Introduction

A significant part of the community and Government response to the Victorian bushfires of 2002/03 and 2006/07 has been an increased focus on prescribed burning on public land. This was reflected in the evidence provided to the Committee, an overriding theme of which was the importance of prescribed burning as a means of mitigating the size and intensity of bushfires, and as a tool for achieving appropriate fire regimes for ecological communities.

The importance attached to prescribed burning is also reflected in the fact that it is the subject of the Inquiry’s first five terms of reference and is also relevant to terms of reference eleven and twelve.

Prescribed burning is an issue which has tended to polarise opinion between those in favour of increased “broadscale” burning, particularly for fuel reduction but also for ecological purposes, and those who argue that burning on such a scale does little to reduce the risks associated with large bushfires and can be damaging to the environment. This polarisation was also apparent in the views presented to the Committee during the course of the Inquiry, although the majority of stakeholders argued for an increase in the level of prescribed burning for fuel reduction and forest ecology. The Esplin Report referred to a divergence of values within the community as one basis for this polarisation:

In any society there is a range of held values that determine what constitutes an asset and for whom. Any evaluation of a fuel-reduction program using prescribed burning (or any other technique) will often depend on the assessors own values.82

However, as the Esplin Report also noted, “held values” are merely one of a number of factors that have influenced the prescribed burning debate.83 Other factors include: the various practical constraints on the conduct of prescribed burning; incomplete scientific knowledge; incomplete records; and a lack of certainty regarding the most appropriate way to evaluate the prescribed burning program.84 In the Committee’s view, there is significant

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potential for ongoing progress in each of these areas to reduce the relative influence of diverging values on the prescribed burning debate.

Overview of prescribed burning

Prescribed burning is the practice of lighting fires, under specified conditions, to achieve particular land management objectives, which include:

- fuel reduction to assist in the control of bushfires – also known as “fuel reduction burning”;
- the conservation and management of flora and fauna – also known as “ecological burning”; and
- the re-regeneration of forest following commercial harvesting operations – also known as “regeneration burning”.

A more detailed definition, which reflects the influence of the range of interrelated factors that affect the planning and conduct of prescribed burning is:

Prescribed burning is the “controlled application of fire to natural or modified fuels under specified environmental conditions that allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to attain planned resource management objectives” (Cheney 1993). Controlling fires in prescribed burns is [achieved]...by carefully exploiting the fire environment. The skilful combination of lighting pattern, timing, use of topography, weather and fuel conditions is the key to successful prescribed burning.

“Prescribed burning” is clearly a broad term. Moreover, it is sometimes used to refer to any one, or all three, of the land management objectives noted above. “Prescribed burning” is also often used interchangeably with a variety of other terms such as “controlled burning” and “planned fire”.

It should also be noted that an individual prescribed burn may have multiple land management objectives. For example, a goal of the Department of Sustainability and Environment (DSE) in recent years has been the increased use of burns with the goal of achieving fuel reduction and ecological goals simultaneously. The integration of these objectives is a major area of research and development within DSE’s prescribed burning program, which is discussed below.

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86 Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, p. 79.
The types of prescribed burning which are the primary focus of this chapter are fuel reduction burns and ecological burns as these were the issues on which the Committee received the bulk of its evidence. While the Committee recognises that traditional definitions of prescribed burning include regeneration burning, for the purposes of this report prescribed burning will refer only to fuel reduction burns and ecological burns. However, since the practice of regeneration burning has historically caused the diversion of some resources from the fuel reduction and ecological burning programs, regeneration burning will be discussed separately towards the end of this chapter.87

The history of fuel reduction burning

Fuel reduction burning, is generally considered to have begun as a silvicultural practice during the early the 20th century. However, as the Committee has noted in Chapter One, the deliberate use of fire to alter the landscape is now widely acknowledged as a practice of Indigenous Australians prior to European occupation. Deliberate fire has also been used extensively in Australia since the arrival of Europeans to clear areas of forest and woodland for agriculture.88

Fuel reduction burning in Australia was developed by forest managers in the jarrah forests of southwest Western Australia during the 1920s as a means of protecting the commercial value of forests from bushfires.89 Prior to the 1950s in Victoria, fuel reduction burning was undertaken in an informal manner by a range of stakeholders including the Government, graziers, foresters, bushman and adjacent private landholders. From the 1950s, the approach towards fuel reduction burning was formalised as the primary Government strategy for reducing the risk of uncontrolled fires.

Prescribed burning on public land

Prescribed burning in Victoria is predominantly conducted on public land. Public land comprises about one third of Victoria’s total land area – about 7.7 million hectares out of a total of 22.7 million hectares.90 Approximately 92 per cent of public land is forested, comprising approximately 3.4 million

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hectares of State forest and 3.7 million hectares of national parks and other reserves.\textsuperscript{91}

The extent of forest on private land is significantly less than on public land. Privately owned forest accounts for around 1.2 million hectares of largely native forest and 360,000 hectares of plantation.\textsuperscript{92} \textit{Victoria’s State of the Forests Report} defines “forest” as:

An area, incorporating all living and non-living components, that is dominated by trees with an existing or potential stand height exceeding 5 metres, and with existing or potential projective foliage cover of overstorey strata at least 30 per cent.\textsuperscript{93}

However, the \textit{Esplin Report} noted a study by Tolhurst, which found that there are two “broad forest types” which would generally be excluded from prescribed burning programs: “wetter forests” such as the south eastern slopes in steeper country; and some native conifer forests where surface fuels do not reach the levels that would trigger fuel reduction burning.\textsuperscript{94} Tolhurst estimated that the exclusion of these areas would remove around 21 per cent of public land from any prescribed burning program, leaving the area of public land available for prescribed burning at around 6.2 million hectares.\textsuperscript{95} Figure 2.1 shows the relative extent of: State forest (shaded green); national park and other reserves (shaded pink); and freehold land (shaded yellow).

\textsuperscript{91} Department of Sustainability and Environment, \textit{Victoria’s State of the Forests Report}, Department of Sustainability and Environment, Melbourne, 2005, p. 7.
\textsuperscript{92} Department of Sustainability and Environment, \textit{Victoria’s State of the Forests Report}, Department of Sustainability and Environment, Melbourne, 2005, p. 7.
\textsuperscript{93} Department of Sustainability and Environment, \textit{Victoria’s State of the Forests Report}, Department of Sustainability and Environment, Melbourne, 2005, p. 13.
Significant areas of non-forested public land include: areas above the tree line in north east Victoria; heathlands, mallee shrublands; hummock grasslands and wetland areas.

Prescribed burns are generally conducted in Autumn or Spring when the air temperature is lower and fire behaviour is more predictable. DSE informed the Committee that more than 75 per cent of Victoria’s prescribed burning is conducted during Autumn, while the Spring burning program is largely restricted to asset protection.

The Department of Sustainability and Environment is responsible for the management of all prescribed burning on public land. Burns are also conducted with the assistance of other agencies, including Parks Victoria, VicForests, and CFA.

**Burning on private land**

There is no coordinated program of prescribed burning on private land. Private landholders are largely responsible for bushfire prevention and mitigation works on their own land and may engage in “burning off” as one such measure. Landholders may light fires in the open at particular times of the year to burn off grass, stubble, weeds, undergrowth or other

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vegetation. Burning off is prohibited during a total fire ban and can only be
conducted under a written permit issued by the Municipal Fire Prevention
Officer or CFA Regional office during a fire danger period. Private
landholders can be held liable for the cost of extinguishing any fires which
escape onto public land.

Management of the interface between public and private land, including
community engagement in the planning and conduct of prescribed burning,
is discussed further in Chapter Six.

Legislative and regulatory arrangements for
prescribed burning

Legislation and the Code of Practice

There are a number of state and Commonwealth legislative provisions of
relevance to prescribed burning. The most significant provisions include:

- s. 62(1) of the Forests Act 1958 (Vic), under which DSE is
  responsible for “the prevention and suppression of fire in every State
  forest and national park and on all protected public…". The Act
defines “protected public land” in section 3, as including State
Forests, National and State parks, wilderness areas and Crown
Reserve (which include areas managed by Alpine Resort
Management Boards);

- ss. 63 to 69 of the Forests Act 1958 (Vic), which contain DSE’s
general powers in relation of fire suppression and prevention under
the Act;

- the Flora and Fauna Guarantee Act 1988 (Vic), under which
“inappropriate fire regimes causing disruption to sustainable
ecosystem processes and resultant loss of biodiversity” are listed as
a threatening process;

- the Environment Protection Act 1970 (Vic), which creates a legislative
framework for the protection of Victoria’s environment by reference to
a range of principles, including:
  - the principle of integration of economic, social and
    environmental considerations, s. 1B;

99 Department of Sustainability and Environment, ‘Burning off on Private Land’, viewed 15 April 2008,
100 Country Fire Authority, ‘Can I or Can’t I?’ viewed 15 April 2008,
101 Department of Sustainability and Environment, ‘Burning off on Private Land’, viewed 15 April 2008,
102 Department of Sustainability and Environment, Code of Practice for Fire Management on Public
Land, Department of Sustainability and Environment, Melbourne, 2006, p. 1.
the precautionary principle, s. 1C;

the principle of intergenerational equity, s. 1D;

the principle of conservation of biological diversity and ecological integrity, s. 1E; and

the principle of accountability, s. 1L.

- the Environment Protection and Biodiversity Conservation Act 1999 (Cth);\(^{103}\) and

- s. 17(2)(b) of the National Parks Act 1975 (Vic).


The Code describes “minimum statewide standards” for the management of fire on public land in Victoria. More specific conditions are contained in a range of plans, instructions, prescriptions and guidelines, each of which must comply with the standards contained in the Code.\(^{104}\) Three important DSE guidelines which are referenced in the Code, are the:


- Synopsis of the knowledge used in prescribed burning in Victoria (1999); and the


The Code contains the following “general principles” in relation to prescribed burning:

- prescribed burning, which is to be directed to the achievement of stated land management objectives, should be thoroughly planned, follow safe working practices, be controlled and have its outcomes monitored and recorded;

- DSE will work with communities to promote understanding of the role of fire as a management tool in the Victorian environment; and

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\(^{103}\) Department of Sustainability and Environment, Code of Practice for Fire Management on Public Land, Department of Sustainability and Environment, Melbourne, 2006, p. 4.

\(^{104}\) Department of Sustainability and Environment, Code of Practice for Fire Management on Public Land, Department of Sustainability and Environment, Melbourne, 2006, p. 3.
prescribed burning activities and processes are to be planned in partnership with communities.\textsuperscript{105}

The Code also provides that an approved Burn Plan must be prepared for every prescribed burn, which must include the following details (the full list of requirements are included at Appendix B of the Code):

- the primary and secondary objectives of the burn;
- the planned area to be burnt, including a map of the planned burn area;
- any areas from which fire is to be excluded;
- land tenures;
- dominant vegetation type;
- when the area was last burnt and by what type of fire (if known);
- the limits of acceptable fire behaviour, weather and fuel conditions from the burn; and
- relevant ecological issues.\textsuperscript{106}

The Code supports a system of planning for fire management at Regional and District levels across Victoria. Fire Protection Plans, which set out overarching strategies for fire prevention and suppression, have been prepared for each DSE Fire District. Fire Protection Plans apply for a period of ten years but may be reviewed after five years and may be amended as required. The Code provides for a process of migration from Fire Protection Plans to Fire Management Plans, which will fulfil a broadly identical role to Fire Protection Plans. Fire Management Plans will, however, contain a number of additional elements, notably:

- fire ecology strategies, prepared by public land managers (e.g. Parks Victoria) outlining overarching ecological and cultural protection goals; and
- demonstrated links to relevant Municipal Fire Prevention Plans.\textsuperscript{107}

The process of migration from Fire Protection Plans to Fire Management Plans is discussed further below.

\footnote{\textsuperscript{105} Department of Sustainability and Environment, \textit{Code of Practice for Fire Management on Public Land}, Department of Sustainability and Environment, Melbourne, 2006, p. 17.}
\footnote{\textsuperscript{106} Department of Sustainability and Environment, \textit{Code of Practice for Fire Management on Public Land}, Department of Sustainability and Environment, Melbourne, 2006, p. 40.}
\footnote{\textsuperscript{107} Department of Sustainability and Environment, \textit{Code of Practice for Fire Management on Public Land}, Department of Sustainability and Environment, Melbourne, 2006, p. 10.}
DSE Fire Regions, Fire Districts, and their associated Fire Protection Plans, are shown in Table 2.1 below. A map of current Fire Districts is shown in Figure 2.2 below.

Table 2.1: DSE Fire Regions, Districts and Fire Protection Plans. 108

<table>
<thead>
<tr>
<th>DSE Fire Region</th>
<th>DSE Fire District</th>
<th>Fire Protection Plan</th>
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<tbody>
<tr>
<td>North West</td>
<td>Bendigo</td>
<td>Bendigo Fire Protection Plan</td>
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<td></td>
<td>Mildura</td>
<td>Mildura Fire Protection Plan</td>
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<tr>
<td>South West</td>
<td>Bacchus Marsh</td>
<td>Bacchus Marsh Fire Protection Plan</td>
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<td>Ballarat</td>
<td>Ballarat Fire Protection Plan</td>
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<td>Horsham</td>
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<td>Otway</td>
<td>Otway Fire Protection Plan</td>
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<td>Portland</td>
<td>Portland Fire Protection Plan</td>
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<tr>
<td>North East</td>
<td>Alexandra</td>
<td>North East Fire Protection Plan - covering Alexandra and Broadford Fire Districts</td>
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<td></td>
<td>Broadford</td>
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<td></td>
<td>Mansfield</td>
<td>North East Fire Protection Plan - covering Upper Murray, Ovens, Shepparton and Mansfield Fire Districts</td>
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<td></td>
<td>Ovens(Myrtleford)</td>
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<td>Shepparton</td>
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<td>(Wangaratta)</td>
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<td>Upper Murray</td>
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<td>(Tallangatta)</td>
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<tr>
<td>Port Phillip</td>
<td>Port Phillip</td>
<td>East Port Phillip Fire Protection Plan</td>
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<tr>
<td>Gippsland</td>
<td>Bairnsdale</td>
<td>Gippsland Fire Protection Plan - covering all 10 Fire Districts</td>
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<td>Bendoc</td>
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<td>Swifts Creek</td>
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<td>Yarram</td>
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</table>

The Code also requires the annual preparation of Fire Operations Plans, which are designed to implement the strategic goals contained in each Fire Protection Plan. Fire Operations Plans contain:

- a three-year forward program, comprising a schedule and maps for fuel reduction and ecological burning; and
- a schedule of prevention and preparedness works planned for the immediate 12 month budget period.\(^\text{110}\)

Fire Operations Plans identify the priority areas which have been selected for fuel reduction and ecological burning. Fire Operations Plans also provide the flexibility to conduct, during any 12 month burning program, burns which have been identified for the entire three year period.\(^\text{111}\)

Fire Protection Plans and Fire Operations Plans are prepared at District level by DSE, following an advertised period of community engagement.

\(^{109}\) Department of Sustainability and Environment, personal communication, 20 June 2008.
\(^{110}\) Department of Sustainability and Environment, Code of Practice for Fire Management on Public Land, Department of Sustainability and Environment, Melbourne, 2006, p. 13.
\(^{111}\) Department of Sustainability and Environment, personal communication, 29 February 2008.
The Code divides all public land in Victoria into four Fire Management Zones as follows:

- the asset protection zone (FMZ 1);
- the strategic wildfire moderation zone (FMZ 2);
- the ecological management zone (FMZ 3); and
- the prescribed burning exclusion zone (FMZ 4).

The 1995 Code defined a total of five Fuel Management Zones:

- asset protection (FMZ 1);
- strategic fuel reduced corridors (FMZ 2);
- broad area fuel reduced mosaic (FMZ 3);
- specific flora and fauna management (FMZ 4); and
- exclusion of prescribed burning (FMZ 5).

At the time of writing, the recently approved Fire Protection Plan for Mildura was the first such plan to employ the revised four Fire Management Zone model. The Committee was advised that the new model would be implemented across DSE’s Fire Regions as existing Fire Protection Plans are revised towards the end of their ten year currency.\(^\text{112}\)

The detailed objectives of prescribed burning within each zone are set out in the Code and in the 1995 Code respectively. In general, more intensive burning has been conducted in zones one and two for the purposes of asset protection, while most ecological burning has been conducted in zones three and four.\(^\text{113}\) The Committee understands that under the new four zone model, ecological burning would largely be restricted to zone three.

Discussion

A common theme in the evidence provided to the Committee was that the legislation and regulations applicable to prescribed burning, and the management of public land in general, are overly restrictive, impractical and detract from the flexibility required for a successful fuel reduction burning program.\(^\text{114}\)

The Committee also notes the observation of the Emergency Services Commissioner that:

\(^{112}\) Department of Sustainability and Environment, Submission, no. 168E, 4 April 2008, p. 3.
\(^{113}\) Department of Sustainability and Environment, personal communication, 29 February 2008.
…the quality of documented information could be further improved to provide greater clarity and accessibility to personnel who need to use it.115

The Committee also found, however, that the legislative and regulatory arrangements are of a high quality and represent a clear hierarchy. In this respect, the Committee agrees with the findings of the Emergency Services Commissioner in 2005 that:

DSE’s requirements for prescribed burning are comprehensively described in legislation, government policy, departmental guidelines and instructions. The review finds no evidence of unsound processes in the documentation that would warrant a significant departure from those policies and procedures.

While the legislative and regulatory arrangements governing prescribed burning in Victoria are complex, the Committee considers that a degree of complexity is inevitable if the risks and benefits of the program are to be appropriately balanced. However, the Committee agrees with the view expressed by a range of stakeholders that a flexible prescribed burning program is essential. The incorporation of local knowledge at every stage of the prescribed burning process is crucial to achieving such flexibility. For example, local knowledge may enable DSE and its partner agencies to conduct a greater number of burns outside of burn prescriptions (discussed below).

The Committee also considers that further integration of the relevant documentation under the Code could be achieved, for example by collation in a single manual and by creating a webpage containing links to all regulatory documentation.

As noted above, the Code provides for the migration from Fire Protection Plans to Fire Management Plans. DSE advised the Committee that the migration to Fire Management Plans was contingent on the development of Fire Ecology Strategies and of linkage documents for Municipal Fire Prevention Plans. DSE advised the Committee that it was aiming to advance the development of Fire Ecology Strategies in cooperation with Parks Victoria over the next three to five years and that the development of linkage documents for Municipal fire prevention plans was subject to the implementation of the Integrated Fire Management Planning Framework (IFMP), currently in its formative stages with primary carriage through the CFA.116 The IFMP is discussed in detail in Chapter 6.

**Delegations and reporting responsibilities**

DSE has primary responsibility for prescribed burning on public land, which it plans and conducts with the assistance of a number of partner agencies, including DPI, Parks Victoria and VicForests. Within DSE there are a range of positions with defined responsibilities for prescribed burning. This hierarchy of responsibility is set out in DSE’s *Fire Management Manual 10.1:*

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Chapter 2: Prescribed Burning In Victoria

Prescribed Burning, (2001) (the Manual) and is illustrated in two flowcharts which have been reproduced as Figures 2.3 and 2.4 below. It should be noted, however, that there have been a number of structural and related changes within DSE since the Manual was last revised. For example, the Director Emergency Management is now known as the Chief Officer Fire and Emergency Management and currently reports to the new division of Land and Fire Management (which has assumed a number of the responsibilities of the former Parks and Forests division). A further change which was recently proposed by DSE is the establishment of a direct line of accountability between the Regional Manager Fire and the Chief Fire Officer throughout the year. Responsibility for the position of Manager Fire is currently shared between the Chief Fire Officer and Regional Director outside of fire management operations.

