C

Uses of Public Land

Part C of the Discussion Paper provides details on the various uses of land within the study area and the implications of these uses on the values and attributes of the River Red Gum Forests as a whole. It covers chapters 10 to 17.

10 Nature Conservation

Nature conservation is a significant use of public land in Victoria and includes the protection of flora and fauna species, their habitat and significant environmental characteristics. Features of geological, geomorphological and scenic significance are part of nature conservation as well as the preservation of processes necessary to conserve species, such as fire and flood regimes. This chapter provides an explanation of the contribution of public land—and in particular the reserve system—to nature conservation.

As discussed in chapter 5 a great deal of Victoria's biodiversity has been lost, largely due to land clearing and the introduction of exotic species. This decline continues in many areas. As a result, the maintenance, protection and enhancement of biodiversity have become important priorities for many communities as well as local, state and Commonwealth governments. Many people appreciate biodiversity for its own sake and for the chance to experience it—and many believe it is important to preserve species for future generations. Some also believe that all life forms have an inherent right to exist. In addition to its intrinsic value, biodiversity is essential to maintain the health of natural systems more broadly, such as healthy soil and waterways—the term "ecosystem services" has been coined recently to recognise the importance of this role.

The conservation of biodiversity is achieved using many different methods on both public and private land. These methods depend upon how many species are present, how intact the ecological processes are and how much human habitation and use there is in an area. Biodiversity conservation can take many forms, ranging from conservation reserves, to the sympathetic management of natural areas used for resource extraction (such as state forests) or utilities (such as road reserves), to improved management of remnant vegetation on private land through incentives and support.

Nature conservation encompasses the protection of both the living and the non-living parts of the environment, including geological and geomorphological features and scenic natural landscapes.

CONSERVATION RESERVE SYSTEMS FOR BIODIVERSITY CONSERVATION

Protecting natural areas in conservation reserves is a cornerstone of biodiversity preservation (Gaston et al. 2006). The need for conservation reserves is recognised worldwide and both the Australian and Victorian governments are committed, through the Convention on Biological Diversity, to establishing a representative conservation reserve system.

Habitat protection within conservation reserves is considered to be one of the most efficient means of conserving biodiversity and reducing extinction rates (Lawler et al. 2003). Protecting biodiversity in natural areas (*in situ* conservation) is more likely to maintain natural evolution and broader ecological processes than focusing on a single species outside of its natural environment. Deforestation and habitat fragmentation are generally much higher outside conservation reserves than inside (Sanchez-Azofeifa et al. 1999). Other human-induced threatening processes such as hunting and grazing are also reduced in conservation reserves (Bruner et al. 2001) and this can improve conservation of

threatened species in these areas (McKinney 2002).

In situ conservation is usually the cheapest and most effective long-term option. *In situ* conservation of threatened species in reserves is cheaper than *ex situ* conservation (Balmford et al. 1995; Lindsey et al. 2005). Numerous studies have compared (on a global scale) the costs of conserving biodiversity in conservation reserves with the costs of conserving biodiversity in the general landscape. James et al. (1999) estimated that a global network of conservation reserves would cost $27.5 billion per year while the conservation and remediation of biodiversity in the agricultural, forestry, coastal and aquatic landscapes would be nearly ten times as great (approximately $290 billion per year). Retaining an intact area of biodiversity may also have greater economic benefits than converting the land for production. Balmford et al. (2002) reviewed studies that included the benefits of recreation and ecosystem services (see chapter 5) such as carbon sequestration, water supply and regulation, and storm protection, and consistently found that retaining the area as intact habitat was more cost effective than clearing it for production. The cost of managing the conservation reserve system is estimated at 0.1–1% of the value of ecosystem services provide (James et al. 2001; Pimm et al. 2001).

DESIGN CRITERIA AND SETTING GOALS FOR RESERVE SYSTEMS

The conservation reserve system began early in Victoria's European history with the first national park declared in 1898 although early reserve declarations tended to be ad hoc and favoured sites that were scenically spectacular or of little use for agriculture, timber or mining. This pattern is common across the world (Margules & Pressey 2000). From 1971 to the mid 1990s, the Land Conservation Council conducted systematic regional studies of public land across Victoria. These studies recommended parks and reserves that included parts of each major land system found in the state. Most of Victoria's existing conservation reserve system result from these recommendations (see chapter 9). However, many of the recommendations were made with the limited ecological information available at the time. More recent research has changed scientific thinking on bioregional approaches (see chapter 5) or the appropriate size and configuration for reserve systems. In the 1990s, more sophisticated and systematic considerations of reserve systems were developed in recognition of their central role in biodiversity conservation.

Recent developments in terrestrial reserve systems in Australia have largely come under the auspices of the National Reserve System (NRS) and the Regional Forest Agreement (RFA) processes, both of which have been consistently supported by all state and Commonwealth Governments since the inception of each process in 1992. The Regional Forest Agreement process aims to balance sustainable forest production (largely through timber resource commitments to industry) and conservation (largely through reserves and sustainable forest management outside reserves). As the name suggests, this process involved a series of regional agreements (between the Commonwealth and state governments). In Victoria, five RFAs were signed but only the North East RFA (Commonwealth of Australia & State of Victoria 1999) overlaps with the River Red Gum Forests study area—the area of overlap being the current North East Forest Management Area (Map 14.1 in chapter 14 shows the boundaries of Forest Management Areas overlapping with the study area).

The Commonwealth funding program for the National Reserve System mainly focuses on terrestrial ecosystems other than forests, with particular emphasis on adding poorly reserved environments to the national conservation reserve system, using a bioregional approach.

Comprehensive, Adequate and Representative (CAR) reserve systems

Both the National Reserve System and the Regional Forest Agreement processes incorporate the need for a comprehensive, adequate and representative (CAR) conservation reserve system. In the context of the study area, these terms are defined as:

> **Comprehensive:** includes examples of the full range of ecosystems within each Victorian bioregion within the study area;
>
> **Adequate:** of sufficient size and number, and of appropriate shape to ensure the maintenance of ecological viability and integrity of biological populations, species and communities;
>
> **Representative:** areas selected for inclusion in reserves should reflect the diversity of the flora and fauna within each of the protected habitats and biological communities.

In summary, the conservation reserve system should contain examples of all types of ecosystems to be comprehensive. For each ecosystem, the reserved areas should be of sufficient size and configuration to maintain the integrity of its biodiversity (adequacy). Also, each ecosystem should be represented within each bioregion to cover the range of biological variation (representativeness). Bioregions are the broadscale mapping units for biodiversity planning in Victoria and capture the patterns and ecological characteristics in the landscape (for a full description of bioregions, see chapter 5).

Biodiversity may be defined in terms of species, genetic variation, habitats and/or ecosystems (see Ricotta 2005). The CAR criteria describe biodiversity at the level of "ecosystem" and assume that other levels of biodiversity are protected if coverage of ecosystems is comprehensive, adequate and representative.

However, ecosystems may also be difficult to map and thus, Ecological Vegetation Classes (EVCs) have been used as ecosystem surrogates to measure comprehensiveness, adequacy and representativeness for a number of years (Woodgate et al. 1996; Parkes et al. 2003) (see chapter 5 for further details). EVCs are the principal unit for vegetation circumscription and mapping for land-use planning and management in Victoria.

EVCs may not be the most suitable indicators for the distribution of all components of biodiversity (e.g. Mac Nally et al. 2002) and additional measures may be

needed to identify the conservation requirements of these components. For example, restricted colonial nesting species such as pelicans and egrets may not be well represented with the EVC approach. The vulnerability of particular EVCs (or ecosystems), species or other components of biodiversity to further loss or decline needs to be incorporated into the priorities for reservation.

Setting Goals to achieve CAR: The JANIS Criteria

A number of goals have been set to help establish a conservation reserve system that is representative, adequate and comprehensive. The Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia is widely known as the JANIS criteria (after the acronym for the group that developed the criteria) (JANIS 1997). Through successive Regional Forest Agreements, these criteria have been the benchmark for region-based assessments and establishment of forest reserve systems. The Terms of Reference for the River Red Gum Forests Investigation require VEAC to have regard to these nationally agreed criteria.

The JANIS biodiversity criteria specify appropriate minimum representation for ecosystems in each bioregion according to the status of each ecosystem. Typically, areas most intensely subject to human use are poorly represented in conservation reserve systems and consequently are often in most need of protection. More threatened or depleted ecosystems require higher levels of conservation reserve system representation. The JANIS definitions of threatened ecosystems—what constitutes endangered, vulnerable etc—are similar to more recent definitions of bioregional conservation status in Victoria's Native Vegetation Framework, see Appendix 6 (DNRE 2002i). The targets for reservation of each ecosystem are broadly:

1. 15 percent of the pre-1750 distribution of each vegetation type.
2. At least 60 percent of the remaining extent of vulnerable ecosystems. A vulnerable ecosystem is one which is i) has been reduced by around 70 percent within a bioregional context and which remains subject to threatening processes; or ii) is not depleted but subject to continuing and significant threatening processes.
3. All remaining rare and endangered forest ecosystems. A rare ecosystem appears within a small range of less than 10,000 ha, occupying a total combined area of generally less than 1000 ha or in isolated patches of generally less than 100 ha. An endangered ecosystem has contracted to less than 10 percent of its former range or former total area, or where 90 percent of its area is in small threatened patches.

Although drawn from a limited literature, the minimum 15 percent target was based on best advice from scientific experts and exceeds the targeted 10 percent protection of current forest area set internationally (Kanowski et al. 1999; Kirkpatrick 1999). Others suggest that the targets should be evidence-based (based on the conservation requirements of species and communities) rather than policy-based (Svancara et al. 2005) and that higher levels of reservation are therefore required in some Australian landscapes (e.g. 30 percent: Freudenberger et al. 1997). An over-reliance on broad-scale attributes and an emphasis on 'representation' in reserve system establishment has been criticised by some scientists who suggest that unique areas and hotspots for biodiversity may be being missed (e.g. Brooks et al. 2004). Thus identifying 'key biodiversity areas' may be

an important complementary process in selecting reserves (Eken et al. 2004). In Victoria, 'Biosites' (see chapter 5) may provide a framework for identifying important elements of biodiversity not accounted for using the JANIS criteria.

The recently-released Directions for the National Reserve System—a Partnership Approach sets a number of timelines for achieving CAR outcomes (NRMMC 2005a).

JANIS Criteria for Conservation Reserves

Recognising that the conservation reserve system should first be selected from public land, the JANIS criteria identified three public land components of the reserve system, in decreasing order of preference:

Dedicated reserves: reserves established by legislation for conservation purposes and for which a Parliamentary decision is required to revoke their status;

Informal reserves: areas reserved under other secure tenure or management arrangements, where it is not possible or practical to include conservation values in dedicated reserves; and

Protection by prescription: values protected by prescription where protection in reserves is impracticable because of the nature of the value.

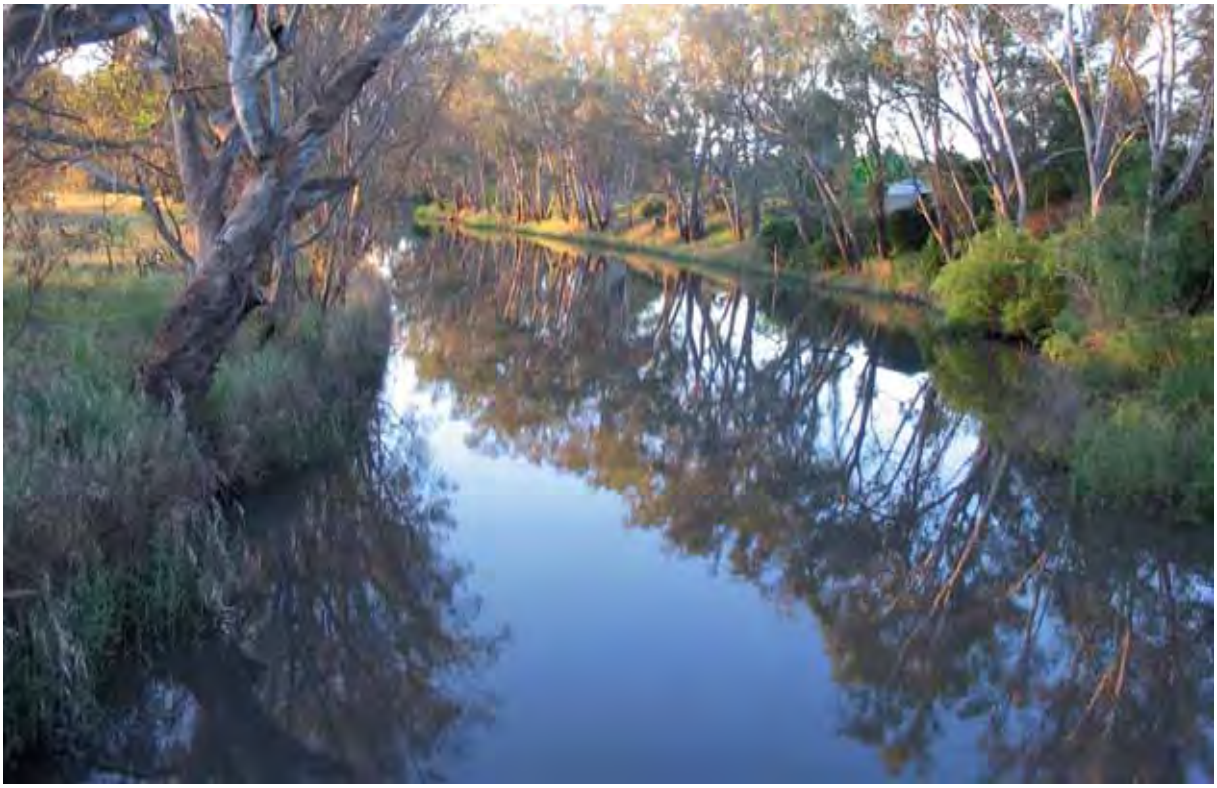
'Dedicated reserves' are equivalent to those reserves meeting the World Conservation Union definition of 'protected area' (see below). Informal reserves, mostly Special Protection Zones (SPZs) in state forest, result from forest management planning undertaken by DSE (see chapter 14). Other measures taken by DSE, such as Special Management Zones and prescriptions for timber harvesting, give a level of protection to natural values and complement the conservation reserve system but are not considered as part of the system.

There are two key points to take into account in interpreting the JANIS criteria for River Red Gum Forests and associated ecosystems:

Flexibility: the need for flexibility in the application of the criteria to ensure that the CAR reserve system delivers optimal nature conservation outcomes as well as acceptable social and economic outcomes is specifically mentioned in the JANIS criteria and is aligned with Section 18 of the *Victorian Environmental Assessment Council Act* 2001 which specifies that Council is to have regard to "the potential environmental, social and economic consequences of implementing" its recommendations.

Context: in the Regional Forest Agreement process, the JANIS criteria were applied to forested landscapes with a relatively large proportion of off-reserve areas supporting substantially intact tracts of indigenous vegetation. In contrast, much of the vegetation in the River Red Gum Forest study area has been cleared or degraded. In some areas, only small, highly degraded areas may be available for reservation. Such blocks are generally very expensive to manage, often with little reason to expect a significant contribution to the conservation of biodiversity. This may make it very difficult to meet some JANIS targets.

When the JANIS criteria were applied in the North East Regional Forest Agreement, some red gum areas were protected through the establishment of Special Protection Zoness, although no new dedicated reserves were created. The JANIS criteria were also used as a basis for Special Protection Zone establishment in the Forest Management Plans for the Mid-Murray and Mildura Forest Management Plans (DNRE 2002a; DSE 2004f), although at that time EVC mapping was inadequate even to quantify representation targets.



VICTORIA'S PROTECTED AREA SYSTEM AND THE NATIONAL RESERVE SYSTEM

A protected area is a park or reserve with a primary aim of biodiversity conservation. International thinking has been led by the World Conservation Union (IUCN), which has developed definitions and classifications for protected areas (see Box 10.1). In Victoria, protected areas include reference areas; national, state, wilderness and some regional parks; nature conservation reserves; heritage rivers and some natural features reserves (see below for details). Some other categories of land known as 'parks' or 'reserves' are not considered protected areas as their primary purpose is not biodiversity conservation (e.g. most regional parks, historic reserves, lake reserves, highway parks).

The National Reserve System (NRS) represents the collective efforts of the States, Territories, Commonwealth Government, non-government organisations and indigenous landholders to achieve a system of terrestrial protected areas that samples all regional ecosystems in a comprehensive, adequate and representative manner. It includes all protected areas throughout Australia, including securely protected private land[1].

In Victoria, those public land use categories that meet the definition of protected area (see below) are included in the National Reserve System. The existing conservation reserve system is largely a product of the work of the LCC, ECC and VEAC who sought to represent all land systems or vegetation types in dedicated reserves. DSE, through Parks Victoria, is responsible for management of most dedicated reserves on public land in Victoria.

Dedicated reserve status of land in the categories included in the reserve system is conferred by one of four Parliamentary Acts. Broadly speaking, national, state and some other parks are scheduled and managed under the *National Parks Act 1975*, nature conservation reserves and natural features reserves are reserved and managed under the *Crown Land (Reserves) Act 1978*, reference areas are proclaimed and managed under the *Reference Areas Act 1978*, and heritage rivers are proclaimed and managed under the *Heritage Rivers Act 1992*.

Recognising that the National Reserve System cannot achieve the CAR goals of being comprehensive, adequate and representative from public land alone, the Commonwealth's National Reserve System Program has a key role in enhancing the reservation of some of Australia's most under-represented ecosystems, mainly through the provision of funds for land purchase. Within Victoria, this is complemented by DSE's Conservation Land Purchase Program which acquires, on a voluntary basis, freehold land supporting high-quality examples of key ecosystems to enhance the conservation reserve system. Within the study area, most of the focus for land purchase has been on native grasslands and grassy woodlands, specifically in the Patho Plains region near Mitiamo. Since 2000, six properties containing endangered Northern Plains Grasslands have been purchased in this region totalling almost 1500 ha. Elsewhere, buloke grassy woodlands near Lake Moodemere, cane grass wetlands at Wanalta and saltbush shrublands at Winlaton have been purchased and declared as nature conservation reserves (Fitzsimons & Ashe 2003; Fitzsimons et al. 2004; Fitzsimons et al. 2006).

[1]Note that land purchased by private organisations through the National Reserve System Program meets protected area criteria and thus contribute towards CAR targets. The status of various other conservation agreements over private land is currently being evaluated by DSE.

Box 10.1 Protected Areas: Definition and Management Categories.

The definition of a protected area adopted by World Conservation Union (formerly known as the IUCN) is: "An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means".

Although all protected areas meet the general purposes contained in this definition, in practice the precise purposes for which protected areas are managed differ greatly. Thus the IUCN defined a series of six protected area management categories, based on primary management objective (IUCN 1994). Note that in Victoria, each reserve qualifying as a protected area is assigned an IUCN category. In summary, these are:

CATEGORY Ia:	Strict Nature Reserve: protected area managed mainly for science
Definition	Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
CATEGORY Ib	Wilderness Area: protected area managed mainly for wilderness protection
Definition	Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
CATEGORY II	National Park: protected area managed mainly for ecosystem protection and recreation
Definition	Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
CATEGORY III	Natural Monument: protected area managed mainly for conservation of specific natural features
Definition	Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.
CATEGORY IV	Habitat/Species Management Area: protected area managed mainly for conservation through management intervention
Definition	Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
CATEGORY V	Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation
Definition	Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
CATEGORY VI	Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems
Definition	Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Protected Areas within the Study Area: Focus on Conservation

The following section describes various public land use categories that generally are protected areas and contribute to the National Reserve System. More comprehensive descriptions of all public land use categories are provided in chapter 9.

National and State Parks

National and state parks provide the highest level of protection for natural features such as flora and fauna and landscapes, and for Aboriginal cultural sites and places and historic sites. Accordingly, harvesting of forest products, grazing by domestic stock, and hunting and firearms are normally not permitted, and national and state parks are exempt (in most circumstances) from exploration and mining under the *Mineral Resources Development Act 1990*. There are many forms of recreation that are compatible with nature conservation and these are generally encouraged in national and state parks. Management plans are legislatively required for all national and state parks, and all parks in the study area currently have management plans in place. Careful management planning and zoning is required to minimise potential conflicts between human use and the protection of natural features.

Regional Parks

Although most regional parks are usually not considered to be protected areas, the Murray–Kulkyne Park is a potential exception because it is listed on Schedule 3 of the *National Parks Act 1975* (most regional parks are listed under the *Crown Land (Reserves) Act 1978*), which has objectives that meet the criteria for protected areas. Murray–Kulkyne Park is managed in conjunction with Hattah–Kulkyne National Park.

Nature Conservation Reserves

Nature conservation reserves (including flora reserves, flora and fauna reserves and wildlife reserves where hunting is excluded) have a primary purpose of biodiversity conservation. They are generally smaller than national and state parks and declared over areas with important ecological significance or areas sensitive to human use. Generally provision for public use is limited to passive recreation such as nature observation. Timber removal, grazing by domestic stock, and hunting and firearms are generally not permitted.

In heavily cleared and fragmented landscapes, such as the Victorian Riverina, nature conservation reserves are the primary mechanism for high-level conservation of biodiversity. Management planning in these reserves is important, particularly for those ecosystems requiring more intensive management, such as native grasslands. Management statements have been prepared for some nature conservation reserves, while for others, overarching management directions are provided in the *Conservation Reserves Management Strategy* (Parks Victoria 2003).

Natural Features Reserves

Some natural features reserves qualify as protected areas, particularly those with a strong emphasis on the conservation of species, ecosystems or natural features—bushland areas, scenic areas, geological and geomorphological features areas, streamside areas, natural features reserves and the River Murray Reserve (DNRE 1996b). As with nature conservation reserves, natural features reserves are often small, and usually contain features of less ecological significance. Nonetheless, most retain native vegetation that provides habitat for native species, often within fragmented landscapes, as well as scenic values. A greater range of recreational or other activities are usually allowed for in natural features reserves.

Generally natural features reserves receive a lower management priority than the preceding categories, although at certain times of the year, they may be heavily utilised (e.g. the River Murray Reserve during summer holidays). Few reserves are the subject of management plans, but overarching management directions are provided in the *Conservation Reserves Management Strategy* (Parks Victoria 2003).

Reference Areas

Reference areas are generally small areas of land set aside as representations of different land systems or ecosystems for use as a reference for scientific comparison with similar land under other uses and to maintain natural ecosystems into the future. Reference areas exclude entry by all persons (other than management personnel or those with Ministerial approval), provide for approved research work and prohibit grazing, mineral exploration, mining, harvesting of forest produce, quarrying, bee-keeping, educational use, recreational activities and all forms of

harvesting (except water harvesting). Reference areas are usually embedded within other much larger public land blocks, typically parks or state forest. Not all land systems can be represented in reference areas, as for many land systems, no suitable public land exists that can be managed for scientific reference.

Heritage Rivers

Heritage River are a public land use overlay that sets aside stretches of rivers and streams to protect natural heritage, cultural heritage, recreational, and/or scenic values. The *Heritage Rivers Act 1992* commits managing authorities to ensure any heritage river is maintained without further interference to its free-flowing state, which includes new impoundments and dams and diversion of water. It also commits managers to 'take all reasonable steps to ensure that the significant nature conservation, recreation, scenic or cultural heritage attributes of the area are protected'. The management objectives for other uses in heritage rivers vary according to the underlying tenure. For example, in both heritage rivers occurring in the study area (the Ovens and the Goulburn), timber harvesting is allowed in areas of overlap with state forest, but not in nature conservation reserves.

Other Public Land Use Categories with some Conservation Focus

The following public land categories are not considered as protected areas (with exceptions) and are not part of the National Reserve System. However, many have native vegetation and thus contribute in some part to the conservation of biodiversity.

Regional Parks

A regional park is an area of public land, readily accessible from urban centres or a major tourist route, set aside primarily to provide recreation for large numbers of people in natural or semi-natural surroundings. Regional parks are generally in excess of 1000 ha and managed by Parks Victoria. Timber extraction and grazing is often permitted in regional parks but the ECC Box-Ironbark Investigation recommended the proclamation of regional parks where these activities were not permitted and where nature conservation is a major objective. Accordingly, these parks may be considered to be protected areas and thus part of the National Reserve System (ECC 2001).

Natural Features Reserves

Those natural features reserves that are generally not considered protected areas place a stronger emphasis on recreation or other uses than on the conservation of natural features. These categories are public land water frontages, lake reserves and highway parks (DNRE 1996b). Despite their management emphasis, most retain native vegetation that provides habitat for native species, often within fragmented landscapes, as well as scenic values. Lake reserves allow for the seasonal hunting of duck species. Generally natural features reserves receive a lower management priority than the preceding categories, although at certain times of the year, they may be heavily utilised (e.g. lake reserves which allow intensive water-based recreation). Few of these natural features reserves are the subject of management plans, but overarching management directions are provided in the *Conservation Reserves Management Strategy* (Parks Victoria 2003).

Historic and Cultural Features Reserves

Historic and cultural features reserves are established to primarily protect places with highly significant historical values, including remnant historical features such as buildings, structures, relics or other artefacts. In some instances these reserves contain important natural or semi-natural vegetation. As they are mainly small in area, their contribution to nature conservation is generally small.

Special Protection Zones in State Forest

Special protection zones within state forest are designated by Regional Forest Agreements or Forest Management Plans in order to protect sites of ecological significance, aesthetic areas, streams and wetlands, known sites for certain important flora or fauna species, and to meet CAR objectives. As Special Protection Zones exclude the removal of timber and in some cases can be quite large, they potentially play an important role in nature conservation. However other uses permitted in Special Protection Zones (e.g. cattle grazing) may compromise their protected area status. The zones have no legislative basis and can be altered through administrative processes.

Conservation on Other Public Land

The majority of other public land in the study area retains some indigenous vegetation and consequently plays an important role in nature conservation. State forest in particular provides extensive areas of natural habitat.

NATURE CONSERVATION ON PRIVATE LAND

Trust for Nature (Victoria)

The Trust for Nature (Victoria) is a statutory body corporate constituted under its own Act of Parliament, the *Victorian Conservation Trust Act 1972*. The Trust accepts bequeathed land or money for conservation and as well as purchasing properties with high nature conservation values. The Trust can also enter into voluntary conservation covenants with private landowners on their land, permanently protecting significant areas of natural habitat. More recently, the development of a Revolving Fund has enabled the Trust to acquire land for the purpose of conservation and on-sell it with a conservation covenant as a condition of sale. The proceeds of the sale are then returned to the Trust, which acquires another property for the same purpose.

The Trust has purchased a number of properties in the study area with part funding from the National Reserve System Program (i.e. Neds Corner, Korrak Korrak Grassland, Glassons Grassland, and Kinypanial Grasslands). These private reserves increase the representation of some of the State's most endangered or under-represented ecosystems.

Market-based approaches

In recent years, market-based approaches to increasing protection and improving management of native vegetation and other natural assets have been trialed in Victoria. The best-known of these is BushTender, an auction-based approach where landholders competitively tender for contracts to improve native vegetation on their land. Successful bids are those that offer the best value for money, with successful landholders receiving periodic payments for their management actions under agreements signed with DSE. These actions are based on management commitments over and above those required by current obligations and legislation (DSE 2005b). Within the study area the North East BushTender trial was completed in 2002.

Other initiatives currently operating within the study area are Cornella EcoTender project (a tender-based system to allocate funds in a way that delivers multiple environmental benefits for landholders at both the local and catchment scale), the North East RiverTender, as well as initiatives with emphasis on the re-establishment of native vegetation (e.g. CarbonTender, Bush Returns).

Land for Wildlife

The Land for Wildlife scheme provides assistance for landholders who register under the program to manage all or part of their properties for nature conservation. These agreements are non-binding and either party can withdraw from the agreement at any time.

Landcare

Landcare is a major, joint government-community initiative to promote sustainable land use. Under various sub-programs, local Landcare groups receive government support for appropriate activities, many of which have nature conservation as a primary or subsidiary aim.

Environmental Overlays in Local Government Planning Schemes

Planning schemes provide opportunities to protect nature conservation values on private land. The placement of Environmental Significance Overlays on particular areas of private land can limit use of those sites for activities that may impact negatively on their specific values.

COORDINATING NATURE CONSERVATION ACROSS PUBLIC AND PRIVATE LAND

The coordination of nature conservation activities over public and private land is increasingly recognised as an essential element of effectively and efficiently managing biodiversity at a landscape scale. Within Australia, such models are characterised by Conservation Management Networks (CMNs) and Biosphere Reserves. In Victoria, Catchment Management Authorities also play a large role in conservation across public and private land tenures.

A CMN is a network of remnants managed for conservation, their managers and other interested parties. The CMN model essentially coordinates, or helps coordinate, the protection and management of fragmented ecological communities across a range of tenures and with a variety of protection mechanisms (Thiele & Prober 1999, 2000). While originally designed for a 'whole of ecosystem' approach, Conservation Management Networks have been developed at a more regional scale in Victoria (Fitzsimons 2004). Within the study area, the Northern Plains Conservation Management Network, centred on the Patho Plains near Mitiamo, seeks to coordinate the management of native grasslands on both public and private land.

Biosphere Reserves are concerned primarily with integrating biodiversity conservation with ecologically sustainable development across a variety of land tenures and uses. The theoretical Biosphere Reserve model revolves around a 'core' protected area managed primarily for nature conservation, a 'buffer' zone where activities that impact on the biodiversity of the core are minimised, and a 'transition' zone, where the sustainable use of natural resources is encouraged (UNESCO 1995; Brunckhorst et al. 1997). The international 'Man and the Biosphere Program' is coordinated by UNESCO.

Two biosphere reserves currently adjoin the study area in New South Wales and South Australia. The Riverland Biosphere Reserve (formerly the Bookmark Biosphere

Reserve) incorporates public and private land along the South Australian Murray River corridor and large former pastoral properties in the South Olary Plains. The recently declared Barkindji Biosphere Reserve is located in the southwest of New South Wales, and incorporates the Australian Inland Botanic Gardens, a number of pastoral properties and smaller blocks of public and private land. Although the Hattah–Kulkyne National Park is a listed biosphere reserve, its boundary does not currently extend beyond the national park.

Cooperative tri-state conservation initiatives already exist between Victorian, New South Wales and South Australia through programs such as the Murray Mallee partnership and The Living Murray program.

PROTECTION OF OTHER IMPORTANT NATURAL, SCENIC, GEOLOGICAL AND GEOMORPHOLOGICAL VALUES

Although EVCs are the main surrogate for landscape-scale conservation planning in Victoria, particular elements of biodiversity, or significant features or sites require particular attention. These are outlined below.

Large Old Tree Sites

Sites with a relatively high abundance of large old trees can be a significant factor in reserve system planning in regions where the original abundance of such trees has been greatly reduced (see chapter 5 for more details). They are important for many reasons including the following (not all of which are related only to biodiversity conservation) their:

- Contribution to biodiversity by providing habitat—including hollows, a distinctive forest structure, and abundant bark and fallen timber—for many threatened species. For example, Barking Owls, which are endangered in Victoria, can only breed in large tree hollows. In addition, many of their prey species use tree hollows. Loss of hollow-bearing trees is one of the factors contributing to the decline of this species in Victoria.
- Importance as places of scientific and management, providing unique insights into the ecological functioning of what may once have been the dominant forest age-class in the River Red Gum Forests.
- Irreplaceablity in the short-term, taking hundreds of years to re-establish if lost.
- Scenic landscape values, provide landscape diversity and aesthetic appeal—people boating along the rivers, for example, enjoy the picturesque views of large old trees along the riverbanks.
- Represention of places of great antiquity and reminders of another age, producing strong emotional reactions.
- Cultural element to both Indigenous and non-Indigenous people. Large old trees provide a link to people's ancestors and their uses of and affinity with the forests.

Freshwater Ecosystems

Freshwater ecosystems include rivers, anabranches, floodplains, wetlands, and ephemeral lake systems. The conservation of freshwater ecosystems poses unique challenges due to the hydrological connectivity of freshwater habitats. Partial reservation of individual freshwater habitats may not ensure the long-term sustainability of those sections of rivers, wetlands, and other freshwater ecosystems that are considered 'protected'. For example, by only reserving a portion or even most of a river or wetland, it is likely that any degrading processes occurring in unprotected areas will ultimately affect the reserved portion of the same system (Fitzsimons & Robertson 2005). Within the study area, of those wetlands with at least some form of reservation, 51 percent are not completely reserved (Robertson & Fitzsimons 2005g). The variation in hydrological processes between riverine, wetland and groundwater ecosystems means that a variety of different strategies are required.

Recent reviews suggest that Australia does not have a comprehensive freshwater reserve system (Georges & Cottingham 2001; Nevill & Phillips 2004; Kingsford & Nevill 2006) and the Directions for the National Reserve System paper highlights the need for increased emphasis on this issue (NRMMC 2005a). As part of the Intergovernmental Agreement on the National Water Initiative (Council of Australian Governments 2004), the Parties' water management framework also stated that they will "identify and acknowledge surface and ground water systems of high conservation values, and manage these systems to protect and enhance those values" (s25.x.).

Three important indices in the assessment of wetland reservation have been identified for assessing wetland reservation in Victoria: 1) reservation status (area of different wetland types in reserves, relative to pre-European and current extent); 2) reserve design (percentage of wetland area included in a reserve); and 3) reservation categories (type of reserves which protect wetlands) (Fitzsimons & Robertson 2005).

Wetlands listed under the Ramsar Convention area are not considered protected areas in their own right and have no specific legislative protection in Victoria. Ramsar sites are however considered under the *Environment Protection and Biodiversity Conservation Act 1999* as a 'matter of national environmental significance'. The Barmah Forest Ramsar site is mainly state park and state forest, Gunbower is mainly state forest, Kerang Lakes a mix of natural features reserves and other public land, while Hattah Lakes are totally

contained within the Hattah–Kulkyne National Park. The NSW Central Murray State Forests Ramsar sites adjoins the Barmah and Gunbower sites in New South Wales, while the Riverland Ramsar site in South Australia adjoins the Victorian border.

The Directory of Important Wetlands in Australia (Environment Australia 2001) is a national inventory of significant wetlands. While not providing any increased legal protection, the Directory provides information for use in planning decisions including identifying new Ramsar sites and sites of importance for particular species, including threatened or migratory species. Numerous Directory wetlands occur in the study area, including the Corop Lakes, Wallpolla Island and Lindsay Island.

The recently established Living Murray Initiative, coordinated through the Murray–Darling Basin Ministerial Council, aims to improve the health of the Murray River and adjoining ecosystems through the provision of additional water for the environment. An initial focus for action is on maximising environmental benefits for six 'significant ecological assets'. Five of these sites are at least partially within the study area: Barmah–Millewa Forest, Gunbower and Koondrook–Perricoota Forests, Hattah Lakes, Chowilla Floodplain (including Lindsay and Wallpolla Islands), and the River Murray Channel (MDBC 2005b).

Threatened Species and Communities

The recovery of threatened species and communities is important in the conservation of biodiversity (see chapter 5). This is reflected by legislation at the state (*Flora and Fauna Guarantee Act 1988* (FFG Act)) and federal (*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) levels. This legislation calls for the development of Action Statements and Recovery Plans for individual species and communities. The plans outline a range of actions required for the conservation and recovery of these species or communities, including the management of public land. The amelioration of listed potentially threatening processes, for example, "degradation of native riparian vegetation along Victorian rivers and streams", is also essential for the maintenance of biodiversity and often for the recovery of threatened species and is covered under this legislation. The distribution and abundance of threatened species and communities, and potentially threatening processes requires special consideration during the process of conservation reserve system design.

Scenic Landscapes

Scenic landscapes focus on the natural beauty and appeal of the landscape which, while essentially subjective, typically have in common features appreciated by many people. These include natural-looking landscapes with focal points such as waterfalls and rivers, towering mountain ranges with spectacular

Table 10.1 High scenic quality rivers and streams within the River Red Gum Forests study area.

River	Section(s)
Ovens River	Killawarra to Lake Mulwala
Goulburn River	
Loddon River	
Murray River	Wodonga west to the Ovens River junction
	abutting Barmah State Forest and State Park
	abutting Gunbower State Forest
	Mildura area
	Wentworth west to the SA border

Source: LCC (1989b).

rock formations, or vast forests interrupted by fast-flowing rivers and sheer cliffs. Scenic landscapes allow people to enjoy nature and often provide a sense of pleasure and well-being. They also provide opportunities for recreation and tourism and hence contribute to local economies.

The Murray River largely determines the scenic qualities of the study area. The importance of water in this dry, and sometimes arid, landscape provides inspiration and rejuvenation for many visitors and residents, as it has for thousands of years. In places, the major rivers form tight meanders and steep cliffs, while other areas have popular sandy beaches with large river red gums overhanging the watercourse.

With such a dominance of water-related features across the study area, the broad alluvial plains extending from the Bendigo area to Swan Hill and Echuca may be easily overlooked. These flat alluvial floodplain areas, now largely cleared of native vegetation, are utilised for extensive and intensive agriculture. The broad expanses have their own appeal, punctuated by chains of lakes and swamps in shallow depressions, and by elevated hills of bedrock such as in the Mt Hope–Terrick Terrick area.

Formal scenic landscape quality was assessed for the great majority of Victoria's larger rivers and streams by the Land Conservation Council (LCC 1989b). A number of river reaches in the study area were assessed as high scenic quality areas (Table 10.1). The other high scenic areas are located in farm-forest or mixed agricultural and natural areas, agricultural and small town or suburban river settings (LCC 1989b). In addition, particular reference was made to the outstanding values adjoining the Victorian banks of the Murray River.

Much of the Victorian landscape has been significantly modified by human intervention over the last 200 years and while changes such as historic homesteads or railway bridges may enhance scenic qualities, others such as powerlines or communications towers generally detract and have a negative visual impact.

Scenic landscapes are often protected in national parks, e.g. the Twelve Apostles in Port Campbell National Park. Scenic values are specifically protected as Victorian Heritage Rivers for the river corridors in Table 10.1, with the exception of the Loddon River (LCC 1991). Smaller scenic areas such as Red Cliffs Scenic Reserve near Mildura have been set aside as scenic reserves under the *Crown Land (Reserves) Act 1978* for the conservation of areas of natural beauty or interest (LCC 1977b). Other areas may be set aside as Section 50 reserves under the *Forests Act 1958* to protect scenic areas from inappropriate resource extraction or other threatening processes.

In some places local governments have strived to protect current values and control the change of character or inappropriate development through Environmental Significance overlays under the *Planning and Environment Act 1987*. For example, the Significant Landscape overlay listed under the Moira Shire Planning Scheme for Lake Mulwala water and shoreline environs is designed to preserve and enhance the special landscape and natural attributes of the area from inappropriate development or visual intrusion. However the planning scheme process is limited to a role that is only triggered by new applications and does not have ongoing influence on land management practices.

Register of the National Estate

The Register of the National Estate is a national inventory of natural and cultural heritage places maintained by the Australian Heritage Council. Although not directly applicable to conservation reserve system design, the Register provides relevant information on some areas of high nature conservation value. Areas

such as the Barmah–Millewa Forests and Terrick Terrick National Park are listed on the Register of the National Estate. Cultural heritage values are discussed extensively in chapter 12.

Sites of Geological and Geomorphological Significance

Many localities in the study area display geological and landform features of interest for educational, research or conservation purposes. Some sites show rare or unusual minerals, fossils or landforms. These features vary widely and include natural outcrops or landforms, as well as exposures in road and railway cuttings, quarries or other excavated sites. Geological sites generally display features developed in earlier times, such as an outcrop with sediments and fossils. Many geomorphological sites are important for displaying active land forming processes, such as dune development or stream erosion and deposition.

Sites or features may be rated according to a defined scale of significance. Significance is often ascribed to features because they are outstanding in some way or rare. Outstanding sites are excellent examples of a feature, either in the region or on a wider scale. Rare features are uncommon or unique, either regionally or further afield. However, recognition of only outstanding or rare sites is insufficient to identify all important geological elements or values. Representative sites are examples of features typical of a region and compliment high significance features.

A geographic scale is also necessary to compare significance, for example whether the site is of local, state, national or international significance. These ratings may be applied in combination, for example a representative feature for a region may also be an outstanding or rare example on a state or national level.

Significance ratings contain a degree of subjectivity determined partly by what is known about the specific site, but also the level of knowledge of similar sites elsewhere. Geological and geomorphological significance are not necessarily the most aesthetic features of a landscape (see scenic landscapes above). Some sites of very high significance may not be at all aesthetic, e.g. quarry faces or road cuttings, whereas aesthetically pleasing views may have no geological significance.

To be considered for assessment, sites consist of at least one of the following:

- type section (reference location) or type example of a geological unit
- important fossil locality
- exposures of a range of characteristic or unusual features of the rock unit, or boundary relationships between units
- unusual or rare occurrence of a particular geological feature, rock type or mineral
- illustration of tectonic and/or volcanic processes
- attributes which enable palaeoclimatic reconstructions
- demonstration of the effects of weathering, erosion and/or deposition, or geomorphological process (active or relict) such as landform evolution
- representative example of a landform type.

For this Investigation, geological and geomorphological features within the River Red Gum Forests study area have been assessed as outstanding, rare and/or representative and rated as of local, regional, state, national or international significance as described by White et al. (2003). The assessment of significance was undertaken by an expert volunteer panel of the Geological Society of Australia Inc. (Victoria Division), Geological Heritage subcommittee. Sites are identified using an alphanumeric system conforming with that used by the Geological Heritage subcommittee referring to the relevant 1:250,000 geological map sheet (BD Balranald and Deniliquin; BN Bendigo; SH Swan Hill; SR St Arnaud; MD Mildura; TL Tallangatta and WN Wangaratta and part of Jerilderie) and an assigned unique number as described in Joyce and King (1980).

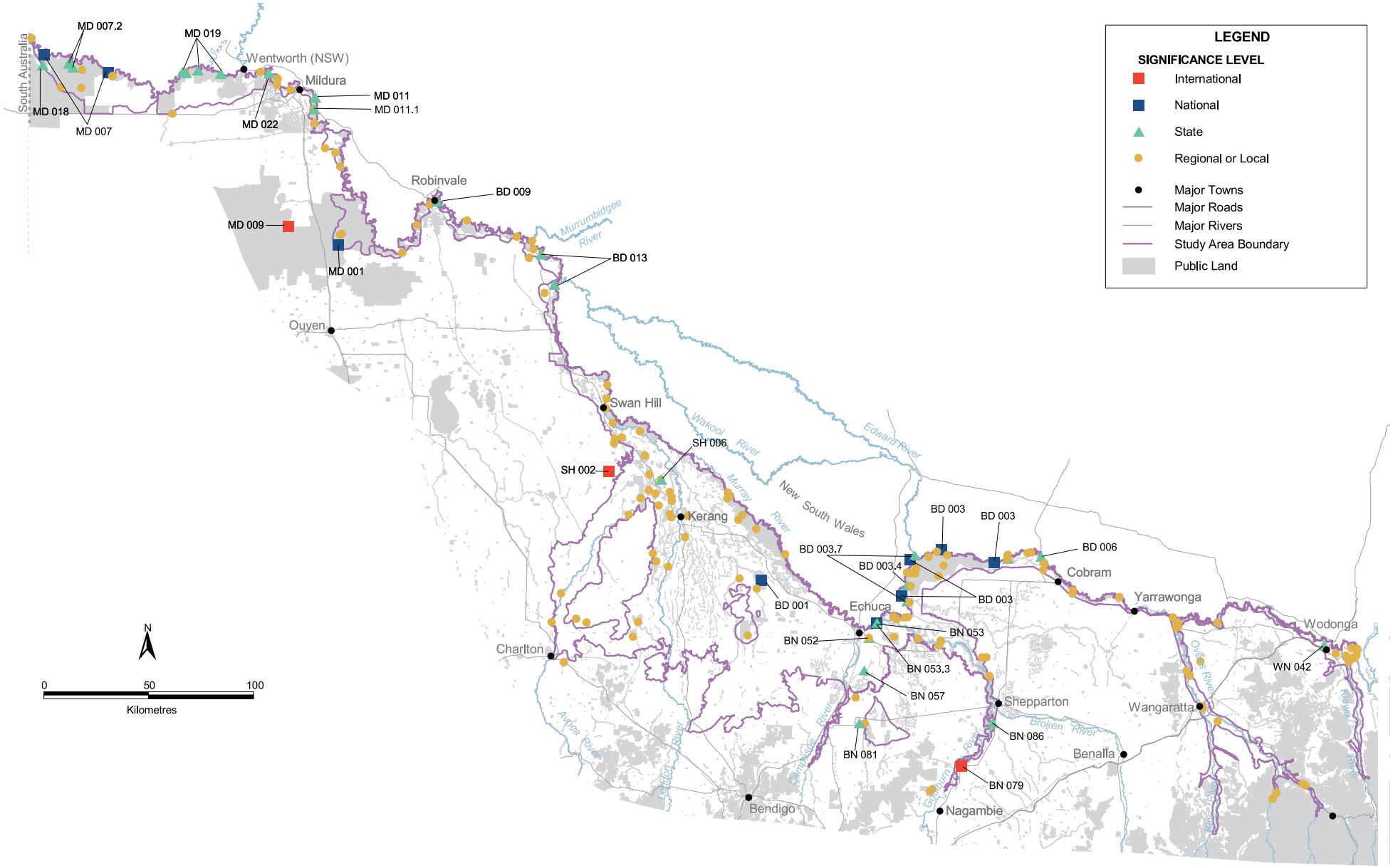
The study area

Significant geological and geomorphological sites of the river red gum forests of northern Victoria are generally Cainozoic rather from the earlier Mesozoic or Palaeozoic periods (see chapter 2). A few isolated sites of older rocks are identified but the geology of the riverine plains is dominated by sedimentary, tectonic and geomorphological processes of the last 30 million years.

