushfire protection measures (such as setbacks and access) may be needed;

- b) give effect to the BCA requirement for construction standards as specified in AS 3959 – Construction of buildings in bushfire-prone areas (see Chapter 5).

If a BFRMP has not been prepared for the LGA, then council should, as a matter of priority, undertake the preparation of a bushfire hazard map and identification of bushfire-prone areas for their local government area.

If a council proposes to amend its LEP, the draft LEP initiating the change needs to give consideration to whether bushfire-prone areas will be affected. If bushfire-prone areas are implicated, then the proposed land-uses must be considered with respect to bushfire protection (including appropriate setbacks).

If a proposed zoning or land-use change affects a designated bushfire-prone area, then the *Planning Principles for Bushfires* need to be applied.

Section 117 of the EP&A Act provides for the Minister for Planning, to direct a council, in relation to the preparation of a draft LEP, to apply the planning principles specified in that direction.

It is anticipated that directions under s.117(2) relating to bushfires will be issued by the Minister for Planning from time to time.

Councils should consult the latest s.117(2) direction relating to bushfires so as to determine current requirements in the preparation or amendment of a LEP. These s.117(2) directions will be consistent with the bushfire planning principles identified below.

If a draft LEP affects a bushfire-prone area, then there are two main options:

#### a) Exclusion of Development

This is a viable option if:

- the development cannot be afforded appropriate setbacks (see Appendix 2); or
- the development is likely to facilitate the spread of bushfire to neighbouring developments in a time of bushfire; or
- the development is likely to be difficult to evacuate; or
- the development is likely to create control difficulties during a bushfire; or



- the development is of a type that should not be permitted (see later this chapter), or.
- there are alternative acceptable sites for the same development.

Exclusion of the development is also a viable option where the environmental constraints to the development and problems with its site access cannot be overcome and where the protective works required to reduce the threat to the development would incur too high a cost in terms of direct financial or environmental costs.

### **b) Planning Controls**

A development in a bushfire-prone area may be able to proceed if planning controls can deliver satisfactory protection of the property, its residents,

and firefighting personnel during the time of an emergency.

## **3.3 STATUTORY REQUIREMENTS**

### **a) Consideration of Bushfire-prone Areas**

Councils should prepare a map identifying bushfire-prone areas throughout the LGA to assist in identifying those areas where bushfire protection provisions may need to be applied.

Following the identification of bushfire-prone areas, the draft LEP should apply Appendix 2 to calculate appropriate setbacks. The provisions listed below then need to be taken into account.

## **PLANNING PRINCIPLES FOR BUSHFIRES**

### **Objectives**

- To prevent loss of life and property due to bushfires, by discouraging the establishment of incompatible uses in bushfire-prone areas
- To encourage sound management of bushfire-prone areas

### **When these principles apply**

These principles will apply when a council is required to prepare a draft LEP that permits land which is bushfire-prone to be developed. Such land would be identified by the council in accordance with *Planning for Bushfire Protection (PBP)*.

### **What a council should do if these principles apply**

A council should not prepare the draft LEP unless it is justified by an environmental study. When preparing an environmental study, the council should consider *Planning for Bushfire Protection*.

If a draft LEP proposes to permit development of land which, has been found to be bushfire-prone, the plan should, as appropriate:

- provide an Asset Protection Zone (APZ) incorporating at a minimum:
  - an Inner Protection Area bounded by a perimeter road or reserve which circumscribes the hazard side of the land intended for development, and has a building line consistent with the incorporation of an APZ within the property
  - an Outer Protection Area managed for hazard reduction, and located on the bushland side of the perimeter road
- contain provisions for two way access which links to the road or fire trail network
- minimise the perimeter of the area of land, interfacing the hazard, which may be developed
- introduce controls which avoid placing inappropriate developments in hazardous areas
- introduce controls on the placement of combustible materials within the Inner Protection Area

The NSW Rural Fire Service should be consulted in the preparation of the LEP which affects a bushfire-prone area.





## **b) Asset Protection Zone and Access**

To ensure that asset protection zones can be incorporated at the subdivision/ development stage, the LEP should provide:

- zoning boundaries of sufficient area and shape to allow for the establishment of Asset Protection Zones; and
- building allotments and perimeter and access roads that meet the specifications outlined in Chapter 4 of this document.

**Development standards** can also be provided in the special provisions section of the LEP to ensure that; sufficient car parking is available (minimising the need for on-street parking); access is maximised; and adequate water supply is available.

## **c) Minimise the Perimeter of the Development**

Consider the principles outlined in Chapter 4 (see 4.4) when determining the zoning pattern.

## **d) Use of the Land Use Table to Avoid Placing Inappropriate Developments in Hazardous Areas**

**Developments which are unlikely to be restricted** on bushfire grounds if located between the hazard and adjacent developments, include those that can be used to create reduced fuel areas, safety refuges for evacuated people and water supply points.

Examples include:

- tennis courts
- golf and race courses
- swimming pools
- cemeteries
- airstrips
- cleared local and regional open space

**Developments which are likely to be of concern** on bushfire grounds, include those that are impacted upon by bushfires and require consideration before they proceed.

Such development will include developments where people live or work or those areas that present problems in managing or are susceptible to bushfire.

Examples include:

- (i) developments where people live or work and which may require evacuation.
    - dwellings
    - residential flats
    - camps
    - places of assembly
    - rural landsharing communities
    - commercial and retail premises
    - tertiary educational establishments
    - developments defined as special protection in BFRMP which will, by their nature, be difficult to evacuate.
    - schools
    - penal institutions
    - institutions for the mentally and/or physically disabled
    - residential aged care facilities (including SEPP 5/SEPP 9 developments)
    - child care facilities
    - boarding houses
    - hospitals
  - (ii) developments which can create control difficulties within their confines
    - bulk stores of flammable material
    - stock and sale yards
    - timber yards
    - factories
    - warehouses
    - plantations
    - waste disposal and landfill depots
- Developments which should not be permitted** on bushfire grounds, include those that may start bushfires, or, are a potential hazard to adjacent areas or to firefighters if they are impacted upon by bushfires:
- power generating works
  - sawmills



- junkyards
- liquid fuel depots
- offensive and hazardous industries
- chemical industries
- service stations
- ammunition storage/dumps
- fireworks manufacture/storage

### ***e) Provide Development Standards that Enable the Control of Combustible Materials and Inappropriate Developments in Bushfire-prone Areas***

Appropriate development standards include:

- (i) **Setbacks** which define the minimum distance between structures and the hazard or boundary lines.

Setbacks may be described in terms of a side, front or rear setback.

Setbacks designed to give effective separation distance between a hazard and a building should specify that the distances are to be measured from the hazard (i.e. not the boundary line) when the hazard is on the allotment. Otherwise, specify the setback from the boundary.

Setbacks used to prevent adjacent buildings being built too close together, thus ensuring that access along the side is possible, should ensure that the distance is measured from the boundary line.

- (ii) **Building lines** which achieve the same effect as setbacks are simply a line drawn on a map beyond which no building may take place.
- (iii) **Minimum lot sizes** work with setbacks and building lines to ensure that the lot is of sufficient size to accommodate a dwelling after the Asset Protection Zone has been identified.
- (iv) **Dwellings density** is a development standard that may also need to be applied.

High density developments tend to reduce fuel loadings but increase the population levels in an area. For a variety of reasons, including limited access, dual and multiple occupancy developments may not be appropriate in

particular areas. In addition, aged care housing under SEPP 5 may not be suitable in areas identified as having a bushfire hazard (see Chapter 4).

- (v) **Landscaping** controls may also be appropriate at times.

In the past brushwood fences and extensive areas of mulch have assisted in the spread of bushfires within properties. The requirement for fencing to be of masonry, steel or colourbond construction is an important element in reducing the heat intensity of a bushfire upon the dwelling.

### ***f) Siting Guidelines***

In preparing a LEP, it may also be appropriate to consider the siting principles outlined in section 4.5 of this document.

### ***g) Water Provision/Access***

In permitting any type of land use, the level of water provided for firefighting purposes is an essential consideration. Firefighting vehicles, if they can arrive in time, have only limited amounts of water available.

Water may be provided from mains water supply or through an on-site static supply. Where mains supply is provided it is not usually necessary to provide supporting static supplies. However, where mains water supply is not available, the amount of static water needed will be dependent on the construction material of the dwelling, the surface area and the nature of the vegetation near the structure. This is dealt with in greater detail in Chapter 6.

## **3.4 DEVELOPMENT CONTROL PLANS**

It is recommended that Development Control Plans be developed to support the objectives of the LEP, particularly if an LEP is to provide for the subdivision of land for residential purposes.

DCPs provide the opportunity for council to set out in greater detail its requirements for development in bushfire-prone areas.





DCPs may detail:

- Preferred subdivision layout
- Preferred road location
- Preferred Asset Protection Zones locations
- Access criteria
- Building envelopes
- Preferred layouts to minimise the perimeter of development
- Preferred staging of the development
- Landscaping and siting requirements
- Construction standards
- Utility requirements
- Water supply requirements

Bushfire protection measures (including setbacks) necessary for the safety of the development and firefighters should be contained on the site of the development unless the most extraordinary circumstances apply.

An example of a bushfire DCP can be found in Appendix 1.

### 3.5 SECTION 94 CONTRIBUTIONS

Councils are required to develop a contributions plan for the purposes of implementing a requirement for section 94 contributions (for the provision of public amenities and services arising from the development of the land).

The plan can cover the whole or part of a council area and relate to one or more public service or amenity. The plan needs to establish a connection between the development and the need for increased services or amenities to justify the type and level of contributions. Councils are allowed some flexibility in determining the form the contribution will take. This form may be monetary, dedication of land or the provision of a material public benefit.

Opportunities for the collection and application of s.94 EP&A Act contributions for bushfire asset protection are limited by the requirements:

- To establish a nexus between the development and resulting increased demand for public facilities or infrastructure;
- For s.94 contributions not to relate to recurrent or maintenance costs (other than roads) [See DUAP (1997) Section 94 Contributions Manual, 2nd Edition].

In relation to bushfire services, a Section 94 Contribution Plan should include:

- fire trail construction;
- brigade stations;
- brigade equipment; and
- provision of water for fire fighting.

Note that the contributions sought can only be used for demands of facilities created by the new development and cannot be used to make up for a backlog in services from past development.



## BUSHFIRE PROVISIONS – DEVELOPMENT STAGE

### 4.1 INTRODUCTION

This chapter outlines the provisions that should be taken into consideration under s.79C of the *Environmental Planning and Assessment Act, 1979* when a relevant development application is to be determined for residential subdivision, rural-residential subdivision and development, rural dwellings, infill development and special protection development.

The provisions to be applied are:

- development and maintenance of Asset Protection Zones on the hazard side of the development;
- provision and maintenance of adequate access;
- design, staging and siting of the development; and
- provision of appropriate water supply and availability during times of bushfire emergency.

The provisions of this chapter should be considered and applied when a bushfire hazard assessment, carried out as indicated in Chapter 3, indicates that the site of the proposed development is bushfire-prone.

Appendix 2 describes the methodology for assessing development for residential purposes.

Modifications to these provisions, particularly in areas of medium or low hazard may be possible but would need to be considered on a case by case

basis. Any proposed modifications should be done in consultation with the local fire authority (RFS or NSWFB).

### 4.2 ASSET PROTECTION ZONE

#### 4.2.1 Introduction

Where a bushfire hazard exists on or adjacent to the development site, an Asset Protection Zone is to be established on the hazard side of the development as indicated in Figure 4.1.

Asset Protection Zones are required for any development adjoining a bushfire hazard area, whether it is a single building, a group of isolated buildings or an urban subdivision.

The Asset Protection Zone acts as a buffer zone between the development and the hazard. The primary purpose of an Asset Protection Zone is to ensure that a progressive reduction of bushfire fuels occurs between the bushfire hazard and any habitable structures within the development.

Councils need to ensure that the developments they approve, particularly subdivisions, do not offset bushfire protection measures to neighbouring areas. Bushfire protection measures that are essential to a development must occur on the site of the proposed development unless the most exceptional circumstances apply. This has been supported by

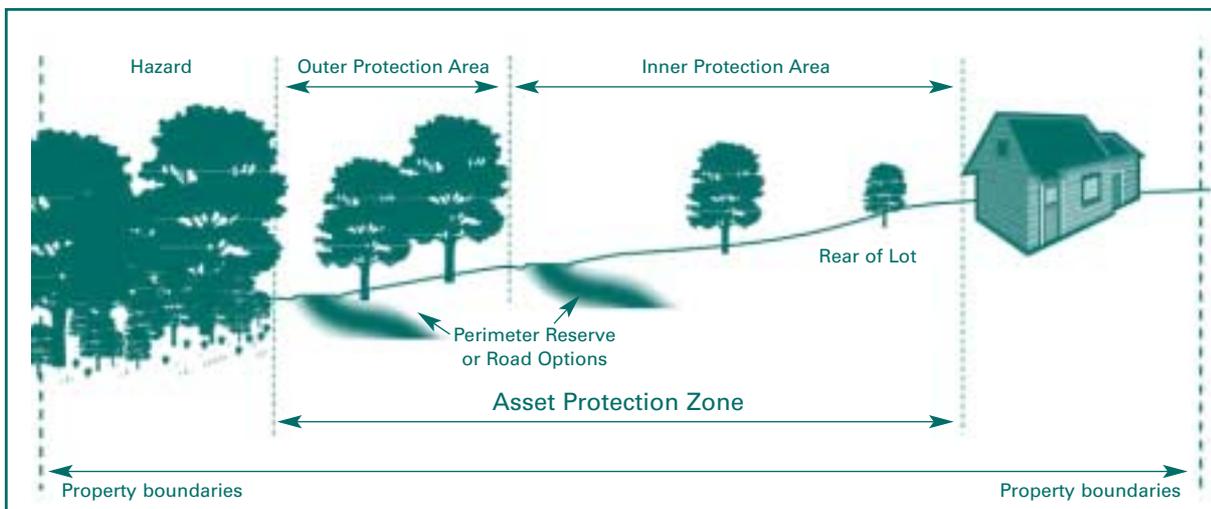


Figure 4.1 Components of an Asset Protection Zone





various court rulings, including *Scott Revay & Unn v. Ku-ring-gai Municipal Council 1994*, *Williams v Blue Mountains City Council 1995* and *Spargo v Wollongong City Council 1997*.

## 4.2.2 Components of an Asset Protection Zone

The Asset Protection Zone (APZ) should incorporate:

- an **Outer Protection Area (OPA)**; and
- an **Inner Protection Area (IPA)**, which should include a perimeter road or reserve (which incorporates an access track).

Specifications are set out in Tables 4.1 and 4.2.

### a) Outer Protection Area:

#### (i) Location:

The Outer Protection Area is located adjacent to the hazard. Originally the Outer Protection Area would have been part of the bushfire hazard but has become an area where the fuel loadings are reduced.

#### (ii) Purpose:

The reduction of fuel in this area substantially decreases the intensity of an approaching fire and restricting the pathways to crown fuels; reducing the level of direct flame, radiant heat and ember attack on the Inner Protection Area.

#### (iii) Depth:

The depth of the OPA is largely dependent on the type of land use and vulnerability of the dwelling or persons affected. For residential development the OPA is usually 10m deep. For special protection development the OPA is usually 15m deep. Some variation may be possible in consultation with local fire authorities (RFS or NSWFB).

#### (iv) Fuel Loadings:

Within the Outer Protection Area any trees and shrubs should be maintained in such a manner that the vegetation is not continuous.

Fine fuel loadings within the OPA should be kept to a level where the fire intensity expected will not impact on adjacent developments. In the absence of any policy to the contrary, 8 tonnes per hectare of fuel is commonly used.