Departmental Secretary

The Secretary is responsible for the provision of fire prevention and suppression works in State forests, national parks and other protected public land in Victoria under Section 62(2) of the Forests Act 1958. The Secretary is also required to ensure that proper measures are taken to protect each national park, State forest and other parks from injury by fire under the National Parks Act 1975.

Fire and Emergency Management

The Chief Officer Fire and Emergency Management (previously known as the Director Emergency Management) holds the delegated responsibility, from the Secretary of DSE, for fire emergencies on public land in Victoria. The Chief Officer Fire and Emergency Management is also responsible for the preparation and amendment of DSE’s Fire Management Manuals and works with relevant DSE divisions and partner agencies (DPI, Parks Victoria and VicForests) to achieve this.

117 Department of Sustainability and Environment, personal communication, 29 February 2008.
118 P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.
Figure 2.3: Departmental responsibilities for fire management on public land in Victoria.\textsuperscript{120}

Note: Solid lines show delegation of authority / responsibility; dotted lines show reporting relationships.

\textsuperscript{120} Department of Sustainability and Environment, Fire Management Manual 10.1: Prescribed Burning, Department of Sustainability and Environment, Melbourne, 2005, p. 2_2.
Fire and Emergency Management is also responsible for the:

- preparation, review, modification and approval of the Prescribed Burning Manual and an associated template for Burn Plans;
- defining the skills and authorisation required by those involved in the conduct of prescribed burns;
- defining a process for monitoring and recording details of prescribed burning operations; and
- recording the annual expenditure on prescribed burning.\textsuperscript{122}

\textsuperscript{\textdegree} According to the Manual, responsibility for these activities is held by the Manager Preparedness and Response (Emergency Management) on the delegated authority of the Chief Officer Fire and Emergency Management.
The role of the Chief Officer Fire and Emergency Management in the conduct of prescribed burning arises out of the requirement that prescribed burns be managed under the incident control principles of the Australasian Inter-service Incident Management System (AIIMS). The Manual states that this arrangement is designed to ensure that there is a management structure in place which is consistent with that for wildfire suppression as a safeguard for prescribed burn escapes which become wildfires. The Committee notes that the introduction of the AIIMS approach to structuring the reporting relationships for prescribed burning has effectively implemented a 2005 recommendation of the Emergency Services Commissioner in relation to the improvement of risk management processes.
for prescribed burning.\textsuperscript{126} As noted above, however, DSE plans to change the existing reporting relationships to make Regional Managers Fire directly accountable to the Chief Fire Officer at all times.

\textit{Regional Director and Manager Fire}

The Secretary also delegates responsibility for prescribed burning to Regional Directors who in turn delegate responsibility to the Manager Fire for each region for the following matters:

\begin{itemize}
\item ensuring relevant land managers are engaged and consulted regarding all burns on public land;
\item approving Fire Operations Plans;
\item preparing, distributing, reviewing and modifying Burn Plans;
\item implementing Burn Plans;
\item ensuring that all appropriate information and actions are recorded;
\item reviewing on-ground performance against objectives of Burn Plans;
\item ensuring corrective action if burns do not achieve their burn objectives;
\item implementing quality control processes to manage risk, including the internal approval process;
\item approving burns located near significant private or public assets; burns ignited between November to February inclusive; and burns which are outside of the standard prescriptions;
\item ensuring the risk mitigation process (Guideline 10.1.10) is satisfactorily completed;
\item approving the commencement of the seasonal prescribed burning program in the region; and
\item ensuring mineral earth control lines are in place around the perimeter of the Burning Unit prior to ignition for burns conducted between November and February inclusive unless specific approval is otherwise granted.\textsuperscript{127}
\end{itemize}

“Manager Fire” is described in the Manual as a “generic” term for the role to which a Regional Director has directly delegated fire management


\textsuperscript{127} Department of Sustainability and Environment, \textit{Fire Management Manual 10.1: Prescribed Burning}, Department of Sustainability and Environment, Melbourne, 2005, pp. 2.3 to 2.4.
responsibilities for the region. The actual title of the person fulfilling this role may vary from region to region.\textsuperscript{128}

\textit{Fire Management Officer}

Managers Fire delegate the following responsibilities to Fire Management Officers:

- approving nominated burns and allocating burn numbers;
- ensuring Burn Plans are prepared and entered on FireWeb (an intranet system which provides DSE's primary source of integrated fire management information), including fuel reduction burns and land manager-commissioned burns;
- ensuring all prescribed burns have an approved Burn Plan before ignition;
- ensuring that all areas planned to be burned are first inspected to assess and prescribe any protective measures required to protect persons and assets;
- ensuring that appropriate indices are recorded for fuel conditions and fire danger;
- ensuring consistency of the proposed burn with the relevant Fire Protection Plan (or Fire Management Plan) and Fire Operations Plan;
- ensuring that all prescribed burning is in accordance with the Manual;
- consulting with any relevant land manager;
- approving all fuel reduction Burn Plans;
- ensuring that approval is sought for burns near significant private or public assets, burns ignited between November to February inclusive, and burns outside prescriptions;
- ensuring appropriate actions are taken in the event of a burn escape; and
- in conjunction with Officer in Charge, ensuring that actions are taken to satisfy rehabilitation requirements.\textsuperscript{129}

\textit{Land Manager}


For prescribed burning for purposes other than fuel reduction burning, the relevant land manager is responsible for:

- ensuring ecological burns meet the objectives of park or forest management plans and ecological burning strategies;
- ensuring all burns are nominated on FireWeb;
- ensuring that all burns go through a strategic planning process (such as a Wood Utilisation Plan, Timber Release Plan or Fire Operations Plan);
- ensuring that all burns go through an operational planning process, i.e. Burn Plans are prepared and entered on FireWeb for all land manager-commissioned prescribed burns;
- ensuring consistency of all proposals with the relevant strategic plans;
- approving all land manager-commissioned Burn Plans;
- ensuring that all areas planned to be burned are inspected prior to burning to assess and prescribe any protective measures required to protect persons and assets in or near the burn area;
- obtaining the endorsement of the local Fire Management Officer (otherwise the burn will be considered to be unauthorised);
- monitoring the effects of prescribed burning;
- in conjunction with the Officer in Charge of the Burn, ensuring that actions are taken to satisfy rehabilitation requirements; and
- paying for the conduct of the operation.

Officer in Charge of the Burn (Burn OIC)

This is the person charged with managing a given prescribed burn – he or she may be the Fire Management Officer, Land Manager and/or any other person who meets the required competencies (the required accreditation for the Burn OIC and for any other personnel involved in prescribed burning is set out in Section 2.5 of the Manual).

The Burn OIC is responsible for:

- being in possession of the approved Burn Plan on the day of the burn;
- meeting all prescriptions and conditions specified in the Burn Plan;
- providing “current status” information to the Burns Controller;
certifying that all notifications and planning requirements have been completed prior to ignition;

- verifying and recording that conditions and preparations at the site of the burn are within the appropriate prescriptions and conditions for the burn;

- authorising ignitions;

- ensuring that the public and assets are protected at all times (including passing traffic);

- before leaving, ensuring that the perimeter of the burn is secure from fire escaping and that dangerous trees do not fall or encroach onto roads before the next scheduled patrol;

- completing relevant details on FireWeb; and

- in conjunction with the Land Manager and Fire Management Officer as appropriate, ensuring that actions are taken to satisfy rehabilitation requirements.¹³⁰

*Burns Controller*

The Burns Controller, which is delegated at Regional level, may be the Fire Management Officer, an employee of a land manager, or any other person charged with management of multiple prescribed burns who meets the accreditation standard (detailed in Section 2.5 of the Manual). The Burns Controller is responsible for the overall management of multiple prescribed burning operations and the supervision and coordination of Burn OICs’ prescribed fires within their respective planning area. Specific duties include:

- implementing Departmental procedures, policies and regulations for prescribed burning operations and ensuring Burn OICs are conducting their burns in a safe manner according to specific policies and standards;

- determining whether or not to give appropriate authorisation for commencement of any particular burn or burning program;

- reviewing Burn Plans prior to implementation;

- determining sequence for ignition of individual burns and advising Burn OICs as appropriate;

- obtaining and interpreting long term weather information;

- managing air quality issues and liaison with State Fire Coordinator regarding consideration;

briefing and instructing Burn OICs on operational procedures, objectives and hazards relevant to the current program;

coordinating resource requests including the requesting, use and release of resources;

acting as liaison/coordinator between DSE and other agencies, State Aircraft Unit, news media, interested public and landowners;

monitoring effectiveness of burns in relation to achievement of stated burn objectives (i.e. ‘secondary objective’);

coordinating the termination of burns if smoke, resource and/or fire management objectives are not being met;

as necessary, declaring escapes from prescribed fires to be wildfires per DSE guidelines, if not already done so by assigned Burn OIC;

maintaining FireWeb Burns & Works record including burn status changes and ensuring completed Burn Plans are returned from Burn OICs and stored appropriately; and

ensuring evaluation and documentation of the achievement of burn objectives, operational procedures and assigned personnel as related to fire and resource management planning.

The Manual provides that authorisation to ignite a burn is to be requested on the day before the burn. Authorisation may be subject to particular conditions and may be overridden or withdrawn by the State Fire Coordinator or Regional Fire Coordinator.  

Authorisation must be given by either the Fire Management Officer (FMO) or the Manager Fire, depending on:

- whether the burn meets the standard prescriptions (based on weather forecasts and preparation);
- the timing of the burn;
- whether the burn is within 500m of significant private or public assets; and
- the current wildfire and prescribed burning situation on a State, Regional and District basis.  

The influence of these factors on the required level of authorisation is shown in Figure 2.6.

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131 Department of Natural Resources and Environment, Fire Management Manual 10.1: Prescribed Burning, Department of Sustainability and Environment, Melbourne, 2001, p. 3_4.

132 Department of Natural Resources and Environment, Fire Management Manual 10.1: Prescribed Burning, Department of Sustainability and Environment, Melbourne, 2001, p. 3_4.
Following authorisation, FireWeb is updated by changing the status of the burn to “Ignition Authorised” and entering the details of the burn authorisation.\textsuperscript{133}

Authorisation for prescribed burns which are adjacent to significant private or public assets, or which may impact on public safety, is contingent on the Manager Fire first ensuring that a risk mitigation process has been completed (outlined in Guideline 10.1.10) and that adequate mitigation strategies have been put in place.\textsuperscript{134}

All authorisations to ignite a burn are required to be in writing and the Burn OIC must be in possession of a copy of the authorised Burn Plan at the time of ignition and for the duration of the burn.

The Manual contains a checklist for the planning and conduct of prescribed burns (Guideline 10.1.13), which is required to be completed for each burn on public land and retained as part of the burn record unless advised otherwise.

\textsuperscript{133} Department of Natural Resources and Environment, \textit{Fire Management Manual 10.1: Prescribed Burning}, Department of Sustainability and Environment, Melbourne, 2001, p. 3-4.

\textsuperscript{134} Department of Natural Resources and Environment, \textit{Fire Management Manual 10.1: Prescribed Burning}, Department of Sustainability and Environment, Melbourne, 2001, p. 3-4.
The Committee finds that while the reporting structure for the conduct of prescribed burning is complex, it provides an appropriate system of risk management for an inherently complex land management practice. While the Committee appreciates the concerns of a number of stakeholders that there is an unnecessary degree of complexity in the chain of command, the Committee finds that a level of complexity in this regard is inevitable. The Committee notes that, appropriately, the decision to authorise and ignite a burn occurs at Regional level. Moreover, the Committee welcomes the recent statement by DSE that Regional Managers Fire will in future report directly to the Chief Fire Officer year round, rather than being jointly accountable to Regional Directors.  

Finding 2.1:

The Committee finds that while the legislative, regulatory and reporting structures for the planning and conduct of prescribed burning activities are complex, they provide an appropriate system of risk management for an inherently complex land management practice.

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136 P. Harris, Secretary, Department of Sustainability and Environment, *Transcript of evidence*, Melbourne, 7 April 2008.
The primary source for the theoretical foundations which underpin prescribed burning in Victoria is DSE’s *Synopsis of the knowledge used in prescribed burning in Victoria* (1999) (“the Synopsis”). The Synopsis provides an overview of the relevant scientific research and field experience and describes the prescribed burning techniques currently in use. Broadly, these techniques involve variations in: ignition patterns; ignition times; and ignition tools.

In order to understand how these techniques are applied, an appreciation of the interrelated effects of the following factors is also required:

- fire behaviour;
- fuels;
- fire weather; and
- topography.

Each of the above can have a bearing on the planning, conduct and outcome of a prescribed burn. The following outline provides only a broad overview of these factors. For further detail the reader is referred to the Synopsis.

### Fire behaviour

#### Ignition and combustion

The main factors affecting ignition are the moisture content of the fuel and the nature of the fuel bed. According to field observations, ignition from extremely small sparks and glowing combustion occurs only when the moisture content of the fuel falls below six per cent.139

#### The effect of wind on combustion

Increases in wind speed cause an increase in the rate of combustion. However, *head fires* (see below) which consumed less fuel through flaming combustion than *backing fires* (see below) have also been observed in forest. This is thought to be caused by differences in the way the fuel burns – *head fires* burn from the top of the fuel bed while *backing fires* tend to burn

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139 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 4.
into the fuel bed and may even burn upwards from the bottom of the fuel bed.\textsuperscript{140}

**The heat transfer process**

Combustion is maintained by heat, which is transferred by the processes of radiation, conduction and convection. The dominant heat transfer process in forest fires is convection, which influences fire development and the speed at which a fire spreads. Convection can be used to manipulate prescribed fires to achieve particular results, such as the degree of scorch or damage to the crowns of the overstorey.\textsuperscript{141}

**The fire perimeter**

In level terrain with homogenous fuels and no wind, a fire tends to spread equally in all directions. However, the presence of wind or slope will generally cause the fire to lean towards the unburnt fuels situated uphill or downwind of the fire, increasing the rate at which the fire spreads in those directions. In these conditions, the fastest moving section of the fire perimeter is referred to as the head fire, which is also the area which tends to draw the heat from the other sections of the fire perimeter. The section of the fire perimeter directly opposite the head fire is the back fire, which is the slowest moving part of the fire. The flank fire, which is parallel to the prevailing wind or slope, is the area of the fire perimeter located between the head fire and the back fire. Flames on the flank fire alternate between heading fires and backing fires with changes in the prevailing wind direction. Figure 2.7 illustrates the fire perimeter for fires originating from a point ignition and a line ignition and shows the approximate proportion of the area burnt by head fire, flank fire and back fire.\textsuperscript{142}

\textsuperscript{140} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 5.
\textsuperscript{141} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 5-8.
\textsuperscript{142} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 8.
Fire growth phases

Fire growth refers to the development of a fire to its maximum potential rate of spread under the prevailing conditions. The process depends on the development of flames into the surface fuel bed, the development of convection, the development of flames into elevated and bark fine fuels, and the development of the width and shape of the head fire. The ignition pattern and the type of ignition used can both influence the rate of fire growth.\textsuperscript{144}

Flame characteristics

Flame characteristics include flame height, length, angle and depth. A further characteristic is “residence time”, which refers to the duration of flaming combustion. Relationships between flame height and rate of spread are often used in burning guides but these cannot be applied to fuel types that are structurally dissimilar.\textsuperscript{145}

Fire shape

Following the development of a head fire, convection becomes the dominant heat transfer process. The convective updraught from the fire tends to constrain the fire within a roughly elliptical shape (subject to the presence of fuels which are continuous and relatively uniform and a constant wind

\textsuperscript{143} Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, p. 8.
\textsuperscript{144} Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, pp. 9-14.
\textsuperscript{145} Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, pp. 14-16.
direction). The proportions of an ellipse shaped fire are determined by the prevailing wind speed, as illustrated in Figure 2.8 below.\textsuperscript{146}

**Figure 2.8: The effects of wind speed on fire shape.\textsuperscript{147}\textsuperscript{†}**

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**Rate of spread**

The rate at which a fire spreads is affected by a number of variables, including: the type, arrangement and quantity of fuel; the dead fuel moisture content; wind speed at the fire front; the overall width of the fire; and ground slope.\textsuperscript{148}

**Spotting**

Spotting refers to the creation of sparks or embers which are carried by the wind or convective activity to ignite new fires.\textsuperscript{149} Bark in eucalypt forests can provide the fuel for spotting even in relatively mild conditions. In some cases, spotting can cause the ignition of new fires several kilometres distant. The onset of spotting in many fuel types can make suppression impossible. Guidelines for the suppression limits (i.e. maximum fire intensities) applicable for: fire fighters using hand tools; bulldozers; and air tankers, have been defined by reference to the intensity at which spotting across a constructed fire line can no longer be contained. Massive spotting across short distances and some long distance spotting have been identified as a major reason for the failure of *first attack* efforts in Victoria. Overcoming discontinuities in fuel and topography has been identified as the most

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\textsuperscript{146} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 16.

\textsuperscript{147} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 16.

\textsuperscript{†} The results shown are for wind speeds measured at 1.5 metres above the ground in forest.

\textsuperscript{148} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 17.

significant effect of spotting, allowing a bushfire to burn across divided country with apparently minimal impediment under extreme conditions.\textsuperscript{150} Spotting across control lines is the most common cause of escapes from prescribed burns in Victoria.\textsuperscript{151}

**Fire intensity and heat output**

Fire intensity is defined as the rate of energy release for a given unit of fire perimeter. It is commonly defined mathematically as the heat (measured in kilowatts) that is released per metre of fire perimeter and is classified as: low (<500 kWm\textsuperscript{-1}); moderate (500-3,000 kWm\textsuperscript{-1}); high (3,000-7,000 kWm\textsuperscript{-1}); or very high (7,000-70,000 kWm\textsuperscript{-1}).\textsuperscript{152}

Fire intensity varies at different points around the fire perimeter, with a maximum at the *head fire* and a minimum at the *back fire*. Fire intensity is used to describe limits for prescribed fires, although fire intensity limits that have been defined for a particular fuel type should not be applied to fuel types that are structurally dissimilar.\textsuperscript{153}

The total heat output of a fire is expressed as a unit of area – kJ/m\textsuperscript{2}. The amount of heat released from surface fuels is important when considering the effects of fire on soil and plant stems. The amount of heat released from all fuels is important when considering the effects on trees and shrubs and the total convective updraught.\textsuperscript{154}

The equations used to calculate fire intensity and the total heat output are shown in Figure 2.9 below.

\textsuperscript{150} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 19.

\textsuperscript{151} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 18-21.


\textsuperscript{153} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 21-22.