Significant geological features in the region include rock units and structures visible as natural outcrops and in exposures created by mining and quarrying operations, road and railway cuttings and water bores. Important geomorphological features include those related to the complex hydrology of the River Murray and its tributaries: the Kiewa, Ovens, King, Goulburn, Campaspe, and Loddon Rivers. The extensive lunette lakes of the Murray Basin and their distinctive crescent shaped dunes are significant parts of the landscape. Sites where hydrological and hydrogeological processes are important are the most common geological sites identified.

A list of all 145 sites of geological and geomorphological significance identified in the study area is provided in Appendix 13, derived from field investigations, scientific literature and personal accounts related by earth science professionals. Sites of high significance (international, national and state) both within and near the study area are presented in Table 10.2. Important sites located near the study area have been included in these lists to provide context. Specific sites are represented as point locations on Map 10.1.

Map 10.1 Sites of high geological and geomorphological significance in and near the study area.



Sites of high significance

Currently, three sites of international significance have been identified which lie just outside the study area boundaries: the Murchison Meteorite fall site (BN 079), Raak Plain boinka (MD 009) and Lake Boga granite quarry mineral type locality (SH 002) (Joyce & King 1980; King 1988; White et al. 2003).

The Murchison Meteorite is rare in a worldwide context — by the nature of its scale, state of preservation and display, and is comparable with examples known internationally. The Murchison Meteorite Shower was observed on September 28, 1969. The meteorite fragments found are of the rare carbonaceous chondrite (CM2) type and many are housed with the Museum of Victoria meteorite and tektite collection. The largest piece in the collection is 1.3 kg in and the entire collection weighs 11 kg although it is estimated that at least 100 kg has been recovered in total. This meteorite has been widely studied as it contains organic compounds such as simple amino acids, important for understanding the origins of life (Henry & Lyle 2003).

Lake Boga granite quarry located to the south of the town contains an unusual suite of minerals. This working quarry is the locality for the mineral ulrichite which was first discovered there in the mid-1980s (and has not been found anywhere else) and bleasdaleite found in 1995. Most of the 50 mineral species that have been identified from this site comprise secondary phosphates of copper, calcium and uranium. Other new minerals are being investigated from this rich deposit (Birch 2003).

The Raak Plain is a boinka (a large saline groundwater discharge lake) landform complex, and consists of a variety of features including sandplains, salt pans, saltbush flats gypsum flats, gypsite hills, and salinas (ephemeral lakes). The boinkas occupy a broad flat depression within a linear dunefield. The Raak Plain is the largest of the Murray Basin boinka (~500 km sq) and is an excellent example of a feature which is unusual on a world scale. This area is also an example of natural salinisation processes, as opposed to salinisation resulting from human activity.

Five sites of national significance have been identified within and near the study area. The extremely complex hydrological system where the Goulburn River and Broken Creek enter the River Murray (BN 053) is of national significance (Bama-Goulburn drainage complex BN 053). In times of high flow from the Goulburn, the Murray is 'dammed' and 'flows backwards' or in reverse. This hydrological complexity is rare in Australia and results in the flooding of the Barmah forest area (BD 003). The other nationally significant site is Hattah Lakes system comprising the natural anabranch lakes, channels, lunettes and dunes (MD 001) and the Lindsay Island floodplain, scroll bars, active and abandoned channel complex (MD 007). The significance of the Kow Swamp (BD 001) is largely related to the cultural heritage sites in a low lunette on the eastern margin of a former lake depression. The site is now used for water storage. A description of the archaeological significance of the site is provided in chapter 12 Cultural Heritage.

Eighteen sites of state significance have been identified (Table 10.2). These sites are important in defining the geology and geomorphology of Victoria. They vary from type-sections of rock types restricted to Victoria e.g. Shepparton Formation type-section (BN 086) at Kialla West, to major tectonic features e.g. Tawonga Fault (TL 139). Other state level sites include Cainozoic climatic and hydrological sites such as Palaeolake Kanyapella at Echuca (BN 052), and complex modern hydrological or geomorphological sites such as Bumbang Bend recent meander cut-off (avulsion) near Robinvale (BD 009) and Cowanna Bend neck meander and potential avulsion site (MD 022) Redgrove, where the River Murray is currently modifying the landscape.

Sites of low significance

Sixty-five sites of regional significance have been currently identified (see Appendix 13). These sites include landforms or geological features representative of regions of about 60-km radius. Examples include the Rochester shire quarry (BN 006) where underlying Palaeozoic bedrock is exposed and is one of the few examples of accessible bedrock in the study area or Tyntynder choke (SH 016.1) near Vinifera where the River Murray is narrow compared to nearby reaches.

Although not of high value, the fifty-six sites have been identified as locally significant for educational purposes and should not be disregarded just because other more highly significant features exist. Documentation of these features may also be important particularly if a feature of higher significance is destroyed or its values reduced in some other way. Features of local significance are typically representative of smaller areas within a region, e.g. Bullock Creek palaeo-drainage, Leitchville (BD 001.2). Such sites are typically related to either a local municipality or an area with a radius of 20 km.

Significance assessments are not regarded as fixed or permanent as sites are reassessed periodically often when new sites, research or information comes to light.

SUMMARY

Systems of protected areas are the cornerstone of nature conservation. A number of criteria and goals have been developed in Australia to ensure the conservation reserves network is comprehensive, adequate and representative and thus gives a level of protection to biodiversity and other natural values including scenic values. Ecological vegetation classes are used as a measure of biodiversity to achieve the CAR goals but other values are also considered important when designing the conservation reserve system. In addition, it is recognised that examples of all environments cannot always be protected on public land and consequently many complementary conservation programs have been initiated on private land. However, the protection of other natural values such as sites of geological or geomorphological significance are not documented in such a rigorous way, and as a consequence are largely represented in the reserve system based upon a coincidence with biodiversity, scenic or recreation values.

Table 10.2 Geological or geomorphological sites of high significance.

Site number	Site name and Location	Land status	Significance
BN 079	Murchison Meteorite fall site, Murchison East	Mostly freehold	International
MD 009	Raak Plain boinka, 16 km NW of Hattah	Mixed freehold/ public land	International
SH 002	Lake Boga granite quarry mineral type locality, Lake Boga	Public land	International
BD 001	Kow Swamp lake and lunette, 3 km S of Leitchville	Public land	National
BD 003	Barmah forest alluvial fan and anabranch network, Barmah	Public land	National
BN 053	Bama–Goulburn drainage complex , Murray / Goulburn rivers confluence area, E of Echuca	Public land	National
MD 001	Hattah lakes overflow lake and anabranch systems, Hattah	Public land	National
MD 007	Lindsay Island floodplain, scroll bars, active and abandoned channel complex, W of Neds Corner	Public land	National
BD 003.4	Moira and Barmah lakes digitate delta and silt jetty, Barmah	Public land	State
BD 003.7	Barmah Choke River Murray constriction, Picnic Point to Barmah	Public land	State
BD 006	Ulupna Creek and Island floodplain complex, ~ 10 km N of Strathmerton	Public land	State
BD 009	Bumbang Bend recent meander cutoff (avulsion), Robinvale	Public land	State
BD 013	Wakool Junction abandoned channels and plains, Kenley	Public land	State
BN 052	Palaeolake Kanyapella area, E of Echuca	Mixed freehold/ public land	State
BN 053.3	Murray and Goulburn confluence area, E of Echuca	Public land	State
BN 057	Cadell Fault, Kanyapella South to NSW	Mixed freehold/ public land	State
BN 081	Lake Cooper quarry mineral locality, Colbinabbin	Public land	State
BN 086	Shepparton Formation Type-section, Kialla West	Public land	State
MD 007.2	Websters Lagoon and Websters Island Reference Area disrupted drainage and scroll plain	Public land	State
MD 011	Kings Billabong and the floodplain between Butlers and Psyche Bends, Irymple	Public land	State
MD 018	Olney Bore Eocene to Miocene Olney Formation Type-section, SW of Pollard Island	Public land	State
MD 019	Wallpolla Island and Creek anabranch and floodplain, W of Mildura	Public land	State
MD 022	Cowanna Bend neck meander and potential avulsion site, Redgrove	Public land	State
SH 006	Kerang groundwater discharge area, Kerang to Lake Boga public land	Mixed freehold/ State	State
TL 139	Tawonga Fault, Kiewa Valley Highway public land	Mixed freehold/ State	State
WN 042	Wodonga Quarry outwash fans, 6 km W of Huon Hill	Public land	State

11 Recreation and Tourism

The study area is a major destination for recreation and tourism. It is valued for its warm, sunny weather, sandy beaches, grand river red gums and natural surroundings. The River Murray and its tributaries provide for tranquility and water activities prized by millions of annual visitors. Recreation and tourism in the River Murray region are important for people living both in and outside of the study area. The first section of this chapter discusses the key recreational activities in the area. The second looks at the importance of tourism to Victoria and to local communities as well as exploring more detail about tourism activities in the study area.

RECREATION

Recreation is an important part of modern life. As our lives become busier, the chance to take a break becomes more valuable. There are many opportunities for recreational activities in parks and reserves and state forests within the study area. Visitors to the region enjoy the feeling of remoteness and the unstructured activities. The most popular activities for people visiting the River Murray parks and reserves are camping, fishing, water-skiing, swimming, motor boating, cycling and having a meal (such as a picnic). However, priorities differ slightly between people from Melbourne and people from regional Victoria. People from Melbourne are most likely to have water-skied on their previous visit whereas people from regional Victoria are most likely to have gone fishing on their previous visit (Newspoll 2005).

Activities range from passive activities where there is little discernible effect on the social (including quality of life) and biological environment, to activities that have large and varied impacts on an area. Each of these activities also contains a spectrum of impact from minimal to a large impact on the surrounding environment.

Land managers report a long-term trend of increasing popularity for recreation and associated developments in the study area, however with no fee or booking system for many activities, it is very difficult to get accurate data on visitor numbers, reasons for visits, expenditure and preferences. Consequently, some of the data reported in this chapter is for only parts of the study area.

Camping

Camping within the study area is focused on the rivers and adjacent lakes (Figure 11.1). There is no fee for camping on public land in the study area except in the various caravan parks on public land and at Hattah-Kulkyne National Park. Campers are not required to notify anyone or use booking systems which are used in other areas of Victoria. People camp on beaches, in the forest, on riverbanks, on the banks of tributaries and beside billabongs. Campsites are generally accessed by car but a number of sites can only be reached by walking or by boat.

Figure 11.1 Camping at Hincheys beach on the River Murray.

There are 76 sandy beaches with camping areas between Yarrawonga and Tocumwal, which become very crowded in the peak season (Figure 11.2). Facilities are generally limited at campsites in state forests and parks, reserves along the River Murray and tributaries, often consisting of only picnic tables and signs or simply a cleared spot. People also camp at commercially operated caravan parks where there are more facilities such as hot showers and flushing toilets. There are 14 caravan parks between Lake Hume and Robinvale with a total of 4480 sites and 3624 cabins (Hassall & Associates & Gillespie Economics 2004). The caravan park at Torrumbarry Weir operates under a lease managed by Goulburn Murray Water (Figure 11.3).

Figure 11.2 Crowded camping and boating area on the banks of the River Murray near Yarrawonga.

Figure 11.3 Caravan park at Torrumbarry Weir.

Parks Victoria surveyed people visiting five parks over the Easter weekend in 1998 and found that the main reason people came to the area was "relaxing/getting away from it all" (Peacock & Reed 1998). The main reasons for choosing the specific location were tradition or familiarity, relaxing or peaceful location, or social reasons such as being with friends. Camping with friends may require a specific location that provides sufficient space, facilities or particular qualities such as a shallow beach or deep section of a river for a boat. Visitors were also asked about park management. In general, they thought positively about the area as a cheap holiday, the sense of being in the "wilderness" and the quality of the beaches. In contrast, they thought negatively about the lack of information on natural and cultural/historical features of the park, ranger availability, litter control and access to toilets and other facilities. People like to camp in relatively large groups (the average group size was ten people) and most groups described themselves as families with kids. Fifty percent of these groups had dogs with them.

The Easter survey found that 44 percent of visitors were from Melbourne and 43 percent were from country Victoria. Of those surveyed, 50 percent of visitors were on their first visit to the Murray parks and reserves in the last 12 months, and about 12 percent were from other states. About half the campers stayed four to seven nights (Peacock & Reed 1998).

Because there are no fees, bookings or access control, detailed information on the numbers of people camping in the study area and how this is changing over time is difficult to establish. However, rough estimates of camper numbers (based on counts of cars) in the area between Yarrawonga and Tocumwal are shown in Table 11.1. The most popular times for camping in the study area are Christmas and Easter (see below Figure 11.15 for the peak in tourism in March-April). While fewer people visited the area over Christmas compared with Easter, the longer school holiday break over Christmas means the number of visitor nights was greater at Christmas than Easter. Indications are that the Melbourne Cup weekend is also increasing in popularity (Parks Victoria, unpublished data). This part of the river is probably the most popular area for camping given the sandy beaches and proximity to Melbourne. However, it is likely that other river frontage in the study area has similar numbers.

People participate in numerous activities whilst camping. These include the many activities described in the remainder of this chapter as well as swimming, day walks, picnicking and having a meal, drinking and socialising with friends and family, touring local towns, participating in local festivals and events, travelling to local towns to shop, going to the local hotel for a drink and a meal. Many of these activities bring money into the towns and although this is highly seasonal, it contributes greatly to local economies.

Camping Issues

Campfires

Many campers enjoy having a campfire. In fact, they may choose their camping location partly based on whether or not wood fires are permitted (compared with areas that only allow gas units). Campers use fire for many purposes including cooking, keeping warm and heating water as well as for social enjoyment and ambience.

However, in some popular camping areas, such as along the Murray at Hattah-Kulkyne National Park, the Lower Ovens, and near Yarrawonga, Cobram and Tocumwal, the current rate of use of firewood is unsustainable, with firewood becoming very scarce. Roadsides around Yarrawonga have been stripped of their fallen timber, affecting flora and fauna that require the fallen timber for habitat (as discussed in chapter 5). It is not only the small, easily handled wood that is taken (Figure 11.4). Some campers attach very large logs to their four-wheel-

Table 11.1 Estimated Numbers of Campers between Yarrawonga and Tocumwal.

Time of year	Approx. no. vehicles	Average stay	Average /vehicle	Visitor nights
Christmas/New Year 2003/4	2080	8 nights	3 people	49,920
Easter 2005	3320	3 nights	3 people	29,880

Source: Estimates were made by Parks Victoria rangers on patrol and based on counts of cars in reserves managed by Parks Victoria (Parks Victoria, unpublished data).

drives and drag them through the forest causing soil disturbance and erosion. Campers have also been known to ring-bark standing living trees to use for firewood the following season, despite the possibility of prosecution and heavy penalties (Figure 11.5). In some Victorian parks, such as Wilsons Promontory National Park, rangers supply firewood over the periods fires are permitted in established fireplaces. Campers and day visitors are not allowed to gather their own supplies.

Figure 11.4 Large amounts of firewood are collected from the river red gum forests by campers.

Many wildfires are started by unattended and abandoned campfires. In response to this issue, the Department of Primary Industries in New South Wales first introduced a ban on solid fuel fires in State Forests in 1990. This ban extends along the Murray River from Howlong (west of Albury) to Tooleybuc (north of Swan Hill) during the summer high fire danger period (NSW Department of Primary Industries 2004). Fire managers report that this ban appears to have reduced the number of wildfires caused by summer campfire escapes but appears to have increased camping and firewood pressures on the Victorian side of the Murray. A ban on summer campfires similar to that in New South Wales was proposed a couple of years ago by the River Murray Users/Water Watch Committee but has not been introduced for public land along the Murray in Victoria.

Figure 11.5 Ring-barked tree in the Lower Ovens Regional Park.

Toilets

Permanent long-drop or pit toilets are provided at several beaches. These toilets are pumped out regularly at times of high visitor use and before floods so the faecal matter does not get washed through the forest. However, at beaches and campsites without permanent toilets and at those with toilets but high visitor demand, campers must either bring their own toilets or make other arrangements. Portable chemical toilets are recommended but pit toilets can be acceptable if well maintained. Pit toilets must be at least 100 m away from any waterway or from the high bank of the river (Parks Victoria 2004a). Some campers do not bury their faecal waste and the bush becomes littered with toilet paper and waste. At the start of the recent summer holiday periods, Parks Victoria published "The Murray River Guardian", a newspaper distributed free to campers and visitors, in an attempt to reduce environmentally damaging practices. The risk campers' waste—buried or left at the surface—poses to water quality and the health of water consumers downstream, remains unclear.

Rubbish

Campers leaving rubbish in the bush is a major issue for public land managers who previously provided bins for campers and collected large amounts of rubbish. For instance, from Christmas 2003 to the beginning of February 2004, Parks Victoria collected 1114 cubic metres (an average car trailer is about one cubic metre) of rubbish between the Lower Ovens and Ulupna Island (Figure 11.6).

As part of the "Don't waste the Murray" campaign promoted by Parks Victoria and local shires, Easter 2005 was the final year in which bins were provided at the main entry points to riverine public lands in the Moira and Campaspe shires. Thereafter, signs were erected to direct campers to transfer stations for which hours were extended to meet campers' needs. Campers can leave rubbish at transfer stations for $2 per bag and recyclables are free of charge. This initiative is intended to encourage campers to take their rubbish home or to a transfer station, reducing the amount of rubbish left in the bush.

Figure 11.6 Rubbish dumped illegally in a park.

Long-term Campers

Itinerant workers in the horticultural industries sometimes camp for long periods on public land in the study area—particularly in the Yarrawonga, Cobram and Mildura regions. The itinerant workers stay in these areas at no charge and are relatively close to seasonal work locations. However, when people camp in one place for extended periods firewood typically becomes scarce and human waste, including faecal material, accumulates. Vegetation under tents and caravans becomes degraded and trampled. Additionally, there is an equity issue, as other people are denied access to the public land.

Campers cannot stay on Crown land for more than 21 days without a valid permit, lease or licence (*Land Act 1958*). Dealing with long-term camping requires considerable management resources and land managers report difficulties in evicting long-term campers.

Figure 11.7 Campsite of an itinerant worker.

Boating

Boating is a common recreational activity in Victoria. It was estimated that in 2000 there were over 170,000 boats (including jet skis, canoes, sailing boats, row boats and power craft) owned in Victoria with an estimated value of $620 million (Henry & Lyle 2003). Figures are not available for boat usage in the study area. Although issues of boating on the River Murray are reviewed in this section, the River Murray is actually in New South Wales and therefore the ability of Victorian government agencies to address some of these issues is limited.

Canoeing, kayaking and other rowing are activities that are unlikely to cause pollution or physical damage to the river and lake systems. Canoeing is a popular way to access shallow areas during flooding and provides good transport for birdwatching (Figure 11.8). There is a canoe trail on and around Gunbower Island. The Murray Marathon is the longest flat-water canoe race in the world, extending 404 km from Yarrawonga to Swan Hill. It has been run each year since 1969 and is a fundraiser for the Red Cross. The Marathon is a major event and thousands of people associated with the event (competitors, organisers, and support crews) camp in football grounds in major towns.

Figure 11.8 Canoeing on Barmah Lake.

The major rivers within the study area are popular water-skiing spots because the surface of the water is often flat throughout the day (unlike lakes where the wind and thermals create waves on a long reach of water) and the water level does not change significantly (Figure 11.9). Some places within the study area specifically cater for water-skiers and water-skiing clubs with permanent slalom courses and jump ramps set up (e.g. Lake Moodemere near Rutherglen). Water-skiing is particularly popular in the Lower Ovens River. Some areas of the Murray do not have sufficient water and have too many snags for safe water-skiing (e.g. around Hattah-Kulkyne National Park).

Figure 11.9 Water-skiing and other water sports are popular activities on the River Murray.

The "Southern 80" is an annual high-speed 80 km ski race between Torrumbarry and Echuca. It is organised by the Moama Water Sports Club and attracts up to 350 competitors in several classes and over 40,000 spectators. The event attracts many campers, many of whom stay in reserves and parks along the River Murray. Whilst many of the campers are environmentally and

socially conscious, the combination of groups of spectators and alcohol requires considerable Police and Parks Victoria resources to retain a pleasant atmosphere for all. In 2006, 30 cubic metres of rubbish was picked up by Parks Victoria following the Southern 80. Other races include the Mildura 100 held over Easter while several ski schools and ski clubs are located along the River Murray, on Lake Mulwala and on Lake Hume.

Wake-boarding has risen in popularity over the past ten years. Like skiing, wake-boarders are towed behind a powerboat, but unlike skiing, participants favour a very large wake from which they can jump and perform tricks. Wake-boarders often put a plastic bladder of water or other ballast into the stern of the boat to achieve this large wake. Unfortunately, this wake also affects other river users. The large wakes cause bank erosion in rivers (Shoalhaven City Council 2005) although it is also likely that rising and falling water levels for irrigation contribute to bank erosion in the River Murray. Placing bans or restrictions on wake-boarders on some sections of the River Murray (particularly around Yarrawonga) has been discussed by the River Users/Water Watch Committee (convened by NSW Maritime which has responsibility for River Murray waters) and other stakeholders, but these are yet to be instituted.

Jet skis and other personal watercrafts are also commonly found on the Murray River and can be hired from a number of locations. Riders of these craft typically like to jump waves and "do donuts" rather than travelling long distances in a straight line. This potentially creates noise pollution and contributes to bank destabilisation.

Houseboats are a popular means to relax and explore rivers (Figure 11.10). Houseboats can be hired at most major centres along the River Murray including Wentworth, Mildura, Swan Hill and Echuca, however, mooring places along the River Murray are limited and can be costly. There are approximately 50 houseboats for hire and 250 private houseboats just in the area between Robinvale and the South Australian border (Hassall & Associates & Gillespie Economics 2004).

Figure 11.10 Houseboat moored nearing sunset on the River Murray at Mildura.

Houseboats on the River Murray are required to have onboard wastewater treatment systems connected to a holding tank, which must be discharged to an approved sewage pumpout facility. Grey water is also a potential problem with houseboats. This may contain solid and liquid foods, soaps, washing powders, detergents, skin, hair, and microbial pathogens such as bacteria and viruses (Laginestra undated). In the past grey water from houseboat showers and sinks was disposed of directly into the river carrying with it the soaps and detergents that contribute to pollution and possible eutrophication. Recently, regulations have been introduced that require grey water to be stored in a holding tank and then disposed of away from the River (Section 120 under the NSW *Protection of the Environment Operations Act 1997)*. Companies and individuals risk fines of up to $1M and $250 000, respectively, for polluting New South Wales waters. This section of the legislation is enforced by New South Wales Maritime. In Victoria, the *Water Act 1989, Lake Eildon Houseboat Regulations: Houseboat Regulations 2001, Schedule 2* provides the requirements for sewage disposal from houseboats.

Paddlesteamers are a major tourist attraction in the Echuca–Moama area, which was once the biggest inland port in Australia (see also chapter 12), but are also located at Mildura, Swan Hill and Albury-Wodonga. Historically, paddlesteamers transported produce, timber, mail and passengers up and down the River and today they provide a link back to early European settlement. Several boats, badly damaged over time, have been fully restored at Echuca. Some paddlesteamers can be chartered for private functions or overnight stays.

Other tour and cruise boats also provide opportunities for visitors to explore the rivers of the study area and socialise. These include the *Kingfisher* at Barmah, the *Paradise Queen* and the *Lady Murray* at Yarrawonga, the *Kookaburra* at Swan Hill and the *Mundoo* at Mildura. The commercial cruise boats at Lake Mulwala require an occupational licence arrangement with Goulburn-Murray Water although the authority for this water is NSW Maritime.

At Lake Mulwala there are six public boat ramp facilities. Each has rubbish removal and three have public toilets. Goulburn-Murray Water licences about 175 private jetties and concrete boat ramps along the shore of Lake Mulwala. The annual licence fee is currently set at $165 per annum and each licence holder is required to have their own public liability insurance policy. There has not been a formal study to determine the environmental impact of these structures but the numbers have been capped since 2002.

Boat licences are required to drive all powered recreational vessels (including hire boats but excluding houseboats) and personal watercraft (e.g. jet skis) in Victorian (regulated by Marine Safety Victoria) and New South Wales waters (regulated by NSW Maritime Authority). The Victorian General Boat Operator Licence is recognised on the River Murray but boat operators must understand and obey the New South Wales regulations as the Murray falls under the jurisdiction of New South Wales (through NSW Maritime). Goulburn-Murray Water is the boating authority for Greens Lake and Loch Garry.

Fishing

Recreational fishing is a popular recreational activity in Victoria. It is promoted as a healthy and fun family activity (Fisheries Victoria 2000). The fish species of the study area are described in chapter 5. This section describes recreational fishing habits in Australia, Victoria and the study area.

A 2000-2001 study of recreational fishing (Henry & Lyle 2003) found that 550,000 (12.7 percent) of Victorians (aged five years and older) went fishing at least once in the 12 months prior to the survey period and there were approximately 2.6 million fisher days/year in Victoria. Just over 40 percent of Victorian's fishing effort was spent at rivers, lakes and dams (compared with estuaries, offshore and coastal locations). In dollar terms, Victorian fishers spent an estimated $396 million on fishing per year. This equates to approximately $721 per Victorian fisher per year. An earlier study estimated that approximately $200 is spent per kilogram of fish caught and kept (National Institute of Economic and Industry Research 1997).

Fishing was more popular with males than females and the main method was line fishing (over 85 percent of fishing effort in Victoria). The most popular primary motivation for going fishing was "to relax and unwind" (37 percent of respondents), with the second most popular being "sport". "Fishing for food" as a primary motivation was only listed by 7.5 percent of respondents (DAFFA 2003).

The Department of Agriculture Fisheries and Forestry Australia Recreational and Indigenous Fishing Survey asked respondents about the numbers of fish taken annually by recreational fishers (Table 11.2). This survey indicated that recreational fishers harvested approximately 136 million aquatic animals in the survey year across Australia (Henry & Lyle 2003).

In the study area the popular recreational fish species are brown and rainbow trout in the upper reaches of the tributaries and Murray cod and golden perch in the lower reaches of tributaries, and the River Murray. The areas accessed for fishing have increased over the past few decades with newer, more reliable outboards (Figure 11.11). Use of 4WD vehicles for access is also becoming more common.

Figure 11.11 Fishing from a small boat on the River Murray near Barmah.

A Victorian fishing licence is required to fish in all Victorian waters while a NSW fishing licence is required to fish in the River Murray. In 2004-05, 245,230 recreational fishing licences (administered by the Department of Primary Industries) were purchased in Victoria, producing revenue of more than $4.5million. This was a $300,000 increase compared with the previous year. Revenue from the fishing licences in Victoria goes to the Recreational Fishing Grants program from which it is dispersed to projects designed to improve recreational fishing such as new fishing platforms, improved fish habitat and increased stocking. In 2004-05, over $759,000 was allocated to 35 such projects.

In addition to fishing licences, there are also closed seasons and size- and bag-limits for many species in an effort to maintain sustainable fish populations.

Table 11.2 Estimated annual harvest (rounded to the nearest thousand) for all of Victoria in 2000-01, including the River Murray for species found in the study area.

Recreational Fishing species	Estimated number	Estimated weight (kg)
Native species		
freshwater crayfish	1,887,000	75,000
golden perch	142,000	85,000
Murray cod	11,000	27,000
Introduced species		
redfin	949,000	237,000
trout/salmon including rainbow and brown trout	345,000	173,000
European carp	328,000	246,000

Source: Henry and Lyle (2003).

Table 11.3 The growth stage, species, number, location and cost of fish stocked (in the study area) through the Recreational Fishing Grants program.

Stage and species	Number	Location stocked	Cost ($)
Yearling brown trout	10,000	Lake Hume	10,780
Fingerling Murray cod Fingerling golden perch	5000 15,000	Goulburn River from Murchison to Mooroopna	6818
Yearling Murray cod Fingerling golden perch	3000 40,000	Kow Swamp, Reedy Lake, Lakes Charm, Kangaroo, & Boga	23,636
Fingerling golden perch	150,000	Lake Hume	27,273
Fingerling Murray cod Fingerling golden perch	10,000 50,000	Campaspe River & near Greens Lake	17,727

Source: DPI (2005)

For example, Murray cod have a minimum legal size of 50 cm, the bag limit is two (of which no more than one fish may be equal to or exceed 75 cm in length) and the season is closed from the beginning of September to the end of November to protect reproduction. In comparison, trout cod (which are very similar in appearance to Murray cod) are a fully protected species.

Fish stocking is carried out in many Victorian rivers, dams and lakes to address the conservation status of some species and to improve the recreational fishing opportunities of other species (Table 11.3). Fish stocking is coordinated by the Department of Primary Industries. Some of the funding for fish stocking comes from recreational fishing licence fees.

Bardi grubs are popular bait for fishing, especially as bait for Murray cod. Digging for grubs is not permitted in parks, the River Murray Reserve or public land water frontage reserves and only permitted in State Forest with a permit under the *Forests Act 1958*.

Four-Wheel Drives, Motor Bikes and Trail Bikes

Four-wheel driving is an activity that allows participants to access remote areas. Experienced drivers can safely gain access on slippery tracks without damage. Four wheel-driving is legitimate on formed tracks that are open to the passage of vehicles. Driving off formed vehicle tracks is illegal under the *Land Conservation (Vehicle Control) Act 1972.* Parks Victoria has established a Memorandum of Cooperation with Four Wheel Drive Victoria to work towards common goals for 4WD use in parks and reserves in Victoria (Parks Victoria & Four Wheel Drive Victoria 2004). The Department of Sustainability and Environment has published a 4WD Touring code that promotes safety and care of the environment. It advises that vehicles should only be driven on formed roads and vehicle tracks, and that driving off-track can cause erosion and damage vegetation. Participants should avoid using muddy tracks and remove fallen tree branches from the track rather than driving around them. Care should be taken in creek crossings to disturb the creeks as little as possible.

Unfortunately, some 4WD participants do not adhere to the code recommended above. This often results in roads and tracks being badly damaged with rutting, potholes and corrugations. As a consequence, large proportions of land managers' budgets are consumed with continually repairing damaged tracks. This is particularly the case in areas around Mildura, Gunbower Island and Yarrawonga. Road damage also leads to erosion, damage to vegetation and water pollution.

Rallying is conducted on formed mapped roads and is highly regulated. Rallying is conducted in close cooperation with forest managers from the Department of Sustainability and Environment with processes for scheduling events, financial provision for road damage to be compensated, insurance cover and community consultation.

Many people enjoy motor bike and trail bike riding as it gives them an exhilarating way to see rugged and beautiful country that many other people don't get to see. It also fits in well with other similar activities such as spending time in the outdoors and camping (Figure 11.12). Public land in state forest and national parks provides large tracts of land with well-formed tracks for trail riding. All bikes ridden on public land must be registered, the rider must be licensed and must wear the appropriate safety equipment as required by law. Additionally, bikes must stay on formed tracks, similar to 4WDs.

Some areas of State Forest have been temporarily or permanently closed to trail bikes due to environmental damage. In New South Wales, Benarca State Forest west of Moama and parts of Moira State Forest adjacent to Barmah Forest were closed to trail and motor bikes in 2004 (NSW Department of Primary Industries 2005b). Inappropriate use of bikes was degrading vegetation on sandhills and in the forest, and spreading weeds such as spiny burr grass. Bikes also often cause noise pollution and disturb wildlife. Some bike riders cause damage to Indigenous heritage areas as they use midden and burial sites as ramps from which to jump. Fencing is required at some sites to prevent this.

The Department of Sustainability and Environment has developed guidelines for trail bike riders to limit environmental damage. The Australian Motorcycle Trail Riders Association (AMTRA) advises riders to follow the Tread Lightly principles and aim for minimal impact.

Figure 11.12 Trail bikes at a campsite along the River Murray.

Hunting

Hunting is a permitted recreational activity during the prescribed season on both public and private land within the study area. The land categories that permit and do not permit hunting game and feral animals on public land are shown in Table 11.4. This section provides brief information about hunting in the study area. Recreational hunters should consult the *Victorian Hunting Guide* for further information.

Duck hunting is a popular recreational activity in Victoria with over 22,000 hunters licensed to hunt ducks in 2006 (DSE 2006j). The wetlands in northwest Victoria are an important area for recreational hunters as this area provides suitable wetland habitat. The most visited wetlands tend to change between years as the water levels change and the ducks move from area to area. In 2006, duck hunting was permitted on a number of Goulburn–Murray Water storages in the study area including Greens Lake (near Corop), Lake Boga, Lake Charm, Little Lake Charm, Racecourse Lake, Yarrawonga Weir (Victorian waters), Lake Tutchewop and Kangaroo Lake. Duck hunting is not permitted on Goulburn–Murray Water irrigation channels.

The *Wildlife Act 1975* provides for the hunting of eight species of native duck that have been declared "game". The prescribed open season starts on the third Saturday in March and finishes at sunset on the second Monday in June each year. This is reviewed annually. In addition to the restricted seasons, bag limits are also imposed to assist in sustaining duck populations. The regulations specify a notional bag limit of 10 birds per day but drought and declining habitat mean that the bag limits have been reduced in recent years. The aerial survey of wetland area index and wetland bird counts help to set the bag limits each year (Kingsford et al. 2005).

The number of ducks counted in the Summer Waterfowl Count was high in 2004 because populations from interstate were concentrated on Victorian waters. Numbers reduced close to the long-term average in 2005 but the wetland area index (conducted across eastern Australia and incorporating 1500 wetlands) for the 2006 duck hunting season was the second lowest in 23 years (DSE 2006a).

In 2006, the bag limit was imposed at seven ducks per day including a maximum of one Blue-winged Shoveler. Eight species of native duck were permitted to be hunted: Pacific Black Duck, Chestnut Teal, Hardyhead (White-eyed duck), Australian Shelduck (Mountain duck), Pink-eared duck, Maned Duck (Wood duck) and Blue-winged Shoveler.

Hunters require a Firearms Licence as well as a Game Licence. To hunt ducks they must also pass a Waterfowl Identification Test that requires them to successfully identify bird species, and hunters are required to follow the ethical guidelines set out by the Department of Sustainability and Environment. Firearms are prohibited in Murray River parks and reserves (Parks Victoria 2004a).

In February 2004, there were in excess of 11,100 licensed deer hunters in Victoria, an increase of 60 percent over the last eight years. In 2005 the number had risen to approximately 14,600. Deer species legally hunted in Victoria include sambar deer, hog deer, red deer and fallow deer. Only sambar may be hunted with gundogs and scent-trailing hounds (in restricted areas). Scent-trailing hounds can only be pure beagles or pure bloodhounds as both of these breeds are slower than other dog breeds, putting less pressure on deer being trailed. Hunting of Sambar in the study area does not seem to be as popular as in other areas of Victoria due to smaller areas and limited populations.

Fallow deer have been found in Barmah Forest but hunting of this species is only permitted on private land. Red deer and hog deer are probably not found within the study area. Other game species hunted in Victoria include stubble quail, and introduced game birds such as pheasants and partridges. While stubble quail is a popular game species, with about 8000 active shooters, they are mostly hunted on private property.

Hunting of feral species is also undertaken within the study area. A Firearms, but not a Game Licence, is required. Species hunted include pigs, foxes, hares, rabbits, wild dogs and goats. Instead of setting out to hunt a particular species as in duck or deer hunting, people hunting feral animals will generally shoot opportunistically at whichever feral species is found. People generally hunt feral animals to be in the outdoors, to socialise, to help reduce feral animal populations and, for some species, for food. Hunters also participate for trophies including horns, tusks, skins for tanning and heads to mount. Increasingly, hunters film the hunt and associated activities, with the films forming a type of trophy.

Pigs are generally hunted by walking through the bush with a rifle or spotlighting at night. Dogs can be used to track pigs but must not be used to hold the pigs. Foxes and rabbits are generally spot-lit at night although hunters are more likely to shoot rabbits during the day if the rabbits are for food.

Table 11.4 Public land use categories in the study area where hunting is generally permitted or not permitted (specific details should be obtained from a DSE office).

Land Category	Game species	Pest species
National parks and state parks	✗ (with some exceptions)	✗ (with some exceptions)
Nature Conservation Reserves and Flora and Fauna Reserves	✗	✗
Natural Features Reserve-wildlife areas, classed under the *Wildlife Act 1975* as:		
• Sanctuaries	✗	✓ at any time.
• State Game Reserves	✓ during open seasons only. authorised by DSE).	✓ at any time (unless specifically
State forest	✓ during open seasons only.	✓ at any time.
Licensed Crown land (including licensed water frontages and unused roads)	✓ during open seasons only unless licensed under the *Land Act 1958*.	✓ at any time unless licensed under the *Land Act 1958*.
Private land	✓ during open seasons only & with permission of land owner/manager.	✓ only with permission of land owner/manager.

Source: Table modified from DSE(2006j).

Horse-riding

Numerous horse-riding clubs are located in the study area. These include the Cohuna Trail Riding Club, the Murrabit Riding Club, the Murray Darling Trail Horse Riders Club and the Shepparton Adult Riding Club. Such clubs provide the opportunity for beginner riders (both children and adults) to gain experience and see more country. Most clubs organise rides on public as well as private land. The Australian Trail Horse Riders Association, ATHRA, also holds rides in the study area.

Trail riding businesses conducting trail rides in the study area include the River Murray Horse Trails at Strathmerton, Billabong Horse Trail Rides at Echuca, Riverland Trail Rides at Wodonga, Cohuna Trail Riding club and Murray–Darling Trail Horse Riders Club in Mildura.

The major annual horse-riding event in the study area is the Barmah Muster, held over a week in April (Figure 11.13). The Muster culminates when as many as 150 riders assemble and bring the cattle into the muster yards. Several other events are held in association with the Muster including a dance and trail ride that attract up to 2000 visitors from across Victoria and interstate. The Barmah Cattleman's Association estimates the event has a turnover of approximately $50,000 and contributes to the local economy.

Horse-riding is permitted in State forests in the study area but permits are required for some activities. Impacts on the environment from horse-riding including soil compaction and erosion, making new tracks and weed introduction are generally highest in areas without tracks or where tracks are wet, boggy or steep.

Figure 11.13 Horse-riders checking the cattle in the muster yards during the Barmah Muster.

Thus, riders are required to stay on track, avoid easily damaged areas and use buckets to carry water from streams to horses (Cook 2003).

Bushwalking

Bushwalking, both overnight hiking and day walks, are popular activities in Victoria. There are many clubs where novice bushwalkers can join more experienced people. Formed, walker-only tracks are not as numerous in the study area as in other areas of Victoria (e.g. the Great South West Walk) and bushwalkers generally use vehicle tracks and camp at sites that are also accessible

by car. Presence of public land with frontage along most of the rivers and streams in the study area means that walkers have access to long stretches of river. This contrasts with New South Wales where the river frontage is private in many areas.

Enjoyable bushwalking is diminished by lack of practical access and degraded areas which have lost some of their natural beauty. The latter may be caused by development on adjoining private land, resource extraction and degradation of the natural environment, for example spread of weeds or a high density of cow pats.

Dog walking

Many pet owners consider their dog as 'part of the family' and make decisions about where to go on holiday based on whether they can take their dogs. Also, many people living in the study area enjoy walking their dogs in areas of high scenic value. While dogs off the leash are known to chase wildlife and disrupt breeding birds, dogs on leads can also cause lesser impact simply by leaving the scent of a predator in the area. To minimise the disruption to breeding birds, dogs are better kept on the leash (Burger et al. 2004) and should not be permitted in key areas for native species.

Other Recreational Pursuits

The study area is used for a number of other passive recreational activities including sightseeing, car and bicycle touring, picnicking, birdwatching, wildflower study (e.g. orchids) and photography (Figure 11.14). Birdwatching is particularly popular at Hattah–Kulkyne National Park where a number of different habitat types intersect allowing the possibility of observing many different bird species. The ibis rookery at Reedy Lake near Kerang also attracts many bird watchers. The northern plains grasslands are of special interest to wildflower specialists as a number of species grow there and are very difficult to find elsewhere in Victoria. These activities do not require many facilities and bring tourists dollars to the local economy.

Sightseeing is an activity enjoyed by many in the study area. Visitors can see many natural attractions, Aboriginal historic sites including middens and canoe trees and European historical attractions such as the port precinct at Echuca, homesteads such as Tyntynder and Byramine, and the Swan Hill Pioneer Settlement (see chapter 7).

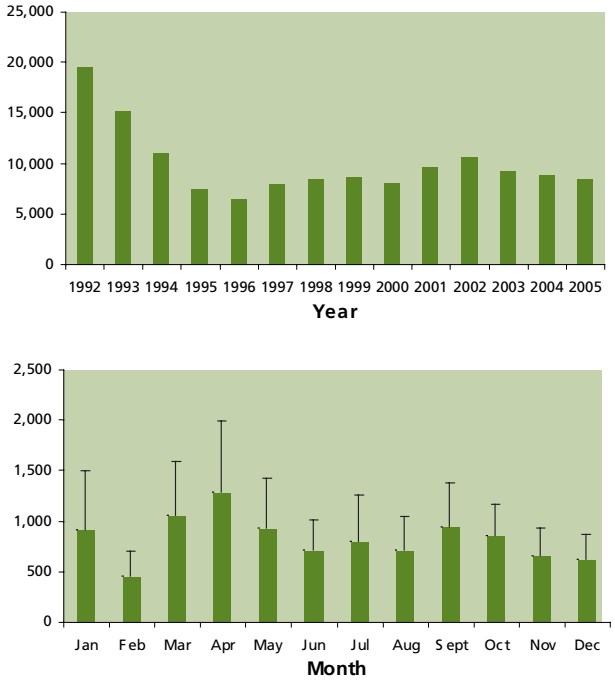
The Dharnya Centre is an information and education resource located on Sand Ridge Track in the Barmah forest. It was established in the 1980s to enable groups and individuals to learn about the heritage and ecology of the forest and originally offered accommodation. Aboriginal Cultural Officers are on hand to help visitors gain an appreciation of the culture and history of Aboriginal people such as the Yorta Yorta. The number of visitors to the Centre (Figure 11.15) demonstrates its importance as a tourist attraction in the area. The second figure demonstrates that the greatest number of visitors come to the Centre in April although the number per month is highly variable between years.

Figure 11.14 Picnic tables and BBQ facilities at near Howlong.

Figure 11.15 demonstrates the high degree of seasonality found in recreation and tourism along the River Murray generally. The peak in March and April is due to the relatively warm (but not too hot) daily temperatures and the Easter holiday. The peak in visitors to the Dharnya Centre in April may also be due to the Barmah Muster attracting people to the region at that time. The lower numbers in November and December probably reflect the decline in numbers of people camping in the Barmah forest while it is flooded in spring.