In grasslands, fuel height should be maintained below 10 centimetres.

### b) Inner Protection Area:

#### (i) Location:

The Inner Protection Area extends from the edge of the Outer Protection Area to the development (see Figure 4.1).

#### (ii) Purpose:

The Inner Protection Area ensures that the presence of fuels, which could become involved in a fire, are minimised close to a development. Therefore the impact of direct flame contact and radiant heat on the development is minimised.

#### (iii) Depth:

The depth of the IPA is dependent upon the slope of the land. The greater the slope, the greater the intensity of any approaching fire and hence the greater the depth required for the IPA.

#### (iv) Fuel Loadings:

It is more practical to determine the specifications of the IPA in terms of performance than in terms of a minimum fuel loading.

The performance of the Inner Protection Area must be such that:

- there is minimal fine fuel at ground level which could be set alight by a bushfire; and
- any vegetation in the Inner Protection Area does not provide a path for the transfer of fire to the development – that is, the fuels are discontinuous.

The presence of a few shrubs or trees in the Inner Protection Area is acceptable provided that they:

- do not touch or overhang the building;
- are well spread out and do not form a continuous canopy;
- are not species that retain dead material or deposit excessive quantities of ground fuel in a short period or in a danger period; and
- are located far enough away from the house so that they will not ignite the house by direct flame contact or radiant heat emission.

Woodpiles, wooden sheds, combustible material storage areas, large areas/quantities of garden mulch, stacked flammable building materials etc should not be permitted in the Inner Protection Area.



## c) Perimeter Road or Fire Trail

### (i) Location:

The perimeter road or fire trail often lies between the Outer Protection Area and the boundary of the allotments.

It may form part of the Inner Protection Area. A perimeter road should be the preferred option where possible.

### (ii) Purpose:

- provide firefighters with easier access to structures, allowing more efficient use of firefighting resources;
- provide a safe retreat for firefighters; and
- provide a clear control line from which to conduct hazard reduction or back burning operations.

### (iii) Specifications:

- The perimeter road should have a minimum road reserve width of 20m. The gradient should not exceed 15°.

- If a perimeter fire trail is preferred to a perimeter road, the fire trail should:

- be located within a perimeter reserve a minimum of 6m wide (4m wide trail & 1m wide cleared area each side of the trail), with the reserve maintained in accordance with the specifications for an Inner Protection Area;
- the trail should be constructed in accordance with the design criteria established in section 4.3.2;
- the fire trail must be trafficable by firefighting vehicles under all weather conditions;
- the fire trail should link into the street network (if applicable) at regular intervals via an access track constructed in accordance with the design criteria established in section 4.3.2; and
- the fire trail should be maintained and in a serviceable and accessible condition at all times by the owner of the land.

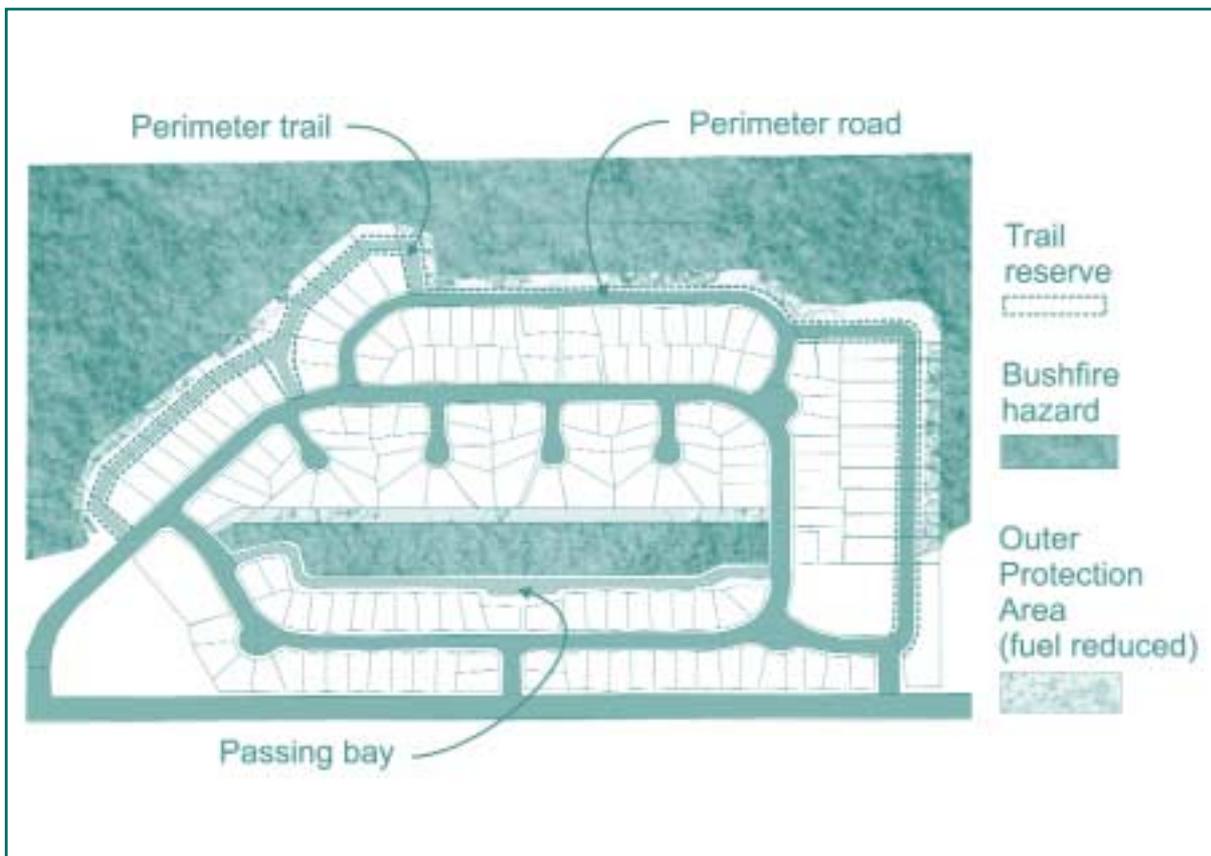


Figure 4.2 Perimeter roads and fire trails





## 4.2.3 Location of Asset Protection Zones

### a) Location within Boundaries of the Development

Asset Protection Zones should be located within the boundaries of the development. This principle is particularly important for new subdivision developments. Bushfire protection measures should be contained within the site of the development unless the most unusual circumstances apply. It is not reasonable to place the burden for provision and/or maintenance of the Asset Protection Zone for a development onto other adjacent land management agencies or land owners (e.g. NPWS, neighbouring SEPP 14 landholders).

As a condition of development consent council should ensure that a mechanism is established to allow for the maintenance of Asset Protection Zones over the life of the development. Options include a levy on property owners to fund ongoing maintenance, body corporate or community title schemes and covenants (under s.88B of the Conveyancing Act) at the development stage.

Council may also consider the capacity of landholders (both current and future) to maintain the APZ over the life of the development before approving.

### b) Location on Slopes over 18 Degrees

Asset Protection Zones should not be located on land steeper than 18 degrees as:

- on land steeper than 18° some management practices are impossible, and all become difficult. In addition, the environmental consequences of ground clearing (erosion) may not be acceptable; and
- on steeper slopes the canopy fuels are more readily available to a fire, cancelling out the advantage of having an Outer Protection Area.

Developments abutting such slopes should be located so that both the Asset Protection Zone and the development are not located on slopes steeper than 18°.

Table 4.1  
Minimum Specifications for Asset Protection Zones (APZ) for Residential Purposes in Bushfire-prone Areas

Forests (Grp 1 see Fig.A2.2)		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	20 = 20 + 0
5–0°		30 = 20 + 10
Woodlands, heaths, open scrub (Grp 2 see Fig.A2.2)		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	20 = 20 + 0
5–0°		30 = 20 + 10
>0–5°	Downslope	35 = 25 + 10
>5–10°		40 = 30 + 10
>10–15°		50 = 40 + 10
>15–18°		60 = 50 + 10
Rainforests, grasslands, open woodlands, mallee (Grp3 see Fig.A2.2)		
<i>Minimum separation distance of 20m (cleared/managed vegetation) required regardless of construction level for all slopes. Fire trail recommended.</i>		
Distance in metres. See Appendix 2 to interpret table.		
IPA – Inner Protection Area		
OPA – Outer Protection Area		



## 4.3 ACCESS

Where a bushfire hazard exists on or adjacent to the development site, the following access design criteria need to be applied to the development:

### 4.3.1 Public Roads

#### a) Description:

- These include the perimeter road and the internal road system of any urban subdivision as well as public roads in rural-residential subdivisions.

#### b) Design Criteria:

- Roads should be two-wheel drive, all weather roads;
- Roads should be two-way, that is, at least two traffic lane widths (8m minimum) with shoulders on each side, allowing traffic to pass in opposite directions;
- The perimeter road should be linked to the internal road system at an interval of no greater than 500 metres in urban areas;
- Restrict the use speed humps and chicanes to control traffic;
- Roads should be **through** roads. Dead end roads are not recommended, but if unavoidable, dead ends should be not more than 200m in length, incorporate a minimum 12m radius turning circle, and should be clearly sign posted as dead ends;
- The capacity of road surfaces and bridges should be sufficient to carry fully loaded firefighting vehicles (approximately 28 tonnes or 9 tonnes per axle);
- Curves should have a minimum inner radius of 6m and be minimal in number to allow for rapid access and escape;
- The minimum distance between inner and outer curves should be 6m;
- Maximum grades should not exceed 15° and preferably not more than 10° or gradient specified by road design standards, whichever is the lesser gradient;
- There must be a minimum vertical clearance to a height of 6 metres above the road at all times;

- Roads should provide sufficient width to allow firefighting vehicle crews to work with firefighting equipment about the vehicle.
- Roads should be clearly sign-posted (with easily distinguished names) and buildings should be clearly numbered. Bridges should clearly indicate load rating;
- Roads should have a minimum total reserve width of 20m where they are a perimeter road as defined in section 4.2.2(c) of this document; and
- Roads should not traverse through a wetland or other land potentially subject to periodic inundation.

### 4.3.2 Property Access Roads

#### a) Description:

- Provide access to individual dwellings or groups of dwellings on battleaxe blocks or in lower density developments. They should join directly to the through-road system. These are roads built on private property.

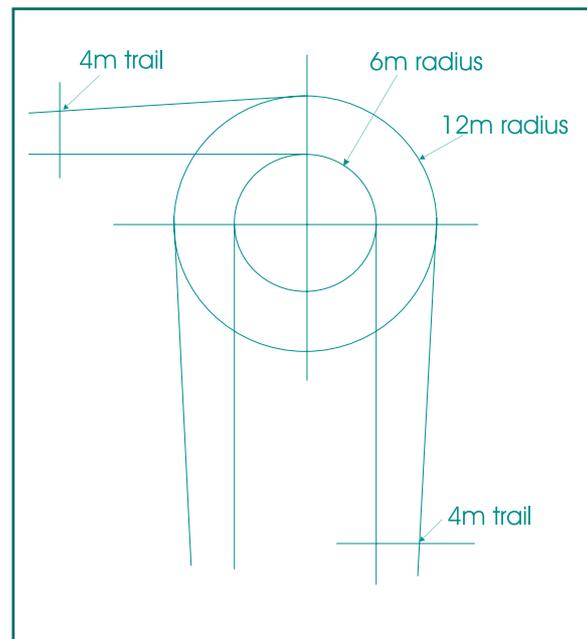


Figure 4.3 Dimensions for inner and outer turning circle radius on trails





## b) Design Criteria:

- A minimum trafficable width of 4m with an additional 1m wide strip on each side of the road kept clear of bushes and long grass.
- The road should have a passing bay about every 200m where possible, which should be 20m long by 3m wide, making a minimum trafficable width of 7m at the passing bay.
- The capacity of road surfaces and bridges should be sufficient to carry fully loaded firefighting vehicles (approximately 28 tonnes or 9 tonnes per axle).
- A minimum vertical clearance of 6m to any overhanging obstructions, including tree branches.
- Curves should have a minimum inner radius of 6m and be minimal in number to allow for rapid access and escape.
- The minimum distance between inner and outer curves should be 6m.
- Maximum grades should not exceed 15° and preferably not more than 10°.
- Roads should provide sufficient width to allow firefighting vehicle crews to work with firefighting equipment about the vehicle.
- Dwellings not sited within 200m of the road system should have an alternative access road providing emergency egress to the through road system; and
- Roads should be clearly sign-posted. Bridges should clearly indicate load rating.

## 4.3.3 Fire Trails

### a) Description:

- Used as access for firefighters, fire control lines and for APZ maintenance.
- In rural residential subdivisions they should surround isolated dwellings or groups of dwellings and can form part of the Inner Protection Area around individual or groups of dwellings.
- In suburban subdivisions they may function as a perimeter road, around the hazard side of the Inner Protection Area, if they are connected to the internal road system at frequent intervals and it is not possible to construct a perimeter road.

### b) Design Criteria:

- Where a fire trail forms part of the Inner Protection Area it must be constructed to the specifications outlined in section 4.2.2(c) of this document.
- A minimum trafficable width of 4m with an additional 1m wide strip on each side of the road kept clear of bushes and long grass.
- A maximum grade of 15°.
- A minimum clearance of 6m to any overhanging obstructions, including tree branches.
- The road should have the capacity for passing either by:
  1. reversing bays using the access to properties to reverse fire tankers, which are 6m wide

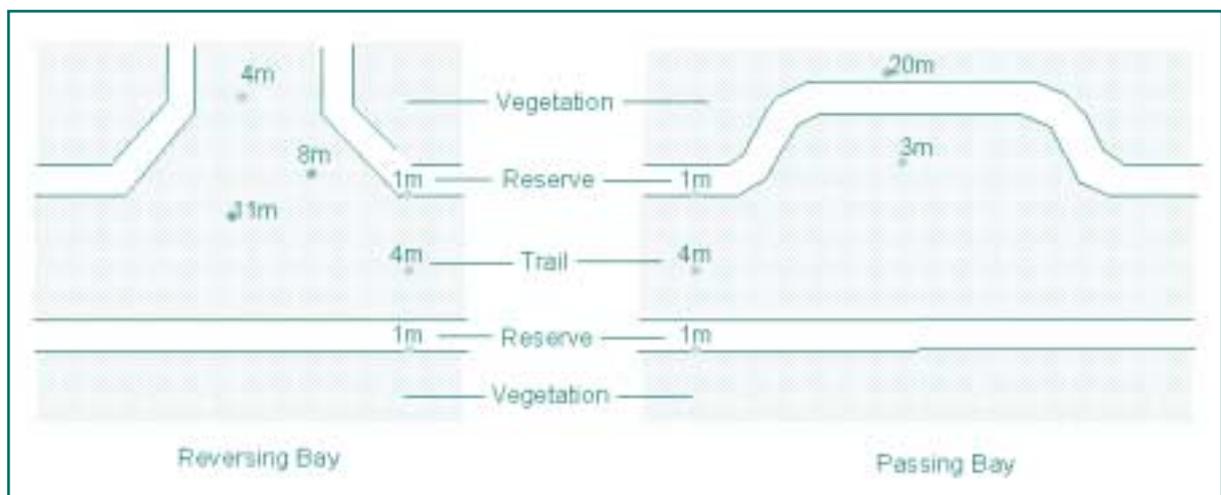


Figure 4.4 Design specifications for passing bays on trails



and 8m deep to any gates with an inner minimum radius of 6 m and outer minimum radius of 12m; and/or

2. a passing bay about every 200m, which is 20m long by 3m wide, making a minimum trafficable width of 7m at the passing bay.