\textsuperscript{154} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 21-22.
Figure 2.9: Fire intensity and heat output.\textsuperscript{155}

<table>
<thead>
<tr>
<th>Byrns Fireline Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I = H \cdot W \cdot R$  (equation 2.1)</td>
</tr>
<tr>
<td>where:</td>
</tr>
<tr>
<td>$I$ = fireline intensity (kW/m)</td>
</tr>
<tr>
<td>$H$ = heat content of fuel (kJ/kg)</td>
</tr>
<tr>
<td>Approximately 18,600 kJ/kg</td>
</tr>
<tr>
<td>$W$ = weight of fuel burnt per unit area (kg/m$^2$)</td>
</tr>
<tr>
<td>$R$ = rate of fire spread (m/s)</td>
</tr>
</tbody>
</table>

Total heat released

$H_A = H \cdot W$  (equation 2.2)

where:

$H_A$ = total heat released per unit area (Kj/m$^2$)
$H$ = heat content of fuel (kJ/kg)
$W$ = weight of fuel burnt per unit area (kg/m$^2$)

**Junction zones**

A junction zone is an area where two fire edges meet, resulting in rapid combustion and a significant increase in flame height and intensity. The intensity and size of junction zones in a prescribed burn can be reduced by spacing the ignition points at a sufficient distance to prevent them joining before weather conditions have moderated. Ignition points can be spaced closer together to have the opposite effect.\textsuperscript{156}

**Fire whirls**

Fire whirls are vortices of ascending hot air and gases, which rise from a fire carrying smoke, debris and flame, and which may pose challenges for both safety and fire containment at prescribed burns. They are common during high intensity prescribed burning if the atmosphere is unstable.\textsuperscript{157}

**Smoke**

Smoke comprises water vapour, particulates (tar, ash, carbon, unburnt fuel fragments), and gases (CO$_2$, N$_2$O, S$_2$O, NH$_3$, CH$_4$, NO$_x$, ozone and other non-methane hydrocarbons). Particulates are the product of incomplete combustion. Over half of the total mass of particulates is made up of tar

\textsuperscript{155} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 21.

\textsuperscript{156} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 22-23.

\textsuperscript{157} Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 24-36.
droplets with the remainder being crystalline ash and carbon particles which may also contain absorbed hydrocarbons. The proportion of fuel converted to particulates is around 0.44 per cent for high-intensity fires under very dry conditions and around two to four per cent for low-intensity fires during mild weather conditions. An average of around 1.5 to two per cent of the total weight of fuel consumed is converted to smoke. The issue of smoke produced from prescribed burning is discussed in further detail later in this chapter.

**Fuels**

**Total fuel**

The *Synopsis* describes fuel as “the most important factor” influencing fire behaviour. *Total fuel* is defined as the maximum quantity of combustible material that is burnt under the most extreme conditions. *Available fuel* refers to the proportion of the total fuel that is consumed when fuel and weather conditions are less than extreme. Available fuel depends on a range of factors and cannot be measured prior to the occurrence of a fire. Instead, it must be estimated from current and preceding weather and therefore “presents a major problem in quantifying fuels for fire behaviour predictions”.

**Fuel size and arrangement**

The rate of spread of a fire and its flame dimensions are influenced only by certain components of the total fuel. Fine fuels (e.g. grass, leaves, twigs etc. of <6 mm in diameter) produce the bulk of the flames. In contrast, heavy or coarse fuels are unlikely to ignite in the absence of fine fuels and once ignited, provide only a small contribution to the flame front.

Fire behaviour also depends on the structure of the fuel bed i.e. the relative arrangement of individual pieces of fuel. However, the Synopsis notes that these characteristics are difficult and time consuming to measure in the field. Accordingly, Australian prescribed burning guides, for specific fuel types, are instead described in terms of characteristic overstorey and understorey vegetation.

**Fine and coarse fuels**

The Synopsis divides fuels into the following broad categories:

- surface fine fuels;

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159 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 29.

160 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 29.

- near-surface fine fuels;
- elevated fine fuels;
- bark fine fuels;
- canopy fine fuels;
- coarse surface fuels; and
- coarse standing fuels (usually dead standing trees but includes dead limbs on live trees and hollow live trees).

The location of fuel components within a forest is illustrated in Figure 2.10 below.

**Figure 2.10: Components of forest fuels.**

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162 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 30-34.

163 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 31.
**Fuel and fire behaviour**

According to the Synopsis:

> the complexity of forest fuels makes it difficult to identify and measure simple characteristics that can be used to predict fire behaviour. Even with relatively simple fuels such as grasslands, variables that are significant in laboratory experiments have little effect in the field.\(^{164}\)

Moreover, the Synopsis notes that fuel of increasing size has a greater influence on forest fire behaviour as fire intensity and wind speed increase, so that:

> it is unlikely that a single measure of fuel, e.g. fuel load, will be a good predictor variable over the full range of fire intensities, and over a range of fuel structures as fuels increase with age.\(^{165}\)

The Synopsis also notes that studies of the effect of fuel quantity on rate of spread are limited and provide conflicting findings but nevertheless concludes that:

> broad area prescribed burning changes a number of fuel characteristics that will result in reduced rate of spread, reduced spotting, reduced flame heights, reduced fire intensity and increased ease of suppression for a period of time following the burn.\(^{166}\)

**Fuel accumulation**

The Synopsis outlines the use of fuel accumulation curves, which have been developed for different types of forests. These predict the rate at which surface fine fuels and elevated fuels accumulate following a fire and the time taken to reach equilibrium fuel loads (the point at which the rate of decomposition prevents further fuel build-up). In dry sclerophyll forests fuel loads increase rapidly for the first ten years before reaching an equilibrium fuel load of around 15 tonnes per hectare (although the elevated fuel load may continue to increase for a further 25 years). In wet sclerophyll forests fuel may accumulate for up to 30 years before attaining an equilibrium fuel load of around 30 tonnes per hectare.\(^{167}\)

**Fuel moisture content**

The Synopsis defines fuel moisture content as “the proportion of free and absorbed water in the fuel” expressed as a percentage of its “oven dry

\(^{164}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 34.

\(^{165}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 34.

\(^{166}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 34.

weight” (i.e. the weight of the fuel after being dried at 105°C until any further weight loss has ceased).  

The importance of fuel moisture content is explained in the Synopsis in the following terms:

Fuel moisture content affects the ease of ignition, fire spread rate, fire intensity, smoke properties, fuel consumption, spotting and plant mortality or scorch. Fuel moisture is so important that it forms a foundation for many fire danger rating systems...

Fuel moisture content also affects the rate at which fuel will burn, while the distribution of moisture in the fuel bed affects the amount of fuel that is available to burn.

In general, a fire’s rate of spread is most affected by the dead fine fuels. Accordingly, the moisture content of these fuels is critical to the prediction of fire behaviour and to the planning and conduct of prescribed burns.

Two measurements of the moisture content of surface fine fuels are used when planning a prescribed burn. The first of these is the surface moisture content, the second is the profile moisture content (i.e. the average moisture content of the entire litter bed). The Synopsis explains the way in which these measurements are used when planning prescribed burns of differing intensity as follows:

Low intensity prescribed fire in eucalypt fuels is usually best conducted when the surface moisture content is between 9% and 16%. The lower layers of the litter bed may be much moister than this (>20%), which is usually desirable so that some litter is left to protect the soil from erosion and to protect some of the litter decay organisms (Tolhurst et al., 1992). For high intensity prescribed fires such as regeneration burns, the surface moisture content may be as low as about 6% within the prescribed area, but the surface moisture content in the adjacent undisturbed forest needs to be above 14% to limit the chance of spot fires and the fire escaping outside the prescribed area.

The fuel moisture content of elevated fuels is also important in areas such as heathlands or forests with a wiregrass understorey.

Dead coarse fuel moisture and live fuel moisture are also factors in fire behaviour.
A variety of methods have been developed to measure or estimate fuel moisture content. The standard method is oven-dry determination which involves drying to a constant weight at a defined temperature. This method is susceptible to variations of one to two per cent. The two field-based techniques used in Victoria are:

- the Speedy Moisture Meter, which measures the moisture content of a soil sample; and
- the T-H Fine Fuel Moisture Meter, which measures the electrical resistance of a ground sample.

Other methods of moisture assessment noted in the Synopsis include laboratory based techniques, fuel analogues, meteorological models and remote sensing.\(^{175}\)

**Assessing the Overall Fuel Hazard**

The basis for assessing fuel hazards is DSE’s *Overall Fuel Hazard Guide* (1999) (“the Guide”). The Guide is used by prescribed burn supervisors (and during bushfire suppression operations), to assess the “Overall Fuel Hazard”, which is defined as:

\[
\text{Overall Fuel Hazard} = (\text{the sum of the influences of}) \text{ Bark Hazard} + \text{Elevated Fuel Hazard} + \text{Surface Fine Fuel Hazard} \]

The Guide defines five levels of hazard for each fuel type: low; moderate; high; very high; and extreme, and provides a photographic guide for the purposes of assessment.

Fuel hazard levels are then defined for Fuel Management Zones One to Three, with the protection requirements of each zone to be met by “maintaining each fuel component at or below the following maximum levels”:\(^{177}\)

**FMZ 1 Moderate Overall**

- Surface Fine Fuel Moderate (litter bed height 15-25 mm);
- Bark Fuel High (unless Surface Fine Low); and
- Elevated Fuel High.

**FMZ 2 High Overall**

\(^{174}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 46-49.

\(^{175}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 50-51.


- Surface Fine Fuel High (litter bed height 25-35 mm);
- Bark Fuel High (unless Surface Fine Low); and
- Elevated Fuel High.

**FMZ 3 High Overall on 50%**

- Surface Fine Fuel High (litter bed height 25-35 mm) on 50% of the zone
- Bark Fuel High on 50% of the zone (unless Surface Fine Low); and
- Elevated Fuel High on 50% of the zone.\(^{178}\)

The approach set out in the Guide represents a significant change to the way in which fuel hazards and their fire behaviour effects were previously assessed. Previously, surface fine fuel loads (in tonnes per hectare) provided the sole measure of fuel hazard. The new approach places the emphasis on the entire fuel complex, particularly the bark and elevated fuels, the fuel elements which are primarily responsible for both first attack failure and general suppression difficulty.\(^{179}\)

**Fire weather**

Fire weather describes the effects of both climate and weather on the probability that a fire will ignite, its subsequent behaviour and the difficulty of suppression. The Synopsis identifies a variety of factors which influence fire weather, including:

- long-term weather cycles, produced by variations in weather from year to year, due to phenomena such as the El Nino effect and drought;
- seasonal cycles, which produce significant variations in temperature, wind and rainfall patterns;
- diurnal (i.e. daily) cycles; and
- short term and local weather effects, which include cold fronts, wind gustiness and directional variability, horizontal wind profiles and jets.\(^{180}\)

The Synopsis describes diurnal cycles in particular as having:

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\(^{180}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 53-72.
Inquiry into the Impact of Public Land Management Practices on Bushfires in Victoria

...profound effects on fire behaviour...[which]...must be understood if fires are to be prescribed or suppressed successfully.¹⁸¹

The factors involved in diurnal cycles include:

- temperature and humidity;
- wind speed and direction (noted in the Synopsis as having “potentially the most immediate and significant short-term influence on prescribed burns with the exception of rain”);
- atmospheric stability, which has an affect on fire intensity and which can include the formation of inversion layers (a stable layer of air where temperature increases with height);
- sea breezes and land breezes; and
- katabatic and anabatic winds (katabatic winds occur in mountainous areas on cloudless nights and involve the movement of cooler air down slope; anabatic winds are the result of the opposite process during the day – both are used to control prescribed burning in mountainous areas).¹⁸²

Topography

Topography refers to variations in the land surface according to: slope steepness (as a general rule a fire’s rate of spread doubles with each 10 degrees of slope); aspect; elevation; and landscape pattern (such as rockiness and the continuity of fuels). Variations in topography can have dramatic effects on fire behaviour as well as influencing variations in local fuel and weather conditions.¹⁸³

Prescribed burning techniques

With the above outline of the factors influencing bushfires and prescribed burns in mind, an overview of the prescribed burning techniques described in the Synopsis can be now be placed in context. As noted above, the main techniques of prescribed burning in Victoria outlined in the Synopsis include: control lines; ignition patterns; ignition times; and ignition tools.

Control lines

Control lines are constructed barriers (e.g. a mineral earth trail built by bulldozer, freshly slashed heath or grass, or a wet line created by foam or a retardant strip) or natural barriers such as rocky outcrops or wet gullies. The location of control lines is described in the Synopsis as one of the most...
important decisions for a successful prescribed burn. Moreover, a control line is required to prevent the spread of fire under the conditions prescribed for that fire as well as under more severe conditions that may arise on subsequent days. Control lines may also be based solely on a fuel moisture differential but these are most likely to be effective during late Autumn, especially since smouldering logs may cause re-ignitions many weeks after a burn during periods of high fire danger. A prescribed burn that has been well planned will include a contingency plan, consisting of a fallback control line and, in most cases, the capacity to drive fire suppression vehicles along the control line to reach any areas of spotting. ¹⁸⁴

Buffer zones may also be established in the area beyond the control line to provide additional fuel reduction treatments or vehicle access, although these are more commonly used around high-intensity prescribed burns. ¹⁸⁵

Edging is a type of buffer zone which is used for large aerially ignited prescribed burns. It involves burning the perimeter of a block during mild conditions such as the Autumn prior to the prescribed burn. ¹⁸⁶

**Ignition patterns**

The Synopsis describes the ignition pattern as critical to the success of a prescribed burn and notes that fire intensities can be increased or reduced by a factor of five, according to the chosen pattern.¹⁸⁷ Ignition patterns are often varied to accommodate weather, fuel and topography, and therefore call for a skilled and disciplined lighting crew and fire controller. The Synopsis notes that there are a number of recognised ignition patterns with “countless” variations. The most common ignition patterns, a number of which are illustrated in Figure 2.11 below, are:

- backing fire ignition;
- spot fire ignition;
- strip head ignition;
- chevron fire ignition;
- centre fire ignition;
- ring or perimeter fire ignition; and

¹⁸⁴ Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 79-80.
¹⁸⁵ Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 80.
¹⁸⁶ Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 80.
¹⁸⁷ Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 80.
area ignition. 188

**Backing fire ignition** is used to minimise the fire intensity and maximise the degree of control. It reduces scorch to the overstorey, maximises the proportion of fuel burnt and reduces spotting. A disadvantage of this pattern, however, is its slow burning rate, resulting in a longer time to burn out a given area. 189

**Spot fire ignition** is often used for low-intensity prescribed fires in forests and logging slash on hilly terrain where *centre firing* cannot be applied. Altering the spacing of the lighting grid allows the intensity of the fire to be adjusted. Fire intensity can also be minimised by the spacing of spots so that fires link up during the evening when conditions are cooler. This ignition pattern results in around 30 per cent of the total area being burnt with the intensity of a head fire. The Synopsis notes that this method allows relatively large areas to be burnt at comparatively low cost. However, a possible disadvantage involves access and safety where ignition is ground based and there is dense understorey or difficult terrain. On the other hand, this ignition pattern is described as especially adaptable to aerial ignition. 190

**Strip head fire ignition** produces a more intense fire than spot fire ignition and may be used when conditions are too mild to enable a fire to run with spot fires or where a higher intensity fire is needed to achieve the management objectives for the burn area. This method results in 80 to 90 per cent of the area being burnt with the intensity of a head fire. In general, increasing the number of lines of fire increases the overall intensity of the fire due to the interaction between the lines. This method is generally conducted on the ground and by hand – it is comparatively more expensive than spot ignition. 191

**Chevron fire ignition** involves the ignition of continuous parallel lines of fire in a path directly into the wind, resulting in the majority of the fire being burnt by flank fires. The intensity of the overall fire can be increased by placing the lines of fire closer together since this increases the area subjected to junction zone fires. However, overall intensity is generally lower than that produced by strip head fire ignition but more intense than spot fire ignitions or backing fires. This method produces a relatively quick burn out of the area with relatively good control, although it can also lead to the formation of head fires which then allow the fire to escape control. A high level of skill is needed to use this method successfully. A variation of this technique may be used to burn out the vegetation on a spur. 192

188 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 81.
189 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 81.
190 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 81.
191 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, pp. 81-82.
192 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 83.
Centre fire ignition is only used in areas of heavy fuel, such as logging slash. It produces a high intensity fire with a strong convection column. 193

Ring or perimeter fire ignition also produces a convection column and has a similar effect to centre fire ignition. It can be used where fuels are too low for centre fire ignition or where access is a problem but it is only successful where the effects of wind or slope are minimal. This method is also most applicable to relatively small areas. 194

Area ignition is also used in areas of heavy fuel, such as logging slash, to remove the maximum amount of fuel possible. Its use is limited to flat terrain during light winds. Area ignition produces a particularly rapid burn and involves relatively less time and expense but has a high risk of escape. 195

193 Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, p. 84.
194 Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, p. 84.
195 Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, p. 84.
Figure 2.11: Common ignition patterns used for prescribed burning.\textsuperscript{196}

Note: small arrows show the direction of lighting.

\textsuperscript{196} Dr. K. Tolhurst and N. P. Cheney, \textit{Synopsis of the Knowledge Used in Prescribed Burning in Victoria}, Department of Natural Resources and Environment, Melbourne, 1999, p. 82.
**Ignition times**

The behaviour of a prescribed burn is also influenced by the time of day that it is ignited. The intensity and effects of a fire can be altered when ignition time is combined with ignition pattern and burn duration.197

Ignition of a prescribed burn early in the day produces a fire that starts slowly but which gradually builds as the fuels dry out through the day. As a result, the majority of the area is alight during the hottest and driest period of the day, increasing the difficulty of fire control and maximising the intensity of junction zones. The Synopsis notes that:

> A major cause of prescribed fires exceeding the desired intensity and causing suppression difficulties is that they are started under poor burning conditions early in the morning. Lighters usually place spots too close together in order to get them burning and then have difficulties as the fuels dry out and wind speeds increase during the day.198

The commencement of ignition around noon or early afternoon can delay the formation of junction zones until the late afternoon or evening, by which time the fire intensity has begun to decline so that canopy scorch is minimised. However, if ignition is delayed until late afternoon, the result can be unburnt patches which can reignite on subsequent days.199

Ignition in the late afternoon or early evening can achieve fires of comparatively low intensity under very dry conditions. However, this method is generally only successful during late Spring / early Summer or late Summer / early Autumn. Although the chance of an escape is minimised by this method, the area must be burnt out before the fire is extinguished by fuel moisture conditions.200

The Synopsis emphasises the following issue in relation to ignition times:

> A major problem with area prescribed burning is having areas of fire left within the burn when severe weather conditions are forecast on subsequent days. It is virtually impossible to contain the perimeter of fires inside the burn so all efforts must be made to burn the area out before the onset of severe weather by increasing the intensity of ignition, even if this means exceeding the prescribed intensity.201

**Ignition tools**

Aerial ignition and ground ignition are the two main ignition methods. Ground ignition is generally used where the burn area is under 200 hectares, where there is good access throughout the area and where the

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197 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 85.
198 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 85.
199 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 85.
200 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 85.
201 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.
costs of aircraft are not justified. A particular advantage of aerial ignition is its applicability where there is a narrow window of opportunity to burn within the prescriptions. The choice of an appropriate ignition tool is determined by the factors of fuel, weather, topography, human and financial resources and management objectives.\(^{202}\)

The two primary aerial ignition devices in Victoria are the “Ping-Pong Ball” machine and the “Dragon”.\(^{203}\)

The “Ping-Pong Ball” machine releases small plastic incendiary balls, usually from a helicopter, which ignite around the time they reach the ground. This method is used in difficult terrain, for burning large areas and is commonly used to conduct low intensity burns in forests.\(^{204}\)

The “Dragon” is an aerial driptorch suspended beneath a helicopter, which is used to ignite and release controlled amounts of jellied petrol. Unlike the “Ping-Pong Ball” machine, this method is used where there is limited surface fine fuel but a large amount of elevated or coarse fuel – it allows the ignition of very intense fires.\(^{205}\)

Ground ignition methods include: the hand-held driptorch, fusees (matches which are wind and water proof), and the vehicle-mounted flame-thrower. The choice of device will depend on the conditions and the objectives of the burn.\(^{206}\)

The hand-held driptorch allows ignition points to be precisely located and for continuous changes to be made to the lighting pattern. However, it is “easy to use but difficult to use well”.\(^{207}\) The Synopsis notes that:

> One temptation when using a driptorch is to light too many spot fires too close together or even to light continuous lines instead of spot fires. Experience and discipline are important attributes of a good operator.\(^{208}\)

Fusees are used to achieve a specific pattern of spot fires where there is ample dry surface fine fuel. This method is less likely to result in areas being over-lit and provides the fire supervisor with greater control over the ignition

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\(^{202}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.