Rail trails provide pleasant and often scenic ways of exploring the landscape for walkers and bike riders. Horses can also use some sections of these trails. There are three Rail Trails established (or in development) in or close to the study area. The Murray to the Mountains Rail Trail follows the edge of the study area along the Ovens River from Bright to Wangaratta. This trail has the gentle gradient common to most rail trails and provides great views of the Alpine Country. The High Country Rail Trail begins near Bonegilla and heads east along the shores of Lake Hume (just to the east of the study area). Like many rail easements in Victoria, this rail trail has significant remnant vegetation as historically it was not grazed heavily or cropped but was burnt frequently (see also chapter 9 and 17). The Bonegilla Station Bushland Reserve and School Bushland Reserve have remnant populations of the threatened orchid Wedge Diuris and Western Golden Wattle and also representation of White-Box Grassy Woodland community. There are plans to develop a third rail trail from Whitfield to Wangaratta along the King Valley.

Figure 11.15 The total number of visitors to the Dharnya Centre in Barmah forest from 1992 to 2005, and the average (mean and one standard deviation) number of visitors per month.



Source: Parks Victoria, unpublished data

Economic Values associated with Recreation

A study was conducted in 2004 that looked at the value of a range of recreational activities in the River Murray, the Lower Darling and the Goulburn Broken systems (Hassall & Associates & Gillespie Economics 2004). They aimed to quantify in dollar terms the total economic value of river dependent industries in these areas. They estimated the total economic value of 'non-consumptive' industries (i.e. those other than irrigated agriculture and urban water) that are dependent, or partially dependent, on healthy rivers in the Southern Murray-Darling Basin around $1,620 million.

TOURISM

Tourism is an extremely important part of the economy. Tourism Victoria estimates that in 2003–2004, tourism contributed $10.9 billion to Victoria's economy (5.3 percent of GDP). This is an almost 50 percent increase from six years previously. Approximately half (46 percent) of this reflects Victorians travelling within Victoria, about one quarter is interstate visitation (25 percent) and the other quarter is international visitation (29 percent, equating to $3,108 million) (Tourism Victoria 2005a).

Tourism expenditure in the Murray Tourism region in 2004 was estimated at $696 million from domestic overnight visitors, $229 from domestic day trip visitors and $51 million from international visitors. This equates to an average of $273, $89 and $848 per person per visit, respectively (Tourism Victoria 2006).

The Murray Tourism region received a 19 percent market share of all domestic visitors to regional Victoria for the year ending June 2005. The region also had over 2.5 millions domestic day trip visitors (12 percent market share) (Tourism Victoria 2006). There were 5.7 million visitor nights (number of visitors multiplied by the length of stay) making the region the second highest for visitor nights in Victoria (Tourism Victoria 2005b). Table 11.5 shows the number of overnight visitors to the Murray Tourism Region from within Victoria, interstate and overseas. 54 percent of interstate visitors to the region in 2005 were from New South Wales.

The River Red Gum Forest study area overlaps in areas with the Murray Tourism region, which covers the local government areas of Towong, Wodonga, Indigo, Moira, Shepparton, Strathbogie, Mitchell, Campaspe, Gannawarra, Swan Hill and Mildura. Approximately 7000 people were employed directly in the tourism industry in the Murray region in 2003–2004 (DITR 2005). This was a 4.3 percent increase from 1997–1998. This increase is relatively small compared with some areas. For instance, the areas with the largest increases in tourism employment were the Mornington Peninsula (24.1 percent) and Great Ocean Road (21.5 percent). For further information on the economics and employment associated with tourism, see chapter 8.

The Legends, Wine and High Country area (Figure 11.16), which also takes in a small part of the study area, received 1.1 million domestic overnight visitors for the year ending June 2005 (9 percent market share). The regional also had over 828,000 domestic day trip visitors (4 percent market share). The Legends, Wine and High Country region received 17,000 international overnight visitors (5 percent market share).

Table 11.5. The number of overnight visitors (000s) to the Murray Tourism Region.

	1999	2000	2001	2002	2003	2004	2005
Victorian	1 605	1 576	1 860	1 615	1 739	1 773	1 656
Interstate	577	517	526	596	665	687	442
International	44	49	36	46	50	60	39

Source: Tourism Victoria (2005b; 2005c).

Figure 11.16 A vineyard in the Rutherglen area.

Over 80 festivals and events bring large numbers of tourists to the study area and adjacent areas. A sample of these includes:

- The Peaches and Cream Festival in Cobram/Barooga in January;
- Riverboats Jazz Food and Wine Festival held in Echuca/Moama in February;
- The Music on the Murray event in Swan Hill in March;
- The Barmah Muster in Barmah Forest in April (Figure 11.17); and
- The Golden Rivers Red Gum Forests to Furniture Showcase (Figure 11.18) in Koondrook in November.

Figure 11.17 Preparing for the Barmah Muster.

Figure 11.18 Wood-chopping competition during the Golden Rivers Red Gum Forests to Furniture Showcase in Koondrook.

Visitation to Victorian parks and reserves has increased slowly since 2001–2002. Parks Victoria surveyed Victorians and people from interstate and overseas to determine what types of parks they visited (Table 11.6). The total number of people visiting non-metropolitan parks in 2004/2005 was 28.6 million (www.parkweb.vic.gov.au—Visitation Statistics).

Table 11.6 The estimated number of people visiting areas within the Parks Victoria estate (derived from a phone survey of 12,000 people).

Type	2001/02	2002/03	2004/05
National Parks	26.8 m	24.9 m	28.6 m
Metropolitan Parks	13.5 m	11.6 m	14.1 m
Piers	29.9 m	29.9 m	30.8 m
Total	**70.2 m**	**66.4 m**	**73.5 m**

Source: www.parkweb.vic.gov.au —Visitation Statistics.

Approximately 0.65 million people visited parks and reserves along the River Murray in 2004/05 (Newspoll 2005). Forty-two percent of these visitors went to national or state parks whereas 58 percent went to Murray River reserves (Figure 11.19). It is estimated that 32 percent of visitors were from Melbourne, 58 percent were from regional Victoria and the remaining visitors were mostly from New South Wales. The average number of nights stayed was two; with approximately 1.3 million total overnight stays. Parks Victoria estimates that the largest numbers visit River Murray Reserves (Central), Yarrawonga Regional Park, Barmah State Park, River Murray Reserves (West), Hattah–Kulkyne National Park and Murray Kulkyne Park.

Figure 11.19 Campers enjoying beach activities at Easter on Ulupna Island in Barmah State Park.

Eco-tourism is a fast-growing industry that is focused on natural environments. However, due to its fast growth, it can lack strategic planning and this may lead to the degradation of the environmental resources that were attracting the tourists initially. This has been demonstrated in several studies examining disturbance of wildlife by tourism, resulting in reduced breeding and feeding capacity (Burger et al. 2004; McClung et al. 2004). In other areas both eco-tourists and general visitors/campers place stress on natural resources. Eco-tourism may alternatively lead local tourist operators to place a higher value on the natural resources and thus may encourage sustainable use and protection.

Australia has signed the Convention on Biological Diversity, which has produced international guidelines for eco-tourism, specifically activities related to sustainable tourism development in vulnerable habitats of major importance for biological diversity and protected areas. The guidelines state that any tourism development requires policy-making, development planning and management. These comprise the following steps: baseline information and review, vision and goals, objectives, review of legislation and control measures, impact assessment, impact management and mitigation, decision-making, implementation, monitoring and reporting, and adaptive management. These guidelines have implications for the planning and management of tourism in Victoria.

Community and Tourism Values of the River Murray Region.

Parks Victoria, Monash University, Tourism Victoria and the Department of Sustainability and Environment have commissioned a study into the community and tourism values of the River Murray region. This study commenced in March 2006 and will conclude in December 2006.

The project will evaluate community and tourism values assigned to specific conservation or camping sites along the River Murray. The aim of the project is to provide Parks Victoria, Tourism Victoria and the Department with key insights into community values regarding River Murray sites, for the specific purpose of allowing appropriate prioritisation and development that is consistent with community values. Specifically the project will provide:

- A set of survey instruments that provide community valuations for sites within an area.
- Information on the main locations and tourism attractions along the River Murray mapped from different community valuation perspectives.
- The community perspective on the importance of specific sites along the River Murray.
- The community's assessment of values in the area.
- GIS spatial analysis of this information.

An important potential use of this information is to strategically benchmark and prioritise a specific group of sites for service provision and development consistent with the community's values. Similar work has previously been undertaken by Greg Brown (University of South Australia) in the Otway Region.

Strategic Directions and Plans for Tourism

Many nodes within the study area are major tourism destinations. These include Albury/Wodonga; Yarrawonga; Cobram; Echuca; Barmah; Swan Hill and Mildura.

Tourism Victoria has developed Regional Tourism Development Plans 2004–2007 (RTDPs) for both North East Victoria and The Murray regions. These plans outline the types of tourism activities identified as "product strengths" for both regions. These include the primary segments: food and wine (Figure 11.20); nature and water-based tourism; adventure tourism; and golf. Secondary segments include Aboriginal tourism, touring, arts and cultural heritage. The Regional Tourism Development Plans also identify infrastructure requirements for both regions. For example, the plan for North East Victoria 2004–2007 has a key strategy of "upgrading visitor service facilities and interpretation of key natural attractions". The accompanying action is to "work with Parks Victoria to improve visitor service facilities and interpretation in the North East Victoria region, as well as conducting an audit of facilities and interpretation in the region". For specific detail on these proposed projects and a copy of the Regional Tourism Development Plans, refer to: www.tourismvictoria.com.au

The tourism industry is increasingly focused on enhancing the value of tourism by increasing the length of stay, spreading seasonal visitation patterns, improving

Figure 11.20 Events in neighbouring regions, such as a wine and food event on Pfeiffer's Bridge over Sunday Creek, bring visitors to the River Murray.

visitor dispersal and avoiding duplication of experience across sites. The economic result of this is described as visitor yield. Increasing visitor yield is favoured as an alternative to building capacity for more short stay visits that often provide increased demand on resources but little economic return for input.

The Shire of Campaspe and Murray Shire Council (NSW) recently released a tourism development plan that aims to increase visitor expenditure and increase visitor dispersal both geographically and seasonally (Tourism Destination Plan Steering Committee 2006). A positive aspect of this plan is that it integrates tourism planning in Victoria and New South Wales. However, it does not integrate planning with other shires along the River Murray. Instead it perceives other regions as competition. An integrated tourism development plan is desirable for the length of the River Murray. Such a plan, similar to the Victorian Coastal Strategy, would have a different focus from the plans described above and set directions for priority geographic locations for growth and development given increasing popularity and resulting pressures.

Recently, Tourism Victoria released Victoria's Aboriginal Tourism Development Plan 2006–2009. Tourism data indicates that international visitors have a high interest in experiencing distinctly Australian culture, including our Indigenous culture. Aboriginal tourism visitors represent 18 percent of all international visitors to the state. The Plan identifies key issues and objectives to promote the expansion and success of Indigenous cultural tourism businesses (Tourism Victoria & Victoria's Aboriginal Tourism Industry 2006).

Tour Operators Licences

Much tourism and recreation is dependent on access to public land. Public land is regularly used for non-commercial recreation and tourism purposes, either in a formal organised sense (e.g. community or sporting events), or an informal sense (e.g. family outings). There is a growing market for Indigenous heritage tourism.

All commercial recreation and tourism businesses operating on land managed by DSE directly or by Parks Victoria require a permit/licence. Licensees are given legal access to run a trade or business, subject to conditions. Conditions may relate to the activity, location or more general matters. Operators who breach their licence conditions can have their licence suspended or revoked.

Different activities require different settings, hence certain tourism and recreation activities may be more prevalent in one area (or category of public land) than another. Conditions are applied to licensed tourism and recreation activities to reduce environmental impacts. Local land managers help to determine these conditions.

Parks Victoria (PV) is responsible for managing the Tour Operator Management System, governing all commercial recreation and tourism businesses operating on land managed by DSE or PV. The costs of the licences do not allow full cost recovery of the Tour Operator Management System but operates at about 25 percent cost recovery.

Licence reform

Currently, DSE has released a directions paper aimed at reforming current licensing systems for tour operators and activity providers on public land (DSE 2005c). This is in order to encourage a viable, growing nature-based industry on public land, and ensure safe and sustainable use of that land. DSE sought public consultation on the document (March 2006), which will assist in finalising the policy on the tour operator licensing system. It is expected that this will be available before VEAC completes its Final Report for the River Red Gum Forests Investigation.

The Economics of Tourism

Tourism Victoria commissioned Access Economics to undertake a study into the value of tourism in 2003/04 (Tourism Victoria 2005a). It addresses tourism expenditure, employment in the tourism industry, tourism in regional Victoria, "export" income and tourism's contribution to gross state product. Detailed information in relation to this study can be found on Tourism Victoria's web-site. Further information on the economics of tourism is located in chapter 8.

12 Cultural Heritage

Cultural heritage places and objects are a tangible link to the past. They illustrate Victoria's written and verbal history. These irreplaceable resources evoke a strong spiritual connection to the past for many people. The landscape itself forms a spiritual and cultural heritage place for many Indigenous peoples and reflects deep spiritual connections to traditional lands or country.

This chapter focuses on the management and protection of both Indigenous and non-Indigenous cultural heritage on public land within the River Red Gum Forests study area.

Aboriginal cultural heritage places and sites exist throughout the landscape of Victoria and are often only identified or clarified after disturbance such as infrastructure works. As such, many sites have been lost and the landscape has changed significantly since the arrival of Europeans. The connection and relationship that many Indigenous people have to traditional lands is profound and deeply spiritual after 50,000 years of occupation (see chapter 6).

During the 200 years of European settlement, major changes in technology and patterns of land use have occurred. Initially people were attracted by the promise of vast grazing lands, while other waves of settlement were associated with the discovery of gold and exploitation of natural resources, which underpinned the economy of the state. Over time, many people have grown to appreciate the land and feel a strong connection to many places, particularly along the River Murray, despite or perhaps because of the often harsh and variable environment. Visiting cultural heritage places or objects provides an opportunity for visitors and residents alike to connect to the past. A thematic non-Indigenous history of the River Red Gum Forests study area is presented in chapter 7.

INDIGENOUS CULTURAL HERITAGE

Pre-European Contact

Aboriginal people have occupied the Australian continent for many thousands of years, and there is ample physical and oral evidence that the areas within the Murray Valley supported a rich culture for much of the last 50,000 years.

Archaeological sites from the Willandra Lakes (Lake Mungo)—about 100 km to the north of the River Murray—have yielded remains of some 135 individuals and provide evidence of Australia's oldest human remains dated at between 45-50,000 years before present (BP) utilising new techniques that reach beyond the reliable range of radiocarbon dating (Bowler et al. 2003).

The Murray Valley region contains numerous burial sites, including the unique occurrence of extensive cemeteries. Human remains in the area have been found to date to the late Pleistocene-early Holocene times. More recently, Indigenous groups have reburied ancestral remains within the study area. Sites such as Kow Swamp (Thorne & Macumber 1972; Stone & Cupper 2003) and near Robinvale (Bowdler 1983) show evidence of occupation continuing intermittently through to recent times, and an apparent continuity in cultural practices including complex burial rituals and rights. The Kow Swamp site in particular is one of the largest collections of late Pleistocene human burials at one site. Dating of the site has yielded ages in the range 13,000 to 9500 years before present (BP). Of particular importance is the complex range of human physical characteristics observed across approximately 40 individuals. The site includes men, women, juveniles and infants with some individuals being anatomically quite distinct from both other ancient people—such as those at Lake Mungo—and modern humans, leading to theories regarding multiple waves of occupation of the Australian continent over time by discrete populations (see Flood 2004). Much debate has continued over the description of the rugged or robust characteristics of some Kow Swamp skeletal remains. A similar robust individual from about 6500 years ago recovered from northwestern WA indicates that this physique was not specific to a single population located on the east coast of Australia (Freedman & Lofgren 1979). The Kow Swamp remains were re-buried several years ago at the request of Aboriginal communities in northern Victoria and the full description of the materials has not been published, although documentation and casts exist within museum and research collections (see Flood 2004).

Freshwater shell middens also attest to early and extended Aboriginal use of food resources along the River Murray and its tributaries (see Box 12.1; Figure 12.1). Aboriginal mounds, some of which also contain human remains, are common. Likewise, Aboriginal scarred trees are common, including the largest Victorian concentration of these trees on Bumbang Island near Robinvale. Other types of Aboriginal sites in the study area include hearths, kitchen mounds and artefact scatters. Aboriginal cultural heritage places are often located close to resources required for their way of life. This is of particular interest in the study area given the generally poor preservation of remnant landscapes, such as prior and ancestral streams (see chapter 2 and 3), which may have contained cultural heritage sites. Much of the landscape of the Murray valley has been substantially modified by water management and agricultural practices, particularly on freehold land.

Written descriptions of Indigenous culture, economy and society are generally restricted to those of early European explorers (e.g. Sturt, Mitchell), settlers (e.g. Curr, Krefft, Beveridge) and government-appointed officials such as G.A. Robinson, Aboriginal Chief Protector. These descriptions come from a specifically European perspective which is unlikely to reflect how Indigenous communities might describe themselves. The intimate relationship that Indigenous people had, and in many cases still have, with the landscape is only now becoming apparent to the wider community.

Aboriginal associations with the study area also include broader spiritual values and Aboriginal cultural heritage places associated with the post-contact period. The latter include campsites, meeting places, historic reserves, massacre sites and stations.

European Impact on Indigenous Communities

Recognition of the history of cultural contact, conflict or resistance, adaptation, adjustment, and an awareness of places reflecting that history, are important for understanding our shared, and at times, poorly documented or acknowledged past. These places also provide a historical reference to explore the changing and evolving culture and values of both Indigenous and non-Indigenous societies within Australia.

European settlement significantly disrupted the lives of Indigenous people in the River Red Gum Forests study area. Even before widespread European settlement, a wave of introduced diseases, perhaps from earlier explorers in other parts of the country, had already spread with devastating effects. Smallpox and influenza epidemics in particular are believed to have significantly reduced the Indigenous population prior to the first pastoral settlers reaching the Murray valley area in the 1830s and 1840s (Atkinson & Berryman 1983).

In 1838 Sturt commented that although the Indigenous people he saw at the junction of the Goulburn and Murray Rivers were good-looking, strong and active, "disease had been busy with them" and there were many burials in the sandhills, which appeared "to have been recently tenanted" (Sturt in Hibbins 1978). Curr (1883) commented that both the state of disuse and the number of cooking ovens indicated that the population of Indigenous people in the Barmah region was much greater prior to the arrival of white settlers.

The wave of European settlers that followed the early explorers saw a clash of cultures with very different technologies, attitudes to the land and concepts of ownership, social values and spiritualities. Dispossessed and forcibly removed, Aboriginal people were in many cases relocated to missions and reserves outside their traditional lands. Many deaths occurred, particularly when Indigenous people resisted the occupation or invasion of their country (Clark 1996).

Today, the places of these interactions between explorers, settlers, including massacre sites, mission stations and reserves are often especially significant to Indigenous people as they form part of their cultural heritage. At a more individual level, many people lost their families and ancestors at these places. The protection of these locations is therefore vitally important to some Aboriginal communities, even if there is no remaining physical evidence of such events.

Protection and Management of Indigenous Cultural Heritage

Identification and documentation of Aboriginal cultural heritage places, sites and objects are important for future management and protection. Aboriginal Affairs Victoria or AAV (Department of Victorian Communities) has prepared information sheets to help identify physical cultural heritage such as middens, scarred trees, grinding stones, artefact scatter sites, stone tools and burials. A description of freshwater middens is provided in Box 12.1. AAV also funds regional Aboriginal heritage officers throughout the state to work in partnership with land management agencies, investigate reports of potential sites, carry out community programs and provide advice to the public, developers, or other government agencies about Aboriginal cultural heritage.

Aboriginal cultural heritage places, sites and objects are protected through cultural heritage legislation (described below). Traditional owners and other relevant Aboriginal groups have an interest in the long term survival of their cultural inheritance and are actively involved in ongoing protection and management of these places, sites and objects.

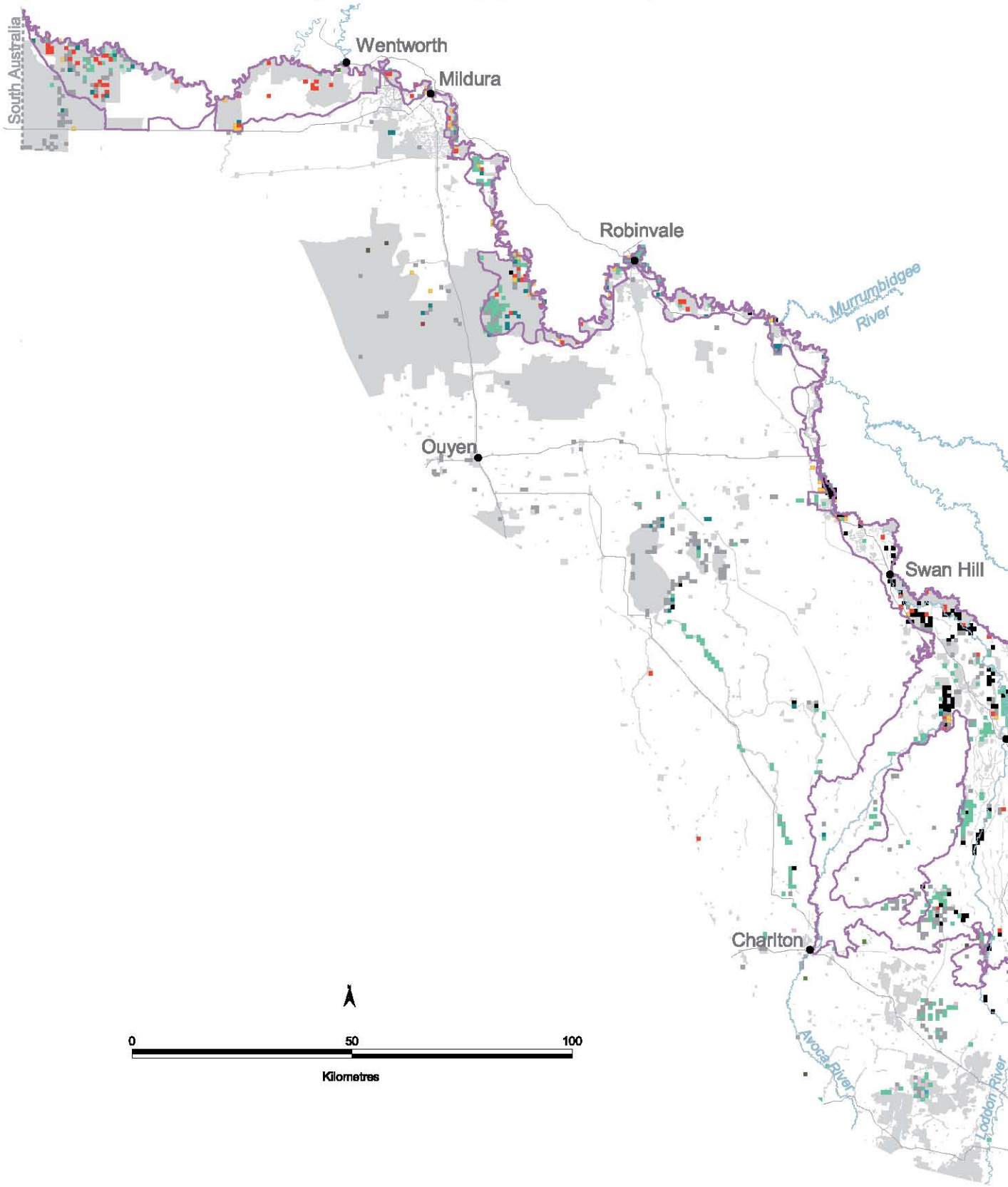
Identification of Sites and Survey Coverage

As described above, sites of Indigenous cultural heritage may have a material or physical nature (such as burials, middens, scarred trees, missions) or may be related to events or spirituality and have no tangible on-ground presence (meeting places, massacre sites, mythology). The documentation, identification, protection and management of Aboriginal cultural heritage places are the responsibilities of all land managers and land owners in Victoria. Aboriginal Affairs Victoria (AAV) and other state government authorities work in partnership with traditional owners and other relevant groups in all Aboriginal cultural heritage investigations and assessments. This includes surveys to locate and record Aboriginal sites and places as well as assessments of the potential impact of proposed works on heritage values.

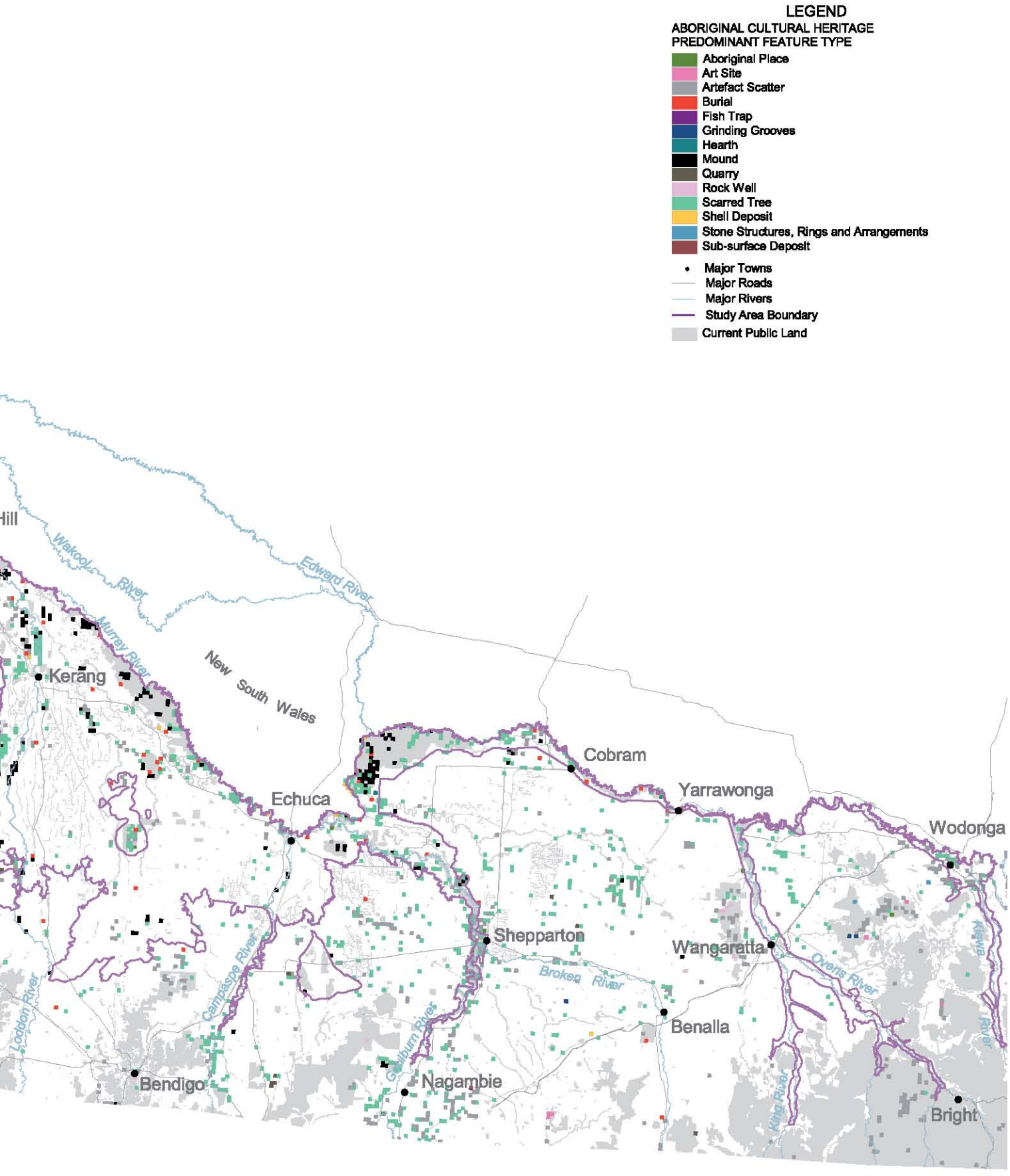
Only some sections of the study area have been systematically surveyed for Aboriginal cultural heritage places. Although the coverage is not comprehensive, a number of notable and important archaeological and cultural heritage sites are known, such as the unique cultural landscapes associated with the Murray Valley including the mound and cemetery complexes, evidence of old shell middens, Kow Swamp and the Robinvale burials, and Bumbang Island sites (Figures 12.1 and 12.2). Many systematic surveys have been associated with the planning and development of specific infrastructure works, such as the construction of roads and forestry activities (e.g. Presland 1981; TerraCulture 2005) while others have been more regional in approach (Bonhomme 1990; Craib 1992; Greenwood 2003; Johnston & Webber 2004).

AAV maintains a Heritage Register of all known Aboriginal sites and places in Victoria, in accordance

Map 12.1 Distribution of known Aboriginal cultural heritage places for the study area.



Source: AAV, data last updated, 30 June 2006.


LEGEND
ABORIGINAL CULTURAL HERITAGE
PREDOMINANT FEATURE TYPE
Aboriginal Place
Art Site
Artefact Scatter
Burial
Fish Trap
Grinding Grooves
Hearth
Mound
Quarry
Rock Well
Scarred Tree
Shell Deposit
Stone Structures, Rings and Arrangements
Sub-surface Deposit
Major Towns
Major Roads
Major Rivers
Study Area Boundary
Current Public Land
Hill
Wakool River
Edward River
Murray River
Kerang
New South Wales
Echuca
Cobram
Yarrawonga
Wodonga
Shepparton
Wangaratta
Broken River
Ovens River
Kiewa River
Campaspe River
Goulburn River
Benalla
Loddon River
Bendigo
Nagambie
King River
Bright

Box 12.1 Aboriginal Shell Middens.

Many freshwater shell midden sites occur along the major waterways and wetlands within the study area, including both relatively recent ones and those created many thousands of years ago when the climate was much wetter. The middens are accumulations of materials from cooking and eating freshwater mussels. Often middens contain charcoal, ash, fire-stones, burnt earth or clay, and animal bones or shells. Some contain stone tools or, occasionally, burials.

The shells may form a discrete layer or an extensive area associated with a range of activities and the remains of meals eaten over thousands of years at a popular campsite (Bonhomme 1990). The shells are typically the freshwater mussel (*Velesunio ambiguus*) and river mussel (*Alathyria jacksoni*).

Some particularly good examples of middens occur along major waterways throughout the study area. As a consequence of this location, the meandering of rivers and erosion of river banks over time is a threat to some middens. Active conservation may be required to preserve the sites for future generations.

Freshwater shell middens provide valuable information about the past including Aboriginal economy and land-use, the local climate, as well as providing a record of events such as floods and droughts. The shells in middens provide information about the environment, and whether the shells were collected at the same time or at a number of different times. Dating techniques ascertain the time when Indigenous people occupied an area. Middens provide an important link to the past, and those that contain burials are particularly significant to Indigenous people (AAV 2003).

Figure 12.1 A stairway cut into a midden along the banks of the Murray River, Echuca Regional Park. It is against the law to disturb or destroy an Aboriginal cultural heritage site or object without written consent from the relevant local Aboriginal community.

with cultural heritage legislation. This includes detailed site information and historical information for some post-contact places. In addition, AAV holds copies of all reports relating to previous Aboriginal cultural heritage investigations throughout Victoria. Records for individual sites are generally subject to access restrictions. However maps of sites portrayed on a 1x1 km grid cell are available as an indicative tool to establish if sites have been registered and what general type of site is present. The distribution of these sites within the River Red Gum Forests study area is shown in Map 12.1. More than one site or cultural heritage type may occur within a grid cell. The absence of grid cells in many areas does not mean that there are no Indigenous cultural heritage sites, but that the area may not have been surveyed or sites documented.

The Aboriginal Community Heritage Investigations Program in 2001-2002 provided opportunities for Aboriginal communities to increase their capacity and participation in cultural heritage management. The program involved a series of training and fieldwork

activities and included an oral history component—recording the stories and memories of community elders—extensive field surveys, archaeological excavations, training in cultural heritage management and administration procedures and site protection programs.

Some of the results have been the recording of over 400 new Aboriginal cultural heritage sites; participation of over 170 Aboriginal community members in the program from a diversity of backgrounds and the employment of seven program participants in cultural heritage management positions in various Victorian organisations. The success of this program has demonstrated an ongoing need for Indigenous communities to undertake cultural heritage field surveys and training exercises in partnership with land management agencies.

Another recent survey of Indigenous cultural heritage of the alpine area of Victoria following the 2002-03 alpine fires, has demonstrated extensive and widespread evidence of past Aboriginal occupation (DSE & Parks Victoria 2005). As a result of the fires, good ground surface visibility was provided through removal of dense vegetation, allowing many artefacts including flaked stone scatters, stone axes and rock shelters to be found. This survey revealed that identified individual sites are only point locations within a broader cultural landscape that contains not only artefacts but also places and associations of spiritual significance for Aboriginal people.

Additional surveys are likely to improve the existing level of knowledge and identification of cultural sites and places within the study area. Aboriginal people report that new sites are found regularly in the study area and there are likely to be many sites and places known to traditional owner groups that are not recorded on government registers. As part of the assessment of public land values throughout the study area, VEAC will commission a desktop study of available cultural heritage information, and where necessary, fill any data gaps revealed.

Legislation

Victorian and Australian legislation recognises the importance and value of identifying and protecting cultural heritage such as sacred sites, burial sites, places of significance and other important sites where there is evidence of Aboriginal occupation of country. Indigenous cultural heritage is protected specifically under two acts administered by AAV: the Victorian *Archaeological and Aboriginal Relics Preservation Act 1972* and the Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* Part II A. Under these acts it is an offence to wilfully deface, damage or otherwise interfere with an Aboriginal object or place without prior written consent from the relevant local Aboriginal community as listed in a schedule to the Commonwealth Act.

The Victorian Act protects sites and materials relating to Indigenous cultural heritage, with the exception of human remains interred after 1834. This includes artefacts, stone tools, rock art sites, ancient campsites, middens, burial sites, scar trees and ruins associated with Aboriginal missions or reserves. The Commonwealth Act provides additional protection for cultural property in a broader sense including places, objects and mythology from pre-historical through to contemporary sites. The Commonwealth Act takes precedence over matters where there is conflict with the state legislation.

The Victorian government is in the process of updating Aboriginal cultural heritage legislation. The new *Aboriginal Heritage Act 2006* will come into effect fully in late 2006 or early 2007 and will replace both the State and Commonwealth Aboriginal heritage legislation and provide for more effective protection and broader involvement of Indigenous people in cultural heritage decision making processes. It is anticipated that the new legislation will result in a more integrated and streamlined process for dealing with cultural heritage management issues between land owners, developers, local governments and Indigenous traditional owner groups.

Significant changes under the new Act include clarity for protection of Indigenous heritage in planning and land developments, including developments that require Heritage Management Plans, cultural heritage audit and stop orders, and dispute resolution mechanisms through the Victorian Civil and Administrative Tribunal (VCAT). Additionally, a Victorian Aboriginal Heritage Council will be established to consider applications and register Aboriginal organisations as cultural heritage decision-making bodies for specific areas. The composition of this Council will be broader than the existing cultural heritage 'communities' described under the schedule to Part II A of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* to include traditional owner groups. This Council will also provide advice relating to the protection of Aboriginal heritage to the Minister for Aboriginal Affairs (Victoria).

Registered Aboriginal parties will advise on the cultural significance of heritage places/objects, participate in heritage investigations and assessment processes, evaluate and endorse Aboriginal Cultural Heritage Management Plans and permits, and negotiate any Cultural Heritage Agreements. Under the *Aboriginal Heritage Act 2006*, a range of measures will be introduced to improve compliance and enforcement or penalties will be increased.

The Act builds upon the Regional Cultural Heritage Program established by AAV as a resource agency to advise on a range of planning, development and cultural heritage management. This program was staffed by Indigenous people with expertise in cultural heritage matters. Existing arrangements for the Regional Cultural Heritage Program will be wound up when the *Aboriginal Heritage Act 2006* is fully enacted. Inspectors will be employed under Part 3 of the *Public Administration Act 2004* and appointed by the Victorian Aboriginal Heritage Council.

The *Planning and Environment Act 1987* also applies to Aboriginal cultural heritage values including Planning scheme overlays (e.g. Kow Swamp is protected by a heritage overlay under the Campaspe Planning scheme). The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* also applies to Indigenous cultural heritage.

Management of Indigenous Cultural Heritage Sites

Aboriginal cultural heritage places are frequently fragile and may be disturbed or destroyed as a result of numerous activities and natural processes, including timber harvesting, controlled burns and bushfires, grazing, road building, sand extraction, channel construction, bardy grub collection, trail-bike riding, camping, pest management, water and wind erosion. The survival of living sites, such as scarred trees, has been affected by fires, land clearing and timber harvesting over the last 150 years. In places where timber harvesting and land clearing have been minimal, a substantial number of scarred trees remain.

Public Land

Within the study area, reservation of public land has been undertaken in order to specifically or exclusively protect Indigenous cultural heritage at Bumbang Island Historic Area (LCC 1989a) and in 2005 the Wallpolla Island Archaeological and Natural Interest Reserve was declared under the *Forests Act 1958*. A committee of management has been formed to manage the latter forest reserve located in the western area of the existing Wallpolla Island State Forest. The committee consists of a partnership between Government agencies and Indigenous communities. Bucks Sandhill in Barmah forest is currently covered by a Declaration of Preservation enacted under provisions of Part II A of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (declared in 2001).

The Yorta Yorta Co-operative Management Agreement between the Yorta Yorta Nation Aboriginal Corporation and the State of Victoria, provides for traditional owners to have a voice in natural and cultural resource management within the public land of Barmah Forest, Kow Swamp water supply reserve, lower Goulburn State Forest and other designated areas. This management arrangement is discussed in greater detail in chapter 6.

In other places throughout Victoria and the River Red Gum Forests study area, specific Indigenous management bodies have acquired land—through various arrangements—to serve specific community needs such as housing and welfare (e.g. Mungabareena Aboriginal Corporation centre, Wodonga; Rumbalara Aboriginal Co-operative, Mooroopna). The land tenure and management arrangements in both Victoria and other states are described in chapter 6.

NON-INDIGENOUS CULTURAL HERITAGE

Sites of European historic significance are located throughout the study area and largely relate to the major historic themes identified in chapter 7 such as exploration and settlement, transport, water supply, and industries such as timber harvesting and agricultural development.

Significant periods of change—such as closer settlement

Figure 12.2 Aboriginal mound fenced and sign-posted at Nyah State Forest.

Figure 12.3 Big Lizzie, on display at Barclay Square, Red Cliffs.

and agricultural development—are closely linked to the establishment of transport and water irrigation infrastructure throughout the study area. Early European settlement is often described in waves associated with pastoralism, gold mining, selection and agricultural developments in closer settlements with intensive farming linked to Government funded irrigation schemes.

Timber harvesting has a history within the study area. Paddle-steamers, plying the rivers, used large quantities of wood in their boilers and stacks of wood were maintained for use on the banks. Logging of the red gum forests began in earnest in the 1860s and by 1877 all suitable timber in Barmah Forest and along the Murray bank was cut back for an average of 2 miles (3.2 km) and partly or entirely worked, sometimes for a second time (Fahey 1987). Forestry records indicate that areas were cut depending on size and age of the stand and, in some areas regeneration events were noted (King 1963). The timber was exported to England for building wharf piles and much of the timber from near Mathoura and Deniliquin in New South Wales was exported to India, for railway construction (Mulham 1994). It was also used extensively in Victoria for railway sleepers, mine supports, bridge culverts, for wharf and jetty construction and most of Melbourne's streets were paved with red gum bricks until the 1960s (Lawrence et al. 1979).

Some cultural heritage objects or artefacts can be relocated without compromising cultural heritage values. For example, Big Lizzie constructed in 1917, is on display at Barclay Square, Red Cliffs as a monument to technology and design development. Its dreadnought wheel was designed to overcome the difficulties experienced with clearing sandy soils and outback conditions (Figure 12.3).

Protection and Management of European Cultural Heritage

Heritage Site Documentation and Lists

Sites and places of cultural heritage are recorded on many lists and registers, although none of these are comprehensive. At the same time, many lists and registers overlap but generally have a confined scope such as sites of national or state significance, or those of natural or historic values. Such registers include the following:

- Register of the National Estate, now maintained by the Australian Heritage Council, is a record of more than 13,000 places of natural, Indigenous and historic places throughout Australia.
- Sites of outstanding national heritage value listed on the National Heritage List are protected under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. These places are selected by the federal Minister for Environment and Heritage, protected by Australian laws and managed under special agreements with state or territory governments and with private land owners. Examples of such places are the Sydney Opera House, Budj Bim National Heritage Landscape (Tyrendarra, Mt Eccles-Lake Condah areas) and the Royal Exhibition Building (Melbourne).
- Places of state significance are listed in the Victorian Heritage Register which is maintained by the Victorian Heritage Council. This register is available to the public and may be searched on the internet. The register includes a range of significant places and objects including extensive land areas, gardens and trees, and archaeological sites.
- Historic archaeological sites and relics are documented on the Heritage Inventory maintained by Heritage Victoria (DSE). Sites listed are protected under the provisions of the *Heritage Act 1995*.
- Historic places on public land are listed in the Historic Places database (DSE).
- Sites of local or regional significance may be listed in a local municipal planning scheme and protected under provisions of the *Planning and Environment Act 1987*.

Sites older than 50 years may be recorded on the Heritage Inventory and those of state significance are recorded and assessed in greater detail for inclusion on the Victorian Heritage Register. This includes both those sites that have been included on a register of cultural heritage places, relics and objects, and those previously unknown sites uncovered during excavations or works.

Sites are identified and then listed on the Heritage Inventory or Victorian Heritage Register. Those sites identified on the Victorian Heritage Register within the River Red Gum Forests study area are listed in Table 12.1. Management of cultural heritage sites is undertaken in a manner consistent with the Victorian Heritage Strategy 2000–2005 (Heritage Victoria 2000).

Identification of Sites and Survey Coverage

In addition to the resources described above for highly significant sites, many local municipal councils have conducted cultural heritage investigations, largely focussed on specific sites, townships and historic buildings or local or regional significance. Examples include Greater Shepparton Heritage study (Allom Lovell & Associates 2003), Indigo Shire Heritage study (Peter Freeman and Associates 2005), and the Mallee Area Review—Study of Historic Sites (Andrew C. Ward and Associates 1986). These studies typically identify historic places and recommend conservation actions to land managers. This information supports decisions made in regard to municipal planning schemes and overlays.

Historic Places section (DSE) has surveyed extant historic gold mining sites on public land across Victoria. Such sites vary in terms of the nature of materials and state of preservation and include mine workings, industrial machinery such as batteries, and habitation sites. However there are some major cultural themes that lack representation on the lists and registers and have not been systematically surveyed within the study area (i.e. forestry, and water management). As part of the assessment of public land values throughout the study area, VEAC will review available cultural heritage information, and where necessary, fieldwork and survey will be undertaken to fill any data gaps revealed.

The National Trust of Australia (Victoria) is a not-for-profit community organisation that owns and operates several historic buildings and museums throughout Victoria and maintains a register of sites. Sites listed on the National Trust Register provide an indication that the community values the attributes present, but does not afford any legal protection. The Trust has compiled a vast body of information since it was established in 1956, and is a strong advocate for nominating and protecting historic places on government registers.

Legislation

In Victoria, the *Victorian Heritage Act 1995* protects all non-Aboriginal archaeological sites older than 50 years. Anyone who damages or excavates an archaeological site without obtaining the appropriate permission, faces a penalty under the Act. Legal recognition and protection under this Act encompasses a range of places, objects, precincts or landscapes, gardens and trees, and archaeological sites. Specific protection measures apply to places listed on the Victorian Heritage Register.

The *Planning and Environment Act 1987* contains provisions for local municipalities to govern cultural heritage values through provisions of planning schemes and overlays. An example is a heritage overlay, or design and development overlay that informs decision making by local councils in response to planning applications and permits.

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* is administered by the federal Department of Environment and Heritage which implements programs and legislation to protect and conserve Australia's cultural and natural heritage.

Historic places on reserved Crown land are also recognised under the land management objectives and provisions of relevant acts. A number of historic sites and places are currently within parks and reserves and state forest throughout the study area and are protected under the provisions of each relevant act (see section below).