*[(1.) is the preferred option so as to minimise the environmental impacts of fire trails]*

- Appropriate drainage and erosion controls;
- A fire trail system which is connected to the property access road and/or to the through road system at frequent intervals;
- Must be maintained in a serviceable condition by the owner of the land;
- Fire trails should not traverse through a wetlands or other land potentially subject to periodic inundation;
- Must be trafficable under all weather conditions; and
- Trail should be inspected annually by authorities.

At the time of subdivision, if fire trails are part of the development then the fire trails should be under council administration to ensure that maintenance occurs. From time to time this may not be possible in which case they can occur as easements and rights of way over private land.

### 4.3.4 General

The public road system in a bushfire-prone area should provide alternative access or egress for firefighters and residents during a bushfire emergency if part of the road system is cut by fire.

At least one alternative access road needs to be provided for individual dwellings or groups of dwellings more than 200m from a public through road. The routes of these roads should be selected to ensure that both roads are unlikely to be cut by a fire at the same time, to ensure that there is at least one safe evacuation route available at all times.

Short access roads are preferable to long ones for the safety of evacuating residents and emergency service personnel, and therefore it is preferable to site dwellings as close as possible to public through roads.

### 4.4 DESIGN AND STAGING OF THE DEVELOPMENT

Where a bushfire hazard exists on, or adjacent to the development site, the following design and staging issues need to be considered:

- minimise perimeters of urban development to bushfire hazards and design roads to provide direct egress at the shortest distances;
- avoid “hourglass” shapes which maximise perimeters and result in bottlenecks;



Figure 4.5 Relative threat from bushfire according to siting (check local conditions)





- provide accessible refuge areas;
- avoid long and convoluted patterns which can lead to isolation of particular pockets;
- develop in “blocks” rather than as scattered development, minimising internal fuel networks and presenting a line of development to the hazard interface;
- avoid a subdivision pattern which results in narrow streets and battle axe blocks, which create access difficulties during bushfires; and
- expand new developments from the perimeters of existing development.

## 4.5 SITING OF BUILDINGS IN BUSHFIRE-PRONE AREAS

### 4.5.1 Introduction

There are a number of siting principles which need to be applied to individual allotments within a development in areas where a bushfire hazard exists.

In addition to the development application stage, these siting principles need to be taken into account at construction stage, or when rezoning land.

In applying the points outlined below it is important to understand that:

- Where these requirements refer to a particular direction (such as protecting the northern side), it applies only for isolated developments. For larger subdivisions, the importance of these measures is directed toward the side bearing the hazard.
- Although fires may tend to come from a particular direction, local variations are always likely and protection for the southern or eastern side of developments must never be overlooked.

### 4.5.2 Siting Principles

- Avoid ridge tops.
- Avoid steep slopes, particularly upper slopes and narrow ridge crests.
- Avoid locations where adequate Asset Protection Zones cannot be provided within the property or subdivision boundary.
- Locate dwellings where vehicular access from two directions can be provided away from identified hazardous areas.



*Photograph 4.1 Effective bushfire protection measures preserve a rural-residential dwelling.*

- Avoid building at the top of narrow gullies, which are natural chimneys.
- Surround isolated habitable buildings with a wide driveway of gravel, concrete, pavers, etc.
- Avoid building on slopes with a northerly to westerly aspect as these slopes are more prone to bushfires.
- Build on level ground wherever possible.
- Where buildings must be constructed on sloping land, they should be built on cut-in benches rather than elevated or above fill.
- Avoid raised floors in preference to concrete slabs.
- Locate the habitable buildings near the property entrance for easier access/egress.
- Keep services underground, particularly electricity.
- Locate water storage onsite and near buildings.

## 4.6 INFILL DEVELOPMENT.

Infill development is redevelopment in existing areas which may not readily allow for asset protection zones or access provisions to be applied consistent with Planning for Bushfire Protection. These areas may require greater emphasis on construction standards, landscaping, siting and vegetation management practices to ensure improved levels of protection are afforded to the development, its occupants and firefighters.



**HOWEVER**, reliance on construction standards alone will not be adequate to provide appropriate levels of safety for the development and people accessing/egressing the development during a bushfire. Separation of vegetation from the development is considered crucial to meeting the performance criteria for protection of buildings in bushfire-prone areas. Therefore, as a minimum in these areas:-

- an Asset Protection Zone must be maintained between the hazard and the building in accordance with Table 4.1/4.2.

- construction standards must be appropriate to Table A3.3
- where construction standards and/or APZ requirements cannot be met, the applicant will need to consult with the RFS to determine if a more appropriate performance standard can be achieved.
- adequate water facilities must be accessible to firefighting crews.

A minimum requirement for infill development exists only in recognition that previous land-use decisions may make complete compliance with the

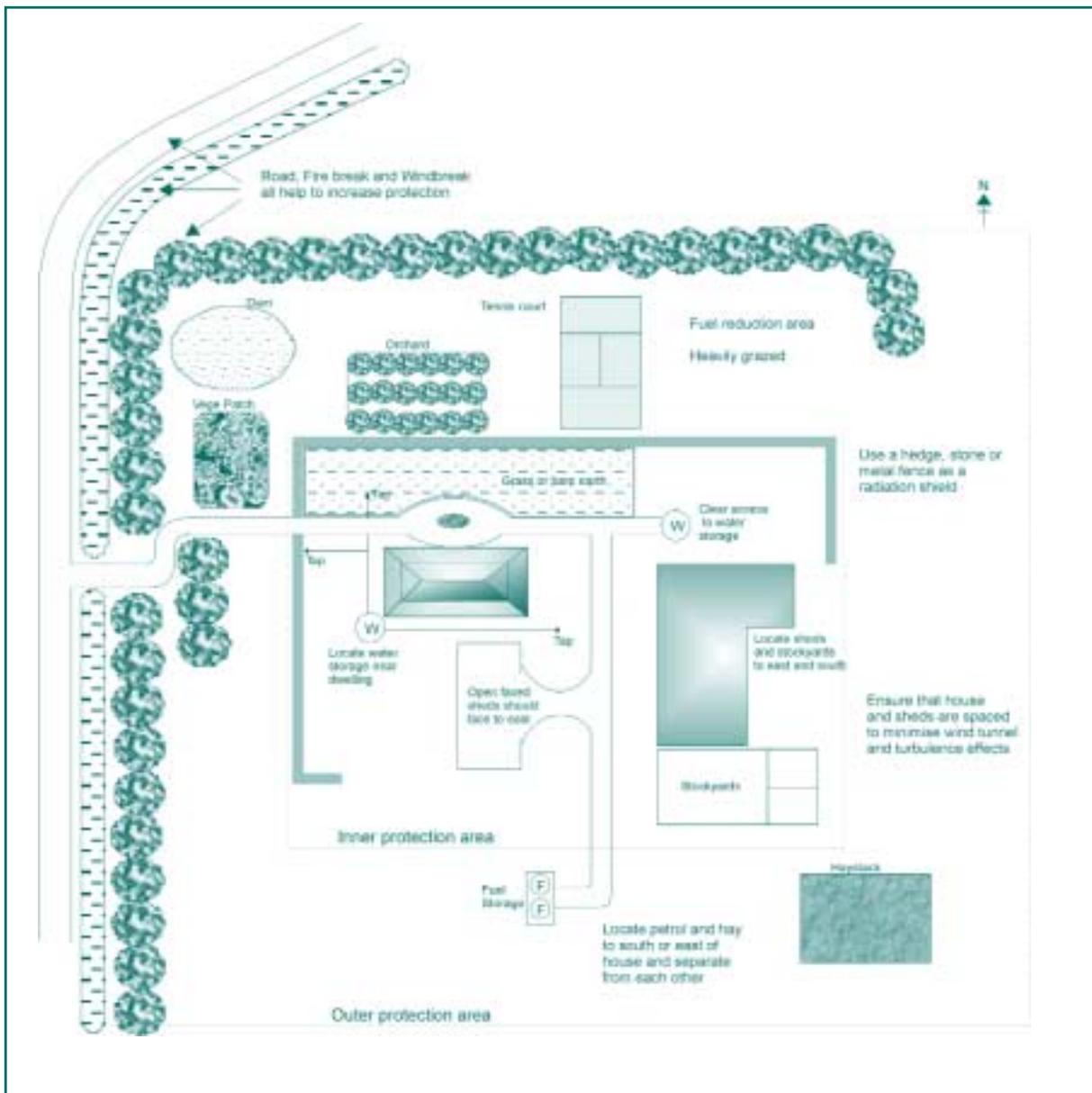


Figure 4.6 Bushfire protection measures for rural residential development





requirements of this document impractical (for example, perimeter roads), yet may still impose an obligation to allow the development to proceed.

However, new developments (not including infill developments) should comply with all of the above performance criteria. All components of these requirements are essential to provide adequate protection for developments and people during a bushfire.

## 4.7 ISOLATED RURAL DEVELOPMENT

Isolated rural developments, particularly in rugged, heavily timbered country pose additional problems in the provision of adequate levels of protection from bushfires. Where developments are located in these areas, occupants may have to travel large distances through bushfire hazards to reach safety of a larger settlement during a bushfire. In addition, the isolation means that if a fire does impact on the development, occupants may also be a long way from firefighting assistance.

Therefore, greater emphasis will need to be placed on:

- provision of safe access/egress to the property so occupants leaving, and firefighters/rescuers accessing the property can do so in relative safety;
- the provision of Asset Protection Zones to create an area where occupants remaining inside will have a good chance of survival; and
- the provision of adequate and independent static water to provide protection arising from ember attack and possible direct flame impingement. Sprinkler systems can be used for additional protection but cannot be relied upon to reduce the need for setbacks or construction standards.

To achieve the required level of protection, static water supplies may need to be extended beyond the specifications recommended in this document. This requirement should be determined depending on the hazard faced and the isolation and access of the development.

## 4.8 RURAL RESIDENTIAL DEVELOPMENT

Councils are encouraged to have a single Asset Protection Zone for rural residential areas. However, the lower densities associated with rural residential developments will mean that provision of a single Asset Protection Zone for the entire subdivision may not always be possible. In these circumstances, the following provisions should be applied:

- Asset Protection Zones around individual, or clusters of buildings.
- A public through road to the new rural residential subdivisions with property access roads joining directly to this road. Refer to section 4.3 for the specifications.
- Consideration should be given to grouping rural residential developments into clusters that allow for establishment of Asset Protection Zones around a group of dwellings rather than having to ensure individual protection for a large number of scattered dwellings.
- The provision of adequate and independent static water supplies where mains water is not available.

## 4.9 STATE ENVIRONMENTAL PLANNING POLICY NO. 15 (RURAL LANDSHARING COMMUNITIES)

Multiple occupancy is permissible under SEPP 15, with council consent, in rural and non-urban zones, subject to a list of criteria in clause 9(1) of the policy. Multiple occupancy is defined as the collective management and sharing of unsubdivided land, facilities and resources. The policy encourages a community-based environmentally sensitive approach to rural settlement and enables pooling of resources to develop communal rural living opportunities.

SEPP 15 developments may include dwellings which will not comply with the construction standards of AS 3959. In recognition of the aims of such development but still maintaining the objectives of this document, at least one building within the development should comply with the separation distances and/or AS 3959 construction standards and the provisions of this document so



that a safe refuge may be provided to residents in the event of a bushfire.

Guidelines associated with SEPP 15 also provide information in relation to the development of fire plans, access arrangements and other provisions related to bushfire matters. These should also be consulted.

## 4.10 CHANGE OF USE

Over time, developments catering for some uses may need to be upgraded, redeveloped or changed in line with changes in socio-economic or demographic factors. Where such changes result in increased densities for residential use or where new structures are to be erected, the provisions of this document should be considered. This could include but is not restricted to, construction standards, setbacks, water supply and access.

Extensions to existing dwellings will need to meet the construction standards set out in Appendix 3.

## 4.11 DEVELOPMENT IN SPLIT ZONINGS

In some cases, a development may be proposed on land with a split zoning (e.g. Rural Residential/ Environmental Protection). Bushfire protection measures may not necessarily be compatible with one of the zones. In these circumstances the APZ should be retained within the compatible zone. If this is not possible, as an absolute minimum, the IPA should be contained within the compatible zone.

## 4.12 SPECIAL PROTECTION DEVELOPMENTS

These are developments that by the nature of their use, present limited mobility issues. In the event of a bushfire these residents may be difficult to evacuate and/or more susceptible to smoke impacts.

### 4.12.1 State Environmental Planning Policy No.5 (Housing for Older People or People with a Disability)

SEPP 5 aims to increase the supply and choice of housing for older people or people with a disability. Such housing is permissible with council consent,

*Table 4.2  
Minimum Specifications for Asset Protection Zones (APZ) for Special Protection Developments in Bushfire-prone Areas*

<b>Forests (Grp 1 see Fig.A2.2)</b>		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	60 = 50 + 10
5-0°		75 = 60 + 15
<b>Woodlands,heaths, open scrub (Grp 2 see Fig.A2.2)</b>		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	30 = 20 + 10
5-0°		40 = 25 + 15
>0-5°	Downslope	50 = 35 + 15
>5-10°		60 = 45 + 15
>10-15°		80 = 65 + 15
>15-18o		100 = 85 + 15
<b>Rainforests, grasslands, open woodlands, mallee (Grp3 see Fig.A2.2)</b>		
<i>Minimum separation distance of 20m (cleared/managed vegetation) required regardless of construction level for all slopes. Fire trail recommended.</i>		
Distance in metres. See Appendix 2 to interpret table.		
IPA – Inner Protection Area		
OPA – Outer Protection Area		

wherever houses, flats, hospitals and special uses are permitted in urban areas or adjoining urban areas, except for some environmentally sensitive lands. The policy contains matters for consideration and development standards to be used by the council in determining development applications.





*Photograph 4.2 While some properties (upper area) appear to have an Asset Protection Zone in place, many (lower area) clearly provide none.*

### 4.12.3 Other Special Protection Developments

The principles adopted for SEPP 5 are also applicable for those developments requiring special protection (such as schools, institutions for mentally and /or physically disabled, residential aged care facilities (nursing homes & hostels), child care facilities and Class 3 buildings under the BCA).

The nature of SEPP 5 development determines that a relatively less mobile residential population is present and as such creates difficulties when evacuation is required. These residents cannot generally be expected to defend the property from bushfire attack.

SEPP 5 specifies that developments for older people or people with a disability can be excluded from lands identified in environmental planning instruments as having a "high bushfire hazard" (or like description). Councils are advised that high hazard areas are a subset of bushfire-prone areas and SEPP 5 exclusion provisions should not be misconstrued as applying to all bushfire-prone areas. However, to reduce the impact of a bushfire event on this type of development habitable buildings must be constructed to the maximum setback identified in Table 4.2 for the relevant vegetation group and slope class. This setback must be maintained regardless of the level of construction applied.

### 4.12.2 State Environmental Planning Policy No.9 (Group Homes)

This SEPP helps to establish permanent and transitional group homes for disabled or socially disadvantaged people in areas where houses or flats are permitted. The policy does not include a building to which SEPP No. 5 – Housing for Older People or People with a Disability applies, or to a transitional group home. The principles adopted for SEPP 5 are also applicable for these developments.



## CONSTRUCTION STANDARDS FOR BUSHFIRE PROTECTION

### 5.1 INTRODUCTION

This chapter provides guidance regarding the design and construction of buildings of Class 1, 2 & 3 of the BCA (see box below) in order to improve their performance when subjected to burning debris or radiant heat generated from a bushfire.

It should be noted however, that the recommended fire-resisting construction measures of AS 3959 only lessen the risk of property damage and hence the risk to life. To provide for an acceptable level of risk these measures should be complimented by the other measures described in this document (e.g. appropriate setbacks from the bushfire hazard, water supply and access).