\(^{203}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.

\(^{204}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.

\(^{205}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.

\(^{206}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.

\(^{207}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.

\(^{208}\) Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.
pattern. However, fusees are less suitable where the surface fine fuels are patchy or have a relatively high moisture content.\textsuperscript{209}

Vehicle-mounted flame-throwers are attached to the back of a vehicle which is driven along a control line or other form of ignition line. This method is useful where it is necessary to ignite a long perimeter burn and where the fuels are discontinuous (e.g. some heathlands, mallee shrublands and hummock grasslands). This method can be very effective and is relatively inexpensive.\textsuperscript{210}

A further method of ground ignition is the hand-held incendiary launcher. However, the Synopsis notes that this method is used infrequently, for example where there is poor access within the burn area but ground ignition is required.\textsuperscript{211}

Planning and conducting the burn

As noted above, the Code requires the planning for prescribed burning operations to be “based on clearly stated objectives” and for each prescribed burn to have a primary objective of either: fuel reduction; silvicultural; or ecological management.\textsuperscript{212}

The Prescribed Burning Manual identifies two main types of burn which are currently used to achieve these objectives: low-intensity prescribed burning (LIPB); and high-intensity prescribed burning (HIPB).\textsuperscript{213}

Low-intensity prescribed burning (LIPB) is used to modify fuels that have generally resulted from natural accumulation. LIPB uses “spreading fires” to burn only a proportion of the fine fuel in the fuel profile and occasionally a very small proportion of the coarse fuels.\textsuperscript{214}

High-intensity prescribed burning (HIPB) is used to modify generally large accumulations of vegetation debris (e.g. following clear-fell timber harvesting, land clearing, roadworks and wind-throw). The manual states that this involves burning large quantities of fine, coarse and even larger fuels at very high heat levels. HIPB fires are relatively confined in area but have a long burn-out time and usually produce strong convection and inflow winds, fire-whirls and large airborne firebrands. The manual notes that “[s]ome ecological burns, particularly where there is a high quantity of

\textsuperscript{209} Dr. K. Tolhurst and N. P. Cheney, \textit{Synopsis of the Knowledge Used in Prescribed Burning in Victoria}, Department of Natural Resources and Environment, Melbourne, 1999, p. 87.
\textsuperscript{210} Dr. K. Tolhurst and N. P. Cheney, \textit{Synopsis of the Knowledge Used in Prescribed Burning in Victoria}, Department of Natural Resources and Environment, Melbourne, 1999, p. 87.
\textsuperscript{211} Dr. K. Tolhurst and N. P. Cheney, \textit{Synopsis of the Knowledge Used in Prescribed Burning in Victoria}, Department of Natural Resources and Environment, Melbourne, 1999, p. 86.
elevated fuel, will also be of a relatively high intensity” but that whether these burns are of a low or high-intensity will depend on the ecological objectives.215

Each Burn Plan must state the primary objective of the burn and the Burn Prescription (the acceptable limits of factors such as temperature, fuel moisture content, wind speed, etc.) that will be used to achieve it.216

The Manual contains a table of standard prescriptions for prescribed burns, which is reproduced as Table 2.2 below.217 These standard prescriptions are based on nine categories of vegetation (defined as “Burn Class”) and are applicable to all Fire Regions across the state.218 The factors included in the standard prescriptions are as follows:

- **Fire Danger Index (FDI (max))**: defined as a “relative number denoting an evaluation of rate of spread, or suppression difficulty for specific combinations of fuel, fuel moisture and wind speed”.219 A Forest Fire Danger Index (FFDI), which includes the long and short term effects of drought, is generally used to calculate the fire danger index in forest areas.220

- **Air temperature (Temperature (°C))**: the air temperature measured in degrees Celsius.

- **Relative humidity (RH (%))**: defined as the “amount of water vapour in a given volume of air, expressed as a percentage of the maximum amount of water vapour the air can hold at that temperature”.221

- **Wind speed (Wind (km/h @ 10 metres in open))**: wind speed measured in kilometres per hour (wind direction is also taken into account).

- **Keetch – Byram Drought Index (KBDI)**: defined as “a numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation, and expressed as a scale from 0 – 200”.222

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- Fine fuel moisture content (FFMC (%)): defined as “the proportion of free and absorbed water in the fuel expressed as a percentage of its oven dry weight”.223

The revised version of the Prescribed burning Manual provides the following as examples of fuel reduction and ecological burn objectives, and the associated Burn Prescriptions, in a Burn Plan:

**Fuel Reduction Burn**
*Burn Operation Objective:*
To produce a mosaic of burnt surface fuels on 50% of the Burn Area, while protecting timber regrowth in the burn area and adjacent wet gully vegetation.

*Burn Prescription:*
DRY SCLEROPHYLL FOREST (MATURE, WITHOUT WIREGRASS) - FDI <10, Day 2 <12. Temp 18-27. RH 35-70%. Wind <20kph (<10kph @ 1.5m in forest). KBDI <50, or <120 (if fallen =>30 from Summer max). FFMC FRB: surface 9-16%.

Hypothetical Land Management Objectives could be:
Reduce fuel levels so that no more than 50% of area has an Overall Fuel Hazard of High or above.
Increase area of vegetation affected by recent fire to bring fire age class distribution closer to that idealised distribution identified through fire ecology studies.

**Ecological Burn**
*Burn Operation Objective:*
To burn 80% of the Burn Area at moderate intensity in Summer/early Autumn.

*Burn Prescription:*
GRASSLANDS - FDI 8 (Grassland FDI). Temp <30. RH >30%. Wind <15kph. KBDI <100. FFMC curing >80%.

Hypothetical Land Management Objectives could be:
Reduce overall biomass (dead grass tillers) and to encourage the regeneration of an assemblage of herbaceous inter-tussock species.
Reduce fuel hazard so that no more that 80% of the area has an Overall Fuel Hazard above Low.224

The Manual describes the circumstances in which the standard burn prescriptions may be altered but notes that “no single parameter should be allowed to deviate from the standard prescriptions without very careful consideration” and that any variation “should not lead to a FDI greater than the standard prescribed”.225 The Manual also requires that approval of any deviation from the standard prescriptions be obtained from a Manager Fire.226

223 Dr. K. Tolhurst and N. P. Cheney, *Synopsis of the Knowledge Used in Prescribed Burning in Victoria*, Department of Natural Resources and Environment, Melbourne, 1999, p. 38.
224 Department of Sustainability and Environment, *Fire Management Manual 10.1: Prescribed Burning*, Department of Sustainability and Environment, Melbourne, 2008, pp. 1-6 to 1-7. This revised version of the Manual was provided to the Committee shortly before the finalisation of the report.
**Table 2.2: Standard prescribed burn prescriptions.**

<table>
<thead>
<tr>
<th></th>
<th>Dry sclerophyll forest (regrowth, without wiregrass)</th>
<th>Dry sclerophyll forest (mature, without wiregrass)</th>
<th>Wiregrass - regrowth forest</th>
<th>Wiregrass - mature forest</th>
<th>Heathlands (coastal foothill, mountain)</th>
<th>Malalea, desert heaths, Hummock grasslands</th>
<th>Grasslands</th>
<th>Ash/HEMS logging slash</th>
<th>Softwood slash</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FDI (max)</strong></td>
<td>8</td>
<td>10</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>20</td>
<td>8</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>RH (%)</strong></td>
<td>35-70</td>
<td>35-70</td>
<td>≥60</td>
<td>&gt;45</td>
<td>45-80</td>
<td>25-80</td>
<td>&gt;30</td>
<td>35-80</td>
<td>&gt;40</td>
</tr>
<tr>
<td><strong>Wind</strong></td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
<td>Beaufort = leaves rustle, some motion</td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
<td>Beaufort = leaves and twigs (only in constant motion)</td>
</tr>
<tr>
<td><strong>KBDI</strong></td>
<td>&lt;50</td>
<td>&lt;50 or &lt;120 (if fallen ≥30 from summer max)</td>
<td>&lt;80 autumn</td>
<td>&lt;30 spring</td>
<td>cured ≥80%</td>
<td>cured ≥80%</td>
<td>cured ≥80%</td>
<td>cured ≥80%</td>
<td>cured ≥80%</td>
</tr>
<tr>
<td><strong>FFMC (%)</strong></td>
<td>Surface 9-16</td>
<td>Surface 9-16</td>
<td>elevated &gt;13</td>
<td>surface &gt;16</td>
<td>curing &gt;80%</td>
<td>curing &gt;80%</td>
<td>curing &gt;80%</td>
<td>curing &gt;80%</td>
<td>curing &gt;80%</td>
</tr>
</tbody>
</table>

The reporting process for prescribed burning

The reporting process for prescribed burning is the subject of the Inquiry’s fourth term of reference. The reporting hierarchy within which the planning, conduct and post-burn assessment of prescribed burning by DSE and its partner agencies occurs has been outlined above. In this section, the Committee outlines the way in which the effectiveness of each prescribed burn is assessed and how the outcomes are reported. The Committee then considers the argument, which was made by a number of stakeholders, that there is a need for greater transparency in the reporting process. The section concludes with a discussion of the use of remote sensing imagery in Western Australia and the potential that exists for the greater use of this technology in Victoria’s prescribed burning program.

Background

Following the completion of a prescribed burn, the officer in charge of the burn (the “burn OIC”) must prepare a record of the burn outcomes, for entry in FireWeb.228 The outcomes recorded, as shown in Figure 2.12 below, include the intensity of the burn and a map showing the areas which were burnt or unburnt.

228 Department of Sustainability and Environment, Fire Management Manual 10.1: Prescribed Burning, Department of Sustainability and Environment, Melbourne, 2005, p. 6_1.
Figure 2.12: Prescribed burn record.

Prescribed Burn Operations Record
[FireWeb]

The following must be recorded in FireWeb for each prescribed burn by the end of May for Autumn burns and the end of December for Spring burns:

- date of the burn;
- Fire Danger Index;
- weather conditions at appropriate times before and during the burn, including:
  - Drought Index (or equivalent) for the day;
  - air temperature;
  - relative humidity;
  - general wind direction and speed;
- intensity class;
- ignition pattern;
- whether or not objectives were achieved.

*Intensity class:*

Very High – means crowns removed  
High – means crowns scorched  
Medium – means understorey scorched  
Low – means surface (only) burn

Defaults:

‘Medium’ – Fuel Reduction Burn  
‘Very High’ – Regeneration Burn

In addition to completing the Prescribed Burn Operations Record, the following documents must be produced and stored:

- copy of the approved Burn Plan and maps;
- list of resources, including personnel, used at the burn (this may be a printout from IRIS);
- map of areas burnt and not burnt;
- map showing the extent of any escapes beyond the planned control lines;
- checklist of tasks completed on the day of the burn;
- details of rehabilitation works undertaken;
- an electronic record of the burn boundary to update fire history layers in the DSE Corporate Geospatial Data Library (CGDL). This should be forwarded to the Manager, Data Unit, Fire Information & Systems Group, Level 4, 8 Nicholson Street, East Melbourne 3002. For information regarding data collection and formatting standards, refer to Guideline 4.1.1: Collection of Fire History Data in Fire Management Manual 4.1 Fuel Management (DNRE 2002a).

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229 Department of Sustainability and Environment, Fire Management Manual 10.1: Prescribed Burning, Department of Sustainability and Environment, Melbourne, 2008, p. 6_1 to 6_2.
The Prescribed Burn Operations Record enables the outcome of the burn to be reviewed according to the objectives of the Burn Plan. Where objectives are not met, the Manual states that “corrective actions must be taken, and burns rescheduled in Fire Operations Plans if necessary.” As noted below, the Committee received evidence from a number of stakeholders that burns are often not rescheduled following a failure to meet the objectives contained in a Burn Plan.

The criteria used by DSE to assess the outcome of a fuel reduction burn are contained in Fire Protection Plans. For example, the Gippsland Fire Protection Plan provides the following in relation to Fuel Management Zones 1, 2 and 3:

Zone 1: Fuel management is to be intensive, i.e. to treat up to 90 % of each fire protection unit in each burning operation.

Zone 2: Fuel management is to be strategic and regular and aims to maintain a nominated range of fuel characteristics that are generally broader than those for Zone 1, i.e. to treat up to 80 % of each fire protection unit in each burning operation.

Zone 3: Fuel management aims to provide a mosaic of fire frequencies and intensities without large contiguous areas of non-managed fuel, complementing the intensive and strategic fuel management undertaken in Zones 1 and 2. Opportunistic burning may also occur in this zone to link areas burnt by wildfire to other strategic fuel management areas. It is aimed to treat approximately 50 % of each burning unit in any burning operation.

The majority of post-burn assessments are currently conducted by means of a “walk-through” by personnel from DSE and partner agencies, although aerial and satellite observation may also be used in some cases. As indicated in the example above, the aim of the assessment is to determine the proportion of the area within each “fire protection unit” or “burning unit” which has been burnt.

The Mildura Fire Protection Plan, which as noted above, is the first such plan to have implemented the new four "Fire Management Zone" model, has also adopted new fuel reduction benchmarks for its zones. As with the current Fire Protection Plan for Gippsland, the new Mildura plan specifies that each “fuel treatment operation” should result in area treatments of 90 and 80 per cent for zones one and two respectively. However, the Mildura plan also states that the object of each fuel treatment in zones one and two is to achieve an overall fuel hazard rating of “Low.” The Committee notes that this introduces a specific requirement to conduct post-burn assessments in zones one and two by reference to overall fuel hazard ratings and therefore, to the level of risk reduction achieved. The Committee

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230 Department of Natural Resources and Environment, Fire Management Manual 10.1: Prescribed Burning, Department of Sustainability and Environment, Melbourne, 2001, p. 6_1 to 6_2.
231 Department of Natural Resources and Environment, Fire Management Manual 10.1: Prescribed Burning, Department of Sustainability and Environment, Melbourne, 2001, p. 6_2.
232 Department of Sustainability and Environment, Fire Protection Plan - Gippsland Region, Department of Sustainability and Environment, Melbourne, 1999.
233 Department of Sustainability and Environment, personal communication, 29 February 2008.
234 Department of Sustainability and Environment, North West Region - Mildura Fire District Fire Protection Plan Department of Sustainability and Environment, 2008, pp. 32, 34.
welcomes this additional level of detail in assessing the effectiveness of individual prescribed burns and is unaware of any reason why it should not be adopted in future plans for all Fire Districts. In relation to zone three, however, the Committee notes that the Mildura plan specifies neither a percentage for the area to be treated nor an overall fuel hazard rating benchmark. The Committee’s concerns regarding the new approach to zone three in the Mildura plan are discussed below. This issue is also addressed by Recommendation 2.1.

The first stage in the reporting process, following the assessment of a prescribed burn, is the production of a weekly internal report by DSE, which details the net treated area within each zone in each Fire District. This reporting process forms the basis of the final statewide net treated area which is reported by DSE in its Annual Report.

DSE also publishes information on the progress of its prescribed burning program throughout the year on its website, which includes details of planned burns, burns in progress and completed burns.

### Evidence received

During a site visit to Cann River, the Committee met with a number of local residents who questioned the accuracy of DSE’s post-burn assessments. Residents claimed that the proportion of a planned burn area that is actually treated is often significantly lower than both the area specified prior to the burn and the area that is subsequently reported. The Committee also heard that burns were often not rescheduled following a failure to treat the specified proportion of a burn unit.\(^\text{235}\)

Grampians Asset Protection also claimed that several planned burns in the vicinity of the Grampians National Park were reported as completed when they had in fact not been conducted. Grampians Asset Protection argued that this demonstrated a need for greater transparency in the reporting process:

> Some of the maps produced over the years have been very misleading, as they have shown burns allegedly completed, but in fact several of them either never took place or were attempted without success under unsuitable conditions. DSE must be accountable in terms of agreed burns actually being carried out…Objective assessments must be made after each attempted burn, indicating the proportion of the targeted area successfully burnt. This data must be fully and openly reported to all interested parties…\(^\text{236}\)

A further problem with the assessment of individual prescribed burns was noted by Dr Kevin Tolhurst who argued that reporting the total area burnt does not provide an effective measure of the burn outcome. Dr Tolhurst argued that, at a minimum, burns should be assessed by reference to the


\(^{236}\) Grampians Asset Protection, *Submission*, no. 167, 1 June 2007, p. 3.
extent to which the desired fuel hazard level is achieved in each fire management zone.237

During a site visit to Western Australia, the Committee was informed by the Western Australian Department of Environment and Conservation that remote sensing imagery, produced by “Landsat” (i.e. satellite), is now used in that state to map both the extent and intensity of prescribed burns.238 An example is shown below at Figure 2.13.

The Committee notes that the adoption of a similar approach to post-burn assessment by DSE, and the publication of the images obtained, may effectively address the stakeholder concerns noted above.

Moreover, the level of post-burn detail possible in such images may also address the concern noted by Dr Tolhurst. The use of a similar indicator to the percentage “biomass change after fire” (shown in Figure 2.13) could provide a more precise indication of the extent to which a prescribed burn had reduced the fuel hazard to desired levels. A post-burn image of this kind could be assessed against a map of the same area showing the pre-burn fuel hazard levels, as measured and recorded using the Overall Fuel Hazard Guide (outlined above).

The Committee notes that the use of Landsat imagery may be more difficult in Victoria’s steep and divided terrain than in Western Australia and that the technology has previously not been cost effective.239 However, DSE has informed the Committee that there is likely to be an increasing use of such satellite imagery in the future as part of the shift to landscape-scale prescribed burning.240

237 Dr. K. Tolhurst, Submission, no. 137, 28 May 2007, p. 4.
240 P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.
Figure 2.13: Landsat image of a prescribed burn in Western Australia.\textsuperscript{241}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{landsat_image.png}
\caption{Landsat image of a prescribed burn in Western Australia.\textsuperscript{241}}
\end{figure}

\section*{Conclusion}

The Committee welcomes DSE's statement that it anticipates and increase in the use of remote sensing imagery as a means of better assessing the outcomes of individual prescribed burns and the effectiveness of the prescribed burning program.\textsuperscript{242} The Committee considers that greater use of remote sensing imagery is likely to significantly increase the capacity of both DSE and the public to determine whether the objectives of a burn have been met and whether there is a need for corrective action such as a follow-up burn. Remote sensing technology has the potential to significantly improve the transparency of the prescribed burning assessment and reporting process.