The Burra Charter

Both Indigenous and non-Indigenous historic and cultural heritage places on public land are managed in accordance with principles of the Burra Charter of Australia ICOMOS (International Council on Monuments and Sites) 1999 which provides principles for the protection and conservation of cultural heritage places and sets a national standard for best practice adopted by many heritage organisations. The Charter can be applied to all types of places of cultural significance including natural, Indigenous and historic places with cultural values. The Charter embodies seven basic tenets:

- Recognise that the place is important
- Understand the significance of the place
- Understand the fabric
- Let significance guide decisions
- Do as much as possible and as little as necessary
- Keep records
- Do everything in a logical order.

In general the principles embodied by the Charter are to manage and conserve sites of cultural significance *in situ* where possible with minimal intervention, alteration or disturbance. The degree to which this can be achieved, and to which management and conservation activities impact with cultural heritage values, is largely dependent upon the type of values present, such as rarity, age, condition, integrity, significance, and aesthetic values. In this context, conservation means that the values or meaning of a site are retained.

Public Land

Many historic places or sites of cultural heritage significance are located on public land and typically those with the most outstanding values are within Crown land reserves. Some sites such as historic buildings may remain as functional institutions and entertain current community use. A number of land status and zoning mechanisms are applied to sites associated with European cultural heritage as described below.

Previous studies of public land in the study area have identified a number of historic places. The Land Conservation Council's 1997 special investigation into historic places across south-western Victoria overlaps slightly with the current River Red Gum Forests study area. In that study eleven historic sites of state significance were identified, as well as a range of other significant and notable historic places on public land. Other LCC studies undertaken as part of the North Central Investigation (LCC 1981a) and Mallee Review (LCC 1989a) identified a number of historic sites (Jacobs Lewis Vines & Architects and Conservation Planners 1979; Andrew C. Ward and Associates 1986). As a consequence, reserves were established to protect places with highly significant historical values that were not within other permanent reserves or parks.

National Parks

National Heritage Park is a relatively new public land category recommended by the ECC in the 2001 Box Ironbark Forests and Woodlands Investigation Final Report. The category was developed to recognise the outstanding and largely intact cultural heritage values present in the Castlemaine area from the gold mining era, whilst recognising that the natural values present did not warrant national park status. The Castlemaine Diggings National Heritage Park is reserved under the *Crown Land (Reserves) Act 1978* and listed under schedule 4 of the *National Parks Act* 1975. This park is the largest protected non-Indigenous cultural landscape in Australia and is registered on both the Victorian

Heritage Register and the National Heritage List. Places on the list are protected under the provisions of the EPBC Act 1999.

Historic and Cultural Features Reserves

As described in chapter 9 Public Land Use Categories and Management, areas of historic significance within the study area have been reserved and protected using existing legislation. These historic sites are reserved under the *Crown Land (Reserves) Act 1978* for protection of the identified historical values. Typically these reserves are small, often containing a single building or group of structures, or remains of structures (e.g. Murchison Waterworks Trust Historic Area, 1 ha). However, some reserves may be more extensive such as Kinipanial Creek Historic Area (61 ha) and Bumbang Island Historic Area (639 ha).

State Forest Historic Sites

In state forest, known historic places are listed in Department of Sustainability and Environment (DSE) forest management plans or regional inventories. In 2002 there were over 1400 historic places recorded in state forests throughout Victoria (DSE 2005h). Typically sites within state forests relate to resource use and include timber mills, railways, cattle muster yards, campsites and buildings. Statewide management procedures for Timber Harvesting Operations (DSE 2005h) apply management procedures for protection of historic heritage values. There are also requirements to protect historic places in the Code of Forest Practice and the Code of Practice for Fire Management. Forest management plans specify management actions designed to protect each site from potentially damaging processes. Significant sites are also protected through forest management prescriptions or heritage management plans. Prescriptions may include buffers, which exclude various activities within a specified area, and filter strips, in which machinery entry and felling of trees may be only be permitted in certain circumstances and under specified conditions.

Information on the location and significance of historic places is incorporated into annual forest management operational plans including the Wood Utilisation Plans, fuel-reduction burning plans and road management plans. Conservation management plans for historic places, or groups of places, may also be developed for the most significant or vulnerable sites. These plans document the cultural heritage significance of the place and make recommendations that will ensure the place is conserved to protect and enhance its identified values. An example of such a site is the Barmah muster yards located at Goose Neck, in Barmah State Forest, or Murray's timber mill in Echuca.

New sites discovered in the course of forest management activities or as the result of further research are documented and assessed by DSE.

Table 12.1 Historic places list of sites of state or regional significance for public land in the study area.

HP No	Site Name	Significance
2969	Condidorio's Bridge	State
119	Echuca Courthouse	State
1626	Lake Hattah Regulator	State
1671	No 1 Flying Boat Repair Depot	State
1552	Pumping Station	State
140	Rochester Shire Hall	State
1711	Yelta Railway Station	State
3592	Dockendorff and Heach's Boorhaman Sawmill	Regional
1705	Lock 9 Lockmasters Residence & Former Post Office	Regional
1574	Locomotive Depot	Regional
6509	Porepunkah Area	Regional
1672	Railway Storage Shed	Regional
1674	Tresco Main Pumping Station	Regional

Source: DSE July 2006.

13 Primary Production

Although primary production in the River Red Gum Forests study area is largely conducted on private land it exerts considerable influence on the economy, community and environment of the whole study area. This chapter therefore, provides an overview of primary production in the study area before focusing on grazing and beekeeping which are the predominant primary production uses on public land.

IRRIGATED AND DRYLAND AGRICULTURE

Both irrigated and dryland agriculture are major forms of primary production and are the dominant land uses in the study area region[1] and across much of the Murray-Darling Basin (MDB) as a whole. The Murray-Darling Basin accounts for one third by value of Australia's agricultural output, and the value of agricultural produce from the Murray-Darling Basin now exceeds $10 billion per year (MDBC 2002). As one of the most agriculturally intensive parts of the Murray-Darling Basin the area along the River Murray and its tributaries contributes substantially to this output.

Irrigated agriculture replaces or supplements rainfall with water from another source in order to produce crops and pastures. The water may be sourced from groundwater, irrigation systems and channels or recycled and re-used irrigation water and wastewater. The scale of irrigation production in the study area is largely due to the land development and settlement policies of Victorian governments over a century and a half. These policies resulted in closer land settlement patterns as well as the development of large-scale water supply infrastructure systems, as discussed in chapters 7 and 15. This use of water for irrigation purposes has major implications for environmental values across the study area, particularly on public land.

The total value of all primary production across the Mallee, Loddon, Goulburn and Ovens–Murray statistical local government areas is in the vicinity of $3.5 billion: approximately $1.3 billion for Mallee, $400 million for Loddon, $1.5 billion for Goulburn and $253 million for Ovens–Murray. Most of this revenue comes from irrigation-based production such as fresh and dried fruit, wine grapes, dairy products and fodder for stock. Map 13.1 shows the distribution of various types of irrigated and dryland agriculture around the study area. Output from irrigated agriculture in revenue and products are expected to increase in the future (GBCMA 2003), primarily due to improved irrigation efficiency and a shift of water resources from irrigated grazing to higher value activities such as horticulture. For example, in north central Victoria horticulture expanded on average 6.3 percent per annum between 1997 and 2001 (NCCMA 2003). Similar trends are evident in the Mildura and Shepparton irrigation regions of Victoria (GBCMA 2003, MCMA 2003a).

Dryland agriculture occurs where agricultural production is based solely on natural rainfall and the resulting soil moisture availability. This form of agriculture is more susceptible to climate variation. Dryland agriculture consists mainly of grain and oilseed cropping as well as livestock production—mostly sheep (for wool and meat) and beef cattle. Like irrigated agriculture, dryland agriculture is an important industry in the study area through its contribution to regional economies and the Victorian economy as a whole, with a total value of approximately $1.5 billion.

A key difference between irrigated and dryland agriculture is the much higher value of production per hectare of land used under irrigated agriculture. A brief description of irrigation and dryland agricultural industries follows.

Livestock Production

Northern Victoria is one of the three major livestock production areas in Victoria and beef-, sheep- and pig-meat production are all significant. Production is for both export and domestic markets. The major beef and sheep-meat producing areas are illustrated in Map 13.2. The value of these industries, including egg production and pig-meat production to the regional economy is $8.7 million per year.

Livestock production is conducted on both irrigated and dryland production systems. Dryland livestock production is more prominent in the north east part of the study area where rainfall is higher (DPI 2006b). In dryland areas sheep-meat production is often preferred over beef because sheep offer additional benefits of wool production and more effective grazing of cereal stubble. Sheep-meat production is therefore more prominent around the grain producing areas of north-western Victoria.

Other livestock activities situated close to the study area include poultry and goat meat production (DPI 2006b).

Dairying

The dairying industry is one of the major agricultural industries adjoining the study area, particularly in the irrigated areas around Kerang, Echuca and Shepparton (as shown in Map 13.3). Victoria dominates the Australian dairy industry producing approximately 6.4 billion litres of milk. The total value of dairying for the statistical local government areas linked to the study area is $5.38 million per year.

Cropping

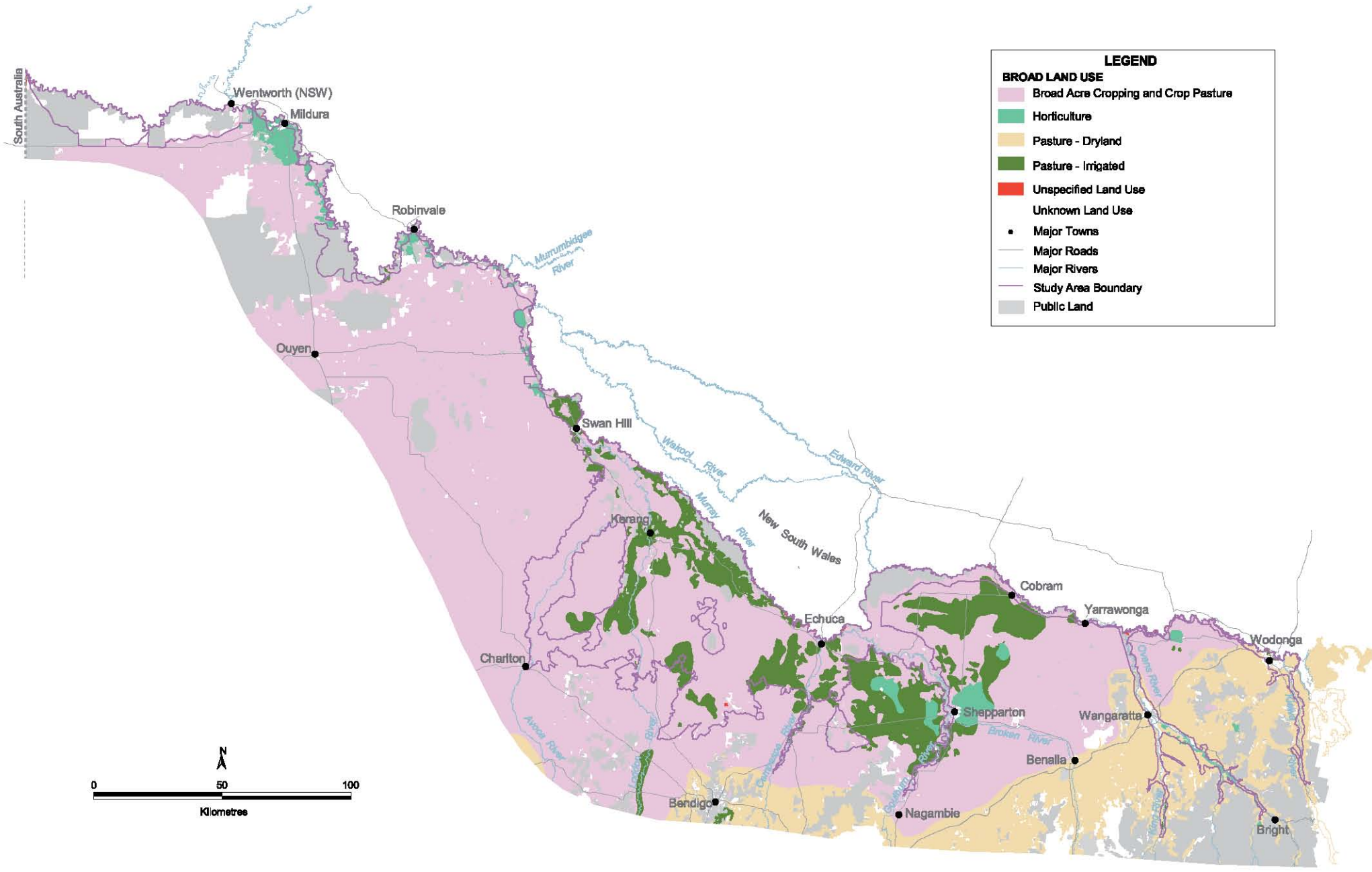
Cropping includes the production of hard grains (such as wheat, barley and oil seeds) and fodder but not horticulture. It may be based on irrigation or dryland production techniques.

Cereals

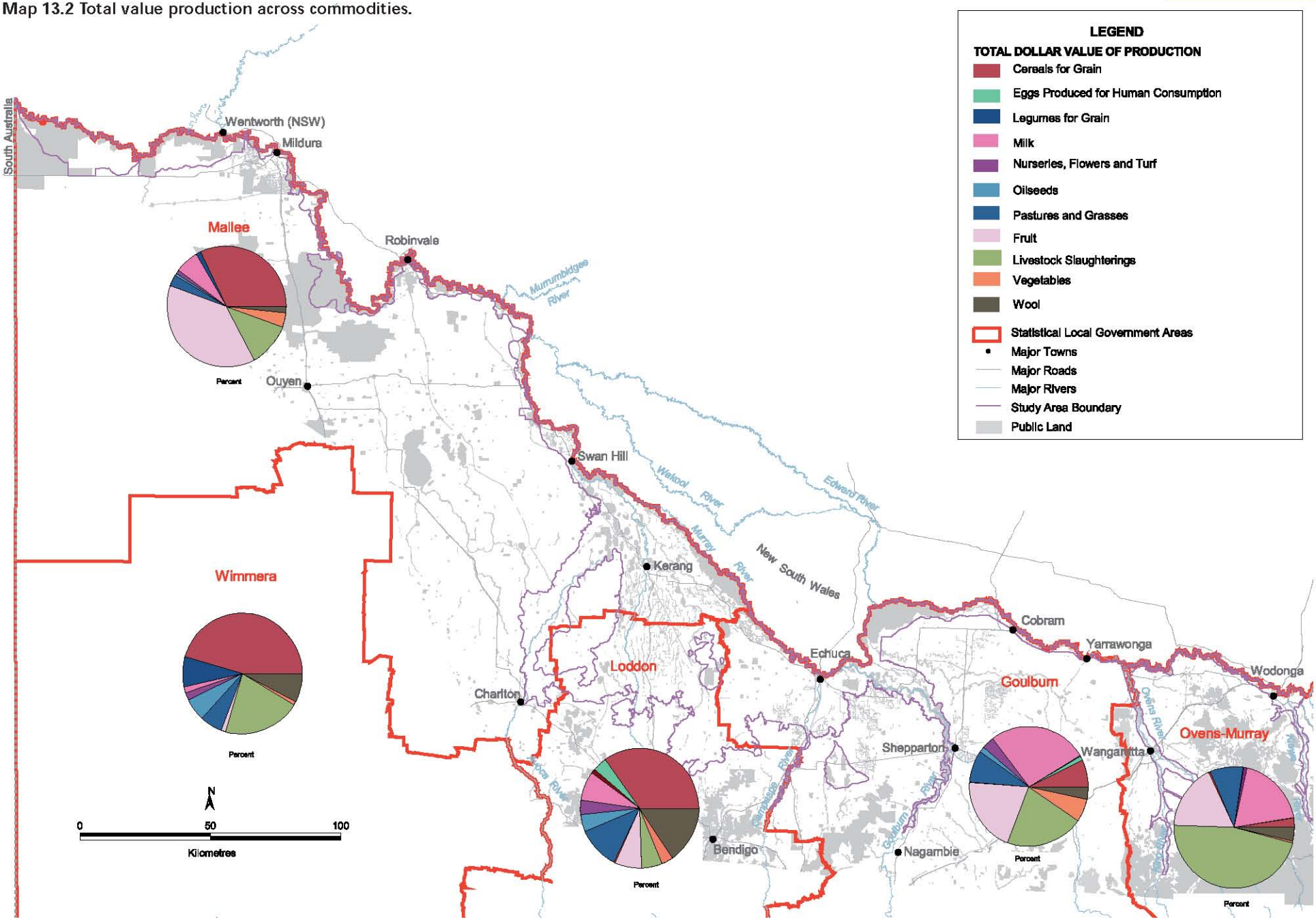
Cereal production, including all grains, legumes and oilseeds is a significant industry for Victoria. Cereal grains are predominantly found around the central and western part of the study area region as shown on Maps 13.1 and 13.2 above. For example, in the Mallee region

1 Note: Agricultural land-use is not a major activity on public land in the study area. However the information regarding agriculture on private land is important to provide some context for the Investigation. To provide some spatial context for the overview of agriculture the area under discussion will be referred to as "study area region".

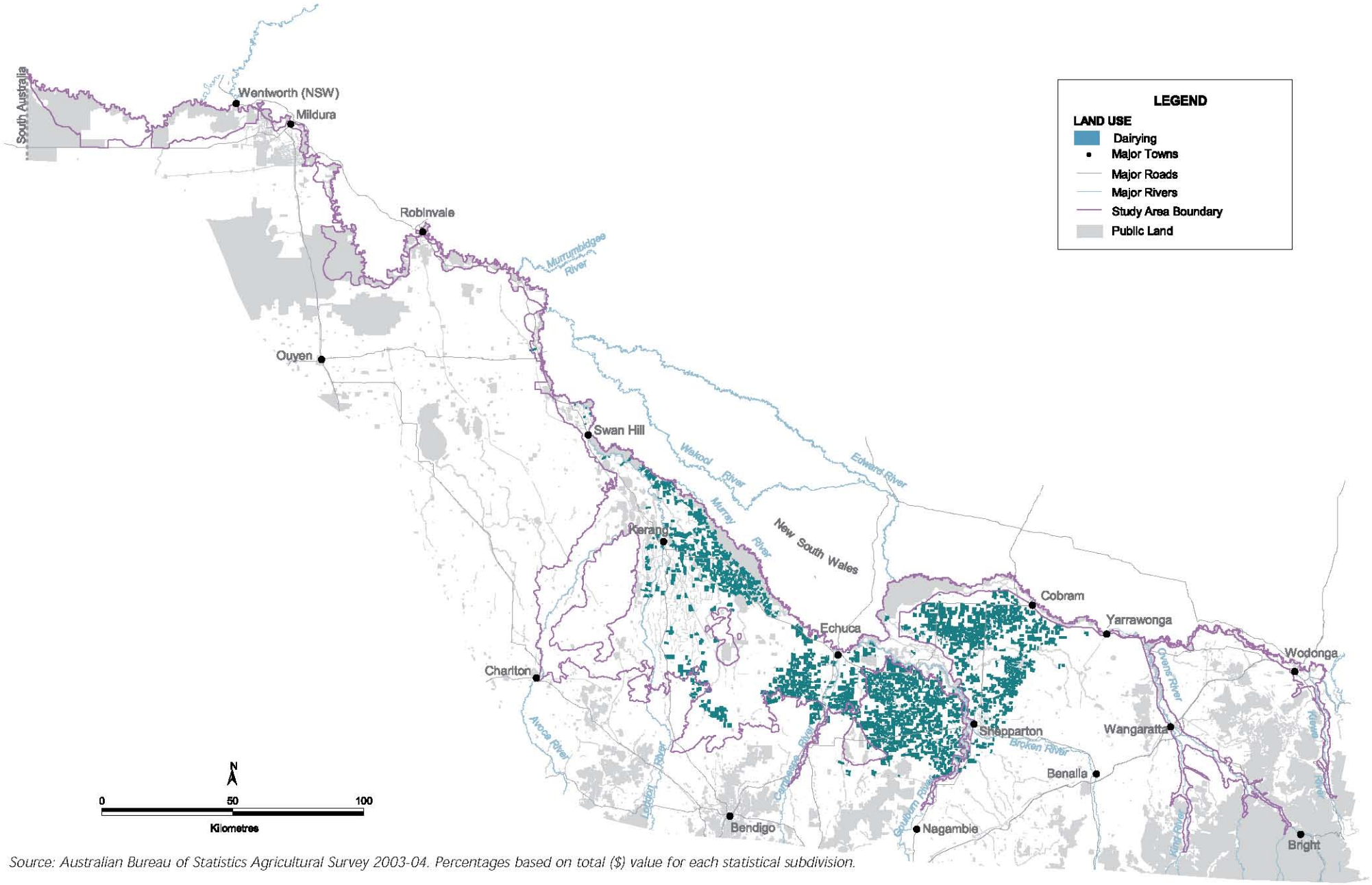
Map 13.1 Broad acre cropping and irrigation land uses.



Map 13.2 Total value production across commodities.



Map 13.3 Dairying areas in proximity to the study area.



Source: Australian Bureau of Statistics Agricultural Survey 2003-04. Percentages based on total ($) value for each statistical subdivision.

cereal production was worth more than $3.9 million in 2003–04.

Major grains produced in the vicinity of the study area are wheat, barley and oats. In most cases these grains are produced under dryland conditions and are therefore most vulnerable to climate variation such as drought and waterlogging. Other grains produced include nitrogen-fixing plants such as field peas, lentils, faba beans, chickpeas and lupins. Production of these grains is often dependent on irrigation.

Oilseeds such as canola and sunflowers are other important crops produced in the study area, albeit not as much as the cereal grains. Oilseeds may be produced through dryland or irrigation techniques and supply both the domestic and export markets.

Rice is also produced in the central part of the study area, abutting the large rice production area of the New South Wales Riverina. Rice growing is totally dependent on irrigation.

All cereals are produced for both the domestic and export markets and for both stockfeed and human consumption.

Hay

Hay production, particularly lucerne, clover and pea straw-based hay under irrigation, is an increasingly important industry for both the export and domestic markets (GBCMA 2003). Straw hay is also sourced through the harvesting of cereal crop stubble such as wheat, oats and barley. This hay is largely used on the domestic market, particularly in the horse industry. Pastures and grasses, including hay production had a value of $2.13 million across the four statistical local government areas in 2003–04.

Horticulture

Fruit

Fruit production is the largest horticultural industry in Victoria and, in 2002–03, had a market value of $966 million. Fruit in the study area is predominantly produced around the Goulburn Valley and near Swan Hill and Mildura, as illustrated in Map 13.1 and 13.2. Major fruits produced in the Goulburn Valley region are pears, apples and stone fruits such as peaches, nectarines, plums, cherries and apricots (GBCMA 2003). In 2002–03 stone fruit production from this area was worth $137 million. Because of the concentration of fruit producers in the Goulburn Valley, the region also supports Victoria's largest cannery.

Citrus production is another major fruit crop with production mainly concentrated around the Robinvale–Mildura and Cobram regions of Victoria. Production is for both the fresh fruit and juice markets and for domestic and export markets.

Grape production is also a major fruit crop industry. Grapes are sold fresh (table grapes) or used to produce wine (see below) or dried fruit as shown in Table 13.1. Table grapes make up 43 percent of all Victoria's fresh fruit exports at a value of $65 million per year (DPI 2006a). Most of these grapes are sourced from the Mildura region, as are dried fruits such as raisins and sultanas.

All fruit production is dependent on irrigation for its production and is for either the domestic food processing industry or for the domestic and export fresh fruit markets.

Vegetables

Vegetable production is second to fruit production as a major horticultural industry and its relative value across the four statistical local government areas is shown in Map 13.2. This map also illustrates the concentrations of horticulture around Shepparton, Swan Hill and Mildura regions. The major products by volume include tomatoes and asparagus (GBCMA 2003; DPI 2006b).

Other Horticulture

Several other horticultural crops are produced in the study area. Some, including olives, strawberries, kiwi fruit, avocadoes, mushrooms, potatoes and nuts such as almonds and walnuts, have the potential to expand in terms of production area and income dollars (GBCMA 2003; DPI 2006b). These crops are also dependent on irrigation and are produced for both the export and domestic markets, including the Victorian food processing market (GBCMA 2003).

Finally, cut flowers such as proteas have recently been grown commercially in some parts of the study area. These are for both domestic and export sales. When vegetables and other horticulture such as nurseries, flowers and turf are included horticulture across the area has a value of approximately $220 million per year.

Table 13.1 Yields and value of grape production around Victoria.

DPI agricultural production zone	Total area in grape production (ha)	Wine grape production (t)	Dried and table grape production (t)	Total grape production (t)	Estimated value of wine grapes
North-west	25,098	224,322	122,221	346,543	$132.0 m
North-east	3514	22,430	172	22,601	$23.3 m
Central	3,798	15,072	345	15,418	$19.2 m
Other	5874	20,615	231	20,856	$36.0 m
Total	38,284	282,439	122,970	405,409	$208.5 m

Source: DPI (2006b).

Wine

Several of Victoria's major wine producing areas are located in proximity to the study area, including areas in central and north-eastern Victoria and the Sunraysia in the northwest. Due to the diversity of conditions such as soil types, rainfall, sunlight hours, aspect and frost frequency across these regions different wines are produced using different production techniques. For example, some wineries concentrate on small-scale, labour-intensive, low-volume, high-quality products to service the boutique wine outlets. Other wine-making techniques are highly capital intensive and concentrate on high volumes for the supermarket-type wine market. Often this form of production involves sourcing grapes through annual contract arrangements with growers rather than through grapes being produced on-site by the wine producers themselves. In 2003, the northwest region of Victoria produced 66 percent of all wine grapes in Victoria (Table 13.1). The wine industry services both the export and domestic markets.

PUBLIC LAND STOCK GRAZING

The history of public land grazing within the study area is closely aligned with the development and expansion of European settlement across Victoria. Initially, the region was occupied by squatters grazing sheep and cattle on their runs, followed by consolidation into pre-emptive rights (for the squatters) and large selections. From the 1840s, at least one squatter regularly drove sheep from southern Victoria to the Moira grass plains of Barmah forest for the summer months (Curr 1883). Gradually grazing was brought under government control and licences or land holdings were issued (see chapter 7).

Over time a preference for cattle grazing became established on much of the river red gum forest and floodplain areas, although downstream of about Swan Hill sheep grazing is more common. Most cattle on public land are beef cattle but the widespread establishment of irrigated dairy farms in many areas—mostly between about 1920 and 1970—has lead to some public land grazing by dairy cattle, particularly along water frontages in the irrigation districts.

Grazing on floodplain river red gum public land has been an additional or alternative source of forage for livestock, provides access to water and management flexibility on private holdings, and reduces the need for fencing. However, with changes in emphasis and improvements in land management over time, the overall economic importance of stock grazing on public land has declined and few graziers depend substantially on public land.

Despite its declining economic importance, public land grazing remains an important cultural tradition for many people, with a history of some 150 years. This tradition is epitomised at the Barmah Muster. Each autumn cattle agisted in Barmah forest over the preceding year are mustered. Since the 1950s the Muster weekend has become a festival and celebration of cattlemen which attracts many visitors, particularly for the associated social activities that include a bush dance and story telling (yarn spinning) competition.

In the decades after the arrival of European stock, grazing probably occurred on nearly all public land in the study area, amounting to several hundred thousand hectares at that time. Currently, the area of public land in the study area authorised for grazing by domestic stock is around 117,000 ha (see Map C) although there is a number of qualifications to this figure (see below). The vast majority of grazing occurs on state forest, the River Murray Reserve and public land water frontages. Other areas grazed include some streamside and other natural features reserves, unused government roads, unreserved Crown land, Barmah State Park, and some land held by public authorities, such as Goulburn Murray Water. National parks, state parks, nature conservation reserves and reference areas are the only public land categories for which stock grazing is specifically excluded as a general rule.

Grazing of domestic stock on public land was addressed in detail in two major LCC investigations that overlap with the River Red Gum Forests study area: the Murray Valley Area (LCC 1985) and the Mallee Area Review (LCC 1989a). The LCC (1985) stated that where public land is managed for the maintenance and enhancement of ecosystems, domestic stock grazing is inappropriate and the land manager should take all steps practicable to exclude it. Recommendations described some areas with high natural values where grazing should be excluded, while the administration and conditions for continuation of grazing in Barmah State Forest and Gunbower State Forest were also outlined. The Murray Valley Final Recommendations (1985) also recommended that domestic stock grazing be phased out of Barmah State Park no later than three years after acceptance of the recommendations because of its incompatibility with the objectives of a state park. This recommendation was accepted by government but following Parliamentary debate on the *National Parks (Amendment) Bill 1987*, specific provision was made for grazing in Barmah State Park. Grazing in Barmah State Park is discussed in greater detail in Box 13.1 below.

Following the Mallee Review Final Recommendations (LCC 1989a), stock grazing was removed from parks and many reserves in the Mallee study area, but permitted to continue on other public land (including the floodplain forests) at the discretion of the land manager and subject to a management plan. However, the LCC (1989a) also recommended that no areas of state forest beyond those licensed at that time should be used for domestic stock grazing. The government accepted these recommendations.

A key step in the implementation of these recommendations has been the preparation of Forest Management Area (FMA) plans. Under the Mid-Murray FMA Plan (DNRE 2002a), grazing management strategies were to be developed by May 2003 for sites with high conservation values and priority areas such as those along parts of the Goulburn and Ovens Rivers which are Victorian Heritage Rivers (LCC 1991). These strategies are still being developed, although details of conditions and principles established by the Department of Sustainability and Environment (DSE) for grazing management are described in more detail below.

The Mildura FMA plan (DSE 2004f) has general management guidelines for grazing activities which

emphasise the maintenance or enhancement of natural ecosystems. The plan allows grazing land management plans to be prepared in consultation with the licence holder for each licensed area on the floodplain. Initially, priority was given to areas over 1000 ha with plans to be developed by August 2005. A review of grazing within special protection zones, ephemeral wetlands and carpet python special management zone are also described in the plan. The Mildura FMA plan also recognises the need for research into tactical grazing on floodplain state forests for management purposes (such as through limited agistment permits) and annual vegetation monitoring using photo points to monitor grazing pressure.

The LCC Rivers & Streams Special Investigation Final Recommendations (LCC 1991) for public land water frontages replaced all equivalent earlier LCC recommendations, envisaging an integrated system of habitat networks along water frontages. Grazing under licence by adjoining landholders was to be allowed only where it did not conflict with: conserving native flora and fauna, maintaining and restoring indigenous vegetation, protecting adjoining land from erosion and providing for flood passage, protecting scenic quality of the landscape, protecting cultural heritage features, and providing access for recreation.

Administrative Arrangements

Domestic stock grazing on public land is authorised and managed under (1) Crown land licences (most areas), (2) agistment permits (Barmah forest and, until recently, parts of Gunbower forest), and (3) commercial arrangements set up by public authorities over land for which they hold title. Terms such as 'licensed grazing' or 'grazing licences' are commonly used—including throughout this Discussion Paper—to encompass all three of these arrangements collectively. Note that there is no public land leased for grazing in the study area (and little elsewhere in Victoria for that matter). Leases are generally for longer terms and provide additional entitlements (often greater exclusivity of access for people as well as stock) than the arrangements for grazing that currently apply in the study area.

Crown land licences have three components: a schedule describing the licence area and details about the licensee; a map showing the extent of the licence area; and standard licence conditions including fees, duration (typically one year), maintenance, fire protection works and other requirements. Licences usually specify allowable stock numbers and requirements for control of stock and pest plants and animals. Crown land licences currently cover approximately 75,000 ha—with large licences over state forest and some regional parks (about 400 licences with an average size of approximately 140 ha), and small licences over public land water frontages (1200 licences, 10 ha average) and unused roads (30 licences, 3 ha average). Usually these licences do not overlap—that is, only one licensee's stock grazes in each licence area (however public access remains unaffected). Water frontage and unused road licences are nearly always held by adjoining land owners, who manage the grazing as part of their overall grazing operation. These areas are often used, for example, to hold temporarily or transfer stock, to provide water, or to maintain usage rights over the area. Many licence areas are not fenced, although in recent years some Catchment Management Authorities have overseen successful programs to fence many water frontages (see chapter 19). In circumstances like these a licensee may agree to implement conservation related-conditions (i.e. fencing and revegetation programs), and even convert to a non-productive licence under Section 138 of the *Land Act 1958* at a significantly reduced fee (e.g. $1 per year) compared to the productive agricultural licence rate.

Grazing conducted under Crown land licence is charged according to the carrying capacity of the land, expressed as 'dry sheep equivalents' (see Glossary). This applies to public land water frontages, unused government roads and unreserved Crown land. Licences over unused roads for agricultural use are generally annual but can be issued for up to 99 years. They may be cancelled if conditions are not met or the road is required for traffic purposes.

Some licences over state forest and regional park share characteristics with Crown land licences but many are much more intermittent, with licensees changing and licences frequently lapsing and resuming. Recently some licences for state forest grazing have been reviewed and offered for a ten-year period in conjunction with a customised grazing management plan developed in partnership with the licensee. Under these agreements, grazing timing and intensity may be modified or excluded from specific areas to conserve or protect important environmental or cultural values.

Grazing under agistment permits occurs in Barmah forest and, until recently at least, in parts of Gunbower forest (and there are other areas where land managers have the discretion to issue agistment permits). Currently and historically, agistment permits generally apply to a specified time period and number of head of stock and cover relatively large areas of land, often with stock from more than one grazier. Specific details of current agistment permit grazing in Barmah Forest are provided in Box 13.1.

Control of pest plants and animals is the responsibility of the licensee on areas held under licence as described in the licence conditions. In state forests, this includes the prohibition of feeding out unless specifically approved by the DSE forest manager. Agistment permits do not require pest plant and animal control to be undertaken by the permit holder.

Legislation

State forest grazing is permitted under Section 52(1)(a) of the *Forests Act 1958* and management guidelines under forest management plans (DNRE 2001, 2002a; DSE 2004f). On public land water frontages, some regional parks, unreserved Crown land, unused Government roads, and some land reserved under the *Crown Land (Reserves) Act 1978*, grazing is conducted as an agricultural activity under Sections 130 and 133 of the *Land Act 1958* and is largely restricted to the owners or managers of adjoining private land. Section 32E of the *National Parks Act 1975* provides for grazing in Barmah State Park, although no relevant licences have been issued under that Act. The grazing that occurs there administered under the *Forests Act 1958* (see Box 13.1). At least partly because of the difficulty in maintaining fencing in the flood-prone public lands

along the major rivers in the study area, it is not uncommon for grazing to be authorised under one Act to spread onto adjoining land where that authority does not permit grazing—most frequently along the numerous long boundaries between the River Murray Reserve and adjoining state forest. The River Murray Reserve (Natural Features Reserve) is managed by Parks Victoria to protect a range of natural and cultural values. Grazing is only permitted where it is compatible with such values. It is administered by the land managers in association with adjoining DSE public land: under the provisions of the *Land Act 1958* consistent with public water frontage licence arrangements in the Mildura FMA; and under the *Forests Act 1958* in the Mid-Murray FMA; and under both arrangements in the North East FMA.

Some areas of public water frontage and other public land abutting the Ovens and Goulburn Rivers, which are within a Victorian Heritage River overlay (LCC 1991) are held under grazing licences for both public land water frontages and state forest. Also, the Victorian portions of the Barmah–Millewa, Gunbower, Koondrook–Perricoota and Chowilla Floodplain (Lindsay–Wallpolla) Living Murray significant assets (see chapter 15) are also partially or wholly held under public land grazing tenures.

Controlled sheep grazing for ecological outcomes is utilised at Terrick Terrick National Park and other land containing northern plains grasslands purchased for nature conservation reserves on the Patho Plains area. Intermittent, adaptive and seasonal grazing at low stocking rates has maintained conservation and habitat values present prior to the acquisition of this land (Diez & Foreman 1996; Tscharke 2001). This grazing pattern largely reflects past grazing practices in these areas. Grazing is in accordance with guidelines that are reviewed every three years and subject to future research outcomes (Parks Victoria 2004b). A particular emphasis is on maintaining habitat structure for the plains-wanderer—a threatened bird species. Future research will inform and guide the use of grazing, ecological burning or other management tools to enhance the

Box 13.1 Barmah Forest Grazing

Cattle are grazed in Barmah forest except in reference areas (300 ha) —29,660 ha comprising Barmah State Forest (21,600 ha) and Barmah State Park (8360 ha) under agistment permits issued under the *Forests Act 1958*. Grazing within most of Barmah State Park may be licensed under Section 32E of the *National Parks Act 1975* with annual licences issued for terms commencing 1 May. However, even though grazing is allowed to occur in the park, because no licences have been issued for the park under the *National Parks Act 1975*, current grazing is technically unauthorised there.

Cattle agistment is restricted to members of either the Barmah Forest Cattlemen's Association (grazing the west end) or the Yielima Forest Grazier's Association (the Yielima or east end). Currently there are 31 and 7 owners respectively in each organisation.

A Barmah Forest Grazing Advisory Committee, which predated the park, currently comprises three representatives from DSE, one from Parks Victoria, and four representatives from the cattlemen's associations (three from Barmah and one from Yielima associations). Following inspection of the forest, the committee makes a recommendation to DSE North East Regional Director and Parks Victoria Central Regional Manager on stocking numbers for each of the summer (1 November to 30 April) and winter (1 May to 31 October) terms. Once the stock numbers are decided by both DSE and Parks Victoria, the Cattlemen's associations allocate quotas to individual members for each section of the forest.

In the past stock numbers have been varied according to seasonal conditions in the forest and the occurrence of 'rain-rejection' floods (see chapter 15 Water Resource Use and Environmental Flows) which, even in dry conditions, occur as a result of the need to transmit large volumes of water downstream at short notice. An average indication of stocking rates is about 2000 head of cattle in the summer term and about 800 head in the winter term, although there has been an overall reduction in number with the persistent dry conditions recent years.

The current fees (set by the Valuer General in 2003) for grazing under existing agistment arrangements in Barmah forest are $14.08 per steer for the summer term and $10.12 for the winter term (including GST). While this value may be less than that commercially charged elsewhere—depending upon seasonal conditions and location—there are significant costs in terms of time and logistics expended in association with agistment, especially transportation and mustering and maintaining facilities. Land managers also have significant grazing related management costs that typically exceed the revenue generated though agistment fees.

Note: *The National Parks Act 1975* specifies that grazing in Barmah State Park involve a Barmah Forest Grazing Advisory Committee appointed by the Minister for Environment, advising the Minister on various matters relating to grazing in the park. Under the Act, the committee has eight members of whom:

(a) One is appointed convenor;

(b) Three are nominated by the Barmah Forest Cattlemen's Association;

(c) One is nominated by the Yielima Forest Grazier's Association;

(d) Three are officers of the [former] Department of Natural Resources and Environment

Although it has not been formally appointed for the park, the existing Barmah Forest Grazing Advisory Committee operates in the spirit of Section 32 of the *National Parks Act 1975*.

grassland values on these sites. Unlike grazing on other public land, grazing in the Terrick Terrick National Park and Patho Plains nature conservation reserves is strictly for ecological purposes. It is administered through short-term contracts rather than under licence.

Overall Extent of Grazing

In total, there are some 1790 licences held by around 1425 licensees (many of whom hold more than one licence), and covering approximately 117,000 ha (see Map C), however this overall impression of public land grazing must be qualified by the following variables:

- Changes in stocking rates. While many licence details include a stocking rate, that does not mean that stock are maintained at that level at all times—indeed there will be times (in some cases more or less permanently) when there are no stock on all or part of many licence areas, even though the licences remain current. In addition, there are permanent 'exceptions' such as the two reference areas in Barmah forest which, although shown in Map C as not subject to grazing licences, are poorly fenced from the surrounding forest. Barmah Lake, by contrast, is shown in Map C as licensed for grazing but is only grazed on its margin because it is permanently inundated.
- Types of licences. DSE issues licences for many activities on public land other than grazing, and it is not always clear whether grazing is permitted or not—when the licence is for 'non-primary producers', for instance. VEAC has categorised these licences as accurately as possible in consultation with DSE.
- Turnover and intermission. While the majority of grazing licences have been continually renewed for long periods, occasionally licences are not renewed, are modified to exclude grazing (see below), or new licences are granted. More significantly, some licences are issued for relatively short periods and renewed or not at the discretion of land managers in response to seasonal conditions or for particular management purposes such as to reduce adverse impacts or pest plant control. The most notable example of intermittent grazing is Gunbower State Forest, much of which was grazed until about five years ago, when permits were not renewed—largely to reduce the impact of prolonged below-average rainfall and flooding. Grazing could, however, be reinstated in the future.

DSE Grazing Licence Review Program

DSE advises that a review of grazing practices and licences is currently being undertaken in some of the designated priority areas described in the Mid-Murray FMA Plan (DNRE 2002a), not including Barmah forest, triggered by applications for renewal or transfer of individual grazing licences. The review process is guided by a set of 'Ecological Grazing Principles'. The Principles are:

- That grazing management in the river red gum forest estate will be based on sound scientific data and rationale to optimise biodiversity benefits and environmental outcomes.
- To utilise grazing as an ecological management tool to achieve biodiversity benefits and to restrict adverse changes in the floodplain forest environment.
- The grazing of stock should assist in the consolidation and recruitment of native plant species by helping to maintain or shift the vegetation composition to the EVC benchmark.
- Grazing livestock selection should be based on the stock type that will facilitate the intended ecological outcomes.
- Stocking rate adjustments for grazing livestock need to be based on Ecosystem condition.
- Appropriately timed rest and graze periods can be used to protect and enhance ecological attributes.
- Vulnerable ecological and cultural attributes can be protected by the appropriate management or exclusion of grazing herbivores.
- Supplementary feeding and watering of stock has the potential to increase the risk of negative environmental outcomes.
- That all grazing herbivores impact on ecosystem condition regardless of whether they are introduced or native.
- Total grazing pressure can reduce or eliminate the seed store of shrub and understorey plant communities necessitating action to restore or rehabilitate these areas.

Exclusion of grazing through fencing has occurred in other non-priority areas reviewed during routine licence renewal or transfer. Stock grazing has been removed from three sites following a review utilising these principles and an ecologically-based grazing management regime has been trialled at a fourth site on the Lower Goulburn in consultation with the licensee.

Management of Grazing on Public Land

It is important to note that throughout much of the study area there is no physical barrier between public land of different tenure e.g. Barmah State Park and Barmah State Forest, other state forests and the River Murray Reserve. In many cases it is impractical and costly to fence on a floodplain, particularly given the length of the River Murray Reserve frontage. Frequent flooding and the associated large debris damage fences. Where fencing has been erected on floodplains, such as those fences within Barmah forest, maintenance costs are met by the land manager and not the licensee or agistor. However, unrestricted stock access to the water's edge has significant effects on water quality in particular (DNRE 2002h). Catchment Management Authorities and land managers are undertaking projects to revegetate and fence along stream frontages and install off-stream watering points for stock (DNRE 2002h; MCMA 2003b; NCCMA 2003; GBCMA 2004; NECMA 2004). The fenced areas provide limited or seasonal grazing along the river's edge in the riparian zone.

A major impediment to fencing riparian land is the additional cost of fencing and installing alternative stock watering points. Investigations undertaken by CMAs into catchment health and riparian grazing practices indicates that fenced stream frontages were in significantly better environmental health than those unfenced, reflecting a reduced level of grazing pressure and reduced rates of land and water degradation (e.g. Robinson & Mann 1998).

In addition, overseas studies have shown that cattle growth rates or weight gain was up to 20 percent greater for animals drinking from a piped water source compared to those allowed unrestricted access to a water hole or stream bed (Kondinin Group 1996; Water and Rivers Commission 2000; Landerfeld & Bettinger 2002). These results reflect the lower volume of water consumed by stock when it is polluted or muddied, which in turns relates to a reduced level of production. Initial fencing and stock water point installation costs are likely to be recovered through increased production, in addition to the ongoing environmental benefits and preservation of infrastructure damaged by stream bank erosion.

Unlike some other economic activities undertaken on public land (e.g. timber harvesting), the revenue generated from public land grazing is returned to the state through consolidated revenue.