#### 5.1.1 Relationship to AS 3959 – 1999

AS 3959 currently sets out requirements for the construction of buildings in designated bushfire-prone areas. It is referred to by the BCA as a Standard which is deemed-to-satisfy the Performance Requirements of that Code relating to bushfire protection.

AS 3959 incorporates both construction requirements for various elements of a building and a methodology for determining when those construction requirements should apply.

Feedback however, has revealed that some practitioners have been interpreting the Standard as allowing buildings with no setback from the bushfire hazard. As clearly indicated in this document and as indicated in the foreword to AS 3959, the construction requirements of AS 3959 are only a part of the bushfire protection solution. This is reflected in the fact that AS 3959 forms a part only of the NSW development control system. An assessment of a development application for a building proposal on land likely to be subject to bushfire attack, pursuant to section 79C of the *Environmental Planning and Assessment Act, 1979* should result in the provision of appropriate setbacks and other protection measures in addition to the relevant construction requirements of AS 3959 where necessary.

In order to overcome this interpretation problem and to meet appropriate performance requirements in relation to elements of a building, Appendix 3

provides an improved methodology for determining when the construction requirements of AS 3959 apply. This methodology recognises and incorporates the need for appropriate setbacks from the bushfire hazard.

#### 5.1.2 Basis for Improved Hazard Assessment Methodology

AS 3959 specifies 3 levels of construction for building in designated bushfire-prone areas. The appropriateness of each is relevant to the hazard from bushfire.

As such, this chapter does not aim to duplicate the construction standards contained in Australian Standard (AS) 3959, but interprets the levels of construction appropriate for each type of bushfire attack.

Ideally, a robust hazard assessment for habitable building development must quantify, for different vegetation types, the parameters of fire attack (embers, radiant heat, flame contact and smoke) that damage or destroy houses. This system must relate these parameters to threshold values of vulnerable components of houses (CSIRO, 2000).

Determining appropriate hazard parameters requires measurements or models to describe for:

- components of structures, the threshold values for radiation heat flux and their duration;
- high intensity bushfires, the flame characteristics of temperature, emissivity and hence radiant heat flux at the flame;
- different vegetation types, the flame height and width of flame-front and flame duration for high intensity bushfires as they reach the edge of vegetation; and
- high intensity fires, the value for radiant heat flux as a function of distance from walls of flame of different dimensions. (see CSIRO, 2000, p6.)

In 2000, the RFS engaged the CSIRO to develop a suitable model which related hazard parameters to various building components. This model has been used as a basis for developing Table A3.3 in Appendix 3. This table can and should be used for determining the likely mode of bushfire attack on a





building and hence which level of construction from AS 3959 is appropriate in the particular circumstances.

Table A3.3 is based on heat flux derived for 13 vegetation types, 6 slope classes and a 1:50 year fire weather conditions (taken as FDI = 80 as a worst case default) based on the CSIRO estimates and applied to different building components.

At radiant heat flux levels of approximately 14.5 – 16 kWm<sup>2</sup>, unscreened windows will shatter and allow heat and embers to enter the building leading to a building fire. At 21 kWm<sup>2</sup> screened windows will fail. At levels of 31 kWm<sup>2</sup> fascia board and other timber will ignite after a short period of exposure.

To illustrate the principles involved, a bushfire of 80,000 kW/m was derived for unmanaged forest fuels on flat ground at an FDI of 80. The difference between the curves in Fig. 5.1 illustrates the effect of wind on flame length (15m) and radiant heat.

This difference can be used to determine the OPA and IPA distances for setback purposes at each

construction level identified in AS 3959. The CSIRO model provides a minimum IPA separation of 20, 30 and 40 metres for Levels 3, 2 and 1 construction respectively (see Table 5.1) under AS 3959 with a 10 metre OPA.

The distances used in Table A3.3 in Appendix 3, can also be used to interpret AS 3959 and can be considered on the basis of the various elements of a building when subject to heat, flames and ember attack. Extensive ember attack can occur beyond 100 metres ahead of a bushfire.

A robust assessment framework allows for development of the system and offers practical options for combinations of distance and construction standard (CSIRO, 2000). The RFS framework provides the flexibility required to facilitate progressive, safe development.

Clearly, it is not acceptable to neglect bushfire provisions at subdivision and LEP stage with the aim of relying on construction standards to provide protection from bushfires. Asset Protection Zones, designed to separate the hazard from the

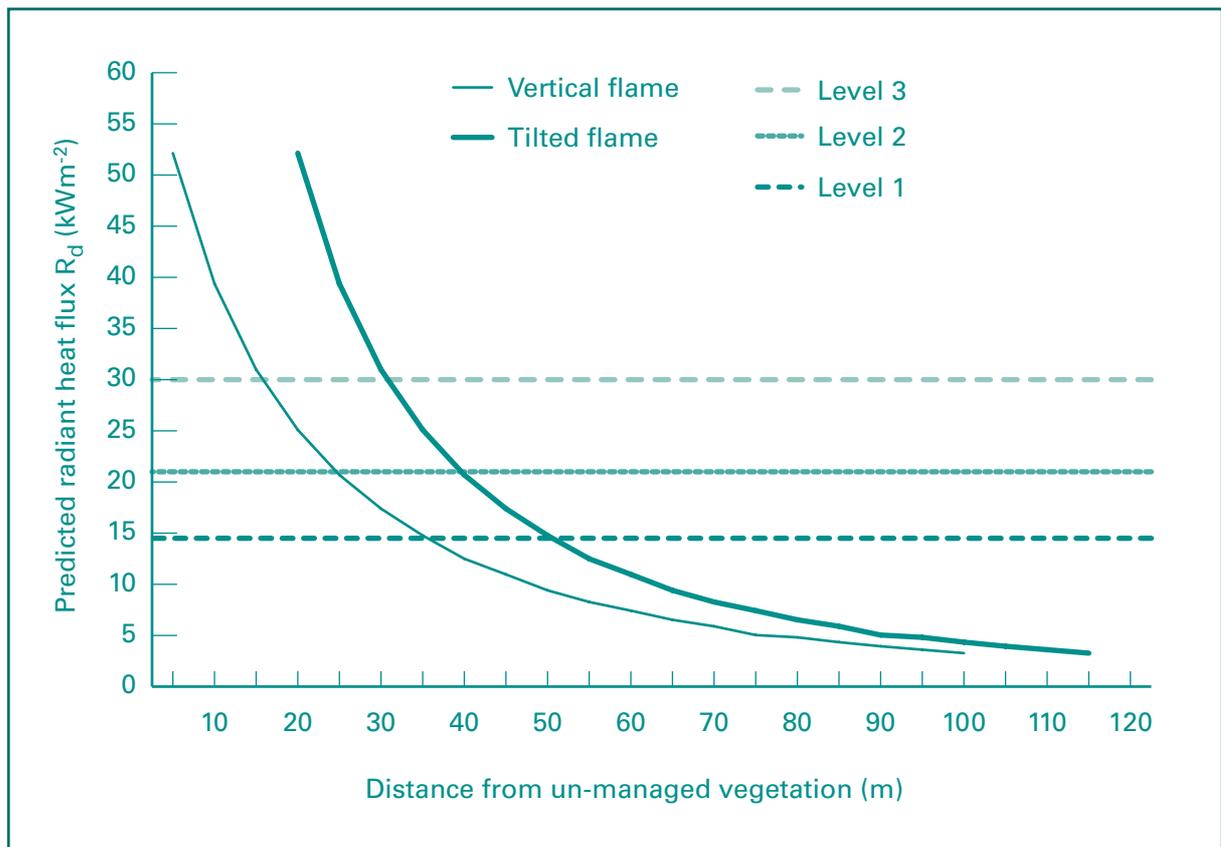


Figure 5.1 Radiant heat modeled for a forest fire of 80,000kW/m upon level 1, 2 and 3 construction AS 3959 – 1999.



*Table 5.1 Radiant heat flux and effects on buildings and people for a forest fire on flat ground of 80,000 kWm<sup>-2</sup> intensity and flame length of 15 metres (Haddad, 1982 & CSIRO, 2000)*

Radiant heat flux	Effect	IPA distances
80 kWm <sup>-2</sup>	Edge of Flame	0 metres
31 kWm <sup>-2</sup>	Ignition of hardwood timber (up to 4 minutes) (Level 3 construction)	20 metres
21 kWm <sup>-2</sup>	Screened windows fail (approx. 2 minutes) (Level 2 construction) 100% Fatal after short period.	30 metres
16 – 14.5 kWm <sup>-2</sup>	Unscreened windows fail (approx 2 minutes) (Level 1 construction) 20% fatality after 1 minute	40 metres
13 kWm <sup>-2</sup>	Timber ignites (piloted)	40 metres
7 kWm <sup>-2</sup>	Firefighter in protective equipment will feel pain (90 seconds)	100 metres
2.1 kWm <sup>-2</sup>	Unprotected person will suffer pain after 1 minute. Is not fatal	140 metres

development, and adequate access provisions must be incorporated at development application stage for all new developments.

For existing subdivisions, where bushfire protection provisions were not incorporated at the development application stage, it may not be possible to achieve an Asset Protection Zone (or equivalent\*) of the required width between the building site and the bushfire hazard at construction stage. Infill development in these areas therefore poses some difficulties. Higher levels of construction standards will be needed in these circumstances. The decision to grant approval to build in these circumstances should be made on the basis of the objectives of this document, one of which is to maximise the level of protection for buildings and people accessing or leaving the building during a bushfire.

There may be situations where a combination of poor access, rugged topography, remote location and an inability to provide an adequate Asset Protection Zone would pose an unacceptable bushfire risk, even if the building was constructed in accordance with the strictest construction standards. In these cases, there are strong arguments for refusal of the development application.

\* In this situation, an equivalent to an Asset Protection Zone is when the building will be separated from the bushfire hazard by other development (maintained in a fuel free condition) with a separation distance greater than or equal to the distance which would have been occupied by an Asset Protection Zone, if the development had been established under the provisions of Appendix 2 of this document.

## 5.2 IDENTIFICATION OF AREAS WHERE AS 3959 CONSTRUCTION STANDARDS SHOULD APPLY

AS 3959 provides the minimum requirements for construction and applies in designated bushfire-prone areas.

This document recommends use of the bush fire risk management maps of an area to determine designated bushfire-prone areas. That is, those areas generally where any high or medium bushfire hazard is found to exist on, or within 100m or on or within 30 metres of a low hazard of the building site.





In a practical sense, areas identified by council as being predominantly grasslands can be readily managed and as such are also not to be considered to be bushfire-prone.

In measuring this 100m, where an Asset Protection Zone exists, the Outer Protection Area is still considered to be part of the bushfire hazard. Therefore, the relevant distances are to be measured from the boundary between the dwelling and the Outer Protection Area.

If no Asset Protection Zone exists, the specified distance is to be measured from the boundary between the bushfire hazard and a development where the vegetation is maintained in a fuel free condition.

An area is described as having a “fuel free condition” where the vegetation is maintained to the standard required in an Inner Protection Area, as established in Section 4.2 of this document.

Generally, no bushfire construction requirements apply to any proposed building located more than 100m away from a high bushfire hazard.

## CLASSIFICATION OF BUILDINGS AND STRUCTURES ADDRESSED IN PLANNING FOR BUSHFIRE PROTECTION

### 1 Principles of classification

*The classification of a building or part of a building is determined by the purpose for which it is designed, constructed or adapted to be used.*

### 2 Classifications

Buildings are classified as follows:

**Class 1:** one or more buildings which in association constitute-

- a) **Class 1a** – a single dwelling being –
  - i. a detached house; or
  - ii. one or more attached dwellings, each being a building, separated by a *fire-resisting wall*, including a row house, terrace house, town house or villa unit; or
- b) **Class 1b** – a boarding-house, guest house, hostel or the like with a total *floor area* not exceeding 300 m<sup>2</sup> and in which not more than 12 persons would ordinarily be resident,
 

Which is not located above or below another dwelling or another Class of building other than a private garage.

**Class 2:** a building containing 2 or more *sole-occupancy units* each being a separate dwelling.

**Class 3:** a residential building, other than a building of Class 1 or 2, which is a common place of long term or transient living for a number of unrelated persons, including-

- a) A boarding-house, guest house, hostel, lodging-house or backpackers accommodation; or
- b) A residential part of an hotel or motel; or
- c) A residential part of a school; or
- d) Accommodation for the aged, disabled or children; or
- e) A residential part of a health-care building which accommodates members of staff; or
- f) A residential part of a detention centre.

Adapted from Building Code of Australia, 1996 Volume One, Part A3



Where an area is identified as bushfire-prone, the assessment detailed in Appendix 2 will need to be employed to determine whether the construction standards of AS 3959 need to be applied.

AS 3959 provisions do not encompass garage doors other than as normal personal access doors such as between garage and dwelling or rear/side access. Larger garage doors can provide opportunities for ember attack during a bushfire event and require attention.

### 5.3 CONSTRUCTION STANDARDS FOR BUILDINGS LOCATED WITHIN BUSHFIRE-PRONE AREAS

Level 1 construction standards should apply if the proposed building is located within the specified distances (Table A3.3) **for Medium Bushfire Attack**.

Level 2 construction standards should apply if the proposed building is located within the specified distances (Table A3.3) **for High Bushfire Attack**.

Level 3 construction standards should apply if the proposed building is located within the specified distances (Table A3.3) **for Extreme Bushfire**.

Construction should not proceed where the building has been identified as being at **'unacceptable risk'** because of any of the following:

- flame impingement will result in insufficient "safe" space to defend the structure. These areas are identified as being within the **"Flame Zone"** in Table A3.3;
- there is no safe escape route for the building occupants and firefighters likely to be involved in protecting the building and its occupants during a bushfire.

In new residential developments, adequate Asset Protection Zones in Table 4.1 should be established as a minimum at the subdivision development application stage, so that at construction stage the appropriate level of construction can then be applied. Table 4.2 should be used for special protection developments.

Each of the above standards is also dependent on the maintenance of vegetation to suitable fuel loadings as identified within Chapter 4.





## PREPARING FOR BUSHFIRES AND MAINTENANCE

### 6.1 INTRODUCTION

Whether or not a house survives a bushfire ultimately depends on the householder. Planning provisions do not provide extensive protection from even severe bushfires but their benefits are hampered when they are not maintained. Some maintenance depends upon adjoining neighbours and some depends on fuel management in adjacent bush land areas by the local councils or fire authorities, but general housekeeping and maintenance of the grounds by the housekeeper is equally important and, in some cases, may even be more so.

**It is too late to undertake general housekeeping when a bushfire approaches – do it early and keep it up!**

In ensuring that the house and its occupants are prepared for bushfire events, three areas to be addressed are:

1. the management of vegetation in the house surrounds, including any Asset Protection Zones;
2. the provision of adequate services including an independent water supply; and
3. personal safety and survival during the fire event.

Experience from Ash Wednesday and fires at Menai all suggest that house losses are greatest in the area up to 180 metres from the bush interface. Distances of less than 100 metres are particularly vulnerable to radiant heat and ember attack. Hence it is within this distance that efforts should be made to prepare for the onslaught of major bushfire events.

While other legislation provides the impetus for planning objectives, the *Rural Fires Act 1997* provides the legislative vehicle to achieve bushfire management objectives.

### 6.2 VEGETATION MANAGEMENT

Where Asset Protection Zones have been incorporated as part of the development approval for subdivision or for dwelling construction, the environmental aspects of the development should have already been taken into account.

In general, it is expected that Asset Protection Zones will be maintained by the owner of the land including maintenance of any fire trail constructed as part of the development.