\textsuperscript{242} P. Harris, Secretary, Department of Sustainability and Environment, \textit{Transcript of evidence}, Melbourne, 7 April 2008.
Recommendation 2.1:

That the Department of Sustainability and Environment implement remote sensing imagery as a routine part of its pre-burn and post-burn assessment process for prescribed burning. Maps of every prescribed burn should be produced in a similar format to those used in Western Australia, indicating the boundary of each burn and the varying fire intensities achieved within the burn area. The boundaries of all Fuel Management Zones within each burn should also be indicated.

Each prescribed burn map should be made publicly available on the Department of Sustainability and Environment’s website, together with a map of the same burn area which shows the pre-burn fuel hazard levels and a statement of the total area treated within each Fuel Management Zone by each prescribed burn.

The effectiveness of fuel reduction burning

There is a general consensus within the Australian and international literature that fuel reduction burning does contribute to bushfire suppression. This finding was expressed in the Esplin Report in the following terms:

Prescribed burning, for whatever purpose, will reduce the amount of fuel present. If the amount of fuel is less, then the potential heat released in a fire from the remnant fuel is less. If this heat is less, then the chance of controlling any unplanned fire is greater. If the chance of fire control is greater, then the chance of loss of human life and property is smaller.243

In summary, fire intensity, which is a critical factor in bushfire suppression, can be reduced by fuel reduction burning. Moreover, as numerous studies have noted, while the fuel load is one of a number of variables that affect fire intensity, it is the only one that can be modified by human intervention.

In its submission to the Inquiry, DSE also emphasised the overall effectiveness of prescribed burning:

The evidence is that prescribed burning has been of significant assistance in fire suppression operations on public land. Fuel reduction burning has assisted directly in the protection of high-value assets, including townships, and it has played a role in helping firefighters reduce the area burnt by large and severe wildfires.244

DSE cited evidence that the effects of fuel reduction burning may persist for up to 10 to 15 years, while noting that the effects are most significant during the first three to five years. This is explained by the fact that although surface fuels may recover within the first three to five years, the reduction in bark and elevated fuels have longer term effects, such as a decline in the potential for spotting and the formation of crown fires.245

244 Victorian Government, Submission, no. 168, 4 June 2007, p. 3.
245 Victorian Government, Submission, no. 168, 4 June 2007, p. 3.
Meredith (1994) has found that prescribed burning is likely to assist suppression efforts for longer than three years for fires that occur on less severe days. However, he suggested that fires occurring under severe conditions may be the more appropriate ‘yardstick’ given that such fires ‘cause by far the most loss of life and property, as well as environmental damage.’

DSE also referred the Committee to case studies which suggest that the effectiveness of a given burn is influenced by the proportion of the area burnt within its boundaries, noting that in strategic burning corridors (not to be confused with the fuel management zones outlined above) a minimum of 50 per cent, and perhaps up to 60 to 80 per cent, of an area may need to be burnt for it to be effectively treated.

In a supplementary submission to the inquiry, DSE provided recent examples of fuel reduction burns which had contributed to the suppression of bushfires across the state.

Recent confirmation of the effectiveness of fuel reduction burning has also been provided by Project Vesta, a study conducted by the Bushfire CRC and the Western Australian Department of Environment and Conservation. The study found that fuel reduction burning produced reductions in the rate of spread, flame height and intensity of fires. The study also found that prescribed burning reduces the number and distance of spot fires by altering the fuel bed structure and reducing the fuel load – effects which may persist for up to 20 years in forests that contain rough-barked trees and shrubby under-storey.

DSE referred the Committee to recent research from the USA which suggests a link between the placement of fuel reduced areas in space and time and the overall effectiveness of a fuel reduction program. DSE concluded that applying the principles of this work to Australia would translate to the treatment of around two to five per cent of the landscape in strategic locations each year to ensure an impact in a large fire situation. DSE also concluded that the same research suggested that for randomly positioned treatments, around four to ten per cent of the landscape would need to be treated each year to have the same effect.

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247 Victorian Government, Submission, no. 168, 4 June 2007, p. 3.
Stakeholders also provided the Committee with a range of views regarding the appropriate extent of prescribed burning on public land in Victoria. East Gippsland Wildfire Taskforce Inc. suggested that, after deducting rainforest and timber harvesting areas, 20 per cent of the forested areas east of the Snowy River in Gippsland should be fuel reduced each year. Forest Fire Victoria Inc. nominated an annual statewide target of 460,000 hectares (almost six per cent of the public land estate). David Packham, a member of Forest Fire Victoria Inc., suggested a minimum annual statewide target of approximately 600,000 hectares (nearly eight per cent of the public land estate). The issue of the appropriate extent of prescribed burning on public land is discussed in further detail later in the chapter.

### The influence of fuel management zones

While the principle of fuel reduction burning as a bushfire mitigation tool is well established, its effectiveness is influenced by the extent to which fuels are reduced in a given area. One aspect of this is the “management intensity” that is applied to a particular area, which refers to the proportion of each fire protection unit that is treated by a burning operation (e.g. 90 per cent in zone one; 80 per cent in zone two; and 50 per cent in zone three). A further aspect is the level to which fuels are reduced within the treated proportion of each fire protection unit.

A study conducted by McCarthy and Tolhurst (2001) assessed the effectiveness of broadscale fuel reduction burning during the preceding two decades with a focus on the location of fuel management zones. The study concluded that fuel reduction burning in zones one and two did contribute to bushfire suppression but that burning in zone three had only a “random chance” of contributing to bushfire suppression. The Committee notes, however, that the finding in relation to zone three is likely a reflection of the approach to prescribed burning in this zone over past decades. That is, a predominantly random placement of burn units – rather than the emerging approach of strategically placed burns – and an insufficient level of prescribed burning within the zone.

Rawson, Billing and Rees (1985) have noted that large fuel-reduced areas, such as those in zone three, have frequently assisted in bushfire suppression. Moreover, the authors concluded that although such burns had sometimes had a minimal effect on spread rates under extreme conditions, this simply demonstrated the need for treatments which achieve greater reductions in fuel quantity:

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The most dramatic examples of the impact of fuel-reduction burning can be found where fires have spread to barriers created by intensive burning [e.g. zones one and two]. Such burns, usually of relatively small area, have played a vital role in settlement protection in particular.

Large fuel-reduced areas [e.g. zone three] have also provided substantial assistance during fire control operations although, because the total fuel quantities left are usually greater than after a small-scale operation, their effectiveness is more closely linked with fire intensity. They have frequently helped to minimise the spread of lightning-caused fires and therefore assist fire control in often difficult and remote terrain. However, under conditions of very high to extreme fire danger, where a fire has entered on a broad front, such areas have sometimes had little impact on spread rates. Because it is clear that the present standard of fuel-reduction is not always adequate, operational techniques which achieve greater reductions in fuel quantity need to be implemented.258

DSE’s evidence to the Inquiry suggests a change of approach in the areas in which much of the shift towards landscape-scale prescribed burning would need to occur; that is, zone three (under both the 1995 Code and under the revised Code). Although zone three has been renamed under the revised Code as the “Ecological Management Zone”, fire protection benefits remain a requirement for this zone. The strategy for achieving such benefits in Fire Protection Plans produced under the 1995 Code was broadly the same as for zones one and two; that is, to treat a defined percentage of each burning unit (e.g. 50 percent under the Gippsland Fire Protection Plan). However, the new approach to burning in zone three apparently acknowledges that such targets may not be appropriate, either ecologically or from a fire protection perspective.259

In its submission to the Inquiry, DSE provided the following generic example of a possible prescribed burning regime for zone three:

...the fire management objectives in Ecological Zones could be achieved by burning drier north and westerly aspects (say 20-40% of the burn area) for several rotations (i.e. where more naturally fire prone vegetation types occur) – followed by less frequent burning of wetter easterly and southern aspects.260

A specific example of the new approach to prescribed burning in zone three is provided by the Fire Protection Plan for Mildura, which as noted above, is the first plan to adopt the four Fire Management Zone model under the revised Code.261 The plan does not specify a target percentage for the area to be treated within zone three for each burn unit but instead provides that prescribed burning intensity, frequency, seasonality and patchiness should be determined by applicable fire ecology strategies or, where these do not yet exist, by reference to Appendix 2 of the plan. Appendix 2 sets out environmental principles for Mallee public land and preferred fire regimes for

261 Department of Sustainability and Environment, Submission, no. 168E, 4 April 2008, p. 3.
various Mallee vegetation types, based on maximum and minimum tolerable fire intervals for a number of Ecological Vegetation Divisions. 262

On the one hand, the Committee notes that the shift away from area treatment targets within zone three may provide DSE with the flexibility needed to increase the level of prescribed burning, and to achieve more strategically placed mosaics of burnt and unburnt vegetation, across the landscape. On the other hand, the Committee is concerned that the removal of area treatment targets for zone three may reduce the accountability and transparency of prescribed burning operations within the zone. For these reasons, the Committee considers it is particularly important that DSE include a statement of the total area treated within each Fuel Management Zone as part of its reporting process for each prescribed burn, as recommended earlier in this chapter; that is, Recommendation 2.1.

Measuring the effectiveness of fuel reduction and ecological burning

The Esplin Report noted that there is currently no “unequivocal and immediate choice of an appropriate measure for the effectiveness of prescribed burning”. 263 In other words, there is currently significant uncertainty regarding how the effectiveness of prescribed burning may be quantified. The report devoted an entire chapter (Chapter 11) to this issue and outlined thirteen possible approaches to measuring the effectiveness of prescribed burning. While the Committee considers that efforts to quantify the effectiveness of fuel reduction burning in mitigating the scale and intensity of bushfires is important, it also acknowledges that this is likely to remain an area of ongoing research for some time.

The 2003 Victorian Auditor-General’s report recommended that DSE supplement the use of “area targets” as a measure of fuel reduction burning with “measures that more accurately reflect the level of risk reduction being sought and achieved” and that it report on the results obtained. 264

The Committee considers that there are two important aspects to measuring the effectiveness of prescribed burning: cost effectiveness; and improved mapping. These issues are discussed further below.

A number of stakeholders argued that prescribed burning in Victoria is actually increasing the vulnerability of the bush to wildfires. 265 The Committee notes that inappropriate fire regimes have been acknowledged...
as having the potential to produce such an outcome i.e. by promoting fire tolerant plant species. However, the Committee also notes that the continuing process of integrating the ecological research findings of DSE, Parks Victoria and the Bushfire CRC within planned fire regimes will reduce the likelihood of inappropriate planned fire regimes.

**Environmental factors**

A major reason for the controversy surrounding the appropriate extent of prescribed burning on public land is the level of concern within the community about its environmental impacts. A number of stakeholders expressed concerns that current levels and methods of prescribed burning on public land are harmful to the environment.266

However, the Victorian Fire Ecology Working Group (a partnership between DSE and Parks Victoria) has found that biodiversity in Victoria is in fact threatened by the infrequency of current fire regimes:

Inappropriate fire regimes (and in particular too-frequent fire) is commonly regarded as a significant threat to biodiversity in Victoria and indeed, high frequency fire has recently been nominated as a threatening process under the Flora and Fauna Guarantee Act (1988). The results from this analysis indicate, however, that over-burning is not occurring at either a Statewide or at any bioregional scale. These results suggest that the threat which fire frequency poses to species composition and community conservation in Victoria is in fact from under-exposure to fire; i.e. fire frequency is too low across the landscape.267

The challenge of returning fire to the landscape in a way that is consistent with environmental needs has been expressed by David Lindenmayer, Professor of Ecology and Conservation Science at the Fenner School for Environment and Society at the Australian National University, in the following terms:

Most natural fires are very patchy, they leave a very patchy environment and that's critical to the recovery of biodiversity and the environment after fire. The big difference with...back-burning and human fires is that they tend to be very uniform and that creates a very homogeneous environment which is not so good for many species to recover, or recover very quickly from.268

DSE's stated approach to solving this problem has been to emphasise the importance of using planned fire in a way that mimics the natural fire regime.269 DSE has adopted a scientific framework to achieve this which is

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set out in the *Guidelines and procedures for ecological burning on public land in Victoria* (2004) (“the Guidelines”). The Guidelines are not prescriptive but instead contain a number of “general principles which may be used as a guide to action or decision-making”.

The approach outlined in the Guidelines involves using the “vital attributes” (also referred to as “life history”) of key plant species to determine the upper and lower tolerable fire intervals for an ecologically appropriate fire management regime. Plant species are categorized according to their Ecological Vegetation Class (EVC), of which there are approximately 300 across the state and which are defined as:

> ...one or a number of floristic communities that appear to be associated with a recognisable environmental niche, and which can be characterised by a number of their adaptive responses to ecological processes that operate at the landscape scale level.

In the case of ecological burns (i.e. burns with a primary purpose of one or more conservation or related outcomes), the vital attributes approach is implemented through the use of an “Ecological Burn Plan” which is completed prior to the burn.

In the case of each Fire District, and therefore presumably for the majority of broad area burns in zone three, the “vital attributes” approach is to be implemented through an Ecological Fire Strategy (since renamed a “Fire Ecology Strategy”). At the time of writing, DSE had yet to finalise its Fire Ecology Strategies, although the Committee was advised that a number had been completed to draft stage.

The Committee understands that the delay in the completion of Fire Ecology Strategies may be due in part to gaps in data collection and in the mapping of EVCs for particular areas. DSE has advised the Committee that the implementation of Fire Ecology Strategies requires “substantial work” and may take a further three to five years. The Committee has also been advised, however, that a number of Fire Ecology Strategies are now in draft form and are already having an impact on the planning process for prescribed burning. The Committee also notes that DSE has adopted an approach of “adaptive management” to its prescribed burning program to facilitate changes to burning practices in accordance with future research findings.

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270 Department of Sustainability and Environment, *Guidelines and procedures for ecological burning on public land in Victoria*, Department of Sustainability and Environment, Melbourne, 2004, pp. 4-10.


275 Department of Sustainability and Environment, *Submission*, no. 168E, 4 April 2008, p. 3.

A limitation of the “vital attributes” approach on which draft Fire Ecology Strategies are based is that it does not currently account for the effects of planned fire regimes on fauna. The Committee notes, however, that this issue is likely to be the subject of future research.

The Esplin Report cited a figure of around 3.3 per cent as the proportion of public land in Victoria that should be burnt each year for ecological purposes. This figure was based on research conducted by DSE’s Fire Ecology Working Group, which found that the ideal average interval between fires for Victorian forests is about 30 years. Since it is based on an ideal average fire interval for all Victorian forests, this figure apparently accounts for the fact that a proportion of the public land estate is unsuitable for prescribed burning. As noted in the introduction to this chapter, approximately 6.2 million hectares of the total 7.7 million hectares of the public land estate is suited to prescribed burning.

It is important to note that the figure of 3.3 per cent was based on an estimate of the average fire interval for the whole landscape. In many areas, the actual interval between successive fuel reduction/ecological burns is significantly shorter; in some areas it is longer; and in some areas fire is excluded altogether. As the Committee discusses below, the average figure may provide a broad indication of the minimum level of ecological burning required on public land in Victoria, albeit one which may be superseded by future research.

Finding 2.2:

The Committee finds that the frequency and extent of prescribed burning has been insufficient, over a number of decades, for the preservation of ecological processes and biodiversity across the public land estate. An increase in the extent and frequency of prescribed burning for the enhancement of environmental values should therefore be a priority for the Department of Sustainability and Environment and its partner agencies.

Water quality and quantity

The Inquiry’s third term of reference requires the Committee to consider the impact of prescribed burning on water quality and quantity. A reliable and high-quality water supply is of crucial importance for Victoria’s homes, farms, industry and environment. Moreover, the Government has recognised that successive years of low rainfall, population growth, degrading river systems, and the anticipated effects of climate change, all highlight the need for “new and better ways to secure water for the future”. The negative impact on water quality and quantity resulting from recent bushfires, and the

threat posed by future bushfires, must be added to this list of challenges to Victoria’s water supply. In this section, the Committee considers the potential for prescribed burning to mitigate the impacts of bushfires in water catchments through the establishment of appropriate fire regimes.

DSE advised the Committee that a further reason for an increase in prescribed burning is the need to reduce the risks posed by bushfires in and around water catchments.\(^{280}\) DSE referred to the impact of the 2006/07 fires on a number of high value water catchments, historic research in Melbourne’s water catchments and the Australian Capital Territory fires of 2003 as case studies of the impacts of bushfires on catchments.\(^{281}\)

In relation to water yield, DSE cited research conducted since the 1950s in Melbourne’s catchment areas which found that there is a significant decline in water runoff and yields following the regeneration of Mountain Ash forests in areas damaged by bushfires. Water yield gradually declines between 10 to 30 years after the fire event and by 25 to 30 years the decline can be as much as 50 per cent. Full recovery to pre-fire water yields can take up to 150 years. Based on a scenario of 100 per cent damage to Melbourne’s catchments, a predicted 30 per cent decline in yield between 10 to 30 years later would represent an overall cost of $520 million per year, or $16 billion over the whole period.\(^{282}\)

In relation to water quality, DSE referred to the example of the Australian Capital Territory fires which severely affected Canberra’s water catchment. The subsequent decline in water quality resulted in the need for the rapid construction of a water treatment plant. DSE noted that if Melbourne’s catchments were to be similarly affected by bushfires, the estimated cost of fully treating the city’s water would be $2 billion plus running costs.\(^{283}\)

Grampians Wimmera Mallee Water (GWM Water) identified similar problems to those experienced in the ACT. The impact of the 2006 Grampians fires on water quality in the area required GWM Water to shut off the water supply to Stawell for several days to a week after each moderate rain event.\(^{284}\) This continued for approximately 12 months after the fire event. As part of the bushfire recovery process, GWM Water also initiated erosion protection works (rock constructed weirs), a review of water treatment processes and increased water quality sampling.\(^{285}\)

\(^{280}\) Victorian Government, Submission, no. 168, 4 June 2007, p. 11.
\(^{281}\) Victorian Government, Submission, no. 168, 4 June 2007, p. 11.
\(^{283}\) Victorian Government, Submission, no. 168, 4 June 2007, p. 11.
\(^{284}\) GWM Water, Submission, no. 224, 3 July 2007, p. 2.
\(^{285}\) GWM Water, Submission, no. 224, 3 July 2007, p. 3.
Wellington Shire, in Gippsland, summarised the impact of the recent fires in the following terms:

Severe erosion has already caused destructive mud slides in the township of Licola and increased the turbidity of local rivers, especially the Dargo, Barkly, Wonnangatta, Macalister and Mitchell. Contamination of these rivers by ash, soil and debris had rendered some town supplies undrinkable and complicated the treatment of water as far downstream as Bairnsdale, with contaminated water also entering Cowwarr Weir Lake Glenmaggie and the Gippsland Lakes.  

East Gippsland Water (EGW) has noted that it may take a number of years for its river catchments to fully regenerate, and for water quality to be restored, following the bushfires of 2006/07. EGW estimated the cost of dealing with the immediate problem of increased sediment loads following significant rain in early 2007 alone, at approximately $6 million.

EGW also reported that the 2006/07 bushfires had a particularly severe effect on the Mitchell River catchment. The catchment provides drinking water to over 17,000 people in a number of areas including, Bairnsdale, Metung, Paynesville, Bruthen, Nicholson, Lakes Entrance and Lake Tyers. The deterioration in the catchment’s water quality required the installation of significant infrastructure, including, water clarifiers, water settlement dams, emergency water bores, an extensive pipeline network, and diesel generators for electricity generation.