Livestock grazing is sometimes promoted as a management tool with the ability to reduce the ground vegetation component of wildfire fine fuel and provide a measure of fire protection. Grazing has not been identified or used as a primary broad-scale fuel management tool under the Mildura or Bendigo fire protection plans but may be used as a short-term method for fuel reduction where the effect on conservation values is minimal (DCNR 1992; DSE 2003f). Additionally, because livestock have preferences for specific vegetation types including native grasses, relatively intense grazing would need to occur for this to be an effective fire control measure. Unpalatable species and woody material remain, both of which can contribute to the intensity of wildfires (DSE 2004f). Grazing intensities required to significantly reduce fuel would be likely to result in adverse biodiversity impacts.

Grazing may compromise natural values and can result in habitat loss or modification, introduction and spread of exotic plants and inhibition of native vegetation establishment and growth (particularly river red gums and other seedlings—see chapter 5). Damage to wetlands has also been demonstrated to affect habitat values for animals such as frogs and birds (Jansen & Healey 2003; Jansen & Robertson 2005). Livestock grazing may also adversely affect on flora, fauna, soil structure and water quality (Robertson & Rowling 2000; Spooner et al. 2002; Jansen & Healey 2003; Dorrough et al. 2004; Jansen & Robertson 2005). Grazing may reduce capacity for riparian zone vegetation to act as a nutrient 'filter' by compacting the soil, increasing erosion and sediment input into waterways. These effects are strongest where grazing is continuous (DSE 2004f). The study area as a whole is an environmentally sensitive location encompassing riparian zones, wetlands and floodplain forests. Most public land grazing in the study area is close to waterways and wetlands. These waterways play a vital role not only in biological systems but also in sustaining agriculture and potable water for rural communities.

Fencing (particularly on floodplains) presents logistical difficulties for land managers as does governance and administration, and the ability of land managers to control overgrazing, stocking rates and potential breaches of licence conditions, while maintaining public access. To date there has been little consistency in management of grazing on public land across Victoria, either administratively or environmentally. The diversity of grazing practices and ecological values across such a broad area has made consistency difficult. In many places Crown land, in particular water frontages and unused roads, has been used as part of the adjoining private enterprise with limited assessment of its impact on natural or ecological values.

A consistent approach to grazing across all public land would provide a clear framework for deciding where it is appropriate for grazing on public land, the economic value of grazing a public resource and equitable fee rates comparable across all available land use categories. These matters are discussed further in chapter 19.

APICULTURE

Apiculture based on the introduced European honeybee (*Apis mellifera*) dates from the early days of European settlement in Victoria. When flowering prolifically, the indigenous eucalypt species found in the River Red Gum Forests study area are keenly sought by beekeepers, and orchards and pastures on nearby private land also have a significant role in the apiculture industry (and vice versa). Flowering of river red gum and black box trees is largely dependent on suitable flooding so, although these species produce high quality honey, significant production is relatively sporadic. Yellow and grey box trees also produce premium honey, although they are not as abundant in the study area.

As well as honey, beekeepers sell pollen, beeswax and queen bees, and are paid by farmers to enhance pollination—and hence productivity—of some pastures and orchards, especially almonds. For both these purposes, beekeepers leave appropriate numbers of hives at locations on private land for bees to access orchards, pastures, or native forests (including those on adjacent public land), as well as on designated public land bee sites for bees to access native forests. There is evidence that bees forage as far as 20 km from their hives (Schwarz & Hurst 1997), although beekeepers report that most bees range no further than a kilometre or two. There are two types of public land bee sites:

- permanent sites, which are licensed for 12 months and have a radius of 1.6 km (i.e. there must be at least 3.2 km between adjacent permanent sites); and
- temporary sites, which are licensed for 6 months and have a radius of 0.8 km.

As part of the implementation of the ECC (2001) Box-Ironbark recommendations and in response to the expansion of the Murray Valley almond industry, an 'Apiculture on Public Land Liaison Group' has been established by DSE. This group provides a forum for representatives of the apiculture industry, DSE, Parks Victoria and DPI to discuss relevant issues and developments as they emerge.

Beekeeping is generally permitted in most public land categories. Reference areas and wilderness areas and zones are the only categories in which bee sites are not permitted at all, although they are also excluded from other public land within two kilometres of these areas.

There are currently six reference areas and no wilderness areas or zones in the River Red Gum Forests study area (Map A). Some people have suggested that—as a commercial venture based on an invasive species with potential to adversely affect natural values (see below)—beekeeping is not an appropriate activity to allow in national parks. In practice, there are very few Victorian national parks suitable for apiculture from which beekeeping is excluded. Map C shows that bee sites are widely distributed on public land in the study area. There are 237 public land bee sites in the River Red Gum Forests study area (Map C), constituting just over 10 percent of the total number of bee sites on public land in Victoria.

Beekeepers are highly mobile, often moving large numbers of hives considerable distances—including interstate—to capitalise on favourable flowering events and to avoid frosts. In addition to full-time commercial apiarists, there are many part-time and non-commercial beekeepers who are not accounted for in official statistics. Although they own relatively few hives per beekeeper, they account for a large number in total. As a result regional data on beekeeping must be interpreted with caution.

Apiculture is worth approximately $10 million per year to the Victorian economy (Centre for International Economics 2005). On the basis that 10 percent of Victorian public land sites are in the study area, it is estimated that apiculture in the study area is worth around $1 million. The ECC (2001) estimated that the 600 or so bee sites on Box-Ironbark public land generated 79 full-time equivalent jobs. The 237 River Red Gum Forests bee sites, then, would be expected to account for around 30 full-time equivalent jobs, although many of these would be based outside the study area.

Apart from seasonal vagaries, apiculture is a reasonably stable industry in Victoria—product demand remains high, and the distribution of bee sites in most favourable native forest areas is at or close to capacity. The expansion of some agricultural enterprises requiring pollination by bees—most notably almond orchards in northwest Victoria—has increased demand for this service. Another issue for apiarists is the relatively recent arrival in Australia of the South African small hive beetle (*Aethina tumida)* which can severely diminish production. The pest does poorly in drier areas and, to date at least, has occurred only occurred sporadically in northern Victoria peripheral to its main distribution in coastal areas to the northeast.

As its name suggests, the European honeybee is an exotic species in Australia. Of the hundreds of exotic species that have established feral populations around the world, very few have (when studied) been found to not have an impact on natural values. It would be surprising, then, if European honeybees did not have an impact on natural pollination systems in Australia. However, studies of the effects of honeybees on natural pollination systems have had difficulty obtaining unambiguous results, largely because of the technical difficulties in excluding or introducing honeybees in a way that does not disrupt other significant plant-pollinator interactions. Feral honeybees also occupy tree hollows, potentially to the detriment of some of the large number of hollow-dependent fauna for which river red gum forests are noted. While carefully managed hives may be unlikely to be a source of feral bees, this is less likely to be the case for hives managed by part-time or non-professional apiarists. The presence of managed hives also constrains options for feral bee control. Honeybees can also have localised impacts on recreational values. The potential impacts of honeybees on natural values are discussed in more detail in chapter 5.

14 State Forest Management and Wood Production

The river red gum forests have been a major source of durable timbers in southeastern Australia since the earliest days of European settlement. While production has decreased over time, Victorian public land forests remain a major source of timber. The extent and nature of the forests varies across the study area, as does their management and the level of information about them. This chapter reviews the history, management and sustainability of timber production from forests in the study area.

While most of the original ecosystems of the broad alluvial plains of northern Victoria have been cleared or extensively altered since European settlement, most of the original river red gum forests (principally Ecological Vegetation Classes (EVCs) such as Riverine Grassy Woodland, Riverine Sedgy Forest and Riverine Swamp Forest—see chapter 5) remain across the floodplains. Regularly flooded land was generally considered unsuitable for conventional agriculture. The Barmah–Millewa Forest, covering about 60,000 ha, comprises the most extensive and consolidated occurrence of river red gum forest in Australia. Gunbower Forest and the contiguous Perricoota and Koondrook Forests in New South Wales comprise the next largest. Further downstream, river red gum forests occupy regularly flooded bends in the River Murray or are restricted to narrow bands along the river itself. Along the lower reaches of the Murray in Victoria, river red gum occurs as a band of about one-tree depth above the regular water line of the river, with black box of similar depth above that and chenopod shrubland as the surrounding vegetation type (Figure 14.1).

Figure 14.1 The lower reaches of the River Murray in Victoria where the band of river red gums is about one-tree depth above the regular water line. Saltbush shrubland occurs in the foreground, black box in the middle-ground and river red gum on the near bank of the river.

The primary commercial use for these forests is timber production, the history, management and sustainability of which is explored in this chapter. River red gum is now the only species available for commercial harvesting from public land in the River Red Gum Forests study area.

RIVER RED GUM TIMBER CHARACTERISTICS AND HISTORY

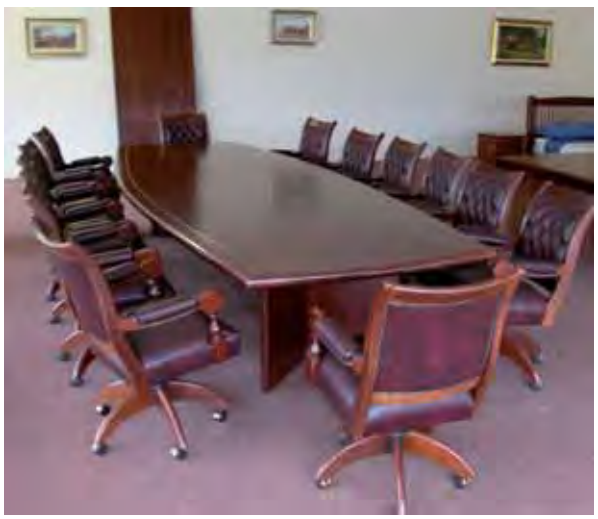
River Red Gum Timber Characteristics and Productivity

The ecology of river red gums has been described in chapter 5. In relation to timber production, river red gums have a number of salient characteristics. Seasoned river red gum is relatively hard (9.7 kN on the Janka test) and moderately dense (900 kg/m^3). River red gum has been structurally graded to F22-F27 indicating its high structural capacity (Australian Hardwood Network 2006). The wood is highly durable (Durability Class 2), particularly in the ground. It is resistant to white ants and borers and, when mature, fairly resistant to ship-worm (Ewart 1925; Forest Commission of Victoria 1928) however the sapwood is vulnerable to lyctid borers.

The interlocking grain and hardness of river red gum can make it difficult to cut and dress. Warping can occur during drying due to the timbers' moderate to high shrinkage rate (approximately 4 percent radially and 8.9 percent tangentially). Drying and seasoning of the timber is therefore a slow process and weighting the stacks may be necessary to prevent warping. River red gum has a low strength rating with an unseasoned strength rating of S5 and a seasoned rating of SD5 and a medium to light toughness rating (Australian Hardwood Network 2006).

River red gum has many uses including farm fences, posts and poles and for heavy construction (such as railway sleepers, beams, bridges, stumps, frames, sills, panels, flooring and lining). It is also used for particle board, plywood and veneer as well as firewood. Increasingly river red gums' rich vibrant colour and decorative grain when polished is appreciated for furniture and fine woodwork (Figure 14.2).

Figure 14.2 River red gum boardroom table in a furniture showroom.



River red gums can be tall (over 50 m), straight-boled trees when growing in relatively dense stands, but tend to branch with short bole lengths in open stands. Strong competition for soil moisture causes larger trees to develop a large 'zone of influence' within which they exclude smaller trees (Figure 14.3). Although seedlings do grow in the zone of influence, they are fewer in number and are less vigorous the closer they are to the mature tree. Such zones of influence seem to be larger on woodland and low quality forest sites than in higher quality forest sites. Larger trees with healthy vigorous crowns are the most competitive on any given site (Opie 1969; Florence 1996). This influence zone extends between 1.7 and 3 times the radius of the tree's crown, depending on the vigour of the tree and the availability of site resources (Bassett & White 2001).

Figure 14.3 Zone of influence where a larger tree reduces the number and vigour of smaller trees near it.

The quality of a river red gum forest for timber production depends on the frequency and timing of flooding. Although some stands may be accessing groundwater, the most productive stands are usually associated with floodways and depressions that are regularly flooded and reliably drained. Before river regulation, some 75 percent of the more productive areas received regular flooding for a few months in 7–8 years in 10 (MDBC 1992). River red gum regeneration on the floodplains of the study area is largely determined by flooding regimes. Recent low-level floods in some low-lying areas of Barmah Forest have fostered the survival of river red gum seedlings that normally would have suffered drought stress.

The productivity of river red gum forests has declined substantially, due partly to fewer and shorter winter–spring floods. This reduction results from the construction of the Hume Weir in the mid-1930s, the subsequent Eildon Weir across the Goulburn River and the Dartmouth Dam on the upper River Murray, as well as associated diversions for irrigation purposes (see chapter 15). These events may have increased the interval between successful forest regeneration events and reduced the growth rates of trees. Jacob (1955) noted that the average diameter increment of the better class trees prior to river regulation was said to be 0.76 cm per annum but, by 1983, growth rates of 0.25 cm per annum were recorded across a wide range of tree diameters (DNRE 2002a; Dexter & Poynter 2005).

Changed flood regimes may also be responsible for mortality in mature river red gums. Many floodplain forests, particularly downstream of Cohuna, are showing symptoms of stress, probably because of altered water regimes (see chapter 5). Pale-fruit ballart, a native root parasite, contributes to red gum deaths in stressed trees in the Gunbower and Nyah State Forests, where it may contribute to tree mortality (MDBC 2003). Water trapped behind weirs for irrigation and navigation and the low-level summer floods in the Barmah forest, have extended some swamplands and killed thousands of trees. Saline drainage water from farmland may also stress trees. Along the lower reaches of the River Murray, particularly downstream of Hattah–Kulkyne National Park but also as far upstream as Gunbower forest, several areas are exhibiting signs of stress that may be associated with salination.

A study into the causes and effects of the dieback of river red gums in northern Victoria and South Australia, under the auspices of the Murray-Darling Basin Commission in 2003, made the following statements on the causes of the observed health decline in river red gums:

- The observed symptoms are consistent with varying degrees of prolonged water stress, indicating a tree response to the significant change in flooding regime (i.e. flood frequency, duration and magnitude);
- Flooding has been insufficient to provide the additional water supply that is necessary for survival. Medium-sized flows in the lower River Murray have been reduced from an average frequency of once every three years, to an average frequency of once every eight years;
- The flooding regime was not sufficient to provide the leaching of salt from floodplain soils that counteracts the salt accumulation that occurs in the period between floods.

As well as reduced growth of river red gums, the effects of altered water regimes include changes to the understorey, replacing river red gum with box species at the margins, promoting crown die-back, limited regeneration and increased insect damage (Di Stefano 2002). Non-flooded areas are more susceptible to damage by the larvae of gum leaf skeletoniser moths because flooding and consequent high humidity facilitates the spread of an entomogenous fungus which, in turn, reduces predatory insects that would otherwise keep populations of gum leaf skeletoniser moths in check (see chapter 5).

River red gum is not particularly fire resistant. Although not killed by light fire, severe fire can kill pile-sized trees and cause dry sides on larger ones. Light fires mark trees, reducing the quality of the timber for saw milling.

When cut off at the base, river red gum trees coppice from the stump (Figure 14.4). Jacobs (1955) observed occasional river red gum trees of mill log size that he presumed were coppice shoots from the stumps of trees cut in the early days of the river trade. Coppice regrowth appears to be more prevalent within higher elevation stands where flooding is uncommon.

Figure 14.4 River red gum coppice.

History of Timber Production from the Study Area

Aboriginal people used the forests and woodlands of the region for shelter, implements and food, while early European settlers sought local building materials and fuelwood. As the intensity of settlement and the development of infrastructure increased, so too did demand for timber. Wood production and forestry has been a key industry in the history of river red gum forests (see chapter 7).

In the late 1800s and early 1900s, large quantities of round river red gum piles were used to underpin road and rail bridges around the state and the harbour wharves and piers of Melbourne and Geelong. River red gum was used for house stumps, road paving blocks, mining and fencing timbers and culverts, and to build the river steamers and barges that plied the River Murray. River red gum poles carried telegraph lines from the early 1900s and power transmission lines from about 1920. While used mostly for southeastern Australia's burgeoning infrastructure, significant volumes of the heavy timbers and railway sleepers were also exported, particularly to India (McGowan 1992).

During the 19th century much of the timber cut from the forests was hauled to the river's edge by bullock or horse teams (and, from the 1920s, by motor lorry) and then lashed to special barges and towed by paddle steamers to sawmills (Figure 14.5). Before locks and weirs were constructed, river transport was restricted to between July and December when the river was navigable. In places, canals called 'pontoon cuts', were constructed between shallow creeks so that logs could be floated out to the river bank on pontoons. Evidence of one of these canals (Figure 14.6) still survives today—for example, the canal known as the 'steamer track' through Barmah Lakes to Cutting Creek. Extension of the rail system caused considerable decline in river transport by the 1900s.

Figure 14.5 Loading wood on the River Murray.

Source: Reproduced with permission of the State Library Victoria (H25256).

The first sawmill based on river red gum timbers was established at Moama in 1856. Arbuthnot Sawmills was established at Koondrook in 1890 and is still operating. Of the 14 sawmills operating in the Barmah–Gunbower region at that time, 12 were located in Victoria, mostly on the riverbank to take advantage of wharf facilities (Dexter & Poynter 2005). Other mills were located at Swan Hill and Mildura. Echuca, with its port facilities and rail link to Melbourne, became the main centre for timber production in the central Murray region.

As well as being produced at the sawmills, railway sleepers were hewn with broadaxes 'at the stump' (in the forest). Records show that from only 1372 sleepers produced in 1898, output peaked at 190,000 pieces in the early 1930s (Dexter & Poynter 2005). Although hewing was economically wasteful, the Railways

Figure 14.6 Cutaway on the Goulburn River near Yambuna.

Department preferred hewn to sawn sleepers (Forest Commission of Victoria 1928), probably because hewers sought out straight-grained logs which were easier to hew, and consequently more predictable in use.

Other species associated with the river red gum forests—the riverine box species and cypress-pine—were also utilised, mainly for small poles, sleepers and fencing materials. Black box woodlands in the west supplied the developing irrigated horticultural areas with several hundred thousand pieces of fencing and vine-trellis timbers each year. For instance, extensive areas of black box woodland were felled on the upper river terraces in the vicinity of Cullulleraine, to feed the boiler of the Millewa irrigation system and little remains of these woodlands. Black box was also useful for carriage building, furniture and house building (Ewart 1925). Because it doesn't split, grey box was used for bridge and wharf decking, tool handles, carriage shafts and mauls (Ewart 1925). Cypress-pine timber is resistant to insects and easily worked and polished. It was used for flooring, wall linings, weatherboards and other joinery in buildings. A firewood mill operated at Picola between 1946 and 1950 and sent firewood to Melbourne by rail (Dexter & Poynter 2005).

The ready access from the river meant that the forests were heavily exploited with selective and uncontrolled cutting. Cutting continued even when the forests were flooded, with fellers standing on specially designed punts anchored either side of the tree (a practice leaving large stumps sometimes up to three metres high). Although official figures were not regularly published before 1890, the average annual consumption of Victorian river red gum in the late 1870s was said to total 48,000 cubic metres, of which 30,000 cubic metres was sawn timber.

Production increased during the Second World War when wood was also cut for charcoal to be used for gas production on vehicles and gas masks. In 1941, some 50–60 charcoal retorts were operating in the Barmah forest (Dexter & Poynter 2005). The post-war years saw a sharp increase in demand for posts and vine-trellis timbers for irrigation areas and building timbers for soldier settlements.

During the 1890–1900 depression, gangs of men were employed after harvesting to thin the 1870–1880 regrowth and ringbark competing larger trees that were unsuitable for sawlogs or sleepers. The aim of this work was to improve growth of sawlog-quality trees (Jacobs 1955). By 1928, more than 16,800 ha of river red gum forest had been thinned or ringbarked (Forest Commission of Victoria 1928). Similar silvicultural treatments were continued throughout the 1930–1940 depression (Figure 14.7) (Jacobs 1957; Lutze et al. 1999). The forest structure today is partly a result of that work but is also due to ongoing utilisation and silvicultural works, grazing by stock and rabbits, changed flood regimes, and fire.

Figure 14.7 Evidence of ringbarking of trees in the 1930–1940 depression is still evident today.

Forest Reservation and the 1897 Royal Commission

The first Parliament of Victoria met in November 1856. The *Land Act 1862* was Victoria's first legislation to create reserves for 'the growth and preservation of timber' to prevent their alienation (conversion to private ownership) and to provide for future timber supplies. The Act was strengthened in 1865 and, within a few years, more than 400,000 ha of land in the state had been set aside as permanent forest or timber reserves (by 1926 this had risen to more than 1,752,500 ha). Permanent dedication of 72,700 ha of river red gum forest was achieved in 1924.

While the Land Act reserved many of the more densely forested areas along the River Murray in Victoria, it offered little protection from exploitation other than from clearing for agriculture. A series of reports from the 1870s detailed ineffective management and waste of forest resources (McGowan 1992). Forests Bills were drafted regularly but were 'usually consigned to oblivion' (Forest Commission of Victoria 1928). A short Forests Act was put into operation in 1876. Bills were presented to Parliament in 1879, 1881 and 1892, but none was enacted, although a royalty system was adopted in 1892. The inaction eventuated in a Royal Commission on Forests, which sat from 1897 to 1901 and produced 14 reports. The Royal Commission drew attention to the anomaly of having the forests controlled and worked under laws primarily designed for the alienation and settlement of Crown lands. It reported that massive timber cutting was occurring under a 'vicious system of indiscriminate licensing' at ridiculously low prices (LCC 1987).

The Royal Commission reported that, if cutting of the river red gum forests was allowed to continue at the then existing rate, the remaining forests would be exhausted within five years. It also saw a need for thinning of large areas of heavily stocked (1870–1880s) regrowth. One outcome of the Commission was to break the monopoly of the portable steam-powered sawmills producing sawn sleepers and to permit sleeper-hewers into the forest to cut 'old and hollow' logs rejected by the sawmillers (Dexter & Poynter 2005).

Forest Administration

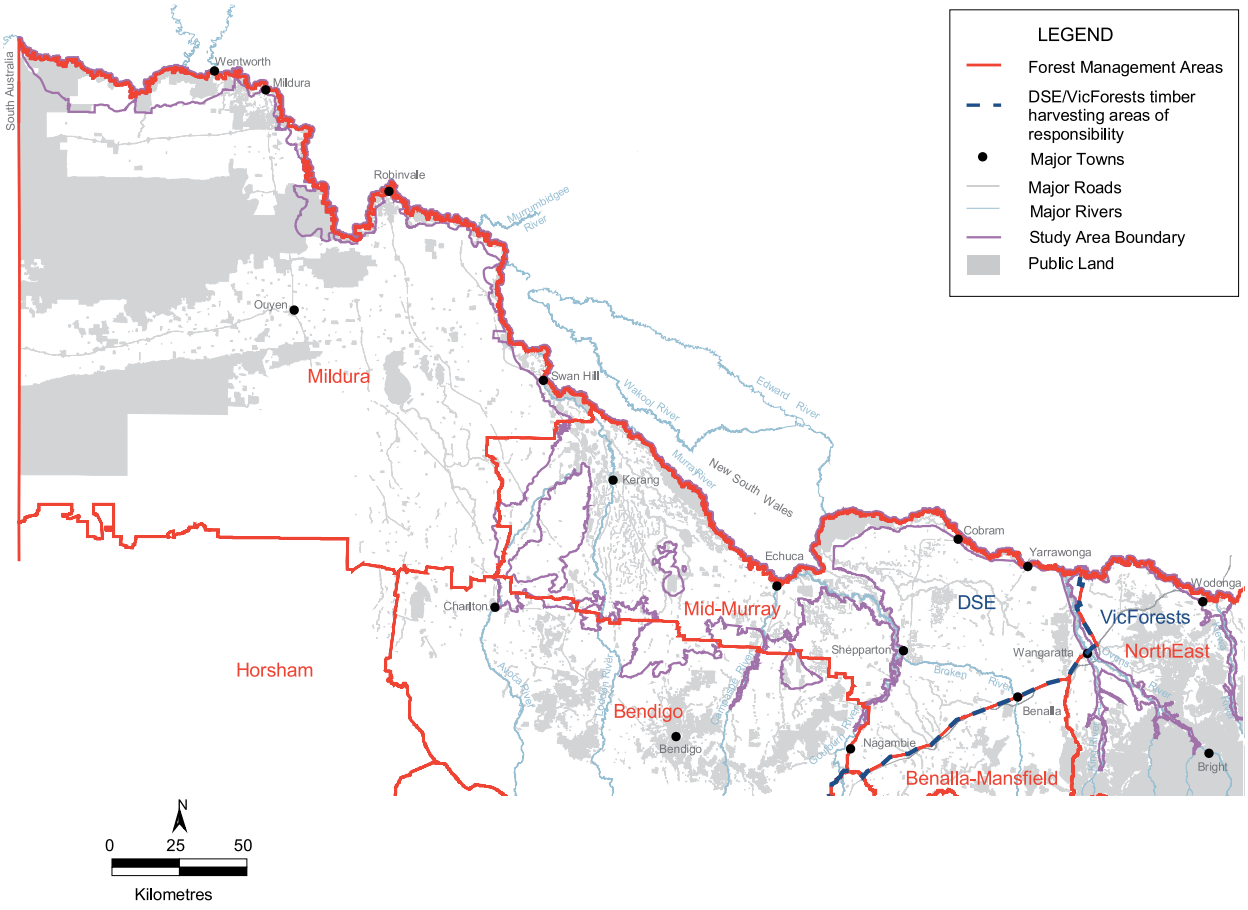
Between 1876 and 1908, administration of Victoria's forests shuttled eight times between three different state departments (Forest Commission of Victoria 1928). A Conservator of Forests had been appointed in 1888, but the position was administratively ineffective. The 1897–1901 Royal Commission led to the *Forests Act 1907*, which established a Forests Department under a Minister of Forests in 1908. It was not until 1919, with the establishment of a separate Forests Commission, that management stability was achieved (Gillespie & Wright 1993).

In 1984, the Forests Commission became part of the new Department of Conservation, Forests and Lands. Forest management was subsequently undertaken through divisions or services within the new department and its successors, now the Department of Sustainability and Environment (DSE).

In 2002, wide-ranging reforms were introduced to the management of Victoria's native forests through the government's policy statement *Our Forests Our Future* (Government of Victoria 2002). These reforms were directed towards a sustainable timber industry and the separation of land stewardship responsibilities from those of the commercial licensing and harvesting of logs.

As a consequence of this policy, and the *Sustainable*

Map 14.1 Forest Management Areas (FMAs) and areas of responsibility (DSE and VicForests) overlapping with the study area.



BOX 14.1 STATEWIDE FOREST RESOURCE INVENTORY

A Statewide Forest Resource Inventory (SFRI) was initiated in 1994–95 with the aim of mapping approximately 3.5 million ha of state forest in Victoria and sampling the timber productive areas to determine the volume of sawlogs they carry. The program was also structured to provide the necessary base data to enable development of new growth models for a number of forest types, thereby enhancing the capacity to forecast timber yields. Specifically, SFRI was designed to:

- update the state's timber resource data, replacing 1960-70s data with information independent of forest product standards;
- be the state's first complete forest resource inventory based on a single inventory design and standard;
- provide a consistent classification of all vegetation on public land across the state;
- enable new growth and yield models to be developed for many of the state's native forests;
- enable resource estimates to be made to a uniform standard of utilisation;
- have the capacity to adjust to new utilisation standards; and
- provide a basis for resource estimates, sustainable yield forecasts and management planning well into the 21st century.

Other products of the SFRI included:

- environmental data (slope, aspect, tree hollows) collected at each sample plot and digital elevation model information, that would be applicable for biodiversity and habitat modelling;
- information about disturbance of the forest stands by factors such as timber harvesting, fire and disease; and
- crown cover and crown form information, which could assist old-growth analyses for the purposes of Regional Forest Agreements.

Forests (Timber) Act 2004, responsibility for commercial timber harvesting in eastern Victorian state forests devolved to VicForests, a state-owned enterprise regulated under the *State Owned Enterprises Act1992*. VicForests' area of responsibility overlaps with those parts of the River Red Gum Forests study area in DSE's North East Forest Management Area (Map 14.1) but the 15-year allocation order issued in 2004 does not provide access to any river red gum forest stands. The *Sustainable Forests (Timber) (Amendment) Act 2006*, provides for DSE (i.e. not VicForests) to continue to manage commercial harvesting in western Victoria (i.e the rest of the River Red Gum Forests study area).

DSE remains the custodian of all Crown land, and is responsible for ensuring that all uses of the state's forests are sustainable. This includes managing the entire range of forest uses and values, including conservation of natural and cultural values, recreation and protecting forest ecosystems from wildfire, disease, pests and weeds, as well as managing forests for timber production. DSE also retains management and the licensing of a range of commercial activities other than timber harvesting, such as apiculture, as well as the sale of other wood products, including domestic firewood, throughout Victoria's state forests.

Map 14.2 shows the history of timber harvesting in the River Red Gum Forests study area, to the extent that it has been mapped to date.

Forest Inventory

The first assessment of the timber resources of Barmah forest was undertaken in 1929–30 and was directed at the preparation of a 'working plan' for the river red gum forests. That assessment identified relatively low volumes of trees of sawlog quality compared to the total merchantable volume, which included the volume in smaller trees—'growing stock' (Dexter & Poynter 2005).

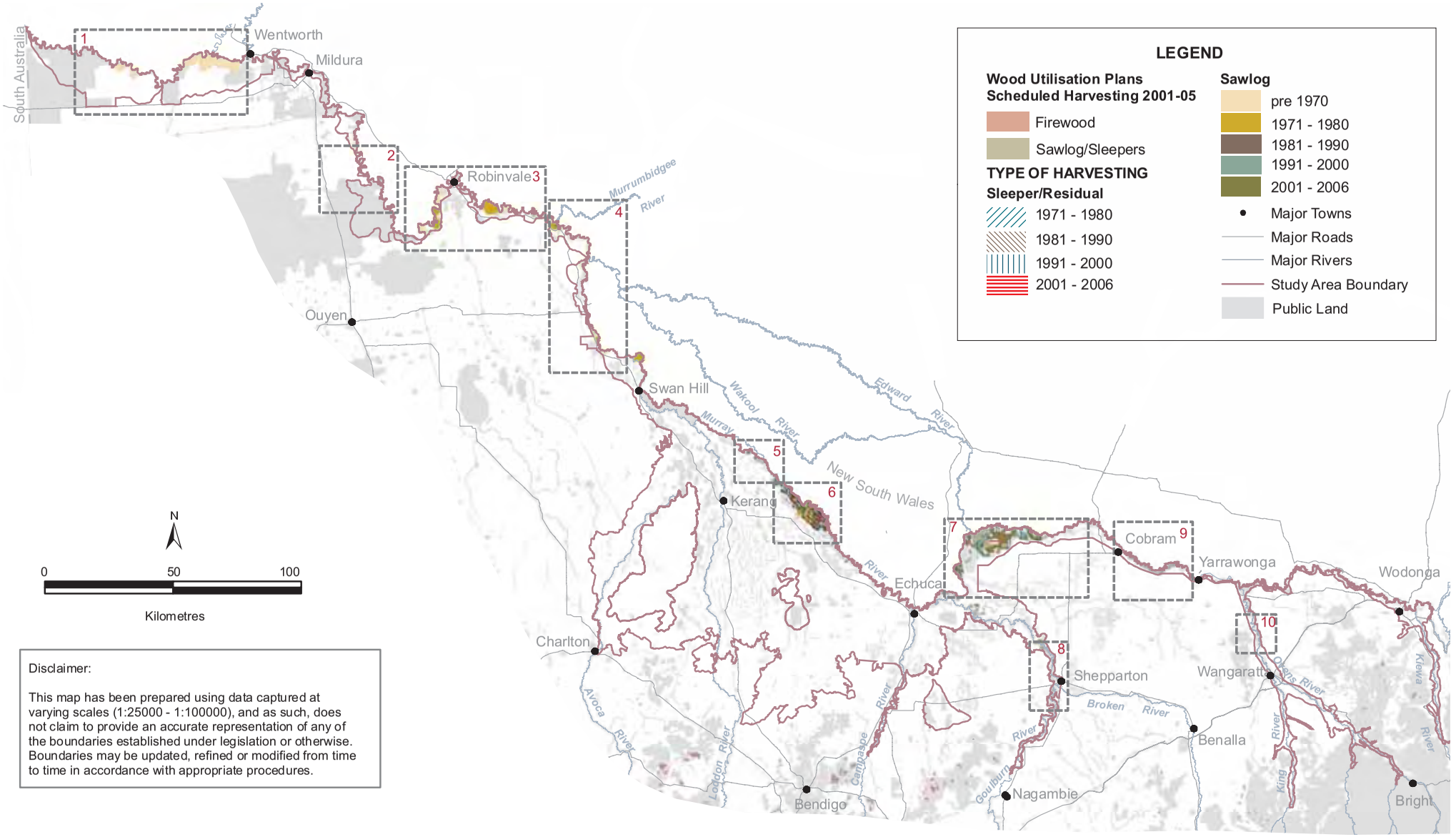
Mapping, classification and intensive assessment of stands in the Barmah forest in 1960–61 found a considerable increase in growing stock and total sawlog volume since the 1930s, notwithstanding that significant volumes had been harvested in the intervening period. Individual forest stands were allocated to one of three site quality classes (SQ) based on the height of the dominant mature trees (SQ I, > 30 m, highest quality; SQ II, 21–30 m, medium quality; SQ III, < 21 m, lowest quality). Site quality is a surrogate measure of the growth potential of a site, which is determined by the soil, climate and water.

During the late 1980s, assessments were again conducted in the Barmah forest as well as Gunbower forest and the larger areas of forest along the Goulburn River (Cuddy et al. 1993). Earlier assessments had covered the forests along the River Murray upstream of Barmah and along the Ovens River. The current legislated sawlog sustainable yield (see below) and permitted levels of harvesting of sleepers derive from these assessments.

Permanent Continuous Forest Inventory (CFI) sample plots enable systematic measurements of timber volumes and forest growth over time. Periodic measurement of trees in CFI plots in river red gum forests began in 1961. As this followed the completion of most major river regulation structures (with the exception of Dartmouth Dam), the initial data would reflect the reduced growth rates caused by the altered flooding regimes up to that time. Although there has been some subsequent measurement of many of the plots, there has been little if any systematic analysis of existing data, or systematic planning for future data collection.

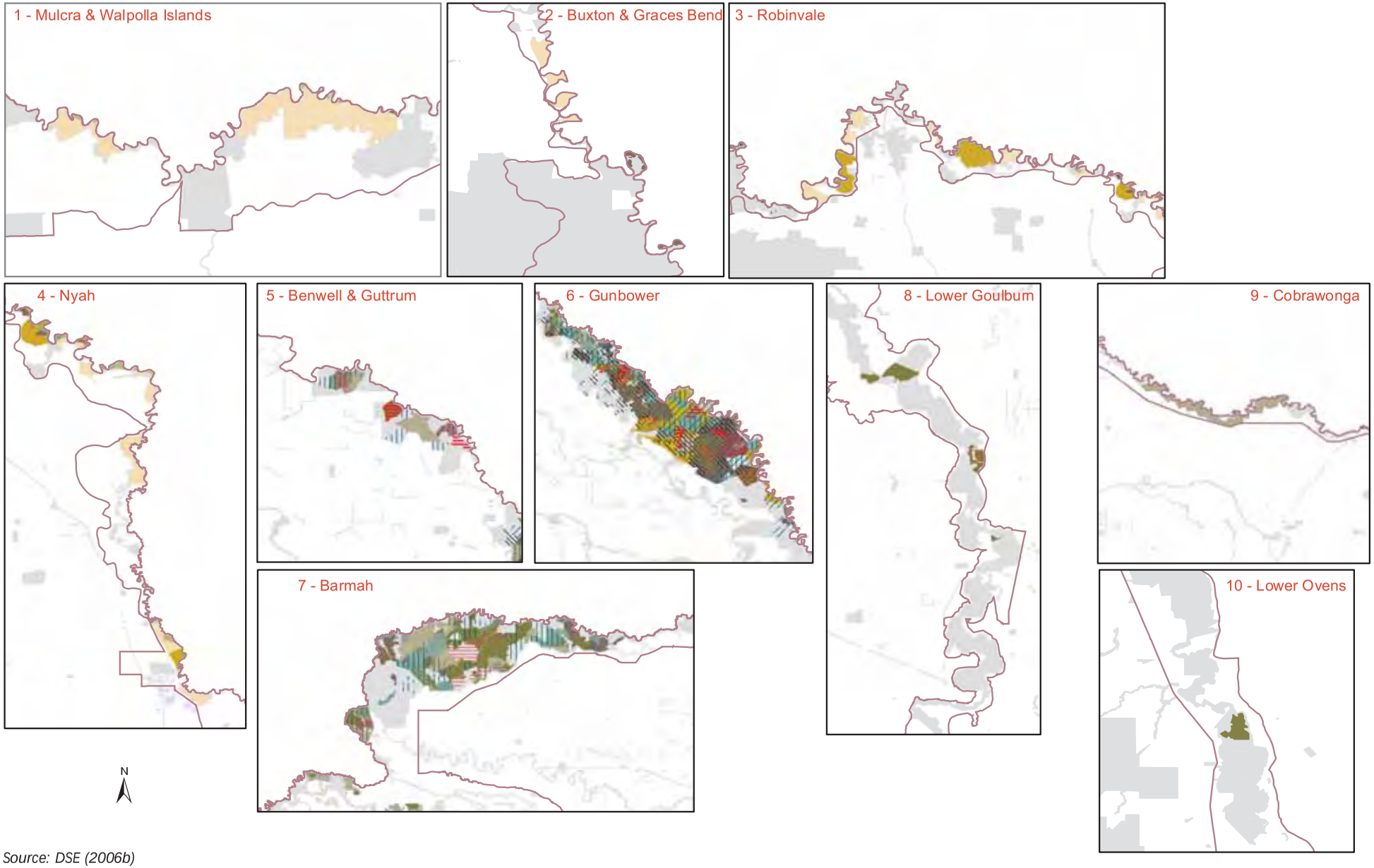
A Statewide Forest Resource Inventory (SFRI) program commenced in 1994 to provide the first systematic, comprehensive and standardised statement of Victoria's native forest resources. The SFRI used a consistent forest

Map 14.2 Logging history of the River Red Gum Forests study area.



Disclaimer:

This map has been prepared using data captured at varying scales (1:25000 - 1:100000), and as such, does not claim to provide an accurate representation of any of the boundaries established under legislation or otherwise. Boundaries may be updated, refined or modified from time to time in accordance with appropriate procedures.



Source: DSE (2006b)

Notes: This map shows all relevant DSE digital mapping data as at September 2006, but is far from comprehensive as a depiction of the full extent of logging in the study area. Virtually no record was kept of the geographic extent of the early decades of logging, during which time nearly all forested areas are likely to have been logged to some extent—including such places as freehold land that has since returned to the public estate. Except for recent decades, mapping—and particularly digitising—have been patchy at best. Even in the recent decades shown here, mapping is not comprehensive. For example, DSE advises that—in addition to that shown on the map—there has been harvesting (1) at Mulcra and Walpolla Islands until at least 1990, (2) near Robinvale until 2000, (3) for sawlogs and sleepers over all of Benwell and Guttrum forests, and (4) along the lower Goulburn from 1990 to the present.

stand classification system across the state. Tree measurements were independent of the particular forest products that they may be able to produce, allowing for accurate volume estimation even if sawlog and other timber product specifications change. The inventory also included the collection of biodiversity information, such as numbers of tree hollows (see Box 14.1).

Mapping of the river red gum forests has been completed but it has not been used for strategic planning, to identify the relative sawlog productivity of stands or to forecast sustainable yield of wood products. Reallocation of priorities within DSE means that such inventory will be unlikely in the short term.

FOREST MANAGEMENT, PLANNING AND CONTROL

To facilitate management of its forest estate, Victoria is divided into three forest management regions (FMR). These regions—North East, Western and Gippsland—are further divided into 15 geographic regions, known as Forest Management Areas (FMAs). Forest Management Areas are defined under the *Forests (Timber Harvesting) Act 1990* as areal bases for determining sustainable yield of sawlogs. They are also used for planning the management of the forests. As shown in Map 14.1, the River Red Gum Forests study area encompasses appreciable parts of three FMAs—North East, Mid-Murray, and Mildura—and small parts (containing very little public land) of the Bendigo Forest Management Area.

A hierarchy of planning, set out as a flow chart in Appendix 13, exists for the management and control of forest operations in the state. The principal elements are described below.

Strategic Level

Code of Forest Practice for Timber Production

The Code of Forest Practice for Timber Production (DNRE 1996a) establishes goals, guidelines and minimum standards of environmental care to be observed during all commercial timber production activities in the state (including growing and harvesting of public and private native forests and softwood and hardwood plantations and associated roading operations).

Although public and private land in Victoria are governed by different legislation, the Code applies across both public and private forests and compliance with it is required under the *Sustainable Forests (Timber) Act 2004* and the Victorian Planning Provisions.

The Code's purpose is to ensure that these activities are carried out in a way that:

- promotes an internationally competitive forest industry;
- is compatible with the conservation of the wide range of environmental values;
- promotes ecologically sustainable management of native forests for continuous timber production.

The Code was last reviewed in 1996, with a commitment to undertake a review at least every 10 years. A full review of the Code is due for completion in 2006 (the public comment period for the draft revised Code closed in April 2006). As well as public consultation, the review will evaluate advances in forestry science, while considering community and industry expectations for an economically and ecologically sustainable timber industry.

Forest Management Plans

A forest management plan is the fundamental plan for the management of environmental, cultural and resource values of state forests within a region. It establishes broad strategies for integrating the sustainable production of timber and other uses with the conservation of natural, cultural and aesthetic values. A long-term goal of forest management is to sustainably manage all forest values, including the supply of wood. Accordingly, areas of state forest are allocated to one of three zones according to priorities in management for the range of intrinsic and community values and uses, including nature conservation and recreation as well as timber harvesting. The zones represent a hierarchy in the levels of protection:

- general management zone (GMZ)—managed for a range of features, with timber production a major use;
- special management zone (SMZ)—managed to conserve specific attributes (such as sites important for nature conservation, historical or archaeological artefacts or recreation sites), with timber production or other land use practices permitted although constrained or modified (rather than excluded) to avoid conflict with the maintenance of the attributes. This zone contributes to the conservation of important species, particularly fauna, as well as encompassing landscape and water management issues;
- special protection zone (SPZ)—managed for conservation and to minimise disturbances or processes that threaten the respective natural or cultural values, with timber production excluded.

Although the strategies set out in forest management plans apply only to state forest, they are framed in the context that conservation is integrated across all native forests on the permanent public land estate. As such, they are designed to build on and complement the protection provided by the system of dedicated conservation reserves established following studies into public land use by the Land Conservation Council and its successors (see chapter 10 Nature Conservation). Special

protection zones, for instance, complement formal reserves and contribute to the development of Australia's comprehensive, adequate and representative forest reserve system (Commonwealth of Australia 1992).

Forest management planning also considers other forest uses, including recreation and silviculture as well as the impact of grazing, water management and pest plants and animals on forest health. The plans provide guidelines for protecting and managing specific values or uses, such as protecting large old trees and promoting the development of maturing trees across the timber-productive forests, developing grazing strategies based on ecological requirements of the forest and the preparation of pest-control programs.

Public input is integral to the forest management planning process. Members from the community with particular interests in the area contribute to discussions on particular issues and assist in decision-making. Similar to the processes followed by VEAC, input is sought from the broader community from the outset of the planning process and comment is invited on discussion papers and draft plans.

Forest management plans for the respective Forest Management Areas that overlap the River Red Gum Forests study area have been completed. From the east these are:

- *Forest Management Plan for the North East* (2001)—the River Red Gum Forests study area encompasses only a relatively small portion of the total planning area, which covers the North East FMA (an operational amalgam of the Wangaratta FMA and the majority of the Wodonga FMA) and Benalla–Mansfield FMAs, and part of the Central FMA;
- *Forest Management Plan for the Mid-Murray Forest Management Area* (2002a); and
- *Forest Management Plan for the Floodplain State Forests of the Mildura Forest Management Area* (2004)—the Mildura FMA covers extensive areas of mallee and chenopod vegetation types which occur to the southwest of the floodplain state forests to which this plan is restricted; these floodplain state forests are entirely contained within the VEAC River Red Gum Forests study area.