It is accepted practice that after construction of a dwelling, gardens will be established and landscaping of the grounds will be undertaken. It is essential that efforts to reduce fuels on adjoining properties are therefore not negated by actions within the immediate curtilage of the building.

#### 6.2.1 Design Criteria

To produce a garden that does not contribute to the spread of bushfires, it is necessary to plan the layout of the garden beds and take an active decision to minimise certain features in favour of other features:

- maintain a clear area of low cut lawn adjacent to the house;
- keep areas under fences, fence posts and gates and trees raked and cleared of fuel;
- plant trees and shrubs such that:
  - the branches will not overhang the roof;
  - the tree canopy is not continuous; and
  - there is a windbreak in the direction from which fires are likely to approach.
- clear all gutters and roof gullies of leaves and keep them cleared;



*Photograph 6.1 Maintain the property to ensure the efficiency of an APZ.*



- keep a low risk garden:
  - with all woodpiles kept at least downhill (burning logs can roll downhill) and well away from the house – preferably kept under cover;
  - of densely foliated deciduous or fire resistant evergreen trees;
  - with trees in clumps not continuous rows;
  - of short, green, well watered lawns where twigs and leaves are regularly raked;
  - containing smooth barked rather than rough barked trees; and
  - with minimum areas of mulch and well watered garden areas.

## 6.2.2 Selection Criteria

While the design of the garden is important, so too is the type of plant species selected. No plant is fireproof. Many plants however, have features that minimise the extent to which they contribute to the spread of bushfires.

Beware of trees with dense crowns that hold dead foliage. Use smooth bark trees in preference to rough or ribbon bark trees that provide a fuel ladder into the crown.

When choosing plants, be sure not to introduce weed species into an area. Fire events may provide the opportunity for weed species to spread and may contribute fuel to an area of otherwise lower fuel loads.

Contact local councils, plant nurseries and plant societies to determine appropriate species for your area.

## 6.2.3 Trees as Firebreaks

The use of trees as windbreaks is a common practice but trees also provide a more than useful firebreak, trapping embers and flying debris, which would otherwise reach the house.

The tree crown will rarely carry fire without a significant fuel loading on the ground.

By reducing the wind speed, a row of trees also slows the rate of spread of a bushfire and a dense foliage traps radiant heat, lowering bushfire intensity.

Because of the effect of turbulence, a balance has to be struck between a high density of trees (that maximises the trapping of embers and radiant heat but also maximises turbulence) and a lower density (that lets more embers and radiant heat pass through but minimises turbulence). A windbreak that allows 50–60% of the wind to pass through is ideal.

To be effective a windbreak/firebreak must:

- be located on the side of the lot from which fire weather normally approaches
- be of sufficient length (generally 100 metres minimum length)
- be located at a distance of 1 to 3 times the height of fully grown trees but not within the IPA
- uses smooth barked eucalypts or deciduous trees
- make sure there are no breaks of sufficient size to allow winds to funnel through



Figure 6.1 Windbreaks act as filters to ember attack

## 6.2.4 Hazard Reduction and the Rural Fires Act

The *Rural Fires Act 1997* (RF Act) was enacted to establish the NSW Rural Fire Service and define its functions; to make provision for the prevention, mitigation and suppression of rural fires.

Vegetation management may require hazard reduction techniques to reduce fuel loads and limit the paths available to the passage of a bushfire event. Techniques available for bushfire hazard reduction works include;

- Mechanical slashing; and
- Hazard reduction burns.





Hazard reduction burning is currently viewed as the most economically viable and effective method of reducing bushfire hazards for larger areas. However, a major environmental disadvantage of this method is its potential to produce large quantities of smoke and ash.

The *Protection of the Environment Operations (Control of Burning) Regulation 2000* clearly allows hazard reduction burning as permitted by the RF Act. Although **section 133** of the *Protection of the Environment Operations Act, 1997* allows the EPA to ban hazard reduction burns on certain days, the legislation is intended not to reduce the amount of hazard reduction burning carried out, but to make sure it is scheduled to coincide with meteorological conditions favouring pollutant dispersion rather than accumulation. The EPA acknowledges that hazard reduction burning is an essential bushfire prevention measure. Consequently, it bans burning only when absolutely essential and in only those locations where smoke could affect major metropolitan areas.

**Further information regarding hazard reduction burning can be found in *Guidelines to the Regulation of Open Burning in NSW*, produced by the NSW RFS in collaboration with the EPA.**

**Section 63** of the RF Act describes the requirement for all public authorities, landowners and occupiers to accept a duty to prevent the occurrence and to minimise the spread of bushfires within their property.

The land manager is required to take steps necessary to achieve these ends and is liable for costs incurred. These steps include immediately extinguishing fires where practicable and or notifying the nearest appropriate officer (as defined in the Act) which will generally be a firefighting authority such as the RFS or NSW Fire Brigades.

A local Bush Fire Risk Management Plan should set out the steps to be taken in managing the bushfire hazard on the property under s.63.

**Section 66** of the RF Act provides for the management of bushfire hazards on private lands through the issuing of notices by local councils.

These notices require the landowner or occupier to conduct bushfire hazard reduction works in a

particular manner, under certain conditions and at a determined time as specified in the notice.

A local authority must serve a notice under this section if required to do so by a Bush Fire Risk Management Plan applicable to the land.

A person to whom a notice under **section 66** of the RF Act has been issued has the right of objection to the notice (**section 67**). The grounds for objection are that the vegetation to be hazard reduced is required for one or more of the following purposes:

- a) shelter, shade, windbreak or fodder purposes;
- b) protection of threatened species, populations, communities or critical habitat under the *Threatened Species Conservation Act, 1995*;
- c) it is not required by a bushfire risk management plan and does not constitute a risk; and
- d) the proper needs for conservation

**Section 68** allows a person who has objected to a notice, a right of appeal to the Commissioner of the NSW Rural Fire Service within 14 days of the determination of the council, or if the council has failed to confirm, vary or revoke the notice.

**Section 70** of the RF Act, permits a local authority to undertake the bushfire hazard reduction works if the owner/occupier fails to carry out the work within the specified time and allows council to recover the cost of the works from the owner/occupier.

## 6.3 RADIANT HEAT BARRIERS

Radiant heat barriers act to absorb and/or deflect radiant energy from a bushfire source that would otherwise be absorbed by a building surface. The barrier should be located between the hazard and the building and is most effective when sited close to the building. The provision of a heat barrier in most situations can only provide limited protection from radiant heat to windows and generally should not be relied upon to reduce the need for setbacks or construction standards.

Barriers may be best formed using masonry walls (steel or Colorbond fences should be limited to grassland situations if other types are considered inappropriate).



In many cases, these barriers may be incorporated into the building design as a courtyard or fenced off area for gardens, BBQ areas and the like. Areas within courtyards should be maintained free of fallen leaves or dried vegetation matter.

A major limitation for heat barriers is that they are less effective for forest and woodland (Vegetation Groups 1 & 2) situations where flame heights can be anticipated to be larger than for grasslands, however they may be suitable in situations involving some coastal wetland vegetation (e.g. low wet heaths). They are particularly suitable for grassland and other Group 3 vegetation situations and in such situations may be used as fencelines for new urban developments adjacent to improved pasture or native grasslands. Heat barriers are unlikely to be effective against burning embers.

The installation of a fence would not be considered to provide suitable protection (as a heat barrier) if the neighbouring vegetation is a forest (of any slope) or where significant free standing vegetation is located upslope of the dwelling. As such, they should be located within about 5m of the house and should be up to 2m high to cover most windows and doors on the side facing the bushfire hazard.

## 6.4 SERVICE SUPPLY

During major bushfire events, the protection and preparedness of the dwelling and its occupants may be seriously jeopardised with the loss of basic services.

As part of the development consent process for the construction of a dwelling, it may be necessary to specify the provision of certain services. The provision of an adequate water supply and the installation of a sprinkler system is of particular importance.

### 6.4.1 Electricity

Where possible electrical transmission lines should be underground.

Where overhead electrical transmission lines are installed:

- lines should be installed with short pole spacing, unless crossing gullies, gorges or riparian areas
- no part of a tree should be closer to a power line than the distance set out in Appendix 4. Regular

inspection of lines is required to ensure they are not fouled by branches

### 6.4.2 Gas

Reticulated or bottled gas shall be installed and maintained in accordance with AS1596 and the requirements of relevant authorities;

Larger gas cylinders should be kept clear of all flammable materials;

If gas cylinders need to be kept close to the building, the release valve must be directed away from the building and away from any hazardous materials such as firewood, so that it does not act as a catalyst to combustion.

### 6.4.3 Water Supplies (i.e. where a mains supply is not guaranteed)

Maintaining a water supply for firefighting purposes provides protection in three ways:

- connection to hand-held hoses;
- connection to sprinkler systems; and
- water replenishment for firefighting tankers.

As a protective measure, connection to hand-held hoses, sprinkler systems and water replenishment to firefighting vehicles are considered to be an **active** measure (someone, generally, must be present to utilise the system).

They must be considered as additional, rather than an alternative to other bushfire protection measures. The determination of a guaranteed water supply is one that can only be made by the water supply authority where mains water supply is available.

**It is common during major fire events for the supply of mains water pressure to drop significantly, preventing adequate protection.**

#### a) Urban Subdivisions

The water supply to the perimeter road should be delivered by a ring main system.

Fire hydrants must be accessible and located such that a tanker can park within a distance serviceable by a 20m hose and the habitable building must be located such that a fire at the furthest extreme can be attacked by the tanker using a 60m hose and 10m jet of water. A clear unobstructed path between the hydrant and most distant point of the building





cannot exceed 90m allowing for the tanker to be parked in line. Obstructions to the path will reduce the distances. Australian Standard 2419.1 – 1994 details the location of external fire hydrants.

If the building is located such that the distances do not comply with AS 2419 for the location of hydrants, then a static supply of water (5000 litres minimum), or an additional hydrant must be supplied.

In major bushfires there is a possibility that the mains water supply will fail due to excessive demand. The installation of a water supply independent of the mains system on properties along the hazard interface is recommended.

### ***b) Rural-Residential and Rural Developments***

All rural-residential and rural developments in bushfire-prone areas must maintain a water supply reserve dedicated to firefighting purposes. The supply of water can be an amalgam of minimum quantities for each lot in the subdivision, or held individually on each lot.

In planning a water supply for firefighting purposes, a number of factors must be taken into account:

- 10,000 litres will fill three tankers or provide sufficient water to protect a house using hoses.
- 22,000 litres should supply an average sprinkler system. However, manufacturers advice should be sought to determine the volume of water required by the sprinkler system being installed to provide protection for a length of time.
- A suitable connection for RFS purposes must be made available. In general a 65mm Storz outlet with a Gate or Ball valve should be provided (contact local RFS to confirm local requirements).
- Underground tanks with an access hole of 200mm will allow tankers to refill direct from the tank.
- Raised tanks should have their stands protected.

### ***c) Pumps***

Water should be gravity fed or supplied by a diesel or petrol powered pump that is not dependent on mains electrical supply (that may be cut off to protect firefighters during fire operations).

It is generally considered that 3kW (5hp) pumps are adequate for protection of a single dwelling using one or two short hose lines.

### ***d) Taps and Pipes and Hoses***

Taps and pipes should be 19mm diameter for adequate water flow.

Taps should be located away from buildings to avoid heat if the building catches fire.

Taps and fittings should be metal rather than plastic.

Use rubber hoses rather than plastic and store inside while the fire front passes.

Several hoses should be used to reach the areas to be protected.

### **6.4.4 Sprinkler Systems**

The NSW Rural Fire Service does not currently advocate the inclusion of sprinkler systems in construction standards due to the limited research available to substantiate the effectiveness of these systems as protection during a severe bushfire event.

Concerns exist relating to:

- the construction materials used in sprinkler systems;
- the maintenance of systems;
- water consumption rates;
- water pressure levels;
- spray dispersal; and
- automation.

Sprinklers can be a valuable additional bushfire protection measure, but are not an alternative to passive fire protection measures. Where installed:

- roof mounted sprinklers must direct their spray at the roof above the gutter and at the sides of the house. In the high winds that nearly always accompany bushfires, roof mounted sprinklers may have most of their spray blown away unless they are directed and located properly;
- sprays directed at or from the ridge of the roof are largely carried away by even moderate winds;
- sprays must overlap around the roof;



- use metal pipes, buried in the ground to 300mm minimum;
- ground sprinklers should be fixed metal risers;
- butterfly sprays are all metal, easy to operate and trouble free;
- twin-jet impact-drive sprinklers are preferred for ground-based sprinklers.

In areas subject to frequent bushfires or having a regular history of bushfire activity, the use of sprinkler systems as an additional protection measure is appropriate. Sprinkler systems are then likely to be more effective in these circumstances from a cost/benefit of use basis when effectively installed and regularly maintained.

## 6.5 PERSONAL SAFETY AND SURVIVAL

The survivability of a dwelling and its occupants is dependent upon the amount of preparation prior to the actual fire event. Preparation not only includes the maintenance of lawns and gardens but also the preparation of those who may be caught in a wild fire event. Bushfires are chaotic, noisy and frightening experiences and only those who are capable of working quickly before, during and after the firefront has passed should stay behind to effect protection measures.

### 6.5.1 As the Bushfire Approaches

#### *a) Personal Protection.*

Before you can confront an oncoming bushfire, it is important that you protect yourself from radiant heat. This can be assisted by wearing:

- cotton overalls or thicker long sleeved shirt and long pants of cotton or wool
- clothes which are loose fitting
- a strong pair of shoes or boots with woollen or cotton socks
- gloves, if your hands are not used to working with tools
- goggles, if the smoke is thick
- a “bandana” or large handkerchief to protect the airways from smoke and hot air;

- a wide-brimmed hat or hard hat if one is available; but
- leave your ears uncovered – they warn you of heat levels.

**Do Not Wear Synthetics – Wear Wool, Cotton or Denim.**

#### *b) Protection of Children, Elderly and Pets*

During the approach of a bushfire:

- keep children, elderly and pets inside the house;
- give them plenty of water to drink; and
- make sure you keep track of their movements.

#### *c) Outside the Home*

- close windows and doors and any shutters and fit any screens
- block the downpipes and fill them with water
- put doormats inside
- store all combustible furniture and awnings
- wet down wood piles and areas of garden mulch.

#### *d) Inside the Home*

- fill all sinks, baths and any buckets with water and put a filled bucket in the roof
- block any gaps under the doors with wet towels
- place a ladder to provide access to the roof area
- monitor the radio – keep a spare set of batteries
- turn off any gas.

#### *e) The car*

- park in a cleared area
- close all doors, windows and vents
- leave the keys in the ignition
- store woollen blankets inside

### 6.5.2 When the Bushfire is Close

- remain outside as long as possible patrolling the area for spot fires
- suppress any spot fires which start close to the house or in the guttering





*Photograph 6.2 Hazard reduction works can reduce the fine fuels and limit the progress of a bushfire.*

- take refuge when the smoke starts to thicken
- take your hoses and fittings inside when you move inside
- activate any sprinkler system

### 6.5.3 As the Bushfire Passes Over

Remain calm and keep other occupants calm.

Move to the side of the house away from the main firefront.

Carry out regular inspections, particularly of windows to determine if they have shattered and embers have entered any rooms.

### 6.5.4 After the Bushfire has Passed

Before passing through a closed doorway, feel the door – if it is hot do not open it as there may be a fire on the other side – leave it closed to stop the fire spreading and exit via another route.

Check the house for fires – the roof, roof spaces and any underfloor areas.

If the house is on fire move onto burntout ground but keep clear of burning trees.