The High Country Councils Coalition informed the Committee that turbidity in the Mitchell River following the 2006/07 fires had necessitated severe water restrictions. The Coalition also stated that it had been advised by the local water authority that:

….. it has incurred considerable costs in terms of providing that immediate response with regard to water treatment, and is likely to require a further $15 million for an additional reservoir and water treatment plant in the short to medium-term. It is a considerable cost associated with water treatment. We are advised that the situation is likely to remain for several years in terms of the turbidity of the water and the issue of the need for water treatment for human consumption.

The importance of prescribed burning for catchment protection has been recognised by Victoria’s Catchment Management Authorities, which provide input into DSE’s prescribed burning program each year. For example, the North East Catchment Management Authority advised the Committee that it is formally invited by DSE to provide input into the annual development of Fire Operations Plans. This input is in addition to the Authority’s

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286 Wellington Shire Council, Submission, no. 79, 23 May 2007, p. 3.
291 North East Catchment Management Authority, Submission, no. 27, 4 May 2007, p. 1.
participation in community forums held in a number of locations and its examination of Draft Plans.292

An increase in prescribed burning on public land within water supply catchments was specifically endorsed by the East Gippsland Catchment Management Authority. The Authority informed the Committee that the recent fires of 2003 and 2007 had burnt extensive areas of the East Gippsland catchments and predicted that the impacts would persist for many years. The Authority also highlighted the fact that the area contains the majority of the Heritage Rivers in Victoria and referred the Committee to the East Gippsland Regional Catchment Strategy (RCS) which has been endorsed by a number of Victorian Government and former Commonwealth Government ministers, and which strongly supports an increase in prescribed burning on public land in the area.293

A 2004 report by the Council of Australian Governments (COAG) identified a need for further research and monitoring to fully understand the effects of prescribed burning, and large-scale bushfires, in catchment areas.294 However, the report also noted that a number of catchment management agencies in Australia were investigating the use of prescribed burning in water catchments as a means of “reducing the likelihood and magnitude of large bushfires.”295 The Committee also notes the comments of Dr. Dick Williams, Sustainable Ecosystems, CSIRO, who explained the differing impact of wildfires and prescribed burning on water in the following terms:

> Water values may be affected substantially by wildfires, with the effects potentially lasting for decades, but are generally relatively little affected by prescribed burning, with exceptions being on sites where there are highly erodible soils.296

The Committee acknowledges the importance of further research in this area but considers that there is sufficient certainty regarding the likely benefits of prescribed burning in Victoria’s catchments. The Committee is particularly mindful of the significant financial and environmental impacts that recent bushfires have had on Victoria’s catchments. Moreover, the possibility of future bushfires of a similar scale and intensity represents a clear risk to the quantity and quality of Victoria’s water supplies and to the ecosystems dependent on them. The Committee concludes that these risks provide a further justification for an increase in the extent of prescribed burning on public land, both in and around catchment areas.

292 North East Catchment Management Authority, Submission, no. 27, 4 May 2007, p. 1.
293 East Gippsland Catchment Management Authority, Submission, no. 165, 30 May 2007, pp. 3-4.
296 Dr. D. Williams, CSIRO Sustainable Ecosystems, Transcript of evidence, Melbourne, 27 August 2007.
Finding 2.3:
The Committee finds that there is a need for an increase in the extent and frequency of prescribed burning in catchment areas to mitigate the risks associated with future bushfires.

The extent of prescribed burning on public land

As noted in the introduction to this chapter, the majority of stakeholders who provided evidence to the Committee called for a significant increase in the level of fuel reduction and ecological burning.

In the preceding sections, the Committee has outlined the two main factors which are relevant to determining the appropriate extent of prescribed burning on public land:

- the level of burning required to reduce the risk of frequent, large and potentially uncontrollable bushfires; and
- the level of burning which is consistent with the preservation of environmental values, including biodiversity.

In this section, the Committee draws on its findings in relation to the above issues to discuss an appropriate minimum level of fuel reduction and ecological burning on public land in Victoria.

The Committee begins this section with an outline of the historical and current extent of fuel reduction and ecological burning.

The historical extent of prescribed burning

A number of stakeholders referred the Committee to evidence of a significant decline in the level of fuel reduction burning in recent years. Data compiled by Tolhurst provides some support for this conclusion. Tolhurst found evidence of a decline in the extent of prescribed burning from an annual average of around 200,000 hectares during the 1980s to around 110,000 hectares during the last two decades. Tolhurst noted, however, that the actual annual area burnt during the 1980s varied dramatically, with almost 500,000 hectares burnt during 1981 compared to around 34,000 hectares in 1989, and suggested that the fluctuation may have been largely

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due to the number of suitable burning days in a given year and the size of individual burn areas. 299

The Esplin report noted an apparent further decline in the annual area treated during the 1990s. 300 This is supported by data provided by DSE which shows that the annual average area treated during the last ten years has been around 78,000 hectares. 301

The Committee notes that the apparent decline in the extent of prescribed burning may be due, at least in part, to changes in the way that the extent of a burn is measured. DSE advised the Committee that the current method of assessing the "treated" or "net" area burnt differs from that used in previous decades where "large continuous areas within the burn boundary that were not ignited or did not burn" may have been included. 302 In other words, part of the apparent decline in the extent of prescribed burning may be due to more accurate measurement. This point has also been noted by Tolhurst. 303

The current extent of prescribed burning

While a determination of the true extent of the decline in prescribed burning since the 1980s may not be possible, the question of greatest concern to the Committee is whether the current extent of prescribed burning, particularly across public land, is appropriate for both fire protection and environmental purposes.

In its submission to the Inquiry, DSE noted that the annual program has recently been increased from 100,000 to 130,000 hectares, with a total net area of 138,490 hectares treated during 2006/07. 304 Around half of this area was in State forest managed by DSE with the other half (more than 67,000 hectares) located within the Parks Victoria estate. 305 The Committee notes that the current annual target of 130,000 hectares represents approximately 1.7 per cent of the 7.7 million hectares of public land.

The required extent of prescribed burning

Determining the appropriate extent of fuel reduction and ecological burning on public land is a complex issue and one which is unlikely to be finally resolved by the current Inquiry. Moreover, the Committee recognises that any conclusions it makes on this issue will be subject to the findings of future research. Nevertheless, the Committee considers that there is

304 Department of Sustainability and Environment, Annual Report 2006-07, Department of Sustainability and Environment, Melbourne, 2007, p. 159.
sufficient evidence currently available to recommend the minimum annual average extent of prescribed burning required on public land.

As noted above, recent studies suggest that between two to five per cent of the landscape would need to be treated in strategic locations each year for prescribed burning to be effective as a bushfire suppression strategy. The same studies also suggest that for randomly positioned treatments, four to ten per cent of the landscape would need to be treated each year to have the same effect. Research cited in the Esplin Report suggested that around 3.3 per cent of the landscape would need to be treated each year to provide for the persistence of native vascular flora. It is therefore clear that the current level of prescribed burning is significantly lower than is required for both bushfire protection and ecological purposes. In the Committee’s view, a minimum average of five per cent of the public land estate should be treated by prescribed burning each year. This would represent an annual target of 385,000 hectares, which is almost three times the current figure. The Committee believes that such a target strikes an appropriate balance between the ecological needs of the public land estate and the imperative of bushfire mitigation for the protection of communities.

During the Committee’s final public hearing, DSE announced plans to significantly increase the level of fuel reduction and ecological burning. DSE referred to the planned adoption of increased landscape scale burning across “multiple kilometres-wide” areas. The new approach was described as involving a focus on particular regions in a given year, during which a two to three month presence would be maintained by DSE and its partner agencies. In some cases, this would involve maintaining a fire in the region for much of that period and, if necessary, repeated efforts to overcome the vagaries of the weather. DSE also announced its intention to move away from reporting the total hectares treated each year as the sole measure of its prescribed burning program, towards the increased use of “multiple measures”. One such measure cited by DSE was the percentage of the area treated within each kilometre-wide burning area (e.g. whether 50, 70 or 80 per cent of such an area was treated).

Prescribed burning in Western Australia

The south west forest regions of Western Australia cover an area of approximately 2.5 million hectares, consisting of Jarrah, Karri, and Marri trees. The broadly similar geographic and climatic conditions between south-west Western Australia and Eastern Victoria are often cited as providing a basis for comparison between the approaches to prescribed burning adopted by the two states.

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306 P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.
307 P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.
The level of prescribed burning undertaken in south-west Western Australia is significantly higher than the current level in Victoria, with a nominal 200,000 hectare (eight per cent) target applying across the region.³⁰⁸ While in the 1960s and 1970s the level of prescribed burning ranged from 10 to 15 per cent, this figure dropped dramatically in the late 1990s and early 2000s.³⁰⁹ For example, in 2001/02 only 74,739 hectares (approximately three per cent) of prescribed burning was undertaken in the south-west.³¹⁰ During this time the incidence of large wildfires increased significantly. As a result, the level of burning was restored to the 200,000 hectare nominal target in the mid 2000s.

In 2006/07, 330,000 hectares was identified for prescribed burning in the south-west forest regions (approximately 13 per cent), though only 138,600 hectares (approximately 5.5 per cent) was achieved due to a low number of suitable burning days.³¹¹ However, this figure is only slightly lower than the 10 year rolling average of 151,695 hectares (approximately six per cent) for prescribed burning in the region.³¹²

Fernandes and Botelho note that prescribed burning constraints differ between south-eastern and south-western Australia, citing south-west Western Australia’s drier and more predictable weather; milder topography and relatively uniform forests as allowing “larger, safer, and more effective burns that can be conducted more times per year”.³¹³ The Committee recognises that the constraints in south-west Western Australia differ from those in Victoria and that, as such, prescribed burning programs adopted in Western Australia may not readily lend themselves to direct comparison with Victoria. Despite these differences, the Committee strongly supports the view that Victoria should adopt a similar broadscale approach to prescribed burning as is currently practised in Western Australia. While it may or may not be appropriate to treat a similar proportion of the Victoria public land estate by prescribed fire, the Committee welcomes the recent decision by DSE to adopt the Western Australian approach of landscape scale burns.³¹⁴

Conclusion

The Committee welcomes DSE’s acknowledgement of the need for a significant increase in the level of fuel reduction and ecological burning. The Committee believes that such an increase is certainly supported by its research and the weight of the evidence that it has received. The Committee also welcomes DSE’s plans to introduce a range of measures for its future

³¹⁴ P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.
fuel reduction and ecological burning outcomes but considers that performance against an annual state-wide target, measured in hectares, should remain one such measure. There are two main reasons for this. First, such a measure provides a ready means of gauging the average percentage of public land treated each year. Second, the retention of the current measure will provide a means of assessing future progress in increasing the level of fuel reduction and ecological burning. The Committee considers that the capacity for ready comparison between the current and future extent of prescribed burning may be reduced if the existing performance measure was entirely superseded.

A further reason given by DSE for its decision not to quantify the size of the planned increase in prescribed burning by reference to the current measure, was that it is likely to be partly contingent on the finalisation of research into the ecological effects of planned fire regimes.\textsuperscript{315} The Committee is particularly mindful of the need to increase the level of prescribed burning on public land in a manner that also establishes ecologically appropriate fire regimes across the state. The Committee considers that the future implementation of DSE’s Fire Ecology Strategies, which are being designed to refine the timing and pattern of prescribed burning in particular areas, is likely to make an important contribution in this regard. The Committee also notes that an annual prescribed burning target of five per cent of the public land estate is likely to support DSE’s planned shift towards significantly larger landscape-scale “mosaic” burns which produce a greater “patchiness” of burnt and unburnt areas.\textsuperscript{316} The ecological effectiveness of the target recommended by the Committee, and the level of bushfire risk reduction achieved, should also be the subject of a regular review. The Committee considers that such a review should be conducted every three years. For all of the above reasons, the Committee concludes that DSE should adopt an annual prescribed burning target of five per cent of the public land estate of 7.7 million hectares. This is equivalent to a total annual area of 385,000 hectares.

\textsuperscript{315} E. Waller, Chief Fire Officer, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.

\textsuperscript{316} K. King, Executive Director, Land and Fire Management, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 4 June 2007.; P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.
Recommendation 2.2:

That in order to enhance the protection of community and ecological assets, the Department of Sustainability and Environment increase its annual prescribed burning target from 130,000 hectares to 385,000 hectares. This should be treated as a rolling target, with any shortfalls to be made up in subsequent years.

Recommendation 2.3:

A comprehensive review of the effectiveness of the increased prescribed burning target in meeting ecological and bushfire suppression needs should be conducted every three years.

Recommendation 2.4:

The Department of Sustainability and Environment should report its performance against the increased prescribed burning target in its annual report, which should also include the following details:

- the total area treated within each fuel management zone for each region;
- the total number of burns conducted within each fuel management zone for each region; and
- the extent to which planned ecological and fuel reduction outcomes were met for prescribed burns within each fuel management zone for each region (e.g. a summary of the results of the post-burn assessments to be conducted in accordance with recommendation 2.3 above).

### Targets and constraints

#### Introduction

The Committee has recommended above that the annual area of public land targeted for treatment by fuel reduction and ecological burning should be increased to a minimum of 385,000 hectares. This would represent an approximate tripling of the current annual target of 130,000 hectares. In this section, the Committee begins by reviewing the performance of DSE and its partner agencies against annual targets in previous years. The Committee then considers the constraints that have affected the achievement of previous targets and how these constraints may be managed to achieve the increased program recommended by the Committee and foreshadowed by DSE.
Performance against targets

The Victorian Auditor-General found in 2003 that there had been a “consistent failure to achieve hazard reduction targets”. Performance against annual targets for the period 1996/97 to 2006/07 is shown in Table 2.3 below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Target (ha)</th>
<th>Completed (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006/07</td>
<td>130,000</td>
<td>138,490</td>
</tr>
<tr>
<td>2005/06</td>
<td>130,000</td>
<td>49,000</td>
</tr>
<tr>
<td>2004/05</td>
<td>130,000</td>
<td>127,000</td>
</tr>
<tr>
<td>2003/04</td>
<td>100,000</td>
<td>95,000</td>
</tr>
<tr>
<td>2002/03</td>
<td>100,000</td>
<td>49,200</td>
</tr>
<tr>
<td>2001/02</td>
<td>100,000</td>
<td>81,140</td>
</tr>
<tr>
<td>2000/01</td>
<td>120,000</td>
<td>65,800</td>
</tr>
<tr>
<td>1999/00</td>
<td>120,000</td>
<td>105,688</td>
</tr>
<tr>
<td>1998/99</td>
<td>120,000</td>
<td>104,584</td>
</tr>
<tr>
<td>1997/98</td>
<td>120,000</td>
<td>40,000</td>
</tr>
<tr>
<td>1996/97</td>
<td>n/a</td>
<td>131,000</td>
</tr>
</tbody>
</table>

The Committee notes that while there have been a number of years in which the total area treated by fuel reduction and ecological burning was significantly below the target for that year, DSE and its partner agencies have achieved, or been within five per cent of achieving, the annual target in three out of the four most recent years. The significantly lower area treated during 2005/06 has been explained as the result of particularly unfavourable weather conditions.

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320 Department of Natural Resources and Environment, *Annual Report 2000-01*, Department of Sustainability and Environment, Melbourne, 2001, p. 27.
There has also been criticism of the performance against prescribed burning targets on a regional basis over a number of years. The achievement against area targets (and burn numbers) for selected regions are shown in Tables 2.4, 2.5 and 2.6. below.

Table 2.4 Gippsland—fuel reduction and ecological burns: total area and number (planned and actual) 2003/04 to 2006/07.  

<table>
<thead>
<tr>
<th>Area treated (ha)</th>
<th>Number of burns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planned</td>
</tr>
<tr>
<td>2006/07</td>
<td>51,149</td>
</tr>
<tr>
<td>2005/06</td>
<td>53,743</td>
</tr>
<tr>
<td>2004/05</td>
<td>46,606</td>
</tr>
<tr>
<td>2003/04</td>
<td>80,000</td>
</tr>
</tbody>
</table>

Table 2.5: North East — fuel reduction and ecological burns: total area and number (planned and actual) 2003/04 to 2006/07.  

<table>
<thead>
<tr>
<th>Area treated (ha)</th>
<th>Number of burns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planned</td>
</tr>
<tr>
<td>2006/07</td>
<td>37,125</td>
</tr>
<tr>
<td>2005/06</td>
<td>35,237</td>
</tr>
<tr>
<td>2004/05</td>
<td>39,705</td>
</tr>
<tr>
<td>2003/04</td>
<td>35,00</td>
</tr>
</tbody>
</table>

Table 2.6: North West — fuel reduction and ecological burns: total area and number (planned and actual) 2003/04 to 2006/07.  

<table>
<thead>
<tr>
<th>Area treated (ha)</th>
<th>Number of burns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planned</td>
</tr>
<tr>
<td>2006/07</td>
<td>37,125</td>
</tr>
<tr>
<td>2005/06</td>
<td>35,237</td>
</tr>
<tr>
<td>2004/05</td>
<td>23,935</td>
</tr>
<tr>
<td>2003/04</td>
<td>35,00</td>
</tr>
</tbody>
</table>

327 Department of Sustainability and Environment, Submission, no. 168D, 9 January 2008, Attachment 2.  
328 Department of Sustainability and Environment, Submission, no. 168D, 9 January 2008, Attachment 2.
The performance against area targets in Gippsland has also been significantly lower than the target identified in the relevant Fire Protection Plan for a number of years. The current plan, which dates from June 1999, sets out an average annual target for the region of 119,527 ha.\(^{329}\) However, as shown in Table 2.4 above, the actual area targeted and treated in recent years has been well short of this figure.

DSE informed the Committee that the target contained in the 1999 Gippsland Fire Protection Plan was “almost entirely driven from a fire protection perspective.”\(^{330}\) In other words, the target contained in the current plan does not incorporate the findings of more recent research into the level of burning needed for ecological purposes. As the Committee has noted above, DSE plans to integrate these research findings into future plans, including those for Gippsland. An example of the planned implementation of such increased burning for ecological purposes, which has recently been announced by DSE, is the “Southern Burn” in far East Gippsland which will treat approximately 52,000 hectares in coming years.\(^{331}\)

A further aspect of performance against prescribed burning targets is the achievement against targets set for each fuel management zone. Data provided by DSE shows that performance against the target set for each zone also varies significantly between regions and across years. For example the proportion of the area planned for treatment within zone one which was actually treated during 2006/07 ranged from 26 per cent in the North West to 117 per cent in Port Phillip.\(^{332}\) The state-wide performance against targets for each zone for the year 2006/07 is shown in Figure 2.14 below.

While the Committee considers that every effort should be made to meet planned area targets for fuel reduction burning within each zone it also agrees with the finding of the Auditor-General that:

> The impact of achievement or underachievement of fuel reduction targets needs to be considered with care. The actual risk reduction achieved through fuel reduction burning is not directly proportional to the area that has been fuel reduced. Successfully reducing fuel loads in 100 hectares in FMZ 1 (the highest risk zone) may achieve a significantly greater reduction in risk than fuel reducing 100 hectares in FMZ 2 or 3.\(^{333}\)

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\(^{329}\) Department of Sustainability and Environment, *Fire Protection Plan - Gippsland Region*, Department of Sustainability and Environment, Melbourne, 1999, p. 35.