Currently, the overwhelming majority of wood product harvesting, and especially sawlog and sleeper harvesting, occurs in the Mid-Murray FMA.

Operational Level

Management Procedures

The Code of Forest Practice provides for regional prescriptions for timber harvesting and associated activities in state forests. Previously, the regional prescriptions combined the requirements of the Code and strategic forest management plans and accounted for the ecological and growth characteristics of the particular forests found in each Forest Management Area. They were more detailed than the actions and guidelines set out in the forest management plans and provided practical, detailed operational instructions that were applicable at the Forest Management Area level.

In October 2005, the various regional prescriptions were consolidated into *Management Procedures for Timber Harvesting Operations and Associated Activities in State Forests in Victoria* (DSE 2005e) to facilitate consistent statewide implementation of environmental standards in all operational aspects of commercial timber harvesting.

The Management Procedures do not duplicate or replace either the Code or the relevant forest management plan and all three documents need to be considered together.

The objectives of the Management Procedures are to:

- provide detailed prescriptions for forest management activities for specific Forest Management Areas, as required by the Code;

- standardise, where appropriate, management prescriptions across the state;
- set out best practice at a state level;
- provide a comprehensive reference for use by DSE and VicForests staff involved in the planning, management, implementation and monitoring of timber harvesting operations and associated activities;
- prescribe minimum operational standards for VicForests.

The Management Procedures (DSE 2005e) require that the felling of trees to yield only products other than sawlogs and sleepers be permitted only:

- where sawlog productivity and stand health are not compromised;
- for silvicultural treatment;
- where required for seed collection purposes;
- where the trees are a safety risk; or
- for approved fence line clearance or track construction or maintenance.

Trees may also be felled for these products as a follow-up treatment to a sawlog operation.

Wood Utilisation Plans

Schedules of coupes selected for harvesting each year and associated access roading must be set out in Wood Utilisation Plans (prepared by DSE) or Timber Release Plans (prepared by VicForests). VicForests is not responsible for timber harvesting in the study area so Timber Release Plans are not discussed further.

Wood Utilisation Plans (WUPs) are prepared in accordance with the *Wood Utilisation Planning Guidelines for State Forests in Victoria* 2005. They are prepared by DSE annually, on a three-year rolling basis, for all commercial forest operations it manages (including where material is to be used locally by DSE, such as for bridge timbers). The three-year Wood Utilisation Plans provide detailed specifications for the first year and indicative specifications for the following two years. Harvesting of all wood products in the River Red Gum Forests study area is currently managed by DSE under these plans.

As well as commercial production areas, domestic firewood collection areas in which trees are to be felled with firewood as the only product (as occurs with stand thinning), must be identified in the respective plans. Such areas are identified in the Mildura and Mid-Murray Wood Utilisation Plans (DSE 2006e, f, g).

Preparation of these plans involves consideration of each proposed logging coupe individually to comply with the relevant forest management plan, the Code and related Management Procedures to conserve forest values (flora, fauna, landscape, cultural heritage, water, soil and recreation opportunities). Individual timber harvesting areas (coupes) must be selected on the basis that they contain the required quantities and mix of wood products that can be supplied using sound silvicultural practices and in consideration of all environmental care requirements. The plans must provide coupe details, maps and supporting information identifying the location and timing of harvesting and construction works and the silvicultural system to be applied.

Preparation of Wood Utilisation Plans involves public submissions on proposed operations and the final documents are available to the public.

Coupe Plans and Management of Coupes

Coupe plans must be prepared for every timber harvesting operation. Each coupe plan contains a map identifying the boundaries of the coupe, a schedule incorporating the specifications and harvesting conditions under which the operation is to be

administered and controlled and other management requirements, such as habitat tree retention.

Prior to the commencement of harvesting the following must be accurately located on-site and clearly specified and recorded on the coupe plan or relevant site plan (DSE 2005e):

- all coupe boundaries;
- the location of all excluded areas;
- the location of filter strips and buffers;
- habitat tree requirements (these are also marked where required); and
- trees for retention and/or trees for removal.

DSE advice is that, in practice, an operating coupe in the river red gum forests is inspected at least twice a week and only those trees marked by the forest supervisor may be felled. A coupe is also inspected prior to the departure of the logging contractor to check that all marketable wood has been removed and for any breaches of boundaries or other conditions. Monitoring is also carried out some 18 to 24 months after harvesting is completed to assess the level of stocking of natural regrowth and the need for regeneration works.

Environmental Audits

An environmental audit system has operated in Victoria under the *Environment Protection Act 1970* (EP Act) since 1989. In 2002, the Environment Protection Authority (EPA) became responsible for conducting environmental audits of forest operations on public land to assess compliance of forestry activities with the Code of Forest Practice for Timber Production (Figure 14.8). In accordance with the *Environment Protection Act 1970*, audits are also required to identify 'the risk of any possible harm or detriment to the environment caused by forestry activities as may be assessed by adherence to

current controls and operational compliance with the standards in the code' (EPA Victoria 2003b).

The 2003 audit of the 2002–03 timber-harvesting season was the first independent environmental audit of timber production on public land undertaken in Victoria. The independent auditor appointed by the EPA was supported by a team with expertise in forestry, ecology, soil science and engineering (EPA Victoria 2003a). Additional matters may also be referred to the auditor, such as the Special Forest Audit in 2005, which was directed at four logging incidents that occurred in 2004 and 2005 during harvesting operations in East Gippsland and the Mid-Murray FMA (EPA Victoria 2006). This audit found that "a substantial portion of a superb parrot Special Protection Zone has been selectively logged at coupe 105-509-0006 (Flanagans)" (EPA Victoria 2006) and determined that this breach had a number of causes. These included the accuracy and completeness of information held in the Coupe Information System, inadequacies in the coupe plans and modifications to the coupe boundaries without review (EPA Victoria 2006). Flooding prevented the audit team from inspecting the actual site but DSE reported that, although some of the trees in the 100-m SPZ were harvested, no habitat trees were affected by the operation. The audit noted that the DSE has instituted procedural changes to reduce the risk of similar breaches occurring in the future. However, other breaches—such as harvesting of several hectares beyond coupe boundaries—have subsequently occurred.

Outcomes of the audits may include recommendations to improve compliance with the Code and increase environmental performance of timber harvesting operations as well as indications of how the Code may be amended to facilitate compliance. The outcomes of the audit program are expected to be of benefit to the forestry industry and the community as well as DSE and VicForests, by providing an objective and independent assessment of the status of compliance of timber harvesting operations with the Code. DSE's responses to each of the recommendations are recorded in the final audit report.

Area Available for Harvesting

State forest in the study area covers 104,720 ha, or 40 percent of the study area's public land estate (Table 9.1). All state forest is potentially available for timber production. However, not all of the gross area of state forest is actually available or, indeed, suitable for timber production. Some areas in the study area, such as water bodies, open wetlands and grasslands are inherently unsuitable for the growth of trees while others support trees that are unproductive for timber (either because of their species or poor growth). Some species or areas are protected by departmental prescription, while others, although suitable and productive, may be inaccessible or of insufficient size to be commercial.

Protection of Water Quality

Several of the standards established in the Code of Forest Practice for Timber Production (DNRE 1996a) are aimed at protecting water quality and aquatic habitat values. These include:

- retaining a buffer of riparian and other vegetation extending at least 20 m on either side of a permanent stream (i.e. a stream that has open water at minimum flows) and around permanent springs, swampy ground, wetlands or other bodies of standing water;
- retaining a filter strip extending at least 10 m on either side of temporary streams and drainage lines.

Figure 14.8 Auditors, community representatives and Department of Sustainability and Environment staff in Barmah State Forest during an Observation Day designed to consult with the community and improve the audit process.

The Code was primarily developed in relation to mountain and foothill forests where local rainfall is the major influence on water movement, however this is not the case in the floodplain environment. The soils of the floodplains have developed by deposition of sediment from the major watercourses during floods. The presence of sediment in streams is affected more by activities in the catchments than by activities on the floodplains themselves. The topsoils of the floodplains typically consist of silty clay which, if exposed to rapid run-off, is likely to erode. Floods, however, are caused by 'run-on' from upstream events rather than run-off from local rainfall. The low surface profile prevents rapid water movement during river flooding and recession and reduces erosion.

Accordingly, and in line with the Code, the Mid-Murray Forest Management Plan requires the establishment of a 20 metre buffer, from which timber harvesting activities are excluded, on main rivers and anabranches, lakes, billabongs and lagoons that maintain permanent open water at minimum river flows. Further, in the floodplain environment, timber-harvesting activities are not permitted where there is free water or saturated soil and are excluded from within 20 m of the water-line or saturated zone, wherever it may occur at the time of harvesting. Under standard conditions, these latter areas may be harvested when water is absent, however. The Management Procedures also require maintenance of buffer and filter strips (DSE 2005e). These buffers, along with gazetted public land water frontage reserves within state forest, are not available for timber harvesting.

Forest Zoning

The principles behind the designation of forest management zones are discussed above. Zoning

Table 14.1. Area of each Forest Management Zone within the River Red Gum Forests study area.

Forest management zone	Availability for timber harvesting	Total area of each zone in the study area (ha)	Area of each zone in the study area within the respective forest management plans (ha)		
			Mildura	Mid-Murray	North East
Streamside reserves and code of forest practice exclusions	Excluded	1132	522	494	116
Special Protection Zone (SPZ)	Excluded	11,910	143	10,125	1642
Special Management Zone (SMZ)	Permitted, subject to restrictions in excess of standard restrictions	22,569	6671	15,898	0
General Management Zone (GMZ)	Permitted, subject to standard restrictions	67,675	31,494	31,467	4714
Total area of state forest		103,286	38,830	57,984	6472

Notes: Includes buffers prescribed through the Code of Forest Practice and gazetted Public Land Water Frontage Reserves within state forests (equivalent to SPZ). 'Management procedures for timber harvesting operations and associated activities in state forests in Victoria' (DSE 2005e) requires the retention of certain numbers of habitat trees; these are considered by DSE to be standard conditions in the river red gum forests.

excludes harvesting from areas (such as Special Protection Zones) or restricts the intensity or timing of harvesting permitted in others (such as Special Management Zones). Table 14.1 sets out the area of state forest in the study area allocated to each forest management zone.

Not all zones are displayed on public maps. In the Barmah Forest, for instance, the nesting sites of superb parrot—protected by both a 250-m radius Special Management Zone (in which activities are restricted during the breeding season) and a 100-m radius Special Protection Zone around each nesting tree—are not reproduced in the maps accompanying the Forest Management Plan to discourage poaching for the bird trade.

Although timber-harvesting operations are generally excluded from Heritage River Areas, they are permitted, subject to restrictions in accordance with the *Heritage Rivers Act 1992* and the *Heritage Rivers (Amendment) Act 1998*, in parts of the Goulburn and Ovens Heritage River Areas. These areas are treated as Special Management Zones in the planning process.

Prescriptions and Other Unmapped Provisions for Environmental Protection

Prescriptions established through the forest management planning processes make special provisions for the protection of such values as the habitats of endangered species, wetlands and large old trees (see below), as well as to promote the development of large trees across the forest landscape. Under the provisions the Mid-Murray Forest Management Plan, for instance, commercial timber harvesting is excluded from all occurrences in state forest of Buloke Woodland, cypress pine, Black Box Woodland and Northern Plains Grassy Woodland, regardless of whether or not they are included in Special Protection Zone. Similarly, any Black Box Chenopod (saltbush) Woodland occurring within the Special or General Management Zones of the Mildura FMA is protected from disturbance, and timber harvesting is excluded from all occurrences of buloke, cypress pine, grey box and black box in this FMA.

Although these areas are not specifically mapped, and therefore do not appear in the area tables above, they nevertheless further diminish the net available productive area.

Retention of Habitat Trees

Guidelines for the protection of flora and fauna values, set out in the Code of Forest Practice for Timber Production, seek the retention of habitat trees (Figure 14.9) and old-age understorey elements in appropriate numbers and configurations, and the recruitment of potentially hollow-bearing trees (see chapter 5) within or around coupes. A major goal of the forest management plans is to ensure that there are sufficient large old trees across the forest, within the constraints of sound silvicultural principles. The presence of large old trees suppresses the recruitment and growth of young trees so, in production forests, a balance is required.

While the emphasis since the 1970s has been on developing a system of reserves to address the strong community demand for environmental conservation and recreation in the forests (Special Protection Zone), there has also been a shift to greater retention of trees for

habitat in the timber-productive forests, particularly in Special Management Zones—but also in General Management Zones, albeit to a lesser extent.

An analysis of stand structure in Barmah forest (Appendix 14) shows that the numbers of trees in the larger size classes have increased over time, although the Department of Natural Resources and Environment (2002a) suggests that in many areas of public land the proportion of the forest comprising large old trees would still be lower than would occur naturally.

The Management Procedures (see above) establish guidelines for the retention of habitat trees in each Forest Management Area in the state. For the Mildura and Mid-Murray FMAs these are:

- all trees known to be used for nesting by significant fauna (such as superb and regent parrots) must be retained and protected;
- all trees greater than 100 cm diameter at breast height (DBH) must be retained;
- retain a minimum of 20 live trees within the 50–100 cm DBH range for every 10 ha within the Benwell, Guttrum and Gunbower State Forests in the Mid Murray FMA;
- for every 10 ha elsewhere in the Mildura and Mid-Murray FMAs, 20 trees within the 50–100 cm DBH range and 20 within 100–150 cm range; adjusted so that, if there is a deficiency in numbers in one of the size groups, a total of 40 live trees are retained within the 50–150 cm DBH range (DSE 2005e).

Implementation of these habitat tree guidelines is estimated to lead to at least 24 percent of the area of each coupe in river red gum forests being occupied by retained trees (DNRE 2002a). In the Mid-Murray FMA, retention of habitat trees at these levels was estimated to effectively reduce the area of forest that is potentially available for commercial timber production in the General Management Zone by about 6900 ha (about 36 percent) and approximately 4400 ha in the Special Management Zone.

Bren (2001) noted that, at the current prescribed levels of habitat tree retention, 74 percent of the growth potential on SQ I (highest quality) sites would go onto retained habitat trees, while on SQ II and SQ III (medium and lowest quality) sites, habitat trees would absorb 100 percent—suggesting that the potential of habitat trees to absorb site resources is greater than their relative proportion in a stand.

Net Available Area for Harvesting in State Forest

The area of state forest that is potentially available for timber production in the River Red Gum Forests study area, once exclusions are made for the Code of Forest Practice and legislated reserves, totals 102,154 ha (Table 14.1). After accounting for the area of Special Protection Zones and other sites identified in the respective forest management plans where timber production is excluded, a total of 90,244 ha remains; this is defined as the *net available area*.

The Statewide Forest Resource Inventory (see above) was designed to determine the actual extent and indicate the relative timber productivity of stands within the net available area. Using the SFRI data, the *net available productive area* would then be determined by subtracting from the net available area, the areas of forest that are of low inherent productivity, inaccessible or of insufficient size to be commercial. However, the SFRI data are not available to indicate the extent of the other factors. Therefore, the total area of General and Special Management Zones (90,244 ha) in Table 14.1 does not, by itself, indicate the actual area that is both available and suitable for commercial timber production.

Figure 14.9. Large tree retained for habitat values in Benwell State Forest.

Non-State Forest Public Land Available for Timber Production

Commercial timber production was permitted in about 2500 ha of forest in the Barmah State Park (LCC 1985). Licences for timber harvesting here expired in 2003.

Limited extraction of timber products is permitted in about 3103 ha of the River Murray Reserve in the Mildura FMA (in accordance with approved Land Conservation Council recommendations: LCC 1989a) where consistent with protecting natural and scenic values, conserving of native flora and fauna and the protecting of sites of archaeological, cultural and historical importance. This incorporates areas at Spences Bend, Police Bend, Pound Bend, Buchanans Bends, Camerons Bend, Burra Forest and Vinifera Forest (but excludes the 60-m Murray River Public Purposes Reserve). Some small-scale thinning operations that produced firewood have been undertaken within these portions of the River Murray Reserve. LCC (1985) also provided for limited timber production within the Loch Garry Wildlife Management Cooperative Area and in about 790 ha of the River Murray Reserve within the Murray Valley Area. The Mid-Murray Forest

Management Plan excludes timber harvesting from the River Murray Reserve in that Forest Management Area. These areas have not been included in the estimate of sustainable yield for sawlogs.

Timber Production on Other Lands

Wareing (2002) lists about 23,000 ha of the river red gum forest type on private property in northeastern Victoria (as far west as Echuca). The bulk of these areas are on higher ground than the more productive forests and overall productivity is likely to be similar to that of the SQ III sites on public land. A negligible volume of timber is harvested from these forests. Further, the Native Vegetation Retention Controls (introduced in 1989 under the provisions of the *Planning and Environment Act 1987*) reduced the amount of commercial timber harvesting that occurred on private land.

The New South Wales (NSW) river red gum timber industry is based on the floodplain forests of the Murrumbidgee, lower Lachlan and Darling Rivers as well as those along the River Murray. The river red gum forests here total several hundred thousand hectares—probably several times their extent in Victoria. In addition, a much higher proportion of these forests—and the wood products sourced from them—and are on private land than is the case in Victoria. Nonetheless, privately–owned native forests in NSW may be subject to native vegetation retention controls.

Silvicultural Practices

Silviculture is the management of forests through establishment, composition and growth, and describes the harvesting and regeneration system used to achieve specific objectives for an area of forest. The particular silvicultural system applied depends on the object of management—for example, to return the forest to a more natural structure or to sustainably harvest the largest amount of timber, or a combination. One or more silvicultural systems may be applied to an area of forest, depending on its structure, condition and management objective and can be used to produce a mosaic of different stands of various structures within the area. Timber harvesting can be used as a silvicultural system to develop the desired forest structure, for example, firewood harvesting while thinning small, dense stems.

Forest management for timber production needs appropriate silvicultural system to ensure a sustainable yield of merchantable products within sound environmental and economic constraints. Accordingly, successful silvicultural systems in native forests aim to (DNRE 2002a):

- ensure the long-term conservation of the ecosystem (at the forest level, this requires an age-class structure adequately representing all key successional stages of the respective species—including the understorey and non-merchantable species);
- address the basic requirements of the respective tree species for establishment and growth;
- ensure adequate regeneration of harvested areas with the correct species mix;
- foster subsequent development of the forest stands;
- maximise the yield of merchantable timber, where that is an objective;
- minimise environmental impact;
- incorporate social and economic considerations;
- protect the forest, and particularly the regrowth, from damage through factors such as wildfire, browsing, disease and insect attack;

and, in the river red gum forests:

- integrate water management and silvicultural activities.

The structure and density of forest stands determine their timber productivity and the success of regrowth. Options for the management of regrowth can include such actions as the removal of overwood to reduce competition with the regrowth and thinning of the regrowth to foster development of timber-productive trees.

Although large areas of the river red gum forests comprised even-aged regeneration originating from the 1870–1880s, subsequent harvesting, silvicultural activities and restrictions imposed on gap sizes have lead to the creation of a largely uneven-aged forest. This forest structure is maintained and promoted through the current application of single-tree and (small) group selection cutting systems (these are essentially uneven-aged silvicultural systems—see below), retention of habitat trees and stand thinning. Of the 1230 ha of river red gum forest silviculturally treated in 1997–98, for example, 10 percent was subject to group selection, 40 percent to single-tree selection and 50 percent was thinned (Lutze et al. 1999).

This situation is reinforced by the Management Procedures (DSE 2005e), which specify that group or single-tree selection systems should be applied in the riverine forests, and that the seed tree systems may be applied to areas of between 2 and 5 ha where the existing stand is even-aged. The Wood Utilisation Plans for the Mid-Murray FMP exemplies application of these procedures, where, except for regrowth management work, the silvicultural system planned to be applied is exclusively uneven-aged (DSE 2006e, f).

Single-tree Selection System

This system is applicable in naturally uneven-aged stands. Single-tree selection involves removal of scattered individual trees from a stand, with their selection determined by the objectives for stand management and the timber products sought. The period between successive harvests from the one stand is usually between 10 and 15 years and can be repeated indefinitely. Regeneration of the site is usually achieved through coppice or lignotubers as the survival of seedlings in such small gaps can be problematic because of competition from surrounding trees (see above). Single-tree selection is recommended for the lower site-quality areas of the river red gum forests where floods are less common and regeneration less reliable and for sites managed primarily for environmental conservation (Lutze et al. 1999).

Group Selection System

This is the most common silvicultural system currently applied in the river red gum forests. It comprises scattered fellings of either individual trees or small groups to produce gaps of sufficient size, generally less than a hectare, so that natural or induced seedfall from the surrounding trees can be used and to foster seedling development. While, in most forest types, the gaps are usually no more than two tree-heights across, in the river red gum forests, where seed is dispersed on flood waters, larger gaps sizes can be employed. As mature river red gum trees compete strongly for soil water, and trees surrounding a gap readily expand their roots and branches to occupy the site, the size and shape of the gap produced in a harvesting operation is important for successful establishment and growth of the seedlings. The Department of Natural Resources and Environment (2002a) considers this system to be appropriate for the more productive river red gum stands and where seedling regeneration is more reliable.

Under this system, a range of timber products may be harvested from an area of forest on cycles of between 10 and 30 years depending on stand structure, the growth of the trees in the period between harvests, and the products sought.

Seed Tree System

Under this system, all live trees in a coupe are felled, apart from a number of uniformly distributed trees retained to provide seed (seed trees), and those required for environmental (habitat) purposes. Seedfall may occur naturally or be induced.

Australian Group Selection System

The Australian group selection system (Jacobs 1955) can be used to create gaps of 5–10 ha (clear-felling small patches) within which substantial areas of even-aged regeneration can establish, with habitat trees grouped rather than dispersed throughout the coupe. This system is not currently applied in the river red gum forests in Victoria, but is applied to some degree in NSW state forests. Dexter and Poynter (2005) suggest that this system meets the requirements of the Code of Forest Practice better than the systems currently applied in the river red gum forests. They contend that the uneven-aged silvicultural system that is applied to the river red gum forests, superimposed by the prescriptions for retention of habitat trees, appear to meet neither the Code of Forest Practice requirements for sustainability of timber production nor its principles of sound environmental practice.

Regeneration

As current timber harvesting operations produce many small sites requiring regeneration each year, provision must be made to regenerate them to prescribed stocking levels (numbers) within a reasonable time. Native Forest Silviculture Guideline No.10 (DNRE 1997a) requires stocking surveys in areas subject to regular flooding to be undertaken 18 to 36 months after the first flood event following harvesting. In areas not subject to regular flooding, the surveys are to be undertaken 18 to 36 months after the completion of harvesting. If natural regeneration is shown to be inadequate, remedial action is required.

In general, regeneration of river red gums in the floodplain forests is achieved through natural seedfall and seeds are dispersed during flooding. However, seedbed preparation and artificial seeding may be required to produce regeneration on specific sites (Di Stefano 2002). The seedbed may be prepared through soil disturbance or by burning of the logging debris and may be timed to take advantage of natural seed-fall in spring.

Although germination of river red gums seed is usually prolific in the floodplain forests, the longer term survival of the seedlings is often compromised by a lack of water at the appropriate times. Coordination of harvesting and regeneration operations with water management could benefit the establishment and survival of seedlings and subsequent forest growth.

Stand Thinning

Millions of river red gum seeds germinate on the forest floor most years, but the majority die in the first few years through flood, drought, insects or browsing. High seedling losses also occur through soil drought caused by competition from grass or surrounding trees. Subsequent competition between the saplings produces a gradual reduction in the numbers of surviving stems as they grow. At age 8, for instance, SQ I (highest quality) river red gum stands can carry 3600 saplings per hectare, but by age 108, this will have reduced to some 90 trees per hectare. SQ II (medium quality) stands can support some 3000 saplings per hectare at age 8 and about 70 trees at 108 years (Dexter & Poynter 2005). It usually takes about 100 years or more to produce sawlog-sized trees in river red gum forests.

Thinning of young stands removes some trees, most of which are usually already suppressed with poor form. Such management techniques makes more of the site's resources available to the retained trees. The growth potential of the site is thereby concentrated in the retained trees, which grow faster and reach the required dimensions sooner. Thinning does not aim to establish regeneration.

The periodic thinning of regrowth and removal of unmerchantable trees (where not required for habitat) are considered essential to maintain the timber productivity of the river red gum forests. Ecological thinning may also be undertaken to specifically improve biodiversity values, such as by enhancing conditions for understorey growth, the habitat of certain species of wildlife or for forest health. For example, Harris (1975) found that thinning dense stands of 28-year-old river red gum regeneration significantly reduced the level of defoliation caused by the larvae of the gum leaf skeletoniser moth in 1965–66. The recent drought conditions have imposed excessive water stress on many areas of forest, particularly in the west of the study area. Thinning operations have been undertaken to alleviate some of this stress on the retained trees.

Thinning treatments can be 'pre-commercial', in which no timber products are harvested. Such treatments are normally carried out in younger stands. Thinning of older stands can yield commercial wood products (such as poles, sleepers, posts and firewood).

The high costs of labour have meant that the necessary

thinnings have generally not been carried out in the river red gum forests (Figure 14.10). As a consequence, the on-growth of larger-sized trees suitable for sleepers, piles, sawlogs and, indeed, large habitat trees is delayed. This problem was evident at the earliest stages of forest management (Forest Commission of Victoria 1928) and persists today.

Sustainable Yield

The fundamental principle of sustainability in wood production from forests is that the resources should not be harvested at rates faster than they are growing. The volume of logs to be supplied from each Forest Management Area is specified in log licences and is based on forecasts of the sustainable levels at which trees of a suitable size can be harvested. In practical terms, sustainable yield is a forecast of the rate of harvesting that can be maintained for a given period without impairing the long-term productivity of the land. It must take into account the structure and condition of the forest, predicted growth and the diverse range of forest-based activities.

Forecasting the long-term sustainable yield from forests managed under selection harvesting systems is complex compared with the process used for even-aged systems. Mixed age forests are harvested for a range of products at different times in the life of a stand resulting in a varying levels of competition between trees and regrowth is continuous, depending on their age and condition and the productivity of the site.

To forecast sustainable yields of sawlogs data are required on the following range of factors. The Statewide Forest Resource Inventory was designed to capture these data.

Area Available and Suitable for Sawlog Production

The respective forest management zoning schemes establish the area of state forest in each Forest Management Area that is available for timber harvesting, while assessments, such as the SFRI, identify areas actually suitable for sawlog production (see above). For the purposes of counting the available wood resources in the Special Management Zone, only a proportion of the total area is considered available for harvesting—this is to account for the restrictions that are generally imposed in Special Management Zone that exceed those standard across the General Management Zone.

Existing Sawlog Utilisation Standards

The definition of a 'sawlog' changes with technology and industry acceptance. The introduction of the 'residual' log standard (as described in Squire (1992), and see Glossary) is an example.

Figure 14.10 Dense regrowth from a fire at Barmah State Forest.

The volume of sawn products that a log can yield varies with size and quality. While some defects (solid knots, for instance) may be marketed as an attractive natural feature, hardwood logs, particularly, can contain defects that diminish the desired qualities (strength or appearance) of the wood or render the section of log unusable. Many defects are hidden and are only revealed when a log is 'opened up' at the sawmill. Hidden defects are a particular problem in river red gum and a healthy looking tree can have a high degree of internal defect, such as gum veins or pockets (caused by insect attack, fire or flood/drought stresses), occluded fire scars, heartwood, rot or double-hearts, rendering it unsuitable for sawn timber. Some gum veins and other defects may be acceptable in structural grades of timber but not where high-grade timber is required. Sweep, or a gradual bend in the wood, may mean a log cannot produce straight lengths of timber. Sapwood, while not necessarily a defect, is undesirable in higher quality timbers as it performs poorly in the seasoning kilns and is susceptible to borers. However, sapwood is acceptable to a greater degree in railway sleepers, enabling relatively small (38–40 cm diameter) logs from the heads of sawlog trees and thinning operations to be used.

These hidden defects make assessment of the relative grades of timber resources on river red gum coupes difficult. In practice, timber resources of a coupe are assessed visually and comparison is made with recorded product yields from previous coupes in similar forest types. Until recently, grading of river red gum logs for the purposes of royalty determination varied between Forest Management Areas, between supervisors and in relation to the products (sawn timber, sleepers etc) being sought. From 2005, logs have been allocated to three grades only (Appendix 15), leaving it to the purchaser to decide the product yield. The grades are determined by size (diameter and length) and the amount of defect—where the proportion of defect exceeds the maximum allowable, the log is consigned to a lower grade. The allowable proportion of defect increases with the size of the log.

Grading of logs in this way:

- reflects the nature of river red gum logs;
- reflects timber quality, value and potential markets;
- is objective;
- can be consistently applied across all Forest Management Areas (DSE 2005f).

Productivity Class and Site Quality

The capacity of different parts of the forest to support sawlog trees depends on the inherent qualities of the site, such as soil type and fertility, climate and availability of water. As a consequence, site quality is 'measured' in terms of the height of the dominant trees at a particular age.

As documented above, productivity of river red gum forests is intimately related to the availability of water in their floodplain environment. Forest health, which is reflected in long-term sustainable timber production, depends upon near-natural flood regimes.

Indicators of Existing and Future (Regrowth) Resources

Many of the current (now mature) stands of the river red gum forests come from the regeneration events of the 1870–1880s while their condition is a product of subsequent management activities. In Barmah forest there has been an increase in the numbers of trees in the larger size classes and a reduction of the smaller sizes over time (Appendix 14). The competitive pressure exerted by the larger trees is discussed above. While the increased number of larger trees corrects an earlier deficit, increasing numbers of larger trees in selectively harvested uneven-aged stands will reduce the numbers and vigour of growing stock for future timber production.

The Growth Rates of Trees within each Productivity Class

Jacobs (1955) noted that the river red gum forests responded well to selective fellings and, once the veteran trees are removed, would be good examples of the Australian group selection system. He suggested it would be possible, under this silvicultural system, to achieve annual growth rates of 3.5 m^3/ha/yr of sawlog-quality timber and at least as much again of fuel, posts and poles in the high quality (equivalent to SQ I) sites. The yield of SQ II areas would be about half this amount and the poor areas (SQ III) less still. However, Jacobs' data was based on water regimes greater than that now experienced by the forests. Dexter and Poynter (2005) note that, under the current forest management regime, an average sawlog productivity of only 1.48 m^3/ha/yr can be achieved, even under an 'ideal' watering regime. Under current watering regimes, values of the order of 0.22 m^3/ha/yr are being observed (Appendix 16).

The river red gum forests are uneven-aged as a result of the long history of single-tree silviculture which compromises the success of subsequent regrowth through competition from retained trees. Dexter and Poynter (2005) suggest that tall straight trees suitable for high-value uses will become rarer if harvesting continues under this system and through stunted tree growth as a result of the substantially reduced frequency of flooding. Appendix 16 displays the combined influence of silvicultural system and associated management decisions, and water availability on timber productivity.

Current (standing) Volume of Sawlogs

Standing log volume data derive from assessments such as the Statewide Forest Resource Inventory and on-going local assessments. With the discontinuation of the SFRI inventory of river red gum timber resources, estimation of the standing log volume for individual coupes must now be undertaken at the local level prior to harvesting.

Legislated Sustainable Yield

The Third Schedule to the *Forests Act 1958* lists the rate of sustainable yield of sawlogs for each Forest Management Area in Victoria. Legislatively, sawlog sustainable yield must be reviewed every five years (beginning in July 1991), or when there is significant change in the available sawlog resource, or at any other time the Minister considers appropriate. Changes to the legislated sustainable yield rate are effected by Orders in Council.

Table 14.2 River red gum wood volumes available, not including contingencies, for the first year under the 2006–07 to 2008–09 Wood Utilisation Plans in each Forest Management Area that produce river red gum in the study area.

Wood grade	Short code in the WUPs	Mildura (m^3)	Mid-Murray West (m^3)	Mid-Murray East (m^3)
River red gum sawlog	U		1195	5790
River red gum sleeper log	S		790	4100
River red gum residual log	R		4650	5370
Firewood	F	6330	850	7750
TOTAL VOLUMES		6330	7485	23,010

Source: DSE (2006e, f, g)

Notes: These wood grades pre-date the standardised grading system established in 2005. Under the conditions of the new grading system, the total available volume indicated in the table would not have changed but the distribution of wood between grades would better reflect the new grading standards—principally from sleeper log to the standard log or residual log grades. Parts of North East and Bendigo FMAs area also in the River Red Gum Forests study area but there is no river red gum harvested in these FMAs. The Horsham FMA area (outside the study area) also has 3080 m^3 available in 2006–07, mostly as firewood (DSE 2006a). The amount of firewood collected illegally is unknown but may be as high as 60,000 m^3 annually.

A review of the availability of sawlog resources was conducted in 2001 as part of the licence renewal process. Based on existing information (no new assessments were undertaken) this review indicated that an annual sawlog licence level of up to 5200 m^3 was possible from the Mid-Murray FMA (reduced from the scheduled level of 5600 m^3) and 600 m^3 nett from the Mildura FMA (reduced from the scheduled level of 700 m^3). These figures do not include the volumes of logs that do not meet sawlog standard, and which produce sleepers and residual wood.

Vanclay and Turner (2001) argue that the overall data quality and methodological rigour used to determine the sawlog yield estimates for the Mildura FMA was inadequate for making long-term licence commitments and that, for the Mid-Murray FMA, the 'estimates do not provide an adequate basis for making long-term commitments, because of subjectivity in the data and simplistic assumptions inherent in the method (see also DNRE 2002b).

Future adjustments of the legislated licensed levels from the respective Forest Management Areas must take into account forest management plans and new assessments of wood availability as well as any government decisions on land use, including those made after this River Red Gum Forests Investigation.

Determining sustainable yields of timber from the river red gum forests still depends on data collected in the 1980s. The discontinuation of the Statewide Forest Resource Inventory process means that up-to-date and superior data on standing volumes and wood productivity are unavailable to assist determination of the long-term sustainable yield from these forests and legislative commitments. In light of all the above, the ability of river red gum forests to sustain current levels of sawlog production into the future under continuing and possibly worsening conditions of environmental stress is unknown (see chapter 19). The continuing greatly reduced frequency of natural forest flooding—and longer term predictions of further deterioration as a result of climate change (see chapter 4)—may be a major threat to long term wood product harvesting in the River Red Gum Forests study area.

Current Timber Availability

Table 14.2 sets out the wood volumes listed for harvesting in the 2006–07 to 2008–09 Wood Utilisation Plans for the Mid-Murray and Mildura Forest Management Areas (DNRE 2002a; DSE 2004f). Although these plans describe different products to those set out under the standardised grading system established in 2005 (see Appendix 15), total wood volumes are consistent.

Although the *Forests Act 1958* lists 600 m^3 of sawlog resource available from the Mildura FMA and several people have sought sawlogs from there, the volume is not currently allocated and DSE is not willing to consider recommencing commercial sawlog operations until there is some certainty about the ongoing availability of the resource. The absence of sawlog harvesting has affected the availability of firewood in the region. It is more expensive for DSE to produce from its own silvicultural thinning than as a by-product of commercial harvesting for high-value sawlogs. Should the availability of the resource be confirmed, the Mildura Forest Management Plan sets out the process, which includes community engagement, for the recommencement of sawlog harvesting.

Licensing of Wood Production

Harvesting of timber in state forest requires a licence from DSE—granted under section 52 of the *Forests Act 1958*. That Act also permits the sale of timber from public land by auction or tender. The Forest (Licences and Permits) Regulations 1999 requires all licence

Table 14.3 Volume and price for wood licensed from the Mid-Murray Forest Management Area (2006–07).

Log grade or product (see Appendix 15)	Volume available under licence (m^3 gross equivalent)	Price range ($/$m^3$ incl. GST)
River red gum sawlog	6110	56.38–64.87
River red gum standard log	4428	36.25–46.35
River red gum residual log	4618	14.40
River red gum firewood	4380	13.80

Source: DSE, 2005 (unpublished data)

holders to comply with the Code of Forest Practices. Three types of licence currently apply to the removal of wood from state forest in the River Red Gum Forests study area. Overall there are 41 licences for 22 licensees in 2006–07 (sawlogs, standard logs and residual logs, of various grades, and firewood).

S-licence

Up until 2005, long-term S-licences were issued, with Governor-in-Council approval, for commercial timber harvesting for periods of up to 15 years. Transitional processes are in place but, eventually, the traditional system of commercial sawlog licensing will be replaced and no long-term licences will be granted or renewed. At present, and pending transfer of the management of commercial timber harvesting to VicForests (see above), on expiry of each long-term S-licence, it is re-issued on an annual basis. Royalty and other fees and charges are payable on invoice.

Five S-licences for the harvesting of river red gum sawlogs are current in the River Red Gum Forests study area for 2006–07 (Appendix 15 provides a definition of the log grades). Two expire in 2007 and three in 2009.

B-licence

Anyone wishing to harvest forest produce on a commercial basis must apply for a Forest Produce B-licence. These are issued for up to one year and royalty and other fees and charges are payable on invoice.

B-licences are issued through a combination of direct allocation and tender. Many B-licence holders have a long history in the industry and have built up businesses based on ongoing access to resources. Each of these established licensees usually receives a direct allocation of volume based on the quantity they have cut previously. In 2005, the volumes issued to established B-licence applicants were based on their average cut over the three previous years. Nevertheless, they must still apply for the licence each year.

Because established industry takes up most of the available resource and the present level of uncertainty about the ongoing availability of the resource, licences are not issued to 'new' applicants other than through the process of tendering. For example, wood made available as a result of thinning operations (for improvement of forest health) is advertised for tender on a location basis (from Barmah or Gunbower State Forests, for instance). If an established licensee quits the industry, some of the resource freed up would most likely be advertised for tender.

In the River Red Gum Forests study area, a total of 26 B-licences have been issued for the harvesting of river red gum standard logs and river red gum residual logs (for definition, see Appendix 15) and 10 B-licences for commercial firewood collection for the 2006–07 year.

All commercial timber harvesting on public land in Victoria is subject to the Code of Forest Practices. Further, under the Timber Harvesting Regulations 2000, those involved in commercial harvesting are required to hold a Forest Operator's Licence and sign a Forest Coupe Plan before commencing work.

C-licence

C-licences are issued for the harvesting of forest produce for domestic use only. They apply for periods of from one to five days. Royalty and other fees and charges are payable upfront. Between 8000 and 10,000 C-licences, mostly for firewood, are issued each year from the study area, the actual number depending in part on the extent of flooding and the weather.

Royalties

Royalty rates are the means by which government sets prices and sells wood products to processors. While the royalty rate is only a small proportion of the total cost of a sawn product, considerable effort goes into gearing schedules of royalty rates to market prices. Differentials apply for log quality and location and a loading is applied for the use of state roads and to encourage the use of residues.

Table 14.3 sets out the major products, the volumes licensed and the price (which includes royalty, production roading charges and licence fees) paid by commercial licensees to take these products from state forest in the Mid-Murray Forest Management Area.

CURRENT COMMERCIAL WOOD PRODUCTION

River red gum is now the only species available for commercial harvesting from public land in the River Red Gum Forests study area. However, the timber is used by such a diversity of people for such a wide range of applications that it is difficult to collate comprehensive and consistent data on end products and production levels. While large integrated sawmilling companies

Table 14.4 Wood volumes harvested recently from the River Red Gum Forests study area.

Product grade	Approximate equivalence to current grading system	Volume harvested by year (cubic metres gross)	
		2003–04	2004–05
RGA	River Red Gum Sawlogs	5200	4308
RGB	River Red Gum Sawlogs	2839	1706
RGS	25% River Red Gum Sawlogs 75% River Red Gum Standard Logs	1694	1879
RGH	River Red Gum Standard Logs	1853	2090
RGRA	River Red Gum Standard Logs	2002	2557
RGRB	River Red Gum Residual Logs	4151	9352
RL	River Red Gum Residual Logs	658	1011
RGF	firewood	4339	11,638
RGFC	firewood	1888	1507
Total volumes		**24,628**	**36,051**

Source: Department of Sustainability and Environment, Forest Resources Branch

with drying and planing facilities within the study area are theoretically easy to monitor, data on domestic and commercial firewood collectors and individuals with portable mills (barrow saws) cutting sleepers and garden timbers either at the stump or on private property are more difficult to attain, particularly when they have links with similar operations in other areas of the state or interstate.

Licensed Commercial Production

Table 14.4 sets out the volumes of wood harvested from the River Red Gum Forests study area by commercial operators in 2003–04 and 2004–05. As the classification of the product grades in this table predates the rationalisation of 2005, an indication of the approximate equivalents in the current grading system is provided. Some commercial firewood was also sold under C-licence during this period.

Contemporary Uses of River Red Gum Timbers

The characteristic durability of river red gum timber means that it still used for many of the products for which it was first sought. River red gum timber is resistant to white ant. It has the highest rating for fire retardance of all Victorian timbers. As a result, local governments recommend it as appropriate housing timber in fire-prone areas (advice from Arbuthnot Sawmills). These characteristics, coupled with its strong colour, often interestingly figured grain and ability to take a high polish, also mean that the wood is finding increasing applications in furniture and other joinery.

River red gum timbers present unique opportunities for value adding. The river red gum timber industry has invested in drying facilities and other timber processing equipment and developed new products to capitalise on the wood's intrinsic values.

Sawlogs are processed in sawmills and the timber may be marketed as 'green sawn' or kiln dried. Little is wasted, as off-cuts and other residual material are also sold—accordingly, the industry considers that it achieves almost 100 percent utilisation. Sawn timber products include:

- *green sawn:* bridge, railway sleepers and crossing timbers, fencing (posts and droppers) timbers, house stumps, guide posts, survey pegs and garden landscaping timbers and stakes.
- *kiln dried*: indoor and outdoor furniture, parquetry, traditional tongue-and-groove flooring and 'floating floors', laminated bench tops, feature panelling and mouldings, craft timbers and other applications where appearance grade timbers are required. There is a small, but increasing market for river red gum veneers for both furniture and joinery.

Fence posts, poles, garden landscape timbers, firewood, chips (for landscaping purposes or mulch) and, occasionally, charcoal for barbecues, industrial filters or cosmetics are produced as by-products of river red gum sawmilling and sleeper-cutting operations and from residual logs. Sawdust is used mainly for horticultural applications while some is also used to generate heat for the timber-seasoning kilns.

A demand exists for specialty river red gum timbers for the maintenance of heritage buildings and bridges, to retain consistency with the original construction materials. For example, a planned major upgrade of the Port of Echuca may require river red gum timbers (advice supplied by Arbuthnot Sawmills). River red gum timbers continue to be used for the cladding and fuelling of the river steamers that feature amongst the attractions for local tourism.

Sawmilling Industry

The river red gum timber industry along the Murray River comprises six major fixed processing facilities (as distinct from small mills producing sleepers and other products

at the stump or on private property) in both Victoria and NSW. Three are established on the Victorian side: Murray River Sawmill at Echuca, Arbuthnot Pty Ltd at Koondrook and Merbein Sawmilling at Merbein. On the NSW side, sawmills are located in Deniliquin, Barham and Darlington Point.

While all of Murray River Sawmill's sawlogs are harvested in Victoria, Arbuthnot receives logs from both Victoria and NSW and Merbein Sawmilling's sawlogs are harvested in NSW. Conversely, the mill at Barham in NSW draws its river red gum sawlogs from both NSW and the Horsham Forest Management Area in Victoria (outside the study area). Neither the Deniliquin nor the Darlington Point mills draw logs from Victoria.

Ryan and McNulty at Benalla (outside the study area) is also licensed to harvest river red gum logs from the study area and buys green-sawn river red gum timbers from other mills. The bulk of the river red gum sold by this company is dried and reconditioned for supply to markets in Victoria, New South Wales and Queensland; a small volume of lower grade material is sold to local markets for such applications as outdoor furniture. This company also holds licences for mountain ash and other species logs from Victorian state forests.

The relative proportions of the various products yielded by commercial operations from river red gum logs supplied from Victorian state forests are estimated to be:

- 25 percent kiln-dried products and sawn specialty products (furniture, heritage restoration, veneer flitch);
- 26 percent other sawn products (housing, infrastructure timbers, etc);
- 49 percent 'fall down' products (material that fails to meet the grade) from the production of higher value sawn timbers and from thinning undertaken to improve forest health (this includes firewood, landscape timbers, etc) (Department of Sustainability and Environment, unpublished data, 2005).