### 6.5.5 Evacuation

The decision to evacuate or stay in the event of a major bushfire is not an easy one to answer. Research from Ash Wednesday and other major fires show that where people are in attendance and well prepared then dwellings are more likely to survive a

bushfire. Early evacuation is a serious consideration where:

- you are not confident that your house is prepared to withstand a bushfire;
- you are worried about your children or elderly members of the household;
- you suspect that you or members of the household will be unable to cope with the stress of staying;
- it is safe to leave and you have a clear idea of where a safe refuge is to be found; and
- you know the destination to be safe.

**Note: you must evacuate if directed to do so by the Police.**

If you do decide or are directed to evacuate:

- DO IT EARLY
- close all doors and windows and consider leaving them unlocked – a firefighter may need access to your home
- know where you are going
- drive carefully

**Note: during a major bushfire emergency, the chances of a firefighting appliance being available to protect every residence is very remote.**



## SAMPLE DEVELOPMENT CONTROL PLAN PROVISIONS FOR SUBDIVISION IN BUSHFIRE-PRONE AREAS

### OBJECTIVES

- To ensure that all new allotments have measures sufficient to minimise the impact of bushfires
- To minimise the impact of fire protection measures on vegetation, fauna, views, watercourses and so erosion, amenity and access
- To identify the potential bushfire threats to individual sites
- To reduce the risk to property and the community from bushfire
- To ensure that bushfire protection is afforded to all new allotments and likely future improvements.

### 1 PERFORMANCE STANDARDS

- 1.1 A bushfire threat assessment must form part of all development applications for subdivision. The threat assessment is an integral part of the subdivision design, and affects lot shape, size, orientation, and road layout. Bushfire protection measures have the potential to affect vegetation, fauna, views watercourses, soil erosion, amenity and access.
- 1.2 Assessment of threat from bushfire must examine impacts of the proposal both within and external to the site, including the capacity of the existing road network serving the site to accommodate traffic in emergency situations.
- 1.3 Preparation of an assessment of threat from bushfire should include reference to:
  - NSW Rural Fire Service (RFS) – Planning for Bushfire Protection – a guide for land use planners, fire authorities, developers and home owners
  - Consultation with Council and RFS staff
- 1.4 Fire protection measures must be capable of being maintained by owners and users.

- 1.5 Asset Protection Zones must be contained wholly within the subject site, and may incorporate fire trails, perimeter roads, cleared road verges and fixed building lines.
- 1.6 The subdivision design must provide adequate emergency vehicle access to those parts of the site fronting a potential bushfire source.
- 1.7 In instances where the balance between bushfire protection and environmental and social impact cannot be achieved, the proposal may not be supported.

### 2 CONTROLS

- 2.1 Asset Protection Zones
  - 2.1.1 The Asset Protection Zones are to be placed wholly within the subdivision they are intended to protect.
  - 2.1.2 The Asset Protection Zones are to be placed as restrictions on the burdened allotments. No habitable or storage structures are permitted within those zones.
  - 2.1.3 Asset Protection Zones. Fire Trails and Perimeter Roads are not acceptable on land which is considered environmentally sensitive.
  - 2.1.4 Hazard reduction within the Asset Protection Zone is to be carried out so as to minimise site disturbance. Where necessary, reduction is to be carried out by hand with trees being felled rather than pushed over.
- 2.2 Perimeter Roads
  - 2.2.1 Perimeter roads in subdivisions are to have the following minimum specifications:
    - 5.5m wide seal,
    - vertical kerb and gutter on the fire source side of the road,
    - roll top kerb and gutter on the development side of the road,
    - 1 metre wide mountable verge,





- have adequate turning facilities for emergency vehicles.

- 2.2.2 Long “dead end” sections of road are not acceptable.
- 2.2.3 The location of hydrants are to be delineated by blue pavement markers in the centre of the road.

## 2.3 Fire Trails

- 2.3.1 Where a fire trail is located on private land, a 6m wide right of carriageway shall be centrally located over the fire trail.
- 2.3.2 Where a fire trail crosses common boundaries between allotments, a gate or barrier with a Council approved lock will be required.
- 2.3.3 In residential zones, fire trails are to be a minimum of 6 metres wide, free of overhanging barriers and be constructed from reinforced concrete and have a dark oxide finish. The maximum longitudinal grade of fire trails is 15°.
- 2.3.4 Mountable verges are to be stabilised and free of overhanging branches
- 2.3.5 Passing bays should be provided at regular intervals of 200 metres (minimum).

## 2.4 Battle axe allotments

- 2.4.1 Battle-axe shaped allotments, where the access handles are in excess of 30m in length, are to have hydrants located at the end of the access handle

## 2.5 Restrictions on Titles

- 2.5.1 To ensure effectiveness of the fire protection measures, restrictions may be placed upon the titles of the affected lots. These restrictions may relate to:-
- habitable and storage structures being excluded from within the Fire Protection Zone
  - level at which the fuel loading is to be maintained within the Fire Protection Zone
  - responsibility for and nature of maintenance of fire trail, hazard reduction and Fire Protection Zone

## 2.6 Section 94 Contributions

- 2.6.1 Council has established a Section 94 Development Contributions Plan that requires a contribution for bushfire fighting equipment and facilities in addition to the specific protections incorporated in the subdivision.

(adapted from Blue Mountains DCP 27, adopted 22/02/98).



## BUSHFIRE PROTECTION ASSESSMENT FOR RESIDENTIAL PURPOSES

### A2.1 INTRODUCTION

This section sets the methodology for bushfire assessment of precincts or individual allotments for residential purposes.

This assessment will determine the minimum setbacks required for habitable buildings in developments for residential purposes that are designated as bushfire-prone.

#### A2.1.1 Bushfire Theory

Heat intensity is a measure of the rate of energy release by a fire (in kW m<sup>-1</sup>) and bears a close relationship to available fuels. Available fuels for consumption by bushfire depend on size and/or surface area of the fuel and its moisture content as moisture will absorb a portion of the heat reducing ignition potential.

The greater the intensity of the fire the greater the proportion of fuel consumed. The heat output from bushfires effectively preheats the available fuels preceding the firefront reducing the time required to ignite fuels. Increasing intensities result in increasing potential for embers, increased radiant heat output and greater flame lengths.

Weather affects the intensity of a fire by influencing the rate of spread (ROS). Wind will drive a fire forward by pushing the heated air, preheating and drying the vegetation in front of the fire. Humidity or air moisture content will absorb a portion of the heat from a bushfire. Consequently, low humidity will not suppress the heat output of a fire to any appreciable level.

Slope will affect the progress of bushfires in a number of ways. Upward slopes preceding a bushfire will promote an increased ROS and increase the likelihood of crown fires occurring.

The slope will influence:

- Soil moisture content
- Wind patterns
- Vegetation type and structure
- Fuel preheating

As such, vegetation type and structure, slope and weather are the major determinants of ROS and bushfire behaviour influencing flame lengths, intensity and radiant heat. Ember generation is largely the result of the intensity of the fire, the resultant convection column and types of fuels consumed such as fibrous barks and leaves.

Fires proceeding down a slope will be inhibited in that radiant heat will be lost to the immediate vicinity rather than preheating fuels in front of the bushfire and the incidence of spotting will be reduced.

#### A2.1.2 Principles of Protection

Bushfire attack takes essentially five forms; wind, smoke, ember, radiant heat and flame (Fig. A2.1).

Evidence indicates ember attack is responsible for most bushfire related house fires. However, strong winds resulting from severe bushfires will drive embers into vulnerable areas of a building, preheat and dry fuel ahead of a fire, lift roofing and extend flames along a more horizontal plane closer to building elements. To effectively protect a building strategies must be adopted that separate the dwelling from the hazard and reduce the intensity of bushfires to minimise the impact of ember, wind, flame and heat attack.

While smoke will do minimal damage to property, it can severely affect the health of residents.

Smoke is a significant factor in areas in which aged or disabled persons reside and more so where residents are susceptible to respiratory disorders such as with hospitals and nursing homes.

Embers can cause spotting in advance of the bushfire and provide piloted ignition to building elements. Radiant heat (measured in kW m<sup>-2</sup>) can severely impair firefighting operations, the health of residents and the integrity of building elements. Flame attack will severely restrict firefighting operation, provide piloted ignition to building elements and threaten the health of resident and their capacity to evacuate the area.

Overall the intention of bushfire protection measures should be to prevent flame contact to a



structure, reduce radiant heat to below the ignition thresholds for various elements of a building, to minimise the potential for embers to cause ignition and reduce the effects of smoke on residents and firefighters.

The threshold for level 3 construction is  $31\text{kW m}^{-2}$ , the unpiloted ignition intensity for treated hardwood timber. This criteria is used as the basis for minimal setbacks to reduce the impacts of these attack mechanisms. Flame and ember attack initiate piloted ignition of treated hardwood timber at  $12\text{kW m}^{-2}$ .

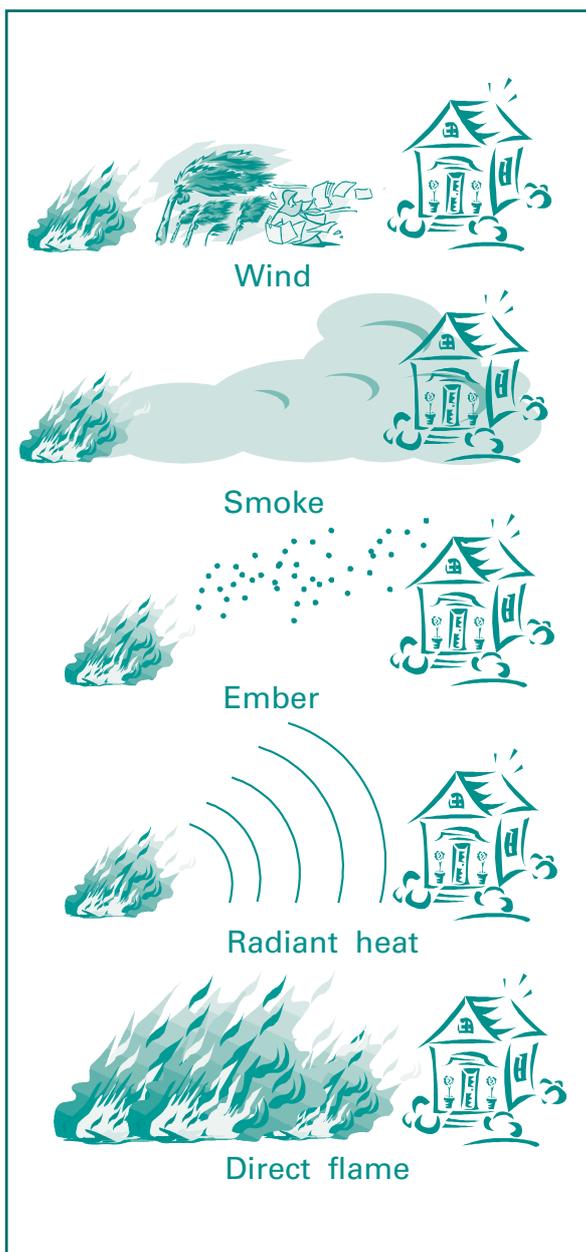


Figure A2.1 Forms of Bushfire Attack

## A2.2 METHODOLOGY

The methodology comprised the following steps:

- (1) Vegetation is classified by structure using Fig A2.2 derived from AUSLIG (1990) and by description using Table A2.1. Vegetation types are aggregated into 3 groups, determined by their fuel loadings (assumed under unmanaged conditions to represent an extreme scenario as the danger period is the lifetime of any proposed development) and fire behaviour characteristics.

The 18 vegetation types identified in Circular C10 were consolidated into 13 types and 3 Groups in *Planning for Bushfire Protection*.

- (2) The 8 slope classes within Circular C10 are consolidated into 6 classes in *Planning for Bushfire Protection*. This recognises the reduced rate of spread (ROS) inherent to fire travelling down slope and the restrictions imposed on development by slopes greater than 18 degrees.
- (3) Assessment assumes a worst case scenario where there is no fuel management, fire history and an absence of any other mitigating factors. The 1:50 year fire weather scenario for the State was determined for NSW as FDI=80. This is believed to occur with reasonable frequency in most local government areas in NSW.
- (4) Fire intensity (I) is determined following the formula adapted from Luke and McArthur (1978),  $I = 0.027 \times \text{HW}r$  where H is the heat yield for vegetation, W for fuel loads (as  $\text{t ha}^{-1}$ ) and r (ROS in  $\text{km hr}^{-1}$ ). ROS is normally determined using McArthur Meter Mark V at an FDI of 80.

- (5) Setback distances provide for:

- minimal separation for safe firefighting (access to fire front);
- minimised radiant heat;
- reduced influence of convection column driven winds;
- reduced ember viability thereby limiting the impact of ember attack; and
- dispersal of smoke which would otherwise severely impact on residents effected by reduced mobility or health issues.



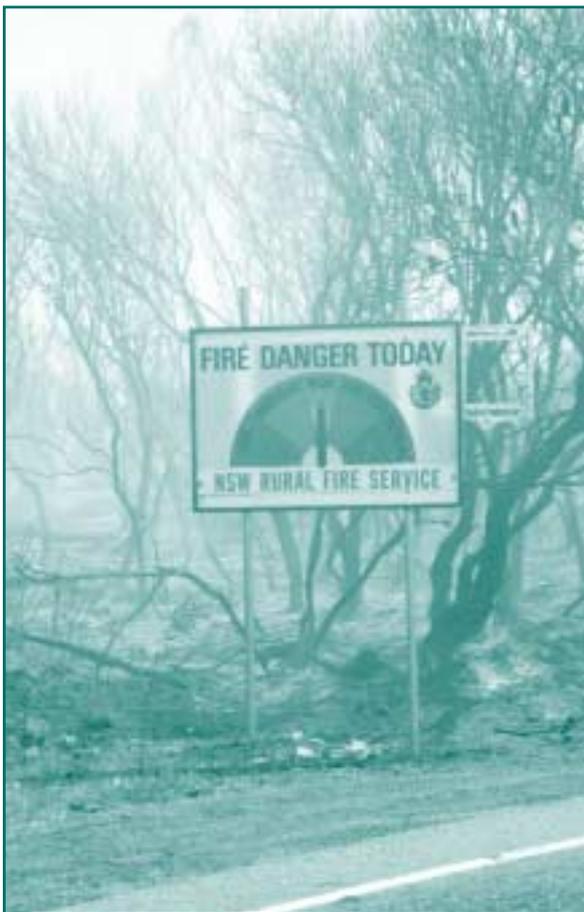
- (6) The Inner Protection Area (IPA) is critical to managing heat intensities at the building surface while the Outer Protection Area (OPA) serves to reduce the potential length of flames by slowing the ROS, filtering embers and suppressing the crown fire.

## A2.3 PROCEDURE

### A2.3.1 Precinct Level Assessment

The following procedure shall be adopted when assessing a development at a refined precinct level in order to determine whether the development is bushfire-prone and if so, which setbacks will be appropriate at subdivision:

- (a) Determine vegetation distance, type and class, as follows:
  - (i) identify all vegetation in each direction from the site for a distance of 140m:



Photograph A2.1

- (ii) consult Figure A2.2 and Table A2.1 to determine the vegetation type which predominates; and
  - (iii) select the predominant vegetation group (1 to 3) as described in Table A2.1.
- (b) Determine the average slope of the land between the Predominant Vegetation Class and the site (slope classes are detailed in s A2.2.5).
  - (c) Consult Tables A2.2–2.4 and determine the appropriate setback for the assessed land use, vegetation group and slope range.

### A2.3.2 Predominant Vegetation Class

Assess the vegetation over a distance of at least 140m in all directions from the proposed building line on the development site.