\(^{331}\) Department of Sustainability and Environment, *Gippsland Burning News: Autumn 2008*, Department of Sustainability and Environment, Melbourne, 2008, p. 3.


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Figure 2.14: Planned and actual area burnt by zone 2006/07.  

Constraints

In this section, the Committee discusses the various constraints that apply in relation to fuel reduction and ecological burning. Factors highlighted by the Victorian Auditor-General as major constraints include: the narrowness of burning prescriptions and the associated planning requirements; resources; and weather. The Victorian Auditor-General has explained the effects of these constraints as follows:

The necessarily strict conditions governing fuel reduction burning mean that considerable advance planning must be conducted for these burns. They can no longer be conducted on an opportunistic basis. The opportunity to conduct fuel reduction burning can be limited by competition for physical resources and limited availability of accredited supervisors as well as meteorological factors.

The importance of resources, weather and climate has also been highlighted by DSE. Chief Fire Officer, Ewan Waller, explained the basis of the current annual target of 130,000 hectares in the following terms:

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334 Department of Sustainability and Environment, Forest Fire Weekly Report (29 June 2007), Department of Sustainability and Environment, Melbourne, 2007, p. 3.

We assume that the resourcing we had and what that could achieve. And looking back over the history of the windows of opportunity you get — the number of burning days in this those burning periods — that was the basis.

Weather and climate

The majority of DSE’s prescribed burning is conducted during Autumn rather than the relatively more risky seasons of Summer and Spring. In general, Winters are too cold and wet to allow prescribed burning. The number of suitable days available for fuel reduction and ecological burning is further restricted by variations in weather, with particularly wet Autumns a major reason for those years in which the treated area targets have not been met. DSE has recently reviewed the possibility of increasing the level of burning conducted during Spring and the Committee understands that there has been some increase in the level of burning conducted at this time of the year. DSE informed the Committee, however, that a significant increase in the Spring burning program may not be feasible and that it is currently exploring the opportunities for an increased level of burning during Winter.

In addition to the season, a range of other factors, such as temperature, wind, fuel moisture and other “prescribed conditions”, also affect the number of days suitable for prescribed burning. A study of weather conditions over a seven year period in the Wombat State forest found an average of just under 11 days each year as suitable for prescribed burning. Suitable days varied between four days in 1995 to 20 days in 1999. A similar study near Omeo found an average of ten days per year, with a range of one to 22 days in each year, as suitable for prescribed burning. Similar results have been found for Melbourne and locations in the North East. In other words, the number of suitable days for prescribed burning each year is broadly consistent across the state.

It is important to note, however, that the suitable days in any given year will vary from one region to another, such that there may be many more days suitable for prescribed burning statewide than at any particular location.

DSE’s capacity to increase the extent of prescribed burning may therefore
be enhanced by increasing the mobility its operational resources for prescribed burning. It has also previously been noted that the number of suitable prescribed burning days could be increased by encouraging the conduct of burns during weekends and evenings.\textsuperscript{345}

Funding and personnel

**Introduction**

Inadequate resource allocation, particularly of personnel, was cited by a number of stakeholders as a constraint on the level of fuel reduction and ecological burning. A related argument, made by a number of stakeholders, was that there has been a loss, from DSE in particular, of the knowledge required to maintain an adequate broad-scale prescribed burning program. These stakeholders cited the decline in forestry, and the related loss of DSE employees with forestry experience, as a reason for the reduced extent of prescribed burning in recent years.

**Funding**

The level of staff and other resources available for fuel reduction and ecological burning is largely dependent on an allocation of funding from DSE’s annual budget.

DSE is required to record its annual expenditure on prescribed burning under the *Code of Practice*,\textsuperscript{346} a requirement which also existed under the 1995 *Code of Practice*.\textsuperscript{347} However, DSE was unable to provide the Committee with details of its current or past annual expenditure on prescribed burning. DSE advised that it was unable to provide such expenditure figures because it does not yet have the Information Technology and Human Resources systems capable of distinguishing expenditure on prescribed burning from other expenditure.\textsuperscript{348}

Prescribed burning expenditure reporting has been an issue for some time and has been discussed in two reports by the Auditor-General in 1992 and 2003.

In 1992 the Auditor-General made the following comments in relation to the then Department of Conservation and Environment’s funding of “fire prevention” (which at that time was defined as including both prescribed burning and other preventative activities, such as the preparation of long-term and short-term strategic plans):\textsuperscript{349}

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\textsuperscript{346} Department of Sustainability and Environment, *Code of Practice for Fire Management on Public Land*, Department of Sustainability and Environment, Melbourne, 2006, p. 43.


\textsuperscript{348} Department of Sustainability and Environment, personal communication, 29 February 2008.

The allocation of funds for fire prevention in the State’s protected areas is not presented for parliamentary sanction within the annual Appropriation Act as a separate line item. Funding for fire prevention is provided from various funding sources across the Department's Land Resource Management program. Consequently, the Parliament and the taxpaying public are not informed of the amount of funds earmarked each year through the budget process for fire prevention.350

The Auditor-General went on to make the following findings in relation to funding for fire prevention:

Audit is of the opinion that fire prevention is far too important an issue for funding decisions to be determined by annual budget negotiations or to be influenced by priorities placed on other activities, whether by government or the Department, in particular budget periods. The overall significance of fire prevention is such that the funds provided for fire prevention activities should be clearly identified in the Department's annual appropriation for the perusal of the Parliament and, subsequently, the public.351

In 2003 the Auditor-General considered the specific issue of DSE’s funding of fuel reduction burning from within its annual budget allocation. The Auditor-General found that there was a lack of transparency in this area, noting that DSE’s fuel reduction burning was “not fully costed internally”. As the Committee has noted above, this remains the case today. Another reason noted by the Auditor-General for the lack of transparency was the practice of borrowing staff from other business units to conduct burns.352

The Auditor-General found that “operational managers setting targets for fuel reduction each year do not have certainty that the resources will be available to achieve targets.” 353 To address this lack of transparency and certainty, the Auditor-General recommended that:

- DSE fully cost its fuel reduction burning activities within its internal budgeting process;
- allocate appropriate funding levels; and
- allocate the cost of staff employed from other business units.354

Although the Committee was not able to determine the current level of funding for prescribed burning, the Auditor-General found that the former Department of Natural Resources and Environment (DNRE) (DSE’s predecessor) allocated around $2 million towards a fuel reduction burning

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target of 100,000 hectares in 2001-02, representing approximately four per cent of DNRE’s fire management budget for that period.\textsuperscript{355}

The Auditor-General noted, however, that this figure did not reflect the total expenditure on fuel reduction burning because the salaries of DSE staff from other business units who assisted with this work were charged against their normal duties to their respective business units.\textsuperscript{356} However, the Committee also notes that the figure of four per cent was apparently based on the combined cost of fuel reduction burning and fire suppression activities in 2001-02 ($48.5 million) and did not include other activities within DNRE’s then “fire prevention and planning environment” program – such as the completion of District Fire Operations Plans and accreditation of personnel – which were then separately costed (at $16 million).\textsuperscript{357} If these activities are included as part of the combined total expenditure on fire management for 2001-02 (as they have been in more recent years),\textsuperscript{358} the proportion of the budget allocated to fuel reduction burning for that year is closer to three per cent.

Mr John Cribbes, Honorary Secretary, Macalister Four-wheel Drive Club, illustrated the apparently disproportionate levels of funding for bushfire prevention and suppression in the following terms:

\begin{quote}
The fact that it is costing the taxpayers of Victoria millions of dollars to hire Elvis and bring it across the Pacific Ocean does not seem to be unattractive to some people. But the fact of the matter is there is no need for that attitude of fighting fire. You reduce the risk by working at the fire for 12 months of the year, not just 3 months in Summer.\textsuperscript{359}
\end{quote}

The Committee also notes that the total cost of fighting the 2002-03 bushfires, at approximately $2 million a day, was apparently greater than the annual expenditure on prescribed burning by several orders of magnitude.\textsuperscript{360}

The Committee was unable to determine whether DSE’s current annual expenditure on fuel reduction / ecological burning remains in the order of around three to four per cent of DSE’s total expenditure on fire management. The Committee notes, however, that although the current target for fuel reduction burning has increased by around one third, to 130,000 hectares, the increase in DSE’s total expenditure on fire

\textsuperscript{357} Department of Sustainability and Environment, \textit{Annual Report 2003-04}, Department of Sustainability and Environment, Melbourne, 2004, pp. 130-131.
\textsuperscript{358} Department of Sustainability and Environment, \textit{Annual Report 2006-07}, Department of Sustainability and Environment, Melbourne, 2007.
\textsuperscript{359} J. Cribbes, Honorary Secretary, Macalister 4WD Club, \textit{Transcript of evidence}, Traralgon, 2 August 2007.
management has been significantly greater – total budgeted expenditure on fire management in 2006/07 was around $288.9 million.\textsuperscript{361}

The Committee notes that DSE’s annual budget allocation for fuel reduction/ecological burning may vary from year to year according to the relative proportions of the total area that is burnt within each Fire Management Zone. As noted above, the Code of Practice defines four Fire Management Zones (although at the time of writing, fuel reduction and ecological burning continued to be conducted according to the five Fuel Management Zones under the 1995 Code). As has also been noted above, an important measure on which Fuel Management Zones vary is the intensity of fuel management required within the zone. For example, a burn located in Zone 1 would typically be designed to reduce the overall fuel hazard to or below the level of “moderate” across perhaps 90 per cent of the burn, while a burn in Zone 2 would typically be designed to reduce the overall fuel hazard to or below the level of “high” across perhaps 80 per cent of the burn. Accordingly, the financial cost of fuel reduction / ecological burning varies for each zone. This variation, and its potential impact on DSE’s total annual expenditure on prescribed burning, is illustrated in Table 2.7 below.

### Table 2.7: Estimate of the cost of fuel reduction and ecological burning 2006/07.

<table>
<thead>
<tr>
<th>Fuel Management Zone and burning cost per hectare\textsuperscript{362}</th>
<th>Total Estimated Area Treated\textsuperscript{363}</th>
<th>Estimated Cost of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1: $50–500</td>
<td>6,954</td>
<td>$ 342,700 - $ 3,477,000</td>
</tr>
<tr>
<td>Zone 2: $30–300</td>
<td>39,317</td>
<td>$ 1,179,510 - $ 11,795,100</td>
</tr>
<tr>
<td>Zone 3: &lt;$10–50</td>
<td>69,801</td>
<td>&lt;= $ 690,801 - $ 3,490,050</td>
</tr>
<tr>
<td>Zone 4: $30–300</td>
<td>12,747</td>
<td>$ 382,410 - $ 3,824,100</td>
</tr>
<tr>
<td>Zone 5: n.a. – exclusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>128,819</td>
<td>&lt;= $ 2,252,721 - $ 19,112,727</td>
</tr>
</tbody>
</table>

**Notes:**
1. The grand total for the total estimated area treated excludes 4,515 ha which was categorised as “other”. This total is also based on the slightly lower state total reported in the Forest Fire Awareness Report for 2006/07, as opposed to the corrected total published in DSE’s 2006/07 Annual Report.
2. The cost per hectare for each of zone is based on data provided to the Auditor-General in 2003 and may have changed.

Chapter 2: Prescribed Burning In Victoria

Recommendation 2.5:

That the Department of Sustainability and Environment, Department of Primary Industries, Parks Victoria & VicForests separately cost, and report, annual expenditure on fuel reduction burning, ecological burning and regeneration burning in their Annual Reports.

The Committee was unable to obtain any data on the cost-effectiveness of fuel reduction burning, primarily because there do not appear to have been any cost-benefit studies of fuel reduction burning conducted in Australia.\(^{364}\) The Auditor-General has also previously referred to the need for a full cost-benefit analysis to be conducted in relation to prescribed burning:

...any consideration of ways to improve fuel reduction burning levels needs to be accompanied by rigorous risk and cost-benefit analysis. The existing prescriptions, which are essential for the safe conduct of fuel reduction burning, mean that the activity will remain costly, and fully meeting current targets would require a significantly increased outlay. The DSE’s understanding of the relationship between the level of fuel reduction burning and overall wildfire risk is currently limited. Analysing different outlay options, in order to see which gives the best overall reduction in risk, is a complex modelling task. Considerable work needs to be done in this area.\(^{365}\)

The Committee agrees with the Auditor-General that there is a need for a full cost-benefit analysis of the prescribed burning program. Such a study would be of particular value in ensuring that future increases in prescribed burning, as recommended by the Committee and foreshadowed by DSE, are implemented in a way that maximises the overall reduction in risk across the State.

A further benefit of such a study would be to demonstrate the reduced costs of fire suppression which flow from increased prescribed burning. Notably, fire suppression activities during 2006/07 necessitated additional funding to DSE, by way of a Treasurer’s Advance, of around $170 million.\(^{366}\) As the Secretary of DSE noted during the Inquiry’s final public hearing, prescribed burning has the potential to significantly lessen budgetary impacts of this nature and magnitude.\(^ {367}\)

A further recommendation of the Auditor-General’s 2003 report concerned the need for greater flexibility in the funding of fuel reduction burning. The Auditor-General recommended that DSE:

\(^{364}\) Department of Sustainability and Environment, personal communication, 29 February 2008.


\(^{366}\) P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.

\(^{367}\) P. Harris, Secretary, Department of Sustainability and Environment, Transcript of evidence, Melbourne, 7 April 2008.
in consultation with the Department of Treasury and Finance, considers revised funding arrangements that introduce greater flexibility to allow for differing levels of funding to reflect factors such as seasonal variations.\textsuperscript{368}

One suggestion made to the Committee as to how this might be achieved was to establish a “prescribed burning trust fund” so that money not spent on prescribed burning in a given year could be carried over for expenditure on prescribed burning in later years, perhaps for a period of up to five years.\textsuperscript{369} DSE responded to this suggestion by noting that funding is not a major constraint in relation to the conduct of its prescribed burning program.\textsuperscript{370} While the Committee notes that this may be the case, it also notes that this may be difficult to demonstrate in the absence of reported data on DSE’s annual expenditure on prescribed burning. On balance, the Committee therefore considers that the suggestion of a “prescribed burning trust fund” has merit and should be implemented.

\textbf{Recommendation 2.6:}

That the Victorian Government establish a five year rolling fund which allows unused prescribed burning monies to be rolled over into future financial years for the purpose of subsequent prescribed burning activities.

\section*{Personnel}

A number of stakeholders were critical of the current staffing policies of DSE and its partner agencies, in relation to fire prevention and suppression in general, and to prescribed burning in particular. Areas of concern raised by stakeholders included insufficient staffing levels, the decline in permanent staff, staff turnover, the skills mix of personnel, and the need for more effective succession planning.

A range of stakeholders expressed the view that Victoria has experienced a significant decline in the number of locally based fire management staff.\textsuperscript{371} Stakeholders also noted that there had been a reduction in permanent staff and a shift towards employing officers primarily for the Summer fire season, who were subsequently unavailable for the prescribed burning program.\textsuperscript{372} A further disadvantage noted in relation to such seasonally-based employment was the difficulties experienced by staff in becoming part of local communities.\textsuperscript{373} Under-resourcing of operational regional staff within Parks Victoria was also noted as a particular problem.\textsuperscript{374}

\textsuperscript{369} Dr. K. Tolhurst, \textit{Submission}, no. 137B, 9 October 2007, p. 7.
\textsuperscript{370} P. Harris, Secretary, Department of Sustainability and Environment, \textit{Transcript of evidence}, Melbourne, 7 April 2008.
\textsuperscript{374} Community and Public Sector Union, \textit{Submission}, no. 97, 24 May 2007, pp. 5,12.
The Commonwealth and Public Sector Union (CPSU) expressed its members' concerns regarding fire management staffing levels within DSE, DPI, Parks Victoria and VicForests as follows:

There is an overwhelming belief amongst union membership that government resourcing is inadequate and a major hindrance in the ability to deliver adequate, effective and safe fire management practices within Victoria. This concern also extends in every instance to the government's ability to deliver adequate public land management throughout Victoria.375

CPSU also reported that its members were concerned that prescribed burning targets may not be realistic given current staffing levels.376 CPSU identified DSE’s “model of cover” as contributing to the problem of seasonally-based staff shortages for prescribed burning. The model of cover is a series of memorandums of understanding and service agreements with DPI, Parks Victoria and VicForests, which is used to determine staffing levels for fire suppression. In addition to noting that the model of cover had been “overwhelmingly criticised” by members for failing to provide sufficient fire suppression personnel, CPSU reported concerns about the lack of a similar inter-agency model for staffing the prescribed burning program throughout the year.377 CPSU recommended both an increase in the level of permanent staff and the development of a model of cover which would provide for fire management across 365 days of each year.378

A related problem is that of staff turnover. Mr Ritchie, Regional Director North East, DSE, referred to the role of an adequate prescribed burning program in preventing the loss of skilled staff:

It was a problem for us a few years ago. I remember 10 years ago we had a long spell with not many fires, and we lost a lot of skilled people. People lost the enthusiasm, the interest and the expertise because of the lack of experience. So the burning program is important.379

A range of stakeholders expressed concerns regarding the typical mix of skills held by fire management staff within DSE and its partner agencies. The loss of practical experience and knowledge associated with the decline in forestry was cited by a number of stakeholders.380

East Gippsland Wildfire Taskforce (EGWT), in common with a number of stakeholders, argued that effective management of the bush requires people with practical forestry and bush skills and sufficient familiarity with a local area.381 EGWT argued that people with such skills are able to deal with the inevitable variations in fuel loads, moisture and related factors and are

375 Community and Public Sector Union, Submission, no. 97, 24 May 2007, p. 5.
376 Community and Public Sector Union, Submission, no. 97, 24 May 2007, p. 12.
378 Community and Public Sector Union, Submission, no. 97, 24 May 2007, p. 10.
379 K. Ritchie, Regional Director North East, Department of Sustainability and Environment, Transcript of evidence, Mount Beauty, 28 November 2007.
therefore best able to make the necessary “on the spot” decisions regarding fuel reduction burning.382

The decline in bush skills was also illustrated by Mr Alan Ashworth, an owner and operator of an earth-moving business in the North East, who referred to the lack of experience in the use of earth-moving machinery within DSE and its partner agencies.383 The Committee notes that this is an issue of particular concern given the specialist skills required to operate such machinery in the steep and timbered terrain where bushfire prevention and suppression activities are often conducted. Mr Ashworth noted that while younger staff were now generally university educated, they lacked experience in the operation of such machinery and the practical experience required to work safely and effectively in the bush.384

The significance of this problem for prescribed burning and fire suppression was confirmed by Mr Ritchie, Regional Director North East:

...getting a good bulldozer driver who knows the bush and can work the bush is a challenge and will be a challenge in the future, because a high proportion of our bulldozer drivers have come up through the long held Forests Commission process and have had a lot of experience.385

Mr Chris Rose, Manager East, Parks Victoria, advised the Committee that the need for personnel with practical skills had been recognised by Parks Victoria and outlined recent developments in this area:

I think there is a need to have a balance. You want some old hard heads who have grown up in the bush and have lived in the bush, and you want some people with different skills. If you have got a mix, then you have probably got it right. We recognise this very much, and the last thing we want are university graduates with no practical experience. We have actually signed a partnership with several universities to provide students with field experience working beside...some of the people that you have met today to ensure that when they do start work with us in the future they have actually got some practical experience as well as the theoretical knowledge. We recognise that and are working on it.386

Dr Kevin Tolhurst also argued for an improvement in the skill mix of public land fire management staff. Dr Tolhurst noted that during the previous 20 years public agencies had tended to recruit generalist staff with generalist tertiary qualifications and that there was a need for more fire behaviour and related specialists:

Maintaining viable fire regimes in the landscape requires the combination of a high level of scientific understanding, good communication skills, and good “bush” skills... DSE is strong on the bureaucratic “process” side, but very weak on the technical / science side. There is a dire need to demand University graduates be well educated in the science behind land management. DSE must then recruit people who are

385 K. Ritchie, Regional Director North East, Department of Sustainability and Environment, Transcript of evidence, Mount Beauty, 28 November 2007.
386 C. Rose, Manager East, Parks Victoria, Transcript of evidence, Mount Beauty, 28 November 2007.
highly skilled, not just equipped with some generalist science, resource management or environmental science degree...what we need is Forest Scientists, Landscape Ecologists or Conservation Biologists.\textsuperscript{387}

A range of stakeholders expressed concerns regarding the ageing workforce available for prescribed burning and other fire management activities. These stakeholders emphasised the need for more effective succession planning. The Australian Workers Union (AWU) informed the Committee that the average age of its fire management members is approaching 49 years.\textsuperscript{388}

DSE acknowledged the challenges posed by succession planning. Mr Ritchie, Regional Director North East, DSE, outlined the issue in the following terms:

We do have an active process both within this region and across the state looking at succession planning at the moment, particularly at field crew level, where we are trying to make sure that we recruit people to work in the field and, as far as possible, retain their services over a lengthy period of time.