As an example of the industry, Arbuthnot Pty Ltd, averaged 47 percent in sawn timber products recovered from the round logs over the five years to 2004–2005 and utilised 100 percent of every log. All by-products, including sawdust, mill ends (firewood) and chips from bark and edges, were sold (see Table 14.5).

While the proportion of kiln-dried timber produced is relatively small, it claims a high mill-door price, reflecting the cost of production and its high market value—it is sought after by many specialist 'high-end' furniture manufacturers. General industry data suggest that dried 800 mm-wide river red gum slabs (for such applications as table or bench tops) can sell for up to $4000 per m^3, while kiln-dried select and feature grade river red gum timber can claim about $2400 per m^3 and that for general furniture and flooring applications sell on average for about $1750 per m^3. Average mill-door prices for structural timbers are about $750 per m^3 and railway timbers about $650 per m^3. Low-grade timbers are sold at about $360 per m^3 (advice provided by Ryan and McNulty Sawmills and Arbuthnot Sawmills Pty Ltd).

The presence of 'cottage industries' based on forest products, such as locally produced furniture featuring natural defects, provides the added benefit of attracting tourists to explore local enterprises and purchase local produce. At Koondrook, tours and an associated 'Redgum Forest to Furniture Showcase' profile the relationship between the forest, primary processing (sawmilling) and the end products. The overall profile of the timber industry, including its employment levels and downstream markets will be investigated by VEAC through a socio-economic study of the various industries in the River Red Gum Forests study area.

Table 14.5 Average annual production (by product) from Arbuthnot Sawmills Pty Ltd, 2000–2005.

Product	Proportion of Total Output	Proportion of Sawn Output
Firewood, other non-mill products	53%	-
Structural, including bridge timbers, heritage structure timbers, building sections, suburban fence posts, drop-bars for water management structures	27%	58%
Low grade, such as landscape timbers and shorts for survey pegs, stakes and fence droppers	12%	25%
Railway timbers, including sleepers and crossing timbers	6%	13%
Kiln-dried for furniture and flooring	2%	4%

Source: Arbuthnot Sawmills Pty Ltd, 2006, unpublished data.

Sawmilling Industry Trends

A decline in traditional markets for unseasoned hardwood has led to a general restructuring in the timber industry. Investment by the industry in air-drying facilities, seasoning kilns (for humidity controlled drying of fresh-sawn timber), reconditioning plant and equipment to finish (plane and shape) the dried timber, means that an increasing proportion of total sawn output is seasoned and processed into higher value products. Appearance-grade river red gum finds a ready market in the building joinery and furniture trades.

While this trend has required significant additional capital investment it has provided benefits in terms of increased value of production and employment. Ryan and McNulty Pty Ltd at Benalla is one example. Established in 1949, the company faced increasing competition in the 1990s from plantation softwood in the house framing market. Following the installation of new green and dry sawmilling equipment, seasoning kilns and air-drying facilities, together with the purchase of additional sawlog resources (some of which was to compensate for a reduction in supplies as a result of adjustments in the sustainable yield from state forests) and green sawn timber from other producers, the company achieved a five-fold increase in annual turnover. The company now supplies kiln-dried ash species (mountain ash, alpine ash and shining gum) and river red gum timbers into the Victorian and interstate markets, ash species to international markets as well as traditional unseasoned hardwood timber to the local building industry (McNulty 2005).

Although river red gum is only a small proportion of the total sawn timber output from Ryan and McNulty as, indeed, the river red gum timber industry is small by statewide standards, the company is supplying 'select' and 'natural features' kiln-dried river red gum into a niche market.

Arbuthnot Sawmills, similarly, is a modern timber processing company with automatic equipment which, in 1994, added a kiln-drying plant to add value to the river red gum timber resource. With kiln dried timber readily available, the furniture industry in the region has grown to now include four substantial businesses (Figure 14.11) (Arbuthnot Sawmills Pty Ltd 2006).

Figure 14.11 Furniture workshop.

Murray River Sawmill has similarly installed a kiln-drying plant and, following considerable market testing, the sawmill at Barham (NSW) now produces river red gum veneer timbers. This process required the installation a kiln to condition the flitched timber and equipment to slice, dry and clip the veneer.

Railway Sleeper Industry

Railway timbers for the Victorian rail network—sleepers and crossing timbers—are produced in sawmills, at small static mills on private property or by mobile mills at the stump. These timbers are now almost exclusively river red gum and are produced by about 12 businesses (sawmillers and sleeper-cutters) in the state. Two sleeper-cutters prepare their sleepers at the stump, the others use small static mills established on private land (as advised by Arbuthnot Sawmills).

The railway sleeper market is valuable to the river red gum sawmilling industry. Although the proportion of sleepers compared to total mill output is small (Table 14.5, for example), sawing them is relatively straight-forward, the market is large and payments are reasonably guaranteed; they are an important component of the total revenue stream. Sleeper production enables utilisation of timbers that fail to meet structural or kiln-drying standards and logs from stand thinning operations that are too small and would otherwise be sawn into lower value products—although the extent to which sleeper production competes with higher value products (including for these smaller logs which could be left in the forest to grow into sawlogs) remains an issue (see chapter 19).

Under the wood grading system now in place in Victoria, timber is no longer sold from state forest according to the expected product, such as sawn timber or sleepers. Rather, the logs are graded according to their quality and size, leaving the purchaser to decide on the product yield. Accordingly, contemporary figures on the actual output level of railway timbers are difficult to derive. Based on the previous licensing system, however, average total production of sleepers by licensed cutters in the Mid-Murray Forest Management Area from 1991–92 to 2000–01 was 3523 m^3 nett per annum (about 38,750 sleepers per annum). Output in the later years fell well short of this average, largely following privatisation of the contracts for maintenance of the rail network in the mid-1990s (DNRE 2002b).

Sleeper Industry Trends

Much of southeastern Australia's railway network still sits on river red gum sleepers and river red gum crossing timbers were used in the recent works at Southern Cross (Spencer Street) Station in Melbourne. Of the approximately 7500 km of rail track in rural Victoria (which includes the interstate system in Victoria, totalling about 770 km), some 6000 km is fixed to hardwood timber sleepers. Similarly, of the 875 km of track in the Melbourne metropolitan network, some 612 km is on timber sleepers. Based on an average of about 1500 sleepers per kilometre, the total rail network in Victoria currently rides on some 9,910,000 hardwood sleepers (advice supplied by Redgum Timbers Producers (Australia)).

River red gum sleepers generally have a 30-year service

life. In the Melbourne metropolitan rail network, this translates to between 35,000 and 40,000 sleepers requiring replacement annually (DoI 2005). The current lessee of Victoria's regional broad-gauge rail network, Pacific National, replaces about 100,000 hardwood sleepers annually as part of normal maintenance. Further, Australian Rail Track Corporation Ltd (ARTC), which leases the two interstate standard gauge corridors from the Victorian Government—Melbourne to Wolseley (in South Australia) and Melbourne to Albury (in NSW)—also requires sleepers both for maintenance and upgrades.

The sawmilling industry and Forests NSW developed an Australian Standard for railway sleepers, which specifies, amongst other things, the acceptable slope of the grain across each piece and sets the acceptable levels of sapwood and fault to ensure safety in operation. Passing of sleepers in accordance with these standards is done either by a recognised contracted sleeper-passer or, in the case of the permanent sawmills, self-assessment. Establishment of this standard has provided some stability in the demand for sleepers as relative consistency in the quality of the sleepers supplied is assured.

Substitutes for Hardwood Sleepers

Only timber sleepers have been used in the Melbourne metropolitan rail network replacement program to date. Concrete sleepers were considered to be unsuitable for interspersion with in-situ timber sleepers, as their deeper profile (28 cm compared to 12–13 cm for timber) makes them much more rigid than timber sleepers. Interspersing conventional concrete sleepers with timber has also caused problems with the overall life of the track (DoI 2005). A lighter, low-profile, pre-stressed concrete sleeper has been designed specifically to be interspersed with timber sleepers in existing tracks. These are under trial on the Frankston line and indications are that they will be suitable but will require approval by the line operator—Connex—before they can be used in the routine annual maintenance program across the metropolitan network. However, hardwood sleepers will continue be used in maintenance of the rural network (DoI 2005). Furthermore, hardwood crossing timbers are required to ensure strength and stability across the converging/diverging rail lines.

Concrete sleepers require significantly more ballast than timber sleepers and their weight (three to four times that of timber sleepers) makes them expensive to transport and difficult to handle with conventional sleeper replacement technology (University of Southern Queensland 2006). Nevertheless, with a life span of some 50 years under normal operating conditions and being fire-resistant, concrete sleepers are gaining increasing acceptance. About two million were used in Australian National's 1420 km trans-continental AustralAsia railway, completed in 2003 and, in 2005, ARTC invited tenders for the supply of another two million. Concrete sleepers will be used in all new lengths of line in both the metropolitan and regional rail systems in Victoria (DoI 2005). Recently, ATRC announced that concrete replacement sleepers would be used on the Melbourne–Brisbane route.

Steel sleepers are also widely used in Australia. Various configurations are available, depending on the intended application (Townsend 2002). There has been some concern that steel sleepers are generally too light to maintain stability, particularly on curves, have poor bearing characteristics, move where there are significant variations in ambient temperature and require high maintenance. The selection of steel sleepers requires a good knowledge of track duty, both current and future, and of environmental conditions under which they are to operate. Townsend (2002) notes that steel sleepers generally fail as a result of fatigue cracking, corrosion or a combination of both. While unprotected steel does corrode, long-term observation of steel sleepers under general environmental conditions has shown the total loss of thickness due to corrosion may be as low as 1 mm over 40 to 50 years. Where corrosive locations are identified (such as the salinity affected areas of northwestern Victoria), it is usual to increase the thickness of the sleeper section, although corrosion protection coatings may also be applied. Australian Standard AS1085 Part 17—Steel Sleepers has been developed as a guide to the selection of steel sleepers.

Successful in-track performance of steel sleepers depends not only on the selection of a suitable configuration but also on the methods of installation and tamping of the ballast. This is especially important where they are interspersed with timber sleepers and differential settlement on the ballast may occur. The pattern of interspersion is important to avoid rail movement and stresses. Steel sleepers have been interspersed into existing timber-sleepered tracks during maintenance programs on a number of rail lines within Australia (Townsend 2002).

A fibre composite railway sleeper, made from polymer concrete and glass-fibre reinforcement, is also being developed. It is approximately 120 mm deep and weighs about 63 kg, although designs can accommodate local conditions outside of these parameters, and can be fitted with standard rail fasteners. The shape of the sleeper provides resistance against lateral movement and it is designed for both interspersion with existing timber sleepers and for new sections. A trial with 500 sleepers is to be established in a track near Toowoomba, Queensland (University of Southern Queensland 2006).

Fencing

A small, but steady demand for fencing materials continues, reflecting the need for replacement fencing

and the increasing intensity of local agriculture. Alternatives to fencing material from native forests include treated plantation pine, concrete and steel. Electric fences are also used and, although usually fitted to timber posts, they use less material than traditional post-and-wire fences.

Firewood

Firewood is an important component of state forest management and wood production. This section discusses the details of firewood collection and consumption with regard to Victorian state forests but also examines some of the wider issues that influence the patterns of firewood use in Victoria.

Firewood is a valuable source of renewable energy. Burning wood to warm homes and fuel industry has been part of Australian culture since European settlement. Many Victorians consider firewood an essential fuel for heating and wood fires have a strong aesthetic appeal. Woodfires may be the most cost-effective heating available for people in regional areas, including many towns in the study area, who do not have access to reticulated natural gas (see chapter 17). It is reported that elderly people and pensioners often rely on firewood as their primary source of heating as other fuels are too expensive. Approximately half of the DSE domestic firewood permits (see below) are issued to concession holders (DNRE 2002c). Socially, many people consider firewood collection to be at least partly a recreational activity and, particularly, an integral part of the ritual and fun of camping out in the bush.

Current Firewood Use

The percentage of households using firewood as primary heating fuel increased rapidly after the price of heating oil doubled in 1978. The development of controlled-combustion heaters since the 1980s also increased the demand for firewood with the percentage of households using firewood as primary heating fuel peaking in 1992. Between 1992 and 1999 the percentage declined but the number of households using firewood stabilised due to increasing population numbers (Todd 2003). Consequently, current sales of firewood from state forests are similar to levels in the 1970s (DNRE 2002c).

Each year in Australia, an estimated 4.5–5.5 million tonnes of timber are harvested for domestic firewood use. When industrial fuelwood is included, the total increases to 6–7 million tonnes, which is roughly double Australia's annual hardwood woodchip export (Driscoll et al. 2000). An average of about 3 tonnes of firewood is consumed per firewood-using household each year although the amount varies across the country, ranging from Queensland with an average of 1.3 tonnes per year to Tasmania where 5.8 tonnes on average is burned each year (DNRE 2002c).

Harvesting occurs predominantly in the cooler southeast of the country with more then half consumed in New South Wales and Victoria. Two-thirds of the firewood consumed is burned in regional Australia, reflecting the limited availability of alternative sources of heating, such as natural gas (Driscoll et al. 2000).

In Victoria in 2002, an estimated 268,350 households (17.1 percent of the total) consumed about 620,000 tonnes of firewood, about half of which was consumed in the greater Melbourne area. Of the 134,500 tonnes of firewood sold in Victoria through firewood merchants, around 107,600 tonnes (80 percent) is river red gum (see Figure 14.12). This high proportion may reflect either the ready availability of river red gum through the merchants or consumer preference for dense, heavy wood.

Figure 14.12 River red gum is a popular firewood species.

Firewood Sources: Collection and Sales

The firewood consumed in Victoria comes from private land, state forest and other public land including roadsides, and also from interstate. Box 14.2 gives details of the estimated amount of firewood from each of these sources. Only about 10 percent is collected legally from Victorian state forests (DNRE 2002c). River red gum firewood is also produced as by-product from sawmills in the study area.

Domestic firewood is collected by two distinct groups: firstly, the commercial firewood cutters (including firewood merchants, sawmills and other groups such as arborists) and secondly, the consumers. In Victoria, about 34 percent (210,800 tonnes) of firewood is purchased from commercial operations such as sawmills with 134,500 tonnes coming from firewood merchants. Most of the firewood bought from merchants is brought from interstate—mostly from New South Wales, in the regions of Balranald, Hay and Deniliquin (Driscoll et al. 2000). Retailers of firewood are generally located between 180 and 330 km from the source (Driscoll et al. 2000). Indicative figures suggest that about 40 percent of interstate firewood comes from NSW state forests with the balance from private property (DNRE 2002c).

The remaining 66 percent or 409,200 tonnes is collected by consumers directly. However, the proportion of consumer-collected wood in some areas is much higher, for example, in the North East, Mildura and Mid-Murray Forest Management Areas in 1999–2000, nearly 100 percent of the firewood sold by NRE was to consumers rather than commercial cutters (DNRE 2002c). Most of the firewood collected by consumers is collected within 20 km of the location where it will be consumed (DNRE 2002c).

In Victorian state forests, firewood can be collected by commercial operators or by domestic collectors through the issue of permits (see above). Firewood permits from

state forests in Mid-Murray and Mildura Forest Management Areas in 1999–2000 totalled 6819 tonnes, principally river red gum, representing 11.8 percent of the total firewood sales from Victorian state forests at that time. In that year NRE also sold river red gum firewood (amongst other species) from the Benalla–Mansfield and North East Forest Management Areas, as well as from Horsham FMA which is outside the River Red Gum Forests study area. In total, almost 12,800 tonnes (22 percent) of the firewood sold by the department across the state in 1999–2000 was river red gum (DNRE 2002c; DSE 2005h).

In 2002/03, 1015 m^3 and 2121 m^3 of firewood were sold to domestic and commercial cutters, respectively. An estimated 2000 m^3 is illegally collected from state forest annually (DSE 2004f).

There is not presently any sawlog, sleeper or post harvesting in the Mildura FMA. The two commercial firewood cutters present in 2004 were cutting firewood from sawlog coupes harvested between 1999 and 2002. However, this resource declined quickly (DSE 2004f). At present, there are no commercial firewood cutters in the Mildura FMA and DSE are cutting dead standing trees to supply firewood for consumer demand in the area.

In the Mid-Murray FMA, commercial operators cut firewood from residual wood (heads of trees and logs felled during sawlog and sleeper harvesting but not taken) and also from thinning operations. In 2000–2001 just over 12,000 m^3 of firewood was taken from Mid-Murray including 3984 by commercial cutters and 8505 by domestic cutters (DNRE 2002a). The largest amount came from Gunbower, Guttrum and Benwell state forests (5730 m^3). The amount collected illegally from state forests is unknown but thought to be substantial (DNRE 2002c).

Very little firewood is taken from public land in the two remaining Forest Management Areas partly within the River Red Gum Forests study area, i.e. Bendigo and North East FMAs.

Domestic firewood collectors (those seeking to collect firewood for their own use) on public land must hold a 'C' licence (see above). These are generally limited to one trailer load, for one day, with conditions and a map specifying the area from which the wood may be taken. Retail outlets in some regions of the state are authorised to sell firewood permits to domestic collectors on behalf of DSE. Firewood for domestic use from state forest is usually licensed by the cubic metre, and the cost (non-concession) ranges between $9.50 and $25.25 per m^3 (2005–2006 prices) depending on the Forest Management Area and the zone (DSE 2005d).

Recreational users of the forest (particularly campers) also collect firewood for use *in situ* and large volumes are collected from state forest in the study area, particularly from sites close to the Murray River. For the Barmah forest, for instance, an estimated 5000 tonnes is collected by campers over the summer holiday period (DNRE 2002a). In some cases, campers have used vehicles to drag large-dimension wood to their campsites. Some firewood may also be produced in parks and other reserves in the course of infrastructure, fire prevention and safety works. In parks, visitors are usually requested to bring their own firewood or alternative heating; although this is limited in effectiveness (DNRE 2002c).

More than 181,000 people (both commercial and domestic) collect firewood each year from both public and private land in Victoria, some 99 percent of whom are domestic collectors who collect about 66 percent of the firewood consumed (DNRE 2002c). Only 8.8 percent of people involved in domestic firewood collection carry a departmental permit—about half of these are concession card carriers (pensioners, war veterans and widows and holders of health care cards).

Factors Affecting the Amount of Firewood Burnt

A number of factors affect the amount of firewood burnt, and hence, the amount and species collected. Hardwoods are the current firewood of choice in all Australian cities, even where there are large softwood resources and almost no local hardwood supplies (Driscoll et al. 2000). The quality of firewood can vary and the popularity of river red gum firewood indicates that many purchasers prefer dense, dry wood.

The type of wood will affect how much heat it releases. In terms of heat released per kilogram of wood ("calorific value"), hardwoods produce slightly more

BOX 14.2: FIREWOOD SOURCES IN VICTORIA

Of the estimated 620,000 tonnes of firewood consumed in Victorian households each year:

- 50% (310,000 tonnes) comes from private property
- 10% (62,000 tonnes) is collected legally from Victorian state forest; of which:
- 4% (23,600 tonnes) is under commercial licence, and
- 6% (38,400 tonnes) is under domestic licence
- 10% (62,000 tonnes) is collected illegally from public land
- 30% (186,000 tonnes) comes from other sources, including interstate (DNRE 2002c).

A significant volume is also collected and burned *in situ* at campsites throughout public land in the state—in Barmah forest alone, an estimated 5000 tonnes is collected by campers over the summer holiday period (DNRE 2002f).

than softwoods (20 MJ/kg v 19 MJ/kg) (Todd 2003). Plantation-grown sugar gum has similar calorific values as natural-grown river red gum and could be used to complement or substitute for firewood production from native forests (DNRE 2002c). However, the moisture content of the firewood is also a contributing factor. Poorly dried river red gum (hardwood) can release the same amount of energy per kilogram as well-dried radiata pine (DNRE 2002c).

Wood density varies between species, between provenances of a particular species and with growth rates and tree age. Density of Tasmanian blue gum wood, for example, ranges between 550 kg/m^3 and 600 kg/m^3 for 12- and 20-year-old plantation-grown trees respectively, and to 800 kg/m^3 in natural forest-grown wood (DNRE 2002c).

The amount of firewood burnt is in part determined by the design of the heater and home. On average, an open fire will burn five times the amount of wood per year as a combustion heater to heat an average house (DNRE 2002c). There are around 800,000 woodheaters and 700,000 fireplaces in Australia (Driscoll et al. 2000). Some, but not all, combustion heaters are designed to heat efficiently with both hardwood and softwood fuel provided they are used appropriately (Todd 2003).

The Impact of Emissions

Woodheaters and fireplaces are the major sources of particle emissions in the southern cities in the colder months and are responsible for those cities regularly exceeding the National Ambient Air Quality Standard for particles set under the Ambient National Environment Protection Measure (Todd 2003). In 1995–96, wood heaters and open fires contributed an estimated 70 percent of fine particulate emissions (DNRE 2002c). Human exposure to elevated particle levels is linked to heart and lung disease. Wood-smoke pollution may reduce the amenity of small town living. The key factors contributing to the inefficient use of firewood relate to incomplete combustion arising from:

- use of unseasoned firewood—excessive moisture contained in green or wet wood
- less-efficient woodheater technology—slow combustion woodheater models vary greatly and open fireplaces are much less efficient
- poor operating behaviour—insufficient air intake can lead to insufficient air mixing (DEH 2006).

The Australian Standard for wood heating appliances (AS 4013) was introduced in 1992 to reduce impacts on air quality and the environment (DEH 2004). In 1994 in Launceston, approximately 66 percent of households used wood for heating and, although the percentage had dropped to 45 percent in 2000, woodsmoke pollution was still above acceptable limits. Programs to reduce wood smoke pollution by increasing the conversion rate from wood heaters to gas heaters and educating wood heater users were put in place. The percentage of households using woodheaters reduced to approximately 30 percent in 2004 and have been successful in reducing pollution in some areas (CSIRO Atmospheric Research 2005). This reduction was driven by an increased awareness of the problems of woodsmoke and by a desire for more convenient sources of heat.

Burning firewood also results in greenhouse gas emissions. The extent of the net impact on those emissions depends largely on the source of the firewood. Cutting firewood from private property without replacing the trees, for instance, makes a 100 percent contribution to greenhouse gases. However, the amount of carbon dioxide released is "at least matched" by the amount of sequestered carbon as a replacement tree grows (DNRE 2002c). Thus, plantations established for firewood production can be regarded as carbon sinks for as long as the plantation area is increasing; once the final area is achieved, they would be close to emission-neutral. Firewood from sustainably managed forests could be reducing net greenhouse emissions if replacing fossil fuel based heating sources.

Firewood and Habitat Degradation

Fallen timber is an important structural element in forests. Many animals, plants and fungi species rely on fallen timber for shelter, foraging habitat and nutrient cycling, refuge from predation and the larger pieces provide a structure to trap fine debris, sediments and nutrients providing microhabitat (Mac Nally et al. 2002). Fallen timber is also important during floods as it provides vital habitat for fish and aquatic invertebrates. The removal of fallen timber for firewood impacts greatly on many species and is one of the major threatening processes for threatened carpet pythons and grey-crowned babblers (Davidson & Robinson 1992; Heard et al. 2004). Strategies have been devised to reduce the impacts of firewood collection on the environment (see below). The impacts of firewood collection on faunal habitat are further discussed in chapter 5.

Future Demand for Firewood

The demand for firewood is based on the level of heating required to warm homes. Improved home energy efficiency would reduce the need for heating and, in the case of woodheaters, firewood consumption (DEH 2006). All levels of Australian governments have initiated actions to improve the energy efficiency of homes for a range of reasons, including reducing greenhouse gas emissions. Actions include incorporating energy-efficient measures into the Building Code of Australia and energy efficiency ratings schemes, which provide requirements or incentives in relation to factors such as insulation and house orientation (DEH 2006).

Reticulation of natural gas continues to be extended providing a cheap alternative to woodheaters. Nevertheless natural gas is a fossil fuel and contributor of greenhouse gas emissions. Despite large reserves, natural gas resources are ultimately limited and Australia is currently exporting natural gas overseas.

Greater use of alternative fuel sources, such as softwood or manufactured fuels, would lessen the amount of firewood collected. However, at present, most woodheater models are certified to meet the Australian Standard (AS 4013) for flue gas emissions on the basis of burning hardwoods only. Given the limited demand for 'softwood certified' heaters, there is currently no incentive for manufacturers to invest in extra tests, which cost about $5000 each, for other fuel types (DEH 2006).

A number of factors, including the cost and availability of firewood and of alternative fuels, will influence future firewood demand. However, it seems clear that demand for firewood will continue into the future. To ensure an ecologically sustainable supply, a broad range of options needs to be considered, including increased use of firewood from plantations, wood waste (from sawmills, manufacturing, demolition sites, arboriculture and households) and residues from silvicultural operations. Although value-adding in the timber industry is continually finding new products, waste will always be generated. Whereas sawmill waste was previously burned, the strong market for river red gum firewood means that these wastes are now sold. In many areas, current demand for firewood outstrips sustainable supplies and the development of alternative fuel and/or heating systems is likely to be needed in the future.

Policy

Firewood collection in state forest comes under the policies and legislation discussed earlier in this chapter. However, the combination of a high proportion of firewood collected from private land and the high proportion being taken by individuals and part-time operators makes the firewood industry very difficult to regulate. Recently, two strategies have been released with the objective of reducing the impacts of firewood collection.

The Australia and New Zealand Environment and Conservation Council developed a *National Approach to Firewood Collection and Use in Australia*. It aims to 'ensure that all firewood collection occurs on an ecologically sustainable basis and is not a cause of loss and degradation of remnant and woodland ecosystems or the habitats of threatened species' (ANZECC 2001). This document recognises six major strategies to achieve its objectives:

- improve the information base
- educate the community
- implement market mechanisms
- increase effectiveness of regulations
- develop a sustainable firewood industry, encouraging plantations, sustainable management of native forest and use of residues
- improve efficiency of firewood use and encourage alternatives.

Following consultation with firewood merchants and state and territory governments, the Natural Resource Management Ministerial Council, on 1 August 2005, endorsed a revised voluntary code of practice for firewood merchants. The code promotes a more environmentally friendly firewood industry and will underpin a sustainable future for the industry. Merchants who sign up to the code will:

- ensure firewood they sell is collected in accordance with relevant legislation and regulations
- promote firewood sourced from plantations and sustainably managed forests
- ensure firewood will not be collected from areas where collection may have a significant impact on listed threatened species or listed threatened ecological communities
- promote good storage and burning practices and the use of seasoned firewood to minimise air pollution (NRMMC 2005).

PLANTATIONS

On-farm timber plantations in lower rainfall areas provide economic benefits as windbreaks and shelterbelts for livestock and for lowering groundwater tables and reducing salinity. They provide environmental benefits through greenhouse gas abatement and the provision of faunal habitat, as well as general amenity. Extensive areas of private property in the Murray River hinterland are suited to agroforestry systems and community based woodlots for the production of substitutes for some of the small-dimension products yielded from native forests, such as fence posts and firewood. But sawlog production requires a much longer timeframe and, in the north of the state, tree growth is slow and productivity is low.

Establishment of commercial plantations necessitates detailed economic analysis. Important considerations in such analyses would include water volumes and costs, irrigation infrastructure costs, land costs, site productivity, values of the products and proximity to markets and the competitive position relative to alternative crops or land uses. The effect of insect predation on the growth rates of native species is also an important factor (Arnold et al. 1999).

The quality of relatively fast-grown, pruned, plantation timbers is likely to differ markedly from that of slow-grown, older, natural forests and would probably be directed to different applications. The density of timber from fast-grown trees is lower, for instance, and knots are larger than in comparatively sized trees from natural forests (Yang & Waugh 1996a, b). Nevertheless, Yang and Waugh (1996a) found that the strength properties of clear wood from plantation-grown blue gum were not inferior to those from mature forests when differences in tree size and age are taken into consideration. They believed that it could be used for structural sawn products in applications where plantation-grown softwoods are now used. The strength properties of plantation-grown shining gum and mountain ash, however, were lower than that of these species from native forests (Yang & Waugh 1996b).

Several investigations into the ability of plantation-grown eucalypts to produce quality sawn timbers have been undertaken. Plantations of species other than river red gum can achieve better productivity values than those for native river red gum forests but even the more productive species grown on 30-year rotations have thus far been found to be economically unviable for sawn products. The following are examples of the range of values for wood productivity measured or estimated for eucalypt plantations in southern Australia:

- 20 m^3/ha/yr (estimated) for Tasmanian blue gum grown in Gippsland (DNRE 2002c);
- 17.8 m^3/ha/yr (measured) for Tasmanian blue gum grown under an intensive thinning and fertilisation regime near Busselton in southwest Western Australia—with more than 800 mm per annum rainfall (Brennan et al. 2004);
- 16 m^3/ha/yr (estimated) for hardwood plantations east of the Hume Freeway in the upper catchments of the Murray and Goulburn rivers where the annual rainfall is more than 700 mm (Wareing et al. 2002);
- 12 m^3/ha/yr (estimated) for a Sugar Gum plantation growing in the 600–650 mm rainfall zone in Victoria (DNRE 2002c);
- 4.5–4.9 m^3/ha/yr (measured) for Sugar Gum plantations growing at the You Yangs in Victoria in the 450–500 mm rainfall zone (Dexter & Poynter 2005).

For comparison, softwood plantations in the north east of Victoria can grow at about 19 m^3/ha/yr (Wareing et al. 2002).

River red gums are inclined to branch (the species has poor apical dominance) rather than being dominated by a single central stem as is the case in many other eucalypts. The bole tends to beak into branches early, leading to short trunks, multiple stems and large branches (Jacobs 1955). This effect is pronounced at the conventional plantation stocking rate of 1000 stems per hectare (Dexter & Poynter 2005). To achieve a well-stocked plantation of trees of good form, river red gum plantations would need to be at close spacing or direct seeded (natural stands carry more than 3000 stems per ha at age eight—see above) to discourage side branching. Planting at such densities requires thinning and stem selection, which is labour intensive and expensive.

Because it is adapted to arid and semi-arid environments, river red gum has been planted widely in countries around the world where it is used as a source of posts, poles, firewood, pulp and to a lesser extent saw timber (Mazanec 1999). As with plantations of exotic species in Australia, river red gum can be much more productive when planted overseas. This is principally because exotic species are less affected by endemic insects and diseases. Plantation species overseas, however, are also selected for their desired characteristics and are more intensively managed. In California, for example, river red gum planted for fibre production is yielding up to 45 m^3/ha/yr on eight-year rotations (Arnold et al. 1999). This particular plantation was subject to intensive site preparation, fertilisation and frequent drip irrigation scheduled on the basis of evapotranspiration estimates and tree age, and comprises tissue-cultured clones that were intensively selected and tested for vigour, straightness, cold tolerance and wood quality. In contrast, following investigation of the potential of river red gum for farm forestry in Western Australia, Mazanec (1999) concluded that, to date, relatively poor growth rates and poor form have rendered it a non-commercial proposition.

Even under optimal watering conditions, stands of river red gum managed primarily for timber production (similar to plantation conditions) would yield only 4.35 m^3/ha/yr (2.5 m^3/ha/yr in sawlog-quality material) (see Appendix 16). It would also take at least 40–50 years to produce sufficient trees of merchantable size and wood quality to warrant economic harvesting (Dexter & Poynter 2005). To be commercially viable in the 250–450 mm rainfall zone of northern Victoria, timber plantations would require access to water, which is a limited resource in the region and in strong demand for more profitable short-term crops (see chapters 13&15).

In recognition of the poor plantation potential of most species grown under low rainfall, hybrid eucalypts that can combine an ability to tolerate drought and salinity with the superior growth characteristics of noted plantation species are being developed. A river red gum–blue gum hybrid is under trial in north-central Victoria but plantings are too young to indicate its success and it will be decades before its ultimate survival, growth and wood quality are known (Dexter & Poynter 2005).

However, although there has been increasing interest in the prospects of commercially irrigated eucalypt plantations in the southern Murray–Darling Basin, few such plantations exist in that region which can provide instructive models. The high rates of evapotranspiration associated with dense rapidly growing plantations has led to their use for reducing soil moisture, such where sewage and other urban and industrial effluent is discharged, irrigation drainage sites and where the groundwater table is shallow. Sydney blue gum and flooded gum species have relatively high water requirements due to their high rates of growth and have been established on such sites in the northeast of the state to reduce the environmental impact of nutrient-rich runoff on river systems. These plantings are generally owned by either private landowners in irrigation areas or water management authorities. Plantations for effluent disposal have been established at Shepparton, Wangaratta and Wodonga and further plantings can be expected (Wareing et al. 2002). Plantations established for the re-use of industrial, agricultural or other effluent are often simply allowed to grow with little management.

Small plantations (averaging 10–15 ha) of mainly blue gum and shining gum are scattered through the central and northeastern parts of Victoria's Murray and Goulburn river catchments (600–800 mm rainfall zone). Totalling about 1600 ha, most are owned by private individuals (members of the FFORNE Hardwood Growers Co-op) and were established with the assistance of financial incentives from the Victorian Government through the 1996–98 North East Farm Forestry Project. These plantations will probably be managed for sawlog production and, although they may produce some pulpwood from thinnings, are not expected to be ready

for final harvesting until at least 2020. The largest concentrations of FFORNE plantations are located in the Delatite (now Mansfield and Benalla) and Murrindindi Shires and Wangaratta Rural City. The rate of expansion appears to have lost impetus, however, in the absence of further financial incentives and the establishment of plantations for pulp-log production closer to port facilities (Wareing et al. 2002).

Environmental Services

Many of the substitutes for wood products are demanding on energy and water and the wastes and other emissions produced in their manufacture have further environmental impacts. Timber, on the other hand, is an environmentally friendly resource. It is energy-efficient, recyclable, biodegradable and a naturally renewable resource and requires less energy to process than other building materials such as bricks, cement, plastic, glass, steel and aluminium (Pearson 1989).

The value of thinning and other silvicultural practices to, for example, reduce the severity of insect attack or to reduce the numbers of trees in stands that are stressed and dying from salinity, inappropriate watering and drought is discussed above. The potential benefits of firewood for reducing greenhouse gas emissions are described above.

Specific silvicultural regimes can be applied in the river red gum forests to maintain or improve habitat value, by:

- improving structural diversity;
- promoting river red gum regeneration to provide or restore roosting sites for colonially nesting waterbirds;
- improving roosting and nesting opportunities for birds, through thinning of dense stands to accelerate the development of heavier branching in the retained trees;
- preventing or reversing forest encroachment onto moira grass plains, through suppression or removal of river red gum regeneration.

Each of these can be undertaken through specific silvicultural operations and, in some cases, wood products may be harvestable (DNRE 2002a).

As with plantations, native forests have a substantial role in reducing the greenhouse effect through the sequestration of carbon from the atmosphere. Regenerating forests absorb a greater amount of carbon than senescent forests (DSE 2005h). This effect continues for as long as they are growing but the rate reduces as the forests mature until the stage when growth and decay are in balance. During senescence, when the rate of decay exceeds that of growth, the forest becomes a net emitter of carbon dioxide.

Forests managed sustainably for the production of timber are regarded as greenhouse 'sinks' as the amount of carbon they sequester exceeds that released during harvesting. Further, following harvesting, carbon remains in the wood for the lifespan of the end product (DSE 2005h). The wooden frame of a brick veneer house stores up to 7.5 tonnes of carbon while a steel frame for a similar house adds 2.9 tonnes of carbon to the atmosphere through the use of fossil fuels for energy to produce the steel (Turner 1989). High quality river red gum furniture is thought to have a service life of 200 years, general construction timbers might remain in use for 80 to 100 years, while sleepers have a 30-year service life, after which they may be used in landscaping for a further 20 years (Dexter & Poynter 2005).

Australia imports some $4.9 billion of forest products, an estimated $450 million of which derives from illegal logging operations and almost half of that (about $214 million) is in the form of furniture (Hopkins 2006). Furniture produced from timbers grown within Australia reduces some of the demand for imported timbers and, although the volume is small compared to that from other native timbers, quality furniture produced from river red gum reduces some of the demand for imported red timbers, such as merbau.

15 Water Resource Use and Environmental Flows

This chapter considers the regulation of the River Murray for irrigation, the consequential impacts on the environment, and the use of managed water flows to achieve environmental outcomes on public land.

The hydrology of the River Murray basin under natural conditions is outlined in chapter 4. That chapter also describes how the natural systems of the river and its floodplain evolved with the unique flow and flood regimes of the river—cycles of wet and dry and different flood types.

During the last 100 years the River Murray and its Victorian tributaries have been modified extensively by humans for economic development and expansion—mostly agriculture (see chapter 13). Most of this economic activity is on private land and is therefore outside the scope of this study. However, modifying natural river flows for water consumption on private land has resulted in significant ongoing environmental, social and economic costs for public land in the study area (see chapters 5, 6, 11, 13 and 14). It has also meant the development of a highly complex network of water regulation infrastructure and management systems and processes around the consumption of water. Current approaches to addressing environmental degradation of the river red gum forests involve utilising that existing river regulation infrastructure.

In previous investigations, VEAC and its predecessors have focused principally on recommending the appropriate category for each area of public land under consideration. Relatively little emphasis has been given to processes and other factors that are not specific to particular public land areas. This Investigation differs significantly from many earlier studies, because river flows and flooding regimes play an important role in the sustainability of ecosystems and local economies. In particular, the provision of environmental flows to sustain the study area's forests, wetlands and waterways is perhaps the most significant determinant of environmental health of public land, and cannot be disregarded by VEAC. At the same time, the possibility of reduced availability of water for irrigation—especially as a result of climate change—is perhaps the largest potential economic issue in the study area.

Understanding how the River Murray and its tributaries are regulated for water consumption is important because regulation influences and constrains how managed flows for environmental outcomes are delivered to the floodplain forests and wetlands. This chapter (to be read in conjunction with chapters 4 and 5) therefore examines:

- how the River Murray is regulated,
- the administrative arrangements associated with river regulation within the context of the River Murray being owned by New South Wales (NSW) and the water shared by NSW, Victoria and South Australia (SA),
- the use of environmental flows as a management tool to achieve environmental outcomes,
- the administrative arrangements associated with environmental flows, and
- briefly, the issues of water accounting and climate change in the context of environmental flows.

The issues under discussion relate primarily to the study area and this chapter is not a comprehensive description of water arrangements in Victoria or the Murray-Darling Basin.

ADMINISTRATION OF WATER USE

The River Murray and its Victorian tributaries is managed by a complex set of administrative arrangements to deliver water to consumers. This Investigation is mainly interested in the administrative arrangements around how water is allocated to consumptive users and how these arrangements impact on water allocations for the river red gum forests in the study area.

Murray-Darling Basin Agreement

Underpinning all arrangements for allocating water from the River Murray is the *Murray-Darling Basin Agreement*. This Agreement (1992) details the roles and responsibilities of the Murray-Darling Basin Ministerial Council and the Murray-Darling Basin Commission, as well as the monitoring and investigation requirements, operational management arrangements, financial management responsibilities and water distribution including water accounting arrangements. The Agreement clearly spells out each state's entitlement and the obligations of NSW and Victoria to SA. This detailed and lengthy document is available on the Murray-Darling Basin Commission website.

As well as the *Murray-Darling Basin Agreement* there is also the National Water Initiative Agreement (2004), signed by the Commonwealth, NSW, Victorian, Queensland, South Australian, Australian Capital Territory and Northern Territory governments. The agreement is intended to be consistent with the *Murray-Darling Basin Agreement* and specifies a set of outcomes and commitments that focus on achieving more efficient and effective water planning and allocation arrangements, building knowledge and capacity and community partnerships and adjustments for jurisdiction associated with the Murray-Darling Basin. It also articulates an integrated management approach to water to ensure environmental and other public benefit outcomes are gained.

Murray-Darling Basin Diversion Cap

As well as these two agreements water from the River Murray system is subjected to the Murray-Darling Basin Cap. This was introduced in 1995 by the Murray-Darling Basin Ministerial Council following a water audit of all rivers in the basin. The Cap limits the amount of water that can be extracted from the Murray-Darling Basin rivers. In regulated rivers diversion is limited to what would have been diverted under 1993-1994 levels of development. In unregulated rivers the Cap is expressed as an end-of-catchment flow regime. The Cap attempts to balance economic and social benefits obtained from water resources and the environmental uses of water in the rivers (MDBC 2002).

For Victorian rivers, the long term diversion Cap is:

- Goulburn, Loddon and Broken Rivers, 2,084 GL per year. These rivers are important sources of inflows for the River Murray system;
- Upper Murray, Kiewa and Ovens Rivers, 1,656 GL per year. These rivers are important sources of inflows for the River Murray system;
- Campaspe River, 122 GL per year; and
- Wimmera and Mallee Rivers, 162 GL per year. These rivers (refer to chapter 4) contribute little or no water to the River Murray system (MDBC 2002).

Although the Cap prevents increases in water diversion, it does not constrain new developments provided the water is obtained by using water more efficiently from an existing entitlement or by purchasing someone else's entitlement. The Cap is a ten year rolling average that allows extracted volumes to be adjusted to take account of water traded between river basins and states. Compliance is assessed by the Murray-Darling Basin Commission's Independent Audit Group, which prepares an annual review of Cap compliance containing preliminary findings, followed by a Water Audit Monitoring Report.

Water Allocation Framework

The principles upon which water allocation is based are described in Box 15.1.

Victoria's water allocation framework includes a three tiered allocation system. The first tier nominates that government retains the overall right to the use, flow and control of all surface and groundwater on behalf of all Victorians. Under the new water legislation the rights of the Crown are extended to include stormwater and recycled water.

The second tier relates to the Minister making large scale or bulk entitlements for both consumption and environmental uses. This tier incorporates the allocation of water for consumption through bulk entitlements and ceilings on total water use from each catchment or aquifer and for the environment through the new Environmental Water Reserve (see below). It allows for other non-consumptive uses to be taken into account, such as recreation.

The third tier is the allocation of rights to private individuals for consumption. These include water entitlements such as water rights, licences and private rights and allocation for households and for rural domestic and stock uses. Figure 15.1 illustrates this three tiered arrangement for water allocation.

Agencies Involved in the Water Allocation Framework

National Level Agencies

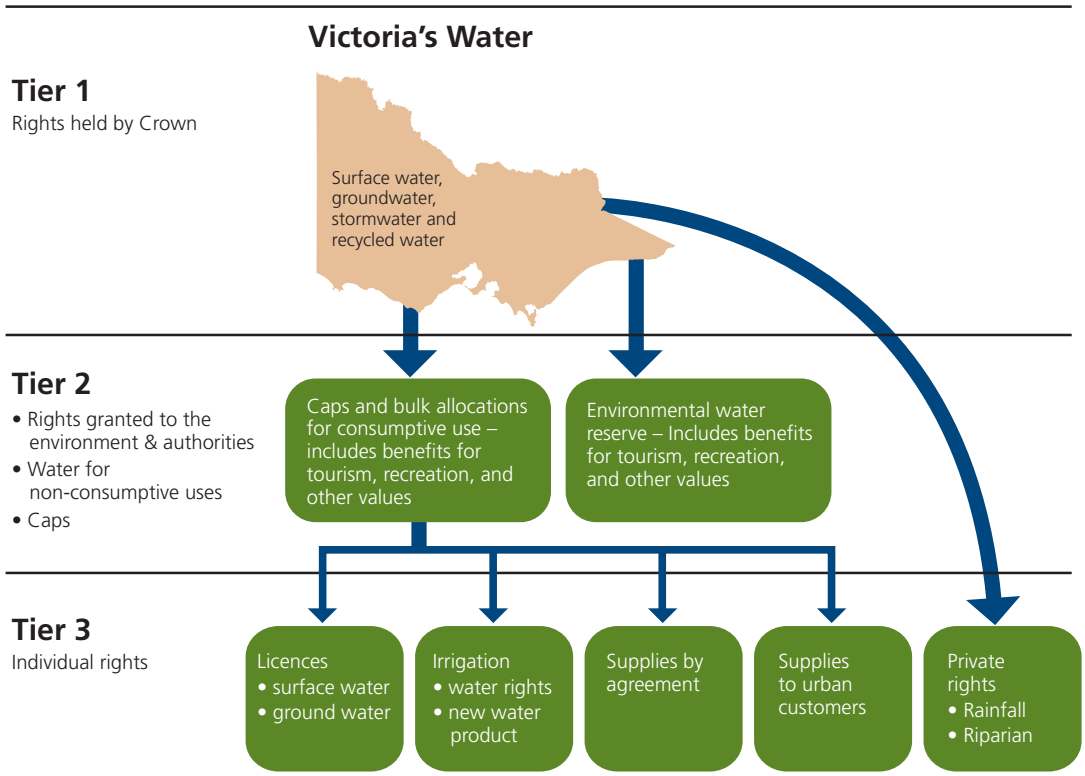
The Murray-Darling Basin Ministerial Council whose membership includes ministerial representation from the Federal, NSW, Victorian, South Australian, Queensland and Australian Capital Territory governments provides overall strategic direction and decision making around the natural resources of the Murray-Darling Basin. The Murray-Darling Basin Commission is the agency responsible for managing the water resources of the Murray-Darling Basin on behalf of Victoria, NSW and SA. River Murray Water is the operational arm of the Commission and undertakes most of the modelling and decision making processes around the three operation modes described below. The operation of Lake Dartmouth, Lake Hume, the Menindee Lakes and Lake Victoria is managed by River Murray Water.