Determine the predominant vegetation communities using high resolution (within 5m) vegetation databases and/or field assessment by qualified persons. Where a mix of vegetation types exist the type providing the greater hazard is said to predominate. Consideration is to be given to the understorey as this may contain the greater mass of fuels.

For the purposes of this document, vegetation is classified as follows (see Figure A2.2 and Table A2.1):

- a) Vegetation Group 1, *forest*
- b) Vegetation Group 2, *woodlands and heaths*
- c) Vegetation Group 3, *rainforests, shrubland, open woodlands, mallee, grassland*

Where forest fuel loads (measured in tonnes per hectare) are to be assessed, the NSW Rural Fire Service has adopted a reliable system of assessing fuel accumulation rates based on canopy cover, years since last fire and shrub layer cover (Forestry Commission of NSW, 1991). For the purposes of assessing available fuel, the forest fuel is assumed to have accumulated over a period of 25–30 years and is illustrated in Figure A2.3 combined with the shrub layer fuels in Table 2.5. Field sampling may be used to validate these estimates, however, the difference in fire behaviour as a result of relatively small differences in estimated fuel loads is minimal in comparison to the greater effect that can occur in fire weather variability.





The NSW Rural Fire Service does not accept photo comparative assessment techniques as a basis of estimating fuel in forests for land use planning and construction purposes due to the significant variability in which these guides can be interpreted.

Although coastal wetlands vary significantly in structure and composition, these wetlands have been generally assessed as being the equivalent of Group 2 vegetation with the exception of mangroves that are assessed as being Group 3 vegetation.

### A2.3.3 Slope

Assess the slope over a distance of at least 100m from the proposed building line on the development site towards the various vegetation communities.

In assessing the slope, there may be found a variety of slopes covering different distances. Determine the gradient which will most significantly influence the fire behaviour of the site having regard to vegetation found.

Slope assessment may be derived from topographic maps displaying a minimum of 5 metre contour intervals and subject to field confirmation.

The slope is determined in terms of the following classes:

- (a)  $>5^\circ$  upslope
- (b)  $0 - 5^\circ$  upslope
- (c)  $>0$  to  $5^\circ$  downslope
- (d)  $>5$  to  $10^\circ$  downslope
- (e)  $>10$  to  $15^\circ$  downslope
- (f)  $>15$  to  $18^\circ$  downslope

### A2.3.4 Determining Appropriate Setbacks

Consult Tables A2.2 to A2.4

Where it is proposed to develop for residential purposes in bushfire-prone areas Table A2.2 is used to determine the appropriate setback requirements involving Group 1 or Group 2 vegetation. These setbacks are based upon the need to conform with a Level 3 construction for Classes 1 and 2 buildings under the BCA.

If it is intended to construct to a lower bushfire protection standard (e.g. level 1 or 2) or to no

specific bushfire protection standards you should consult Appendix 3 for the appropriate setbacks for your circumstances.

For Special Protection Developments (e.g. SEPP 5 and Class 3 buildings), Table A2.3 is used for Group 1 and Group 2 vegetation.

Where Group 3 vegetation is found Table A2.4 should be consulted. This requires a 20m setback of managed vegetation (less than 5 t/ha) for all slopes and regardless of construction levels. A fire trail is recommended where the development forms an interface with this vegetation.

In interpreting the tables refer to the accompanying notes to these tables.

Location of Asset Protection Zones on slopes greater than  $18^\circ$  are not supported for new developments due to environmental constraints. In addition, Group 1 and Group 2 vegetation could carry a canopy fire along these steep slopes where an understorey would normally be required to support a sustained crown fire.

Small remnant forests areas (less than 1 ha) may be considered equivalent to specifications in Vegetation Group 3. This is related to the fire behaviour development period and should be discussed with the RFS to determine the potential fire characteristics of this remnant.

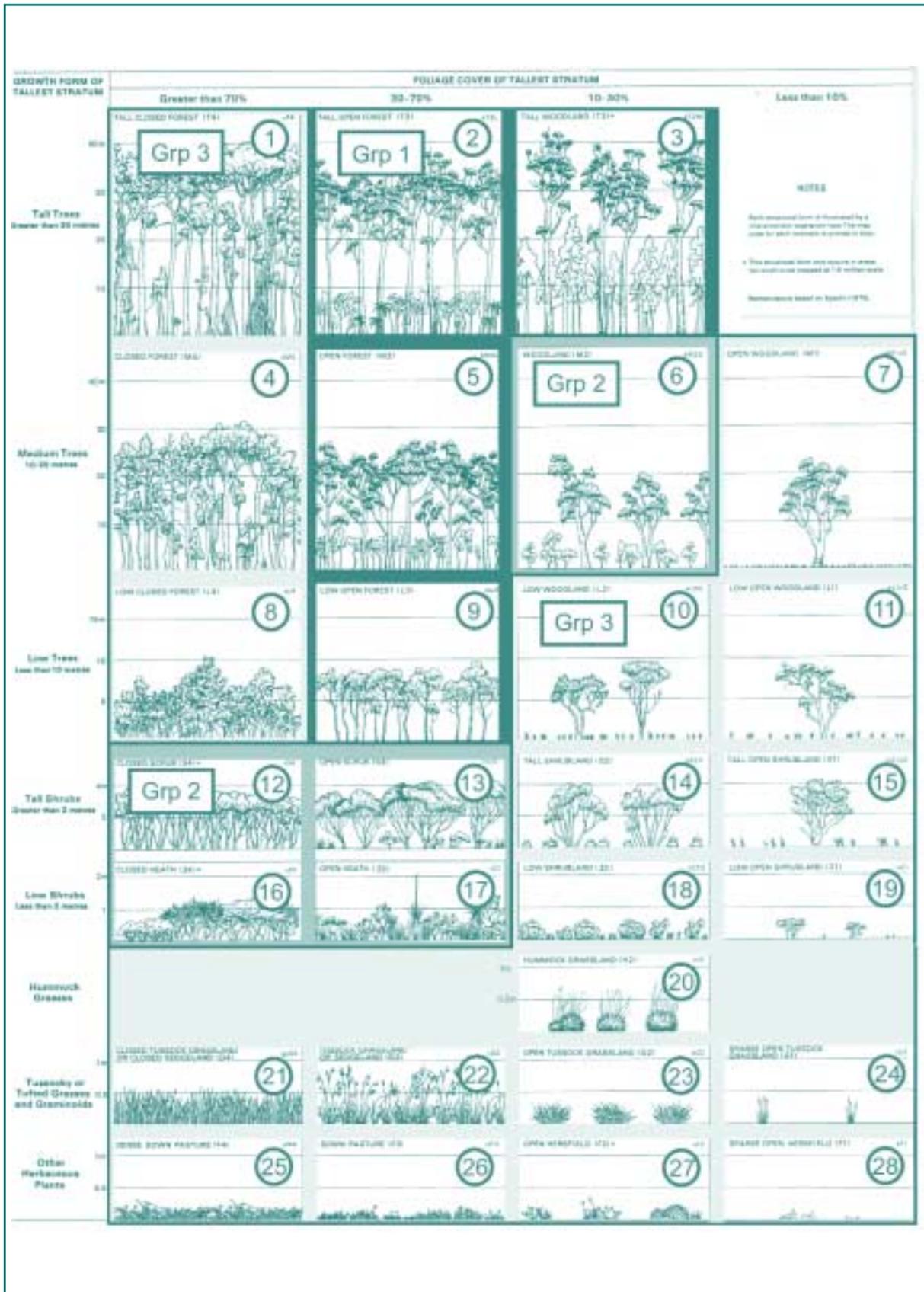


Figure A2.2 Pictorial key to the structural forms of Australian vegetation



Table A2.1. Classification and description of vegetation for the purposes of bushfire assessment

Vegetation Classification	Veg Grp	Vegetation Structure	Assessed Max Fuel Load (t ha <sup>-1</sup> )	Description
Wet sclerophyll forest	1	2, 3	40	Height over 10m; 30–70% foliage cover; understorey ranging from rainforest & tree ferns, to low trees & tall shrubs. Found in areas, with high, reliable rainfall. Usually dominated by eucalypts.
Dry sclerophyll forest	1	5, 9	25	Trees 10–30m high; 30–70% foliage cover; understorey of sclerophyllous low trees & tall shrubs or grass. Usually dominated by eucalypts.
Woodland	2	6	25	Trees 10–30m high; 10–30% foliage cover dominated by eucalypts; understorey low trees to tall shrubs dominated by Acacia, Callitris or Casuarina.
Tall heath (scrub)	2	12	25	Found in areas wet enough to support eucalypt trees, but which are affected by poor soil fertility or shallow soils. >30% foliage cover. Dry heaths occur in rocky areas. Shrubs 1–2m high. Often SEPP 14 Coastal Wetlands.
Open shrub	2	13	15	Trees greater than 2m high, 10–30% foliage cover. Dominated by eucalypts or co-dominant Melaleuca and Myoporum, mixed understorey.
Pine plantation ( <i>P. radiata</i> )	2		15	Pines are introduced species and usually established in plantations. In NSW, <i>Pinus radiata</i> is commonly but not exclusively used.
Closed heath	2	16, 17	15	Found in wet areas but which are affected by poor soil fertility or shallow soils. Shrubs 1–2m high often comprising Banksia, Acacia, Hakea and Grevillea species. Wet heaths occur on sands adjoining dunes of the littoral (shore) zone. Montane heaths occur on shallow or water logged soils in the highlands (e.g. SEPP 14 Coastal Wetlands).
Scrubland (Chenopod)	3	18	12	Shrubs <2m high; <30% foliage cover. Understoreys can contain grasses, Acacia and Casuarina often dominant in the arid and semi arid zones.
Rainforest (closed forests)	3	1, 4, 8	10	Trees 10–30m high; >70% foliage cover; understorey contains a large number of species, with a variety of heights.





Table A2.1. Classification and description of vegetation for the purposes of bushfire assessment continued

Vegetation Classification	Veg Grp	Vegetation Structure	Assessed Max Fuel Load (t ha <sup>-1</sup> )	Description
Mallee or mulga scrub	3	14	8	Vegetation dominated by eucalypts with a multi stem habit; usually greater than 2m in height <30% foliage cover. Understorey of widespread to dense low shrubs (Acacia) or sparse grasses. Usually found in western NSW.
Open woodland	3	7, 10, 11, 15	8	Low trees & shrubs 2–10m high; foliage cover <30%. Dominated by eucalypts and acacias. Often have a grassy understorey or low shrubs. Acacia and Casuarina woodlands grade to Atriplex shrublands in the arid and semi arid zones.
Grassland (pasture)	3	19, 21, 22	6	Usually dominated by introduced grass species but may include bladey grass dominated grasslands. As these result from human interference, they can occur anywhere in the state.
Grasslands (native)	3	19 – 28	3	These communities occur in a variety of forms and locations where environmental factors prevent the growth of trees and shrubs.





**Table A2.2**  
Minimum Specifications for Asset Protection Zones (APZ) for **Residential Purposes** in Bushfire-prone Areas

<b>Forests (Grp 1 see Fig.A2.2)</b>		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	20 = 20 + 0
5–0°		30 = 20 + 10
>0–5°	Downslope	40 = 30 + 10
>5–10°		50 = 40 + 10
>10–15°		60 = 50 + 10
>15–18°		70 = 60 + 10
<b>Woodlands, heaths, open scrub (Grp 2 see Fig.A2.2)</b>		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	20 = 20 + 0
5–0°		30 = 20 + 10
>0–5°	Downslope	35 = 25 + 10
>5–10°		40 = 30 + 10
>10–15°		50 = 40 + 10
>15–18°		60 = 50 + 10

**Table A2.3**  
Minimum Specifications for Asset Protection Zones (APZ) for **Special Protection Developments** in Bushfire-prone Areas

<b>Forests (Grp 1 see Fig.A2.2)</b>		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	60 = 50 + 10
5–0°		75 = 60 + 15
>0–5°	Downslope	80 = 65 + 15
>5–10°		90 = 75 + 15
>10–15°		100 = 85 + 15
>15–18°		100 = 85 + 15
<b>Woodlands, heaths, open scrub (Grp 2 see Fig.A2.2)</b>		
Slope	Upslope	APZ = IPA + OPA
>5°	Upslope	30 = 20 + 10
5–0°		40 = 25 + 15
>0–5°	Downslope	50 = 35 + 15
>5–10°		60 = 45 + 15
>10–15°		80 = 65 + 15
>15–18°		100 = 85 + 15

**Table A2.4** Minimum Specifications for Asset Protection Zones (APZ) for **Residential Purposes and Special Protection Development** in Bushfire-prone Areas Impacted by Vegetation Group 3

<b>Rainforests, grasslands, open woodlands, mallee (Grp3 see Fig.A2.1)</b>
Minimum separation distance of 20m (managed understorey or grasses) required regardless of construction level for all slopes.
Fire trail recommended.

**Notes:**

- Distances are in metres and should be measured from the horizontal (see Fig A2.4).
- IPA = Inner Protection Area
- OPA = Outer Protection Area

- APZ = Asset Protection Zone which is a combination of IPA and OPA distances.
- Bracketed number refers to vegetation groups described in Figure A2.2.
- Using a 1 in 50 year maximum fire event the influence of aspect becomes negligible and as such is not included in this table.

Source: derived from CSIRO (2000)

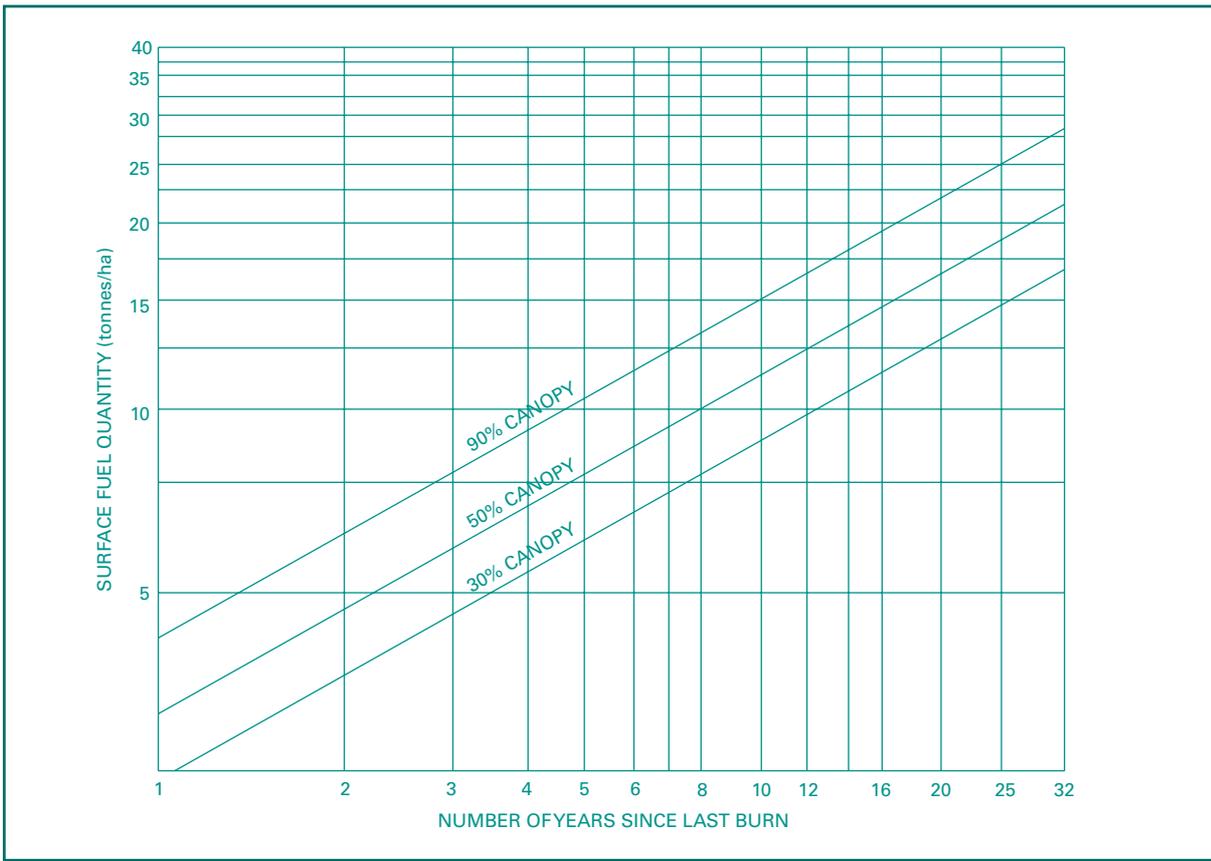


Figure A2.3 Forest Fuel Quantity Assessment (Forestry Commission, 1991)