People do not stick around as long as they used to, and that is one of the challenges. A lot of our crew succession comes through the Summer firefighters. They provide a good resource. We get a lot of returnees year after year; we have put some of them onto three year contracts to try to encourage them to remain. Often they provide the core of both the next generation of field crew and some of the professional staff as well, because a lot of them come with different backgrounds. It is a real problem; it does not solve the succession problem well or completely by any means. Getting people who know and understand the bush and who are be able to lead crews and to make decisions in the field, to work in it for a long period is one of our big challenges, particularly at that crew leader level.\textsuperscript{389}

Conclusion

The Committee was unable to determine the total number of operational staff available for prescribed burning in recent years. However, DSE informed the Committee that there had been an increase in operational and support staff of more than ten per cent between 2002 and 2007. Under the current arrangements between DSE, VicForests, Parks Victoria, and Melbourne Water, around 2,500 fire accredited personnel (and a further 1,000 coordination and support personnel) are available each fire season.\textsuperscript{390}

DSE also informed the Committee that changes to the Project Fire Fighter (PFF) Program, to allow the recruitment of personnel on three year contracts (for the period October to May each year), had boosted the number of operational personnel available for prescribed burning. DSE advised the Committee that under the PFF Program, between 400 and 600 additional personnel were available for the 2006/07 prescribed burning program.\textsuperscript{391}

\textsuperscript{387} Dr. K. Tolhurst, \textit{Submission}, no. 137, 28 May 2007, p. 2.
\textsuperscript{388} Australian Workers Union Victorian Branch, \textit{Submission}, no. 10, 24 April 2007, p. 2.
\textsuperscript{389} K. Ritchie, Regional Director North East, Department of Sustainability and Environment, \textit{Transcript of evidence}, Mount Beauty, 28 November 2007.
The Committee considers that the recent increase in the number of DSE personnel is likely to have made a significant contribution to meeting the statewide prescribed burning target for 2006/07. However, the Committee also agrees with the view expressed by a range of stakeholders that the level of permanent, or long-tenured, locally based staff within DSE, DPI, Parks Victoria and VicForests should be further increased to ensure an adequate level of prescribed burning, particularly during years when weather conditions are unfavourable. The need for an additional increase in the level of such staff is further emphasised by the increased annual prescribed burning target that has been recommended by the Committee. Moreover, the Committee agrees that further initiatives are required to address the problems of staff turnover, the current skills mix of personnel, and the problem of an ageing workforce through more effective succession planning.

**Recommendation 2.7:**

That the Victorian Government provide recurring funding for a significant increase in regionally-based, permanent, or long-tenured, fire management personnel dedicated to the prescribed burning program. The increase in personnel should be consistent with the level required to achieve an annual prescribed burning target of 385,000 hectares.

The pool of available personnel should be suitably diverse and possess a wide variety of disciplines and skill sets, including practical skills. The Department of Sustainability and Environment and its partner agencies should also increase the proportion of personnel with specialist tertiary qualifications, including fire behaviour specialists, forest scientists, landscape ecologists and conservation biologists.

DSE and its partner agencies should also prioritise the development of programs to reduce the level of staff turnover and the problem of the ageing workforce, through more effective succession planning.

**The risk of escaped burns**

The practice of prescribed burning carries with it the risk that a particular burn may escape beyond its planned boundaries. Although this happens in a relatively small number of burns, the consequences can be financially and environmentally significant. However, the consequences of an overly risk averse approach to prescribed burning are likely to be significantly more serious in the long term. Government and community support for an appropriate level of risk is therefore of crucial importance to the success of the prescribed burning program.

Perhaps the best known prescribed burn escape in recent years was the one which occurred in the Wilsons Promontory National Park in March 2005. The escape resulted from a planned burn of 20 hectares at Tidal River, which was ignited by Parks Victoria under DSE’s prescribed burning program. Fire escaped from the area of the planned burn in subsequent days and formed a bushfire which burnt more than 6,000 hectares of the National Park and threatened Tidal River Village. More than $2m was spent on suppressing the fire, which significantly disrupted the Park over a period
of weeks and led to the evacuation of around 600 campers. The fire also had a significant impact on tourist activity.\textsuperscript{392}

In 2005 the Office of the Emergency Services Commissioner (OESC) completed a review of the Wilsons Promontory escaped burn and of burn escapes and practices since 2002.

The OESC found the number of burn escapes to be less than two per cent in total.\textsuperscript{393} Of 2,151 burns undertaken between 1 January and Winter 2005, 48 burns escaped the planned burn area and 12 of these were classified as “significant escapes”. The OESC found that there were common factors across the state which had contributed to burn escapes, and that these included a failure to follow accepted practice or documented policies and procedures – both in the planning and implementation stage of the burn.\textsuperscript{394} The OESC also found that the majority of burns escaped in the days following ignition during the “control phase” of the burn.\textsuperscript{395}

The OESC found that DSE and its partner agencies had already commenced a number of measures to improve the safety and delivery of the prescribed burning program. These included the appointment of regional fire prevention coordinators, improving the regional burn approvals process, establishing a risk management project and the development of upgraded FireWeb mapping tools.\textsuperscript{396}

The OESC also found that DSE personnel involved in prescribed burning are recognised as highly trained and experienced experts but face pressure to meet targets. Some DSE staff considered that there was a lack of organisation support and noted fatigue management as a further problem. The report also found that personnel and resources at the time of year when prescribed burning is conducted were either not available or at a minimum.\textsuperscript{397} The OESC concluded that some burn escapes are “inevitable” and that fire management personnel had experienced fire behaviour, due to the current drought, which had not been encountered previously.\textsuperscript{398}

A number of stakeholders told the Committee that the risk of escaped burns had led to the development of a “risk-averse” culture within DSE and its partner agencies. The threat of litigation was also identified as a potential risk.\textsuperscript{399}

\textsuperscript{393} Emergency Services Commissioner, \textit{Examination of Prescribed Burning Practices}, Office of the Emergency Services Commissioner, Melbourne, 2005, p. 3.
\textsuperscript{397} Emergency Services Commissioner, \textit{Examination of Prescribed Burning Practices}, Office of the Emergency Services Commissioner, Melbourne, 2005, pp. 5-6.
constraint on prescribed burning in the Esplin Report.\textsuperscript{399} The Committee considers, however, that an awareness by personnel of the potential for litigation arising from escaped prescribed burns does not necessarily amount to a "risk-averse" culture. Moreover, DSE’s achievement of higher prescribed burning levels in recent years suggests that risk aversion is currently not a significant constraint on this activity.

Smoke

The smoke released from prescribed burning, like the smoke caused by bushfires, can have a range of negative impacts on individuals and communities, including “adverse effects on people’s respiratory health, aesthetics, tourism and business.”\textsuperscript{400}

Ms Marion Edwards’ submission highlighted her experiences of the health impacts of smoke from prescribed burning as follows:

\begin{quote}
The extent of prescribed burning seems to be too hot, too large and too often. The smoke haze is extremely thick and we, the community, are suffering health issues with this constant problem.\textsuperscript{401}
\end{quote}

Ms Caroline Doolan expressed a similar sentiment, asserting that:

\begin{quote}
There have been days in this area with all of the prescribed burning where the smoke was worse than what we experienced during the recent bushfires. The windows of our house all had to be kept closed to keep the smoke out. It gets into the back of the throat and makes it sore and we don’t have asthma or bronchial conditions.\textsuperscript{402}
\end{quote}

Other stakeholders raised concerns about the scheduling of prescribed burns during peak tourism times. Mansfield Shire expressed the problem as follows:

\begin{quote}
Fuel reduction burns appear to be inadequate, under resourced and more importantly to Mansfield Shire, inappropriately timed. Mansfield Shire experiences its highest visitation periods during school holidays, long weekends and public holidays. These peak periods have on occasions coincided with the times when DSE and parks Victoria have been undertaking prescribed burns.\textsuperscript{403}
\end{quote}

Murrindini Shire expressed similar concerns:

\begin{quote}
As a matter of principle, council fully supports the ongoing provision of cool weather burns – if conditions allow. Whilst it is acknowledged that there is a narrow window of opportunity to meet the criteria to conduct successful management burns, there is an impact on the municipalities such as Murrindindi Shire that has a large component of public forest and relies on tourism visitation. Wherever possible, the burn strategies
\end{quote}


need to be managed in a way that meets the needs of both forestry and tourism issues.\textsuperscript{404}

The importance of improved communication by agencies regarding the timing and location of prescribed burning was also raised by a number of stakeholders. Wellington Shire Council expressed the importance of such communication to the maintenance of community support for prescribed burning operations as follows:

\begin{quote}
Local communities are not concerned to see smoke in their area if they are aware that it is from a controlled burn as they know that the aim is to create a safer situation for the future. Having said that, communication to the public and nearby landholders is very important when burns are occurring and Council would like to see better communication by fire authorities when this happens.\textsuperscript{405}
\end{quote}

The timing and communication of prescribed burning was raised as a particularly important issue by wine industry stakeholders. The effect of “smoke taint” on growing grapes can render the harvested fruit unusable for the production of wine. The Victorian Wine Industry Association of Victoria advised the Committee that the combined effect of the Victorian bushfires since 2003 had been an estimated loss of $70 million in wine sales due to smoke taint.\textsuperscript{406} During the Inquiry, the Committee visited the King Valley vineyard region, which was particularly adversely affected by smoke taint during the recent bushfires. During the visit, the Committee was informed that research was being conducted to determine how future prescribed burns may be timed to coincide with periods when grapes may be less vulnerable to smoke taint.

There are a range of factors which have the potential to alter the impacts of smoke from prescribed burning, including: wind direction; weather on subsequent days; fuel moisture; and the time of day that a fire is ignited.\textsuperscript{407} DSE is also required to determine and periodically review, in consultation with the EPA, guidelines on smoke management issues associated with its prescribed burning operations.\textsuperscript{408} The Guidelines are required to account for current knowledge of air movements and smoke dispersal.\textsuperscript{409} The Committee also notes that research into the management of smoke from prescribed burning operations is the subject of two current research programs by the Bushfire CRC:

- B2.1: Behaviour of smoke plumes and hazes from rural or urban fires; and

\textsuperscript{404} Murrindindi Shire Council, Submission, no. 142, 28 May 2007, p. 1.
\textsuperscript{405} Wellington Shire Council, Submission, no. 79, 23 May 2007, p. 2.
\textsuperscript{406} Wines of Victoria, Submission, no. 213, 13 June 2007, p. 3.
\textsuperscript{407} Dr. K. Tolhurst and N. P. Cheney, Synopsis of the Knowledge Used in Prescribed Burning in Victoria, Department of Natural Resources and Environment, Melbourne, 1999, pp. 27-28.
\textsuperscript{408} Department of Sustainability and Environment, Code of Practice for Fire Management on Public Land, Department of Sustainability and Environment, Melbourne, 2006, p. 18.
\textsuperscript{409} Department of Sustainability and Environment, Code of Practice for Fire Management on Public Land, Department of Sustainability and Environment, Melbourne, 2006, p. 18.
• B2.2 Smoke composition from prescribed and wildfires and health.\textsuperscript{410}

The Committee also recognises that the media plays a role in influencing public perceptions and attitudes towards prescribed burning. Unfortunately, in relation to smoke from prescribed burning, the media is often critical of the Government’s management of the prescribed burning program. The following editorial opinion piece from the Herald Sun provides such an example:

Choking smoke over Melbourne is ruining some of the best days of Autumn and all because the Department of Sustainability and Environment is doing a year’s burning off in a week. Victorians need to feel safe from bushfires that have caused some of the state’s greatest catastrophes. But people coughing and spluttering as the smoke drifts over the city are asking why the burnoff cannot be done in stages. Better management is needed. The department responsible for the burnoffs has failed to show concern for people who have no choice but to suffer the smoke. They have also failed to consider those people suffering from respiratory problems who have had to shut themselves indoors.\textsuperscript{411}

Given that the level of prescribed burning is likely to significantly increase in future years, the Committee believes that greater public acceptance of the impacts of prescribed burning will be in some part dependent upon fostering improved relationships with the media. As such, the Committee believes that DSE and its partner agencies should make concerted efforts to increase the media’s understanding of the importance of prescribed burning. This issue is discussed in greater detail in Chapter 6.

In conclusion, the Committee appreciates that prescribed burns will inevitably have immediate negative impacts upon local communities. However, the windows of opportunity to conduct prescribed burns are already narrow, and may become narrower as a result of climate change. When compared to the environmental, economic and social impacts that result from large bushfires, the Committee considers that communities are likely to become increasingly accepting of prescribed burns. However, as will be discussed in Chapter 6, the Committee also considers that there is further scope for DSE to increase community involvement in prescribed burning programs to maximise opportunities to alleviate the impacts due to smoke.

Forestry and regeneration burning

Timber harvesting on public land, and the subsequent regeneration burning of harvested coupes, also has the potential to affect DSE’s fuel reduction and ecological burning programs. The revised Code of Practice notes the following benefits of regeneration burning:


Regeneration burning after timber harvesting provides for the dual purpose of stimulating regeneration as well as reducing the post-harvest fuel hazard.

This in turn provides protection for newly established forest and allows for the safe conduct of future prescribed burns in the vicinity.\footnote{115 Department of Sustainability and Environment, \textit{Code of Practice for Fire Management on Public Land}, Department of Sustainability and Environment, Melbourne, 2006, p. 17.}

The Esplin Report found that regeneration burning had historically involved a significant diversion of resources which would otherwise have been available for fuel reduction and ecological burning.\footnote{116 B. Esplin, M. Gill and N. Enright, \textit{Report of the Inquiry into the 2002-03 Victorian Bushfires}, Department of Premier and Cabinet, Melbourne, 2003, p. 96.} For example, the report found that regeneration burns in the Gippsland region represented 63 per cent of all planned fires during the period 1991 to 2003.\footnote{114 B. Esplin, M. Gill and N. Enright, \textit{Report of the Inquiry into the 2002-03 Victorian Bushfires}, Department of Premier and Cabinet, Melbourne, 2003, p. 96.} The Committee notes, however, that VicForests has assumed responsibility for regeneration burning in the east of the state (where the majority of timber harvesting occurs) since it began operations in 2004. Although DSE supports regeneration burning operations conducted by VicForests with the provision of planning, personnel and equipment, DSE advised the Committee that costs are subsequently recovered from VicForests.\footnote{115 Department of Sustainability and Environment, \textit{Submission}, no. 168E, 4 April 2008, p. 5.}

A further impact of forestry on the fuel reduction and ecological burning programs is the effect that regenerating forest has on the management of fuel reduction and ecological burning operations. As DSE informed the Committee, the presence of regenerating forest can increase the difficulty of managing prescribed burning for other purposes, particularly at certain stages of the regrowth cycle:

There is no evidence that supports the premise that a reduction in forest management activity has increased the occurrence of fires. Young regrowth (less than 10 years of age) often carries low fuel loads following harvesting (provided the area has been previously slash burnt). As fuel loads increase with time since establishment more moisture is trapped under the developing forest canopy, making these areas relatively safe from fire under moderate, and sometimes high, fire danger conditions. However, more mature regrowth does burn vigorously as fire danger increases, and there are periods in the forest growth cycle where regrowth is both flammable and susceptible to damage by fire. While in this flammable and vulnerable state, the presence of regrowth makes managing prescribed burning more difficult. Patchy regrowth from minor forest uses is most difficult to protect.\footnote{116 Department of Sustainability and Environment, \textit{Submission}, no. 168C, 31 August 2007, p. 13.}

DSE concluded:

The positive and negative impacts arising from forestry activities are manageable if risks and trade-offs are understood and managed. Localised impacts of prescribed fire on future timber resources need to be considered with not achieving broad area fire management outcomes whilst intending to minimise the occurrence and impact of future severe wildfires.\footnote{117 Department of Sustainability and Environment, \textit{Submission}, no. 168C, 31 August 2007, p. 13.}
The Committee received no evidence of an adverse impact by forestry operations on the opportunities for fuel reduction and ecological burning. Moreover, the Committee notes that the protection of existing timber resources is dependent on an adequate level of prescribed burning. The Committee also notes that the transition to what is essentially a purchaser-provider arrangement between VicForests and DSE for regeneration burning has significantly reduced the financial cost of conducting regeneration burning for DSE. The Committee notes that the savings achieved within DSE through this arrangement would now be available for other initiatives, such as an increase in the level of dedicated personnel for prescribed burning as recommended above.

Finding 2.4:

The Committee finds that there is no evidence of an adverse impact by forestry operations on the level of prescribed burning.

Alternatives to prescribed burning

The Committee notes that in addition to prescribed burning, there are several alternative approaches to fuel management available to land managers. As noted in the Code of Practice, the use of these alternatives must be in accordance with the relevant fire protection strategy.\(^{418}\) Alternative approaches to fuel management include grazing (discussed in Chapter Five); slashing; chaining; ploughing; rolling; mulching; and the application of herbicide.\(^{419}\)

The Committee notes that although dependent upon a range of issues, proximity to water bodies and cultural values for example, alternative approaches may be appropriate in certain situations and may be more cost-effective than types of prescribed burning. For example, the Esplin Report noted that in comparison to link burning (a type of prescribed burning), chaining may be a “safer and more cost effective means by which to construct buffers” in the Mallee.\(^{420}\) However, it is the Committee’s view that prescribed burning currently represents the most cost-effective and practical means by which landscape scale fuel reduction can be achieved across the majority of the public land estate.

\(^{418}\) Department of Sustainability and Environment, Code of Practice for Fire Management on Public Land, Department of Sustainability and Environment, Melbourne, 2006, p. 25.

\(^{419}\) Department of Sustainability and Environment, Code of Practice for Fire Management on Public Land, Department of Sustainability and Environment, Melbourne, 2006, p. 25.