Table A2.5  
Additional Fuels due to Shrub Layer  
(Forestry Commission, 1991)

Percentage shrub cover	Additional fuel (tonnes/ha)
10 – 30	2.5
35 – 50	5.0
55 – 75	7.5
>75	10.0

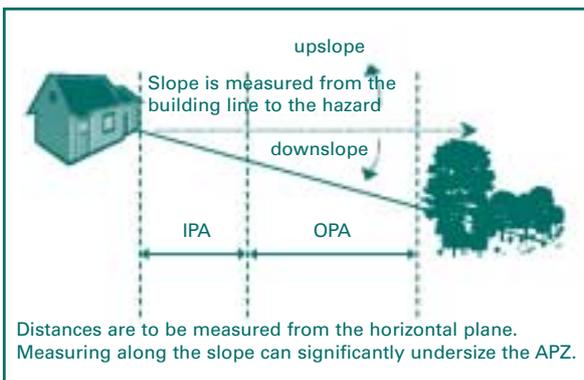


Figure A2.4 Correct technique for APZ and slope measurement





## SITE ASSESSMENT FOR BUSHFIRE ATTACK

### A3.1 INTRODUCTION

This Appendix sets out a methodology for the assessment of the categories of bushfire attack at construction stage for a building proposed within a designated bushfire-prone area. Categories of bushfire attack are determined in order that application of special building requirements in accordance with AS3959 – 1999 may be determined (see Chapter 5).

Five categories of bushfire attack are determined and are described in Table A3.1 below.

### A3.2 SITE ASSESSMENT METHODOLOGY

This general method has been used to determine the categories of bushfire attack using NSW data to provide a more refined assessment for site bushfire attack. It is based upon a simplified methodology largely adapted from AS3959 – 1999.

The methodology comprised the following steps:

- the 1:50 year fire weather scenario for the State was determined for NSW as FDI = 80.
- vegetation types and the corresponding fuel types present (Figure A2.2) were determined.
- the appropriate fuel loads for the fuel types were used for input into fire behaviour models (Table A3.2).
- the fire-line intensity ( $\text{kWm}^{-1}$ ) for a range of slope and distance combinations was calculated (Table A3.2).
- the sustained flame length was calculated (see Table A3.2) using
  - a modified McArthur Mark V formula of  $H = 13r + 0.24W / 2$  for forest fires, and
  - Byrams equation  $L_f = 0.0775I^{0.46}$  for grasslands and pine plantations.

Maximum flame length for forest fires are approximately twice that provided in Table A3.2.

- distance classes for radiant heat flux for  $14.5 \text{ kWm}^{-2}$ ,  $16 \text{ kWm}^{-2}$ ,  $21 \text{ kWm}^{-2}$  and  $31 \text{ kWm}^{-2}$  and flame length were determined.

- based on the calculated fire behaviour, the level of bushfire attack (Levels 1, 2 and 3) corresponding to the relevant heat flux on the proposed building was then determined (see

Table A3.1  
Categories Of Bushfire Attack

Category	Description
<b>Low</b>	Minimal attack from radiant heat and flame due to the distance of the site from the vegetation, although some attack by burning debris is possible. There is insufficient threat to warrant specific construction requirements.
<b>Medium</b>	Attack by burning debris is significant with radiant heat and flame attack insufficient to threaten building elements (unscreened glass). Specific construction requirements are therefore warranted.
<b>High</b>	Attack by burning debris is significant with radiant heat levels and flame threatening some building elements (screened glass). Specific construction requirements are therefore warranted.
<b>Extreme</b>	Attack by burning debris is significant and radiant heat levels and flame could threaten building integrity. Specific construction requirements are warranted.
<b>Flame Zone</b>	Flames and radiant heat levels likely to significantly threaten building integrity and result in significant risk to residents who will not be adequately protected.

NOTE: Attack from burning debris increases as the category of bushfire attack becomes more severe.



chapter 5). If the distance was less than the theoretical flame length then the application of AS3959 – 1999 construction levels are exceeded (i.e. Flame Zone). At distances where the heat flux is less than  $14.5 \text{ kWm}^{-2}$ , no specific construction provisions are required.

## A3.3 PROCEDURE

The procedure detailed below should be adopted when assessing an individual site in order to determine the level of construction required.

**NOTE:** This procedure is based upon the generic method described above and uses the weather scenario of a Forest Fire Danger Index (FDI) of 80 (for forest fuels) and typical fuel loads for NSW vegetation experienced during a severe bushfire in NSW.

The procedure comprises the following steps:

- (a) Determine vegetation types and classes around the site, as follows:
  - (i) Identify all the vegetation types within 140m of the site using Figure A2.2 and considering both overstorey and understorey types; and
  - (ii) Classify the vegetation groups as set out in Table A3.2 below and illustrated in Figure A2.2.
- (b) Determine the distance between each vegetation group (identified as the edge of the foliage cover) and the site.
- (c) Determine the distances from each vegetation group (see Appendix 2) using the classes provided below.

Distances are classified as follows:

- Less than 20m
  - From 20m but not greater than 30m.
  - Greater than 30m but not greater than 50m.
  - Greater than 50m but not greater than 80m.
  - Greater than 80m but not greater than 100m.
- (d) Determine the average slope of the ground for each vegetation group (see Appendix 2) using the classes provided below.



*Photograph A3.1 The results of a bushfire can be devastating to life and property.*

Slopes are classified as follows:

- From  $0^\circ$  but not greater than  $5^\circ$ .
- Greater than  $5^\circ$  but not greater than  $15^\circ$ .
- Greater than  $15^\circ$ .

Upslopes are considered to be  $0^\circ$ .

- (e) Consult Table A3.3 to match the vegetation, distance and slope classes to determine the category of bushfire attack applicable to the site.
  - (i) apply the highest attack category if more than one is obtained.





- (ii) if the nearest vegetation is 100m or more away the level of bushfire attack is categorised as low.
- (f) Utilise the appropriate level of construction found in Section 3 of AS3959 – 1999 and identified within Table A3.3 below. For the categories of bushfire attack determined for the site of the building (see Table A3.3 below) there are five corresponding levels of construction:
  - (i) No specific construction requirements for the category of low bushfire attack;
  - (ii) Level 1 construction for the category of medium bushfire attack;
  - (iii) Level 2 construction for the category of high bushfire attack;
  - (iv) Level 3 construction for the category of extreme bushfire attack;
  - (v) Specific performance levels of AS3959 – 1999 are unachievable for the category of Flame Zone.

*Table A3.2.*

*Comparative structural characteristics and fire intensities for vegetation types on flat ground for an FDI of 80.*

Vegetation Classification	W (t ha <sup>-1</sup> )	r (km hr <sup>-1</sup> )	I (kW m <sup>-1</sup> ) x1000	L <sub>f</sub> (m)	Vegetation Group	Vegetation Structure
Forests	25 – 40	3.84	48 – 77	30	1	2, 3, 5, 9
Woodland	15 – 25	2.4	18 – 30	20	2	6
Tall heath (scrub)	25	2.4	28	20	2	12
Open shrub	15	1.44	14	10	2	13
Closed heath	15	1.44	11	10	2	16, 17
Shrubland (Chenopod)	12	1.44	8.6	10	3	14, 18
Rainforest (closed forests)	10	0.96	5	10	3	1, 4, 8
Mallee / mulga scrub *	18(5)	0.45	4	6	3	14, 15
Open woodland *	8	0.77	–	6	3	7, 10, 11
Grassland (pasture) *	6	10	–	6	3	19, 21, 22
Grassland (native) *	3	5	–	3	3	19 – 28

*\* These vegetation types are dominated by fuels characterised as grasses, which are consumed within 5 to 20 seconds and as such peak values will approximate average (I) intensities. Rate of spread determined on understorey fuels in bracket.*

Key: Value for fuel weight (W), rate of spread (r), Intensity (I), length of flame (L<sub>f</sub>) (modified McArthur Meter Mark V).

Source: CSIRO, 2000 and Department of Planning Circular C10, 1989.



Table A3.3 – New South Wales  
Determination Of Category Of Bushfire Attack For A Site

Distance from vegetation	Less than 20m	From 20m but not greater than 30m			Greater than 30m but not greater than 50m			Greater than 50m but not greater than 80m			Greater than 80m but not greater than 100m		
	All slopes	Greater than 15°	Greater than 5° but not greater than 15°	0 to 5°	Greater than 15°	Greater than 5° but not greater than 15°	0 to 5°	Greater than 15°	Greater than 5° but not greater than 15°	0 to 5°	Greater than 15°	Greater than 5° but not greater than 15°	0 to 5°
Vegetation	Category of Bushfire Attack												
Forest	FZ	FZ	FZ	Ext	FZ	Ext	High	Ext	Ext	Med	Ext	High	Low
Woodland	FZ	FZ	Ext	Med	Ext	High	Low	Ext	Low	Low	Med	Low	Low
Shrub/Heath	FZ	FZ	FZ	Ext	FZ	Ext	High	Ext	High	Med	High	High	Low
Mallee/Mulga	FZ	Med	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Rainforest	FZ	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Grassland	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Non-vegetated	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

Bushfire attack categories:

Low = Low    Medium = Med    High = High    Extreme = Ext    Flame Zone = FZ

NOTES:

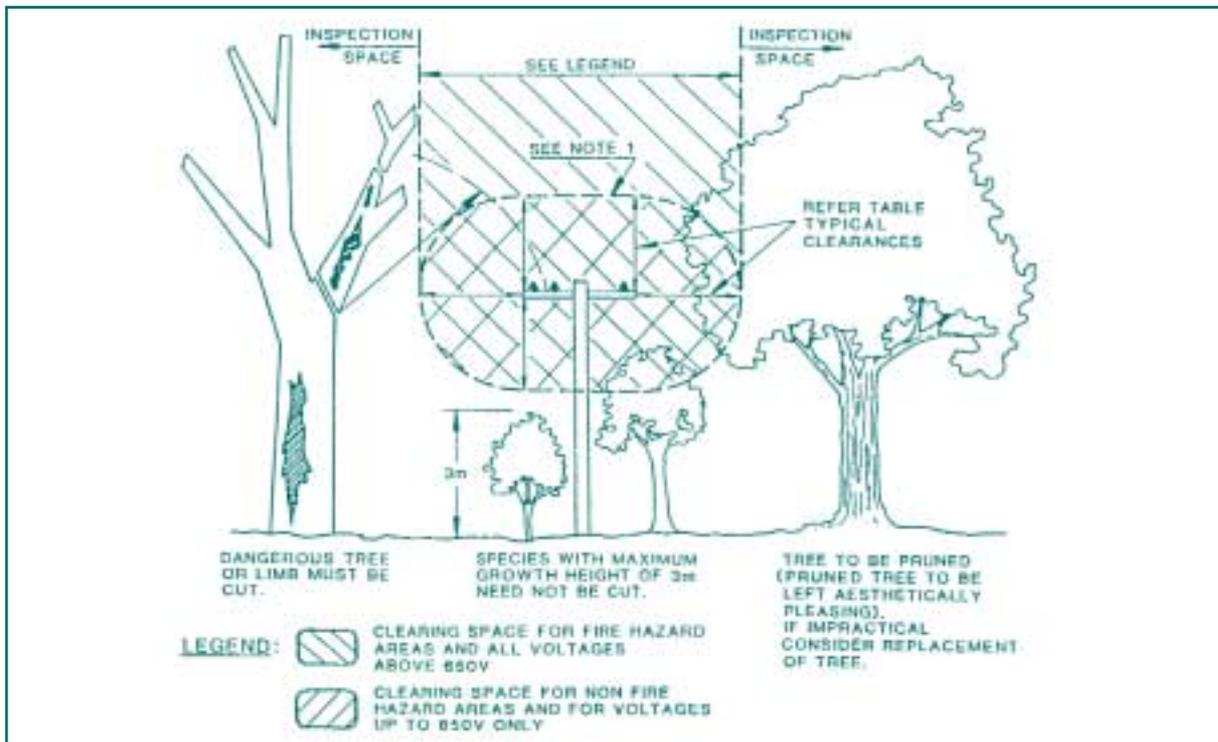
- Categories of Bushfire Attack are based upon a Fire Danger Index (FDI) of 80 and fuel loads for NSW vegetation. The Table has been provided by NSW Rural Fire Service. The fire behaviour models are described in Appendix E to AS3959. Forest includes pine plantations but does not include rainforest.
- The expected fire behaviour for each category is:
  - Low**            insignificant ember attack, radiation no greater than 14.5 kWm<sup>-2</sup> or is greater than 100 metres from all woody vegetation.
  - Medium**        significant ember attack, radiation heat greater than 14.5 kWm<sup>-2</sup> and no greater than 16 kWm<sup>-2</sup>. **(Level 1 AS3959 – 1999)**
  - High**            significant ember attack, possible flame contact, radiation heat greater than 16 kWm<sup>-2</sup> and no greater than 21 kWm<sup>-2</sup>. **(Level 2 AS3959 – 1999)**
  - Extreme**        significant ember attack, possible flame contact, radiation heat greater than 21 kWm<sup>-2</sup> and no greater than 31 kWm<sup>-2</sup>. **(Level 3 AS3959 – 1999)**
  - Flame Zone**    within the Flame Zone and/or greater than 31 kWm<sup>-2</sup>, therefore construction outside the scope of AS3959 – 1999.





## TREE PRUNING – TYPICAL CLEARANCES

Voltage	Clearance at pole to nearest conductor in rest position	Clearance along middle 2/3 of span to nearest conductor in rest position
Insulated service wires	0.5m	0.5m
Up to 650V, see Note 3	1.0m	1.0m or sag at 50° C plus 0.5m (whichever is greater)
>650V to 22kV	1.5m	1.5m or sag at 50° C plus 0.5m (whichever is greater)
>22kV up to 66kV	2.25m	2.25m or sag at 50°C plus 1.0m (whichever is greater)
>66kV up to 132kV	3.0m	3.0m or sag at 50°C plus 1.0m (whichever is greater)



Notes:

1. The extent of the clearing space may be limited as shown where, in the opinion of the chief electrical engineer part of a tree in the clearing space does not constitute a serious hazard to such conductors. This shall only apply in the case of conductors operating at voltages up to 650V.
2. Additional clearance shall be allowed for regrowth, see clause 2.5.
3. An additional clearance of 0.5m shall be added to the nominated clearances for fire hazard areas.
4. Clearances in the table are typical and for guidance only. The appropriate clearance in each situation will vary depending on local circumstances (eg. type of vegetation, climate, locality, etc.). In all cases the most appropriate clearance is a matter for determination by the chief electrical engineer.



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# FURTHER READING



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