Box 15.1 Victoria's Principles for Water Allocation

In Victoria, the *Water Act 1989* and more recently the *Water (Resource Management) Act 2005* provides the legislative framework for the allocation of Victoria's water resources. Allocation is based on a set of principles that include:

- The Victorian Government is responsible for:
  - the sustainable management of the state's water resources;
  - the allocation of water resources for irrigation, urban use, the environment and for all other purposes; and
  - establishing and maintaining the integrity of the state's water allocation system.
- The state's water allocation system encompasses all water resources, including surface water, groundwater, recycled water and stormwater.
- Water will be set aside in an Environmental Water Reserve (outlined below) that will:
  - maintain the environmental values of the water system and the other environmentally dependent water services;
  - sustain biodiversity, ecological functioning and water quality; and
  - have legal status and be held by the Crown.
- In establishing the initial Environmental Water Reserve, the rights of existing entitlement holders will be recognised.
- Water entitlements for consumption will:
  - have secure tenure;
  - aim to provide reliable water supplies;
  - link the entitlement to a share of the total amount of water available for consumption at any time;
  - specify the obligations associated with holding the entitlement; and
  - be allocated by market mechanisms, wherever possible, and be allowed to trade between entitlement holders.
- All water allocation decisions will take into account the availability of water for the diversity of non-consumptive water uses valued by the community.
- Management of the water allocation system will be adaptive – responding to changing demands, community expectations and new knowledge, whilst ensuring the objectives of Environmental Water Reserves are being met.

Figure 15.1 Victoria's water allocation system.



Source: DSE (2004i)

State Agencies

Various water authorities operate the water supply storages in the Murray Basin on behalf of River Murray Water. Goulburn-Murray Water (GMW) operates Dartmouth Dam in Victoria, Yarrawonga Weir (Lake Mulwala), Torrumbarry Weir and Mildura Weir (Lock 11) on behalf of River Murray Water. State Water in NSW operates Lake Hume and the Menindee Lakes and the South Australian Water Corporation operates Lake Victoria and locks downstream of Lock 11.

Victoria shares the volume in the storages with New South Wales under the Murray-Darling Basin Agreement, which grants Victoria a share of the total reservoir capacity to store and release its share of inflows. GMW is responsible for allocating water to bulk entitlement holders from Victoria's share of the water supply storages in the River Murray system. GMW also manages the storages on Victorian tributaries to the River Murray in its own right.

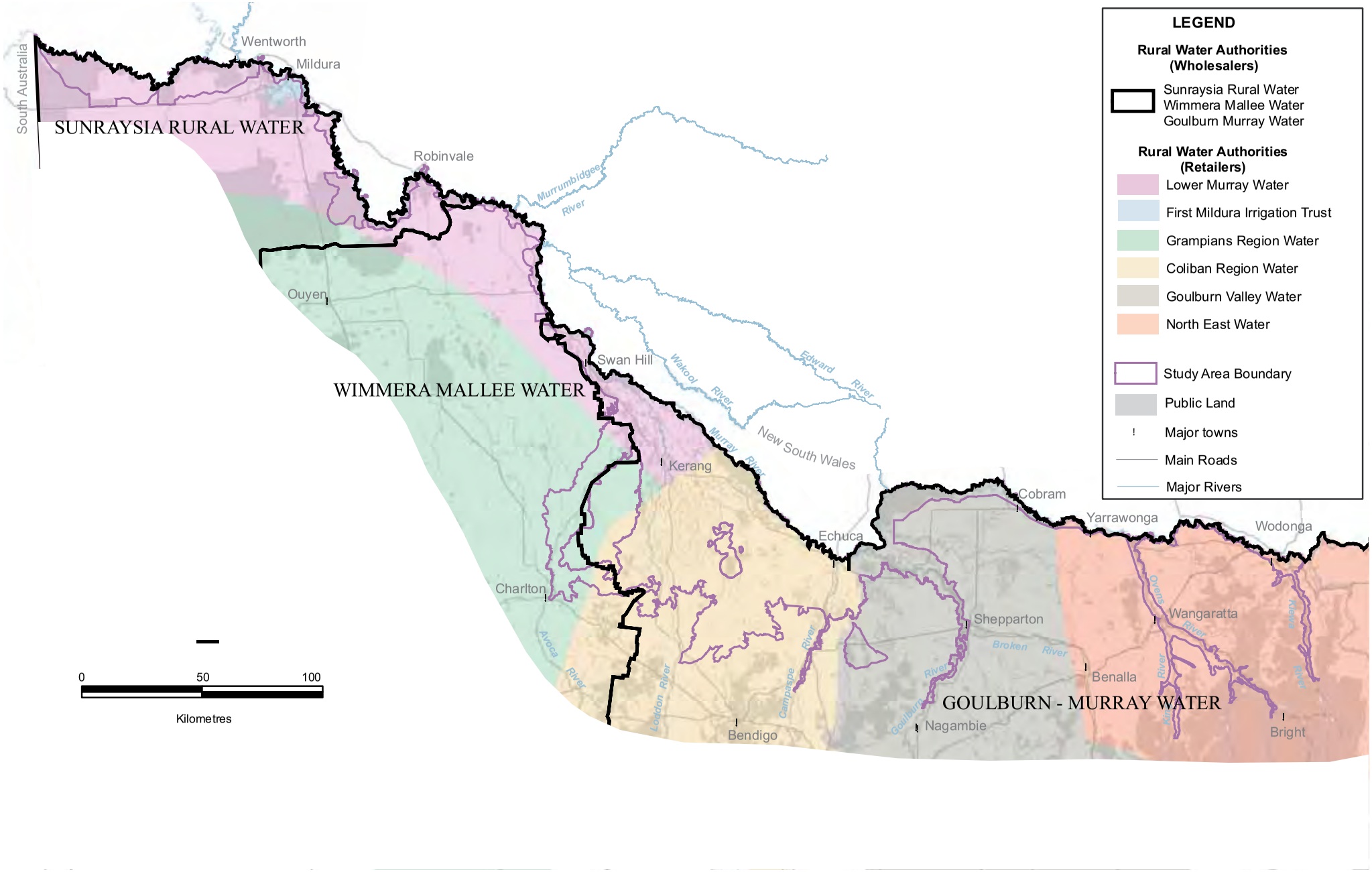
In terms of irrigation systems GMW is responsible for the Murray Valley, Torrumbarry, Tresco and Nyah irrigation areas, and is the licensing authority for groundwater and surface water on the Victorian side of the River Murray basin as far downstream as Nyah. Lower Murray Water (formerly Sunraysia Rural Water Authority) is responsible for managing Red Cliffs, Robinvale and Merbein Irrigation Districts, and is the licensing authority for private diversion of irrigation between Nyah and the South Australian border. The First Mildura Irrigation Trust supplies irrigation water within its district near Mildura.

Various urban water authorities manage town water supplies drawn from the River Murray. North-East Water manages water supply to towns upstream of Lake Mulwala, including Yarrawonga. Goulburn Valley Water manages water supply to towns in the Murray Valley Irrigation Area, while Coliban Water supplies towns in the Torrumbarry Irrigation Area. Lower Murray Water supplies towns from Kerang to the South Australian border (DSE 2006i). Map 15.1 shows the location of water authorities in the study area. Water authorities are also referred to in chapters 9 and 17.

Waterway management functions of Victorian River Murray tributaries reside with the North East, the Goulburn Broken, the North Central and the Mallee Catchment Management Authorities, with the Department of Sustainability and Environment (DSE) and the Murray-Darling Basin Commission coordinating and integrating waterway management along the length of the River Murray. Catchment management authorities (CMAs) also play a major role in floodplain management, environmental flows and in biodiversity management.

Local governments use zoning under the *Planning and Environment Act 1987* to exclude certain land uses that may impact on water quality or where land is subjected to regular flooding. They are also involved in floodplain management activities and stormwater management, including drainage, protection of water quality and restoration of degraded rivers.

Map 15.1 Water authorities in the study area.



Water Accounting

In 2004 the Victorian Government published the Water White Paper to guide the future use of water in Victoria. A major platform of the White Paper is the delivery of water in a more efficient and effective manner, particularly with respect to irrigation practices, but also for environmental flows.

A key aspect of this water delivery involves the development of water accounting systems to clearly identify the stock of water, where it is available from and how much is delivered and where. Efforts are being made at both the national and state level to develop a water accounting system. The Federal Government's National Water Initiative proposes a water accounting framework for the whole of the terrestrial phase of the water cycle, to enable aggregation to a national level. Work is also being conducted into developing national water accounting standards, which are being incorporated into Victoria's State Water Accounts. However, given the many complexities in water resource management, there are many challenges involved in establishing a meaningful state and national water accounting system (DSE 2006i).

Water accounting is used to describe the record keeping and reporting of all water flows and water entitlement transactions associated with the management, allocation and use of water resources. Accounting for water parallels financial accounting in that there are equivalent seasons and year end statements and reports (DSE 2006i).

For accounting purposes the environment's rights to water in rivers falls into two classes, each of which needs to be treated separately in order to develop a consistent accounting system:

- extractive rights. These are entitlements to discrete volumes of water in regulated water systems that can be used at the discretion of the environmental manager for, say, watering a wetland; and
- in-stream rights. This component of the environment's share of flow in a river includes flows maintained by a water authority as an obligation, and above-cap water. The timing of these flows is determined by rules in water authorities' bulk entitlements and flows in river systems, for example in response to rain when a reservoir spills (DSE 2006i).

A limitation of any water accounting system is its inability to report on the ecological effectiveness of environmental flows for rivers, wetlands and aquifers, particularly across time. As well, the State Water Report does not cover reporting of ecological effectiveness and outcomes on environmental flows. In response to these reporting gaps DSE has commissioned the Water Co-operative Research Centre to initiate an ecological monitoring program to assess the outcomes of the use of environmental water. These outcomes will be reported on separately to the current State Water Report once the ecological monitoring program is implemented (DSE 2006i).

Long-term benefits and improvements in the health of Victoria's rivers through environmental flows should, however, be evident in the 5 yearly state of the environment report produced by the Victorian Commissioner for Environmental Sustainability and the Victorian Catchment Management Council's 5 yearly catchment condition report. Such improvements should also, over the long term, contribute to improvements in the health of the River Murray system.

An accounting system may assist with clarification in situations where environmental flows are used to water wetlands (an amount taken from the water system), but where the excess water flows back into the main river system and may be available for other uses downstream. An accounting system may also be a useful management tool to determine environmental flow allocations and where there are multiple or joint beneficiaries such as timber production (DSE 2006i).

REGULATION OF THE RIVER MURRAY

History of Regulation

Since European settlement in the River Murray Basin area, people have actively modified the natural flooding and flow of the river on a large scale. First efforts at regulation included construction of levees in the early 19th century for flood control and basic irrigation. This was followed around the early 1850s by flow regulation to enable commercial navigational use of the river. In the 1870s, the first use of the river for major irrigation systems began around Kerang, Victoria (see chapter 7 for details of the history of irrigation and its role in land development in northern Victoria).

However, further expansion of irrigation was difficult because of the variability of river flows and serious droughts in the late 1890s and early 1900s. The problem of drought needed to be overcome by levelling out the natural flow peaks and troughs across the seasons and years and making more water available during summer and times of drought—in effect an 'insurance policy'. Construction of permanent infrastructure systems to hold greater volumes of water over seasons and years and deliver water in a more reliable and predictable manner provided the answer to this problem.

Figure 15.2 The renowned Furphy water cart used to transport water.

Figures 15.3 Lake Hume.

The history of river regulation is closely tied to the use of water to promote closer land settlement across northern Victoria during the 1930s depression years and following the two World Wars. Implementation of these land settlement patterns was dependent on a readily available and long-term secure water supply (see chapter 7).

The expansion of irrigation in northern Victoria and southern NSW increased the demand by both states for reliable access to water from the River Murray. To manage the competing demands of the two states the *River Murray Waters Agreement* (the Agreement) was signed in 1915. In 1996 Queensland also signed the Agreement which remains in place today, with amendments in 1987, and 1992 (Gippel & Blackham 2002).

The basis of the initial Agreement was for NSW and Victoria to agree on river flow quantities at Albury for the purposes of irrigation development and navigation along the River Murray. Specifically the Agreement ensured that water flow was to be shared equally between NSW and Victoria and that Victoria and NSW retain control of their respective tributaries below Albury. In addition, Victoria and NSW agreed to supply SA with a minimum agreed 'entitlement'. Much of Adelaide's water is supplied from the River Murray via a pipeline from Morgan.

The Agreement also provided for construction of a system of storages, locks and weirs. The large storages were intended to capture and store the large flows generated in late winter and spring, for use in summer and autumn and to increase security of water supply. The smaller structures were to make the river navigable across seasons and years during times of low flows and by providing pools for gravity fed and pumped irrigation diversions. Later, the Agreement was amended to give preference to irrigation infrastructure rather than navigational needs as the latter declined. Since the first Agreement the following dams and structures have been constructed on the River Murray and its southern tributaries:

- Torrumbarry Weir
- Hume Dam
- Yarrawonga Weir
- Lake Eildon
- Lake Eppalock
- Snowy Mountain Scheme
- Dartmouth Dam
- Goulburn Weir (constructed 1891, redeveloped 1987)
- weirs for irrigation and navigational purposes at Mildura, and
- banks, weirs and channels on Menindee Lakes (NSW) to increase the capacity and prevent drainage and back flow up the Darling River.

Information including details on the capacity and completion dates of these structures is summarised in Table 15.1.

Table 15.1 Characteristics and capacities of key storages associated with the River Murray in Victoria

Storage Facility	Capacity	River	Purpose	Irrigation region serviced	Completion date
Hume Dam	3038 GL	Murray	Major storage for overall management of River Murray water levels Irrigation Hydro-electricity generation Flood mitigation Recreation	All regions sourcing water from the Murray system	1936
Yarrawonga Weir	118 GL (largest diversion weir on the River Murray system)	Murray	Irrigation - diverts around 1900 GL per year (17% of river's average annual flow) Power generation Recreation	Murray Valley Irrigation region of Victoria Distributes water to an area of 128,000 ha	1939
Torrumbarry Weir	36 GL	Murray	Navigation Irrigation Recreation	Torrumbarry Irrigation System around Cohuna, Kerang and Swan Hill	Reconstructed in 1996
Mildura Weir and Lock 11	36 GL	Murray	Navigation Irrigation		1927
Dartmouth Dam	3906 GL (largest capacity dam in Victoria)	Mitta Mitta	Irrigation Assists with maintaining base levels of overall flow of river Salinity flushing Recreation	All regions sourcing water from the Murray system	1979
Lake Eildon	3390 GL	Goulburn	Flood mitigation Power generation Irrigation Recreation	Goulburn-Murray Irrigation District	1955
Goulburn Weir	25 GL	Goulburn	Irrigation Flood mitigation Recreation	Goulburn Irrigation District	1891, redeveloped in 1987
Waranga Basin	411 GL	Goulburn	Irrigation Recreation	Goulburn Irrigation District	Re-development completed 1926

Notes: All storages in this table are operated by Goulburn-Murray Water. The power station at Yarrawonga Weir is now owned and operated remotely from New Zealand by Meridian Energy with a network link to the Goulburn-Murray Water weir office. Power was first generated in 1994 with a maximum power generation of nine megawatts.

The Snowy Mountain Scheme was completed in 1974 and the Dartmouth Dam in 1979, both having been built to capture higher surface water run-off levels in the headwaters (see chapter 4), and increase the reliability of the flows over the seasons and across years along the entire length of the River Murray.

Dams and weirs on the Victorian tributaries of the River Murray include Lake Eildon (1955) and Goulburn Weir (1987) on the Goulburn River and Lake Eppalock (1964) on the Campaspe River. The Ovens River, with a small storage on each of its tributaries the Buffalo and King Rivers, remains the only substantial, unregulated tributary of the River Murray in Victoria. Dams and weirs are designed for the same purposes as those on the River Murray, to provide a secure and reliable water supply over time, principally for irrigation. The major dams, weirs and locks involved in the provision of water for irrigation along the River Murray and its tributaries are shown in Map D and briefly described in Table 15.1.

Major Victorian irrigation regions serviced by regulation of the River Murray and its tributaries include, the Rochester, Pyramid-Boort, Robinvale, Red Cliffs, Merbein and Mildura Irrigation districts and the Campaspe, Murray Valley and Torrumbarry Irrigation Areas. These irrigation areas are located in close proximity to the study area. The Murray Valley Irrigation Area is one of Victoria's largest irrigation regions and a major agricultural production area, including the Shepparton

Figures 15.4 Lock 7 weir between Mildura and the SA border.

Irrigation Region. The Torrumbarry Irrigation Area is the only one in this list supplied by direct pumping from the River Murray rather than through gravity-fed delivery. Torrumbarry Weir is also the most upstream lock on the River Murray.

Economic Benefits of River Regulation

The extensive river regulation infrastructure developed across the Murray-Darling Basin has benefited both the communities of the Basin as well as Australia as a whole (see chapters 8 and 13). The Murray-Darling Basin produces around $10 billion of agricultural produce of which $3 billion is from irrigation. Around $75 billion a year is generated from the Basin towards the national economy (MDBC 2002).

As well as providing the basis for agriculture, river regulation provides natural assets for a range of recreation and tourism activities. For example, Lake Mulwala provides a water body well suited to water skiing and motor boat racing and the greater water flows in summer enable water leisure activities to occur in the warmer summer or early autumn months when natural flows would usually be too low. These activities and other tourism-associated activities are important to the Basin's economy and the River Red Gum Forests study area (see chapter 11).

While contributing overall to the region's economy, river regulation involves competing economic interests for water in terms of access by different water users, including the environment, and the timing of that access. For example, irrigators in the upstream regions of the River Murray may feel they have a priority to all water flowing past their region at any point in time, however irrigators around Mildura or indeed, the population of Adelaide, believe that they too have an equal right to a reliable supply of water from the River Murray system throughout the year. Similar competing views exist between NSW irrigators compared with Victorian irrigators. Most of the organisational arrangements around water allocation discussed in this section relate to the management of these competing interests. Over recent decades, water for environmental purposes has become an increasingly important player in this competitive context.

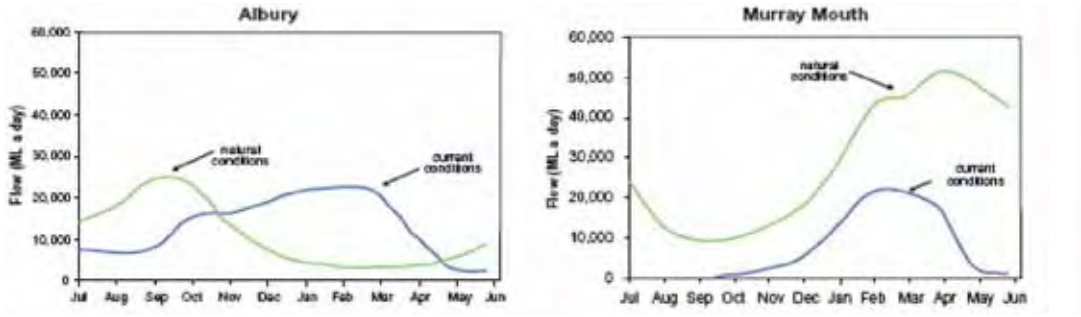
Surface Water Diversion and Storage Operations

Water Diversions

The extensive network of dams, weirs and channels along the River Murray and its tributaries has the capacity to divert around 10,000 to 11,000 GL of water per year (see Map D) from the rivers of the Murray-Darling Basin. This is twice the current average flow at the South Australian border. Its also provides a total storage capacity of approximately 29,500 GL which is more than double the average natural annual discharge at the river Murray mouth (see Figure 15.5).

Table 15.2 compares the natural and current median annual flows for the River Murray and its major Victorian tributaries. The table highlights the significant diversions of the natural water flows from the Goulburn, Broken, Loddon and Campaspe Rivers. The high percentages of the first three rivers result from high use of accumulated flows (Broken River), diversions from the Snowy River Scheme (Murray River at Albury) and relatively little regulation (Kiewa and Ovens Rivers) (Gippel & Blackham

Figure 15.5 River Murray flows under natural and current conditions at Albury and Murray Mouth.



Source: MDBC (2002)

2002). As mentioned in chapter 4 the Goulburn River was, under natural conditions, one of the major rivers contributing to the flows of the River Murray and a major source for the flooding of the River Murray floodplain below Barmah and for the lower Goulburn floodplains.

Surface run-off is at its maximum during late autumn through to early spring (see chapter 4). This is also the optimal timing for diverting surface water for storage purposes. Stored water is then released during the drier periods of the year—usually in late spring through to early autumn, resulting in changed flow regimes. These changed flows and flood regimes between natural and current conditions are shown is Figure 15.5. These figures highlight the shifts of peak flow periods in the River Murray in the upper reaches under natural conditions compared with regulated flows as well as illustrating the decline in flow volume for the river at the River Murray mouth. It also shows that the flow pattern over the seasons has not changed significantly with river regulation at the River Murray mouth.

Water Storage Operations

Across the River Murray system there are eight major storages relevant to this Investigation (Table 15.1). Four are located on the River Murray itself. One, Dartmouth Dam, is on the Mitta Mitta River in Victoria and three are on the Goulburn River system (see Map D for the location of these storages).

There are two other lake systems associated with the River Murray regulation network—both of which were natural lakes—Lake Victoria and the Menindee Lakes. Lake Victoria has a capacity of 677 GL. Its major role is the delivery of uniform water supplies to South Australia in accordance with the requirements of the Agreement. Lake Victoria is downstream of all major tributaries of the River Murray and is therefore able to store water coming from any of these tributaries. This allows for SA's water needs to be met from Lake Victoria while other water in the River Murray system is used to supply consumers in Victoria and NSW during peak demand times. Lake Victoria also provides flexibility in the system to overcome some of the problems associated with the Barmah Choke as it is used to meet the flow shortfalls resulting from the physical constraints imposed by the Choke (as explained in chapter 4). The Lake is also used as a tool in the management of salinity levels in water for South Australia.

The Menindee Lakes system is on the Darling River. The Lakes system was developed and owned by the NSW government. In 1963 the NSW government agreed to

Table 15.2 Comparison of natural and current median annual flows for selected locations on the River Murray and its tributaries.

Location	Natural median flow (GL/yr)	Current median flow (GL/yr)	Current as percentage of natural flow %
Murray at Albury	4324	4832	112
Kiewa	566	560	99
Ovens	1399	1395	100
Murray at Yarrawonga	5590	3904	70
Goulburn	3208	1035	32
Broken	90	159	176
Campaspe	242	77	32
Loddon	188	50	27

Source: Gippel and Blackham (2002).

lease the storage to the Murray-Darling Basin Commission to be used as part of the River Murray network. Its nominal full volume is 1731 GL but this is subject to the highly variable flow rates of the Darling River. Amongst other functions the Menindee Lakes system is used to augment flows in the River Murray to assist the supply of water to NSW, Victoria and South Australia.

All storages located on the River Murray are overseen by the Murray-Darling Basin Commission with River Murray Water having responsibility for operations. At an operational level decisions are made daily on what releases will be made from the various storages along the river. Release volumes and timing are based on meeting the needs of irrigators and flows for SA while also ensuring minimum flow requirements, dilution of salinity, maximum rates water level changes, and river channel capacity requirements. Goulburn-Murray Water implements these decisions as the water manager within Victoria for the Murray-Darling Basin Commission.

The three operating modes involved with running the River Murray system are described in the following paragraphs. This first is **supplying mode**. This mode occurs for most of the irrigation season, with releases occurring from early November through to mid-May each year (the irrigation season commences in August). During this time flow is set to meet consumptive water demands, including those of SA with little surplus over and above these demands. Factors influencing the level of supply to users include:

- river transmission losses and dilution flow requirements,
- the ability to use tributary flows such as flows coming down the Goulburn River,
- the feasibility of releasing water from Lake Victoria and transferring water from the Menindee Lakes to Lake Victoria to supply South Australia's entitlement flows, and from Dartmouth Dam to Hume Dam,
- channel capacity—a factor that varies considerably along the entire river system,
- maximum rates of rise and fall of river levels set to minimise bank slumping and other problems,
- maintaining minimum flows at key points in the river system,
- water reductions at upstream storages, while maintenance works are underway, so as to temporarily reduce flows at downstream storages, and
- releasing water for environmental purposes, such as maintaining flows to wetlands for waterbird breeding.

Storing mode is where the objectives of river operations are to manage excess flows in the system over above those required to meet diversions, water supply and minimum requirements. This mode also relates to maintaining released flows within the river channel. Storing usually occurs during winter and spring. During this time the majority of water in the River Murray originates from high flows in tributaries such as the Ovens, Kiewa and Goulburn Rivers. Decisions on whether to store or release water from storages are based on:

- the ability to capture surplus flows in Lake Victoria for subsequent release during supplying mode,
- making minimum releases from each storage,
- operation of forest regulators for forest watering purposes,
- monitoring tributary inflows, and advising stakeholders within sufficient time if channel capacity will be exceeded, and
- pre-releasing from Dartmouth Dam, Hume Dam and Menindee Lakes at rates up to the downstream capacity.

The third mode is **spilling,** where water is released from storages when they are full or nearly so and inflow rates are high as a result of rain. Such events usually occur in late winter and spring. Where these spills occur the resulting flows usually exceed the river's channel capacity. Decisions on whether to spill or not to spill are complex as flows vary depending on the volume of water already in the system and the capacity of the River Murray channel along its entire length (see chapter 4). For example, the channel capacity of the River Murray downstream of Dartmouth Dam is approximately 10 GL per day, between Hume Dam and Lake Mulwala (Yarrawonga Weir) it is approximately 25 GL per day, immediately downstream of Yarrawonga Weir channel capacity is approximately 60 GL per day and for Barmah Choke it is about 8.5 GL per day. As explained below channel capacity is a major factor influencing the scale of possible environmental flows.

Groundwater

The groundwater systems of the Murray-Darling Basin are undergoing change. Groundwater levels are rising over most of the southern part of the basin as a result of two activities. Firstly, regional recharge rates are increasing as native vegetation is replaced with introduced species with shallower roots that do not utilise as much groundwater. And secondly, irrigation allows excess water to filter through beyond the plant root zone. This increase in infiltration causes aquifer levels and therefore pressures to rise.

The consequences of these processes have been the re-activation of natural groundwater discharge systems and an increase in groundwater flows to river and streams. This is accompanied by an increase in discharge of saline water into the rivers and streams and the development of salt scalds and pans in low lying depressions.

High quality groundwater reserves are being increasingly tapped to supplement or replace surface water supplies during periods of low rainfall and drought. Today, groundwater is viewed as a primary water source, particularly where surface water diversions are limited, lacking or expensive compared to groundwater (despite high energy costs for pumping). The exact extent of groundwater reserves across northern Victoria and southern NSW is not precisely known.

Access to groundwater is usually through a licensing system issued by the Victorian government and its authorities under the *Water Act 1989*. This usually falls under the responsibilities of water authorities. While not directly relevant to the Investigation, groundwater systems are closely linked to surface water movements. Much rain falling on the land percolates into the soil and

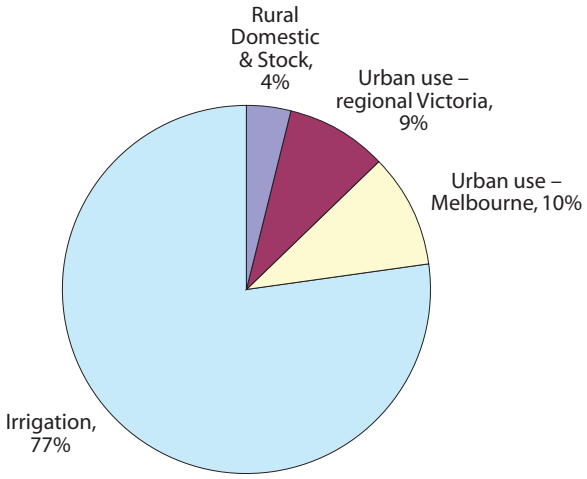
aquifers. Many aquifers then flow into rivers, contributing to their base flows as well as playing an important role in recharging wetland systems. It is estimated that Victorian aquifers are recharged with around 1000 GL of water annually. See chapter 4 for further details on the role of groundwater for the hydrology of the River Murray.

Consumption of Water

In Victoria water resources include surface water, groundwater, stormwater and recycled water. With increasing pressures on Victoria's water, the use of stormwater and recycled water for a range of land use activities, including on public land, may become more common in the future (DSE 2006i). This chapter is concerned with surface water use rather than storm or recycled water.

Today, 95 percent of water diverted from rivers within the entire Murray-Darling Basin is used for irrigation (MDBC 2002). In Victoria around 77 percent or about 4019 GL of total water harvested each year is used for irrigation (see Figure 15.6). Urban and industrial uses account for 17 percent or 860 GL of total use and rural supplies for 5 percent or about 286 GL. The environment is not included in this breakdown as a "use category".

Figure 15.6 Consumption of water in Victoria, 2004–05.



Source: DSE (2006i), Water Report.

Compared with surface water resources, Victoria's useable groundwater resources are small (around 10 percent of surface water resources). The major uses of groundwater resources across Victoria are irrigation at 60 percent, stock and domestic at 20 percent, mine dewatering and urban use at 16 percent and in-situ uses 4 percent. For areas closely associated with the River Red Gum Forests Investigation irrigation and stock are the major users of groundwater supplies. The use of groundwater is likely to increase as surface water availability decreases due to climate change and increased demand.

Constraints on River Regulation

A range of economic benefits is derived from the regulation of the River Murray for water supply and navigation. However, physical barriers, such as dam outlet capacity and river channel capacity variations such as the Barmah Choke, constrain the operations of the regulated system. Constraints are also placed by increasing competition for water resources between different users and the extent to which different users interests are compatible (particularly in the context of climate change). Environmental degradation resulting from changes to flow and flood regimes, is a third limitation on the benefits of river regulation, such as salinity, eutrophication and blue-green algal blooms, river bank slumping, loss of biodiversity and changes in the movement of energy and nutrients between the river and floodplains (see chapters 4, 5 and the environmental flows section in this chapter).

Environmental Consequences of River Regulation

Regulation of the River Murray has changed the natural flow conditions of the river significantly with major impacts on biodiversity of the riverine environment. Today, flow regimes are characterised by the reduced frequency, duration and extent of winter-spring floods and alterations of the timing of floods from late winter to late spring and early summer. Smaller summer floods, particularly around Barmah forest, have increased in frequency because of so-called 'rain rejection' events. The River Murray now flows at a more constant rate for the entire year and water temperatures are more constant across all seasons. Improving these environmental flows is the primary area of VEAC's interest in water, and the subject of the next section of this chapter.

ENVIRONMENTAL WATER FLOWS

This section describes the administrative arrangements associated with environmental flows and how they are used as a management tool to achieve environmental outcomes on public land in the study area.

The Living Murray and the First Step Decision

Since the 1970s there has been increasing awareness by community and governments about the consequences of changed river flow regimes for riverine ecology. Implementation of the Murray-Darling Basin Cap on Diversions is, in part, a response to the decline in river health due to reduced river flow regimes of both the River Murray and its tributaries.

However, over the last two decades there has been increasing pressure placed on governments at both the national and state levels to address the ecological consequences of these changed river flow regimes by returning water to the environment. In response, the Murray-Darling Basin Ministerial Council initiated a number of projects; one involving the establishment of a Scientific Reference Panel to provide advice to the Ministerial Council. Their advice, provided in 2002, indicated that:

- the overall health of the River Murray is in decline;
- the river could no longer be considered healthy; and
- any restoration to improve the river's health would need to involve "major improvement in river management".

In 2002 the Ministerial Council also established The

Box 15.2 Key elements of the First Step Decision

1. An initial focus will be on achieving outcomes for six Significant Ecological Asset (SEA) sites: Barmah-Millewa Forest; Gunbower and Koondrook-Perricoota Forests; Hattah Lakes; the Chowilla Floodplain and Lindsay-Wallpolla Islands systems; the Murray Mouth, Coorong and Lower Lakes; and the River Murray Channel—see Map D.
2. Statements of specific ecological objectives and outcomes for each SEA will be developed.
3. These objectives will be achieved through:
   - recovering water, built to an average of 500 GL per year of "new" water after five years, with the volume to be used each year depending on a range of factors such as droughts and flood events;
   - funding commencing from 1 July 2004; under the $500 million to address water over-allocation in the Murray-Darling Basin announced by the Council of Australian Governments (COAG); and
   - realignment of the previously announced capital works programs of an additional $150 million to effectively manage the water to the six Significant Ecological Assets.
4. An adaptive management approach will be employed.
5. A commitment is given to identifying opportunities for Indigenous partnerships in planning and management under the Living Murray.

Source: MDBC (2005b)

Living Murray Initiative (TLM) with a vision that the River Murray be a healthy working river. This initiative is underpinned by the following principles:

- action will be taken to restore a healthy working river system;
- action taken will be fair and reasonable;
- a range of measures will be used in an integrated and adaptive manner; and
- there will be both government and community (including Indigenous) responsibilities for The Living Murray decisions and outcomes.

While this Initiative is designed to address the health of the River Murray and its associated ecosystems it also has the objective of maintaining the long term sustainability of agricultural industries and communities within the Murray-Darling Basin—that is, its focus is not entirely on biodiversity conservation.

The First Step Decision emerged from The Living Murray Initiative in 2003. This decision by the Murray-Darling Basin Ministerial Council outlined how the decline in the River Murray's health will be addressed initially. The key elements of the First Step Decision are listed in Box 15.2 (MDBC 2005b).

The location of the six Significant Ecological Assets is shown on Map D and Figure 4.5.

The Living Murray Initiative and its First Step Decision is the principal policy instrument guiding all activities by Victoria (and other Basin states) on restoring the health of the River Murray. As such it is crucial for guiding water management and ecological protection on Victorian public land along the River Murray. In this Initiative the Ministerial Council specifies ecological objectives and outcomes for each of the Significant Ecological Asset (SEA) sites. As a signatory to this Initiative, Victoria is required to work towards achieving these objectives and outcomes. Table 15.3 lists the objectives and outcomes for each site. For this Investigation, relevant SEA sites are Barmah-Millewa Forest, Gunbower and Koondrook-Pericoota Forests, Hattah Lakes, Chowilla Floodplain including Lindsay Wallpolla Islands and the River Murray channel.

Murray-Darling Basin Intergovernmental Agreement

Water Recovery

In June 2004 relevant Ministers of NSW, Victoria, SA, the Australian Capital Territory and Commonwealth governments signed the *Intergovernmental Agreement on Addressing Water Over Allocations and Achieving Environmental Objectives in the Murray-Darling Basin*—known as the Murray-Darling Basin Intergovernmental Agreement (MDB-IGA). This Intergovernmental Agreement gives effect to the 2003 decision by governments to commit $500 million over five years to address water over-allocation in the Murray-Darling Basin and recover "water for the environment". The indicative water recovery targets for each jurisdiction set under the MDB-IGA are: NSW, 249 GL; Victoria, 214 GL; South Australia, 35 GL; and ACT, 2 GL.

Water recovery relates to acquiring "new water" through a range of practices from water wholesalers, distributors, retailers and individuals. Practices include the following either in isolation or jointly:

- infrastructure improvements and rationalisations;
- regulatory changes;
- on-farm initiatives such as switching from spray irrigation to drip irrigation techniques;
- efficiency gains in water delivery and use;
- market-based approaches such as water trading; and
- voluntary water purchases.

Water gained through these practices is to be re-directed to water for environmental flows across all Living Murray SEA sites. Under the MDB-IG and the First Step Decision the target for water recovery is an annual average 500 GL by June 2009. There is limited information available on what criteria were used to decide on the 500 GL for the First Step Decision. For example, the Murray-Darling Basin Ministerial Council discussion paper, 2002 presents three reference points for consideration: 350 GL; 750 GL and 1500 GL. The 500 GL agreed upon is therefore, at the lower end of these points.

Table 15.3 Interim ecological objectives and expected outcomes for the six significant ecological asset sites set by the Murray-Darling Basin Ministerial Council in 2003.

Significant Ecological Asset	Ecological objectives	Expected outcomes
Barmah-Millewa Forest	Enhance forest, fish and wildlife values	• successful breeding of colonial waterbirds in at least three years in ten • healthy vegetation in at least 55% of the area of forest
Gunbower and Koondrook-Perricoota Forests	Maintain and restore a mosaic of healthy floodplain communities	• 80% of permanent and semi-permanent wetlands in a healthy condition • 30% of River Red Gum Forests in a healthy condition • successful breeding of colonial waterbirds in at least three years in ten • healthy populations of resident native fish in wetlands
Hattah Lakes	Restore healthy examples of all original wetland and floodplain communities	• restore the aquatic vegetation zone in and around at least 50% of the lakes to increase fish and bird breeding and survival • increase successful breeding events of threatened colonial water birds to at least two in ten years • increase the population size of and breeding events of the endangered Murray hardyhead, Australian smelt, gudgeons and other wetland fish
Chowilla Floodplain including Lindsay and Wallpolla Islands	Maintain high biodiversity values of the Chowilla Floodplain	• high value wetlands maintained • current area of River Red Gum maintained • at least 20% of the original area of Black Box vegetation maintained
Murray Mouth, Coorong and Lower Lakes	A healthier Lower Lakes and Coorong estuarine environment	• open Murray mouth • more frequent estuarine fish spawning • enhanced migratory wader bird habitat in the Lower Lakes
River Murray Channel	To increase the frequency of higher flows in spring that are ecologically significant. To overcome barriers to migration of native fish species between the sea and Hume Dam. To maintain current levels of channel stability.	• expanded ranges of many species of migratory fish • similar levels of channel erosion to those currently existing

Source: MDBC (2005b)

Some proponents argue for greater amounts of water for environmental flows to the SEAs. For example, conservation groups suggest an additional annual flow of 1500 GL is required, to have any impact or success. These groups are also arguing that water recovery practices will, by themselves, not achieve the 500 GL amount for environmental flows to the six SEAs. Other groups, such as the Wentworth Group argue that for the River Murray system to be restored to a healthy working condition around 2000 GL to 4000 GL per year are required combined with profound changes in river management. This raises the issue of whether there is sufficient knowledge available to determine volumes of water required to successfully mimic environmental flows across a diverse natural system such as the River Murray.

In the Living Murray process, the Victorian Government's approach is to recover water via water savings projects, system management changes and strategic water purchased in Victoria. A case in point is the Lake Mokoan Water Recovery Package with water savings in the vicinity of 44 GL going into environmental flows for the River Murray and the Snowy River (DSE 2006i).

Living Murray Environmental Watering Plan and the Asset Environmental Management Plan

The Intergovernmental Agreement provides the framework for the development and implementation of the Living Murray Environmental Watering Plan (LMEWP) and the Asset Environmental Management Plans (AEMP) to achieve the specific objectives of the First Step

Decision. The Environmental Watering Plan must be consistent with or complement other actions of the MDB-IGA and other actions being undertaken by the Murray-Darling Basin Ministerial Council and the Murray-Darling Basin Commission.

The Living Murray Environmental Watering Plan is developed and implemented by the Environmental Watering Group (EWG), which is made up of eight people appointed by the Murray-Darling Basin Commission from a list of up to two people nominated by each jurisdiction and two *ex officio* people (River Murray Water Production Manager and Environmental Manager of the Murray-Darling Basin Commission). The Environmental Watering Plan coordinates the volume, timing, security and application of water necessary to achieve the ecological objectives of The Living Murray for each SEA. The plan is updated annually to reflect improved information and knowledge regarding the relevant river and wetland systems and improvements in delivery practices.

Each year the updated Environmental Watering Plan is submitted to the Murray-Darling Basin Ministerial Council for approval. The Living Murray Environmental Watering Plan is based on consideration of:

- ecological objectives and outcomes for the six Significant Ecological Assets agreed to by the Ministerial Council in 2003;
- potential actions for each asset consistent with the Murray-Darling Basin Agreement and The Living Murray First Step Decision's objectives;
- triggers for these actions and expected outcomes;
- assessment of the likelihood of meeting conditions to trigger actions;
- methods for prioritising between actions competing for water;
- estimated water availability over the year—volumes and locations;
- implementation roles and responsibilities;
- identification of priority actions for the year;
- links to The Living Murray Environmental Works and Measures Program;
- monitoring, evaluation and reporting measures to be undertaken; and
- adaptive management measures.

The Environmental Watering Plan is linked with the Asset Environmental Management Plans (AEMP), developed for each SEA. Developed by the EWG, these plans are agreed to each year by the Murray-Darling Basin Ministerial Council. They are designed to adapt the ecological objectives prescribed in the First Step Decision for each significant site and specify the water regime (volume, timing and security) required for each of the sites to meet the objectives. In effect, they establish the demand side of water allocations under the First Step Decision. The supply side of the equation (the Environmental Watering Plan) is developed through the different states and other parties identifying water volume amounts through their water recovery practices as accredited by the Murray-Darling Basin Ministerial Council. The demand and supply sides of The Living Murray watering requirements across all significant sites and individual sites are coordinated by The Living Murray Business Plan.

Indigenous Involvement in the Living Murray Environmental Watering Plan

An objective of the Living Murray Environmental Watering Plan is to actively involve Indigenous communities in all levels of natural resource management. As such, Indigenous input is sought on all aspects of environmental flow management to ensure the aspirations, interests and contributions of Indigenous people are recognised. Responsibility for achieving Indigenous involvement resides with the EWG. Where the interests of Indigenous groups apply to significant sites on either side of the River Murray, such as Barmah-Millewa then arrangements must be agreed upon between the relevant Asset Managers to develop a consistent approach to those groups, and gain consistent input to the Asset Environmental Management Plan.

Managers of Significant Ecological Assets

Table 15.4 lists the Asset Managers for each of the six SEAs and their agencies. It should be noted however, that the head Asset Manager role is rotated between states where sites cross jurisdictions. Detailed descriptions of the management arrangements for each of the sites are found in the Asset Environmental Management Plan for that site—refer to the Murray-Darling Basin Commission website.

Significant Ecological Asset Water Allocation Arrangements

Potential Actions and Triggers

The allocation of water for environmental flows for the six SEAs requires matching appropriate actions to specific sites and times prior to water being allocated.

Potential actions for environmental flows are also influenced by whether the action can be undertaken as part of a routine river operation associated with bulk water allocations or coordinated by environmental managers for more regionally-based one-off operations—see Table 15.4. Specific actions for achieving environmental flows at the ecologically significant sites include:

- enhancing natural flush—typically, these enhance above channel capacity flows (see chapter 4) but can also be used to enhance flows just below the channel capacity. An example, includes piggy-backing off increased flows down the Goulburn River to assist with topping up the flows coming down the River Murray to achieve a medium flooding event of Gunbower and Koondrook-Perricoota forests;
- weir manipulation—or increasing the volume of water by raising weir heights to increase variability within a channel. Weir raising is a common action for allowing water to enter wetlands that normally would not be inundated with water via in-channel flows. This action is more efficient as a flow delivery mechanism than releasing large volumes of water down the river;
- infrastructure use—for example, infrastructure has been used to pump water into wetlands at Hattah Lakes. Temporary levees are also used as a technique to hold water into wetlands once filled. Figure 15.8 is an example of a levee bank used to manage water flow;

Figure 15.7 Relationship of the asset environmental management plan to the broader Living Murray and associated planning strategies and agreements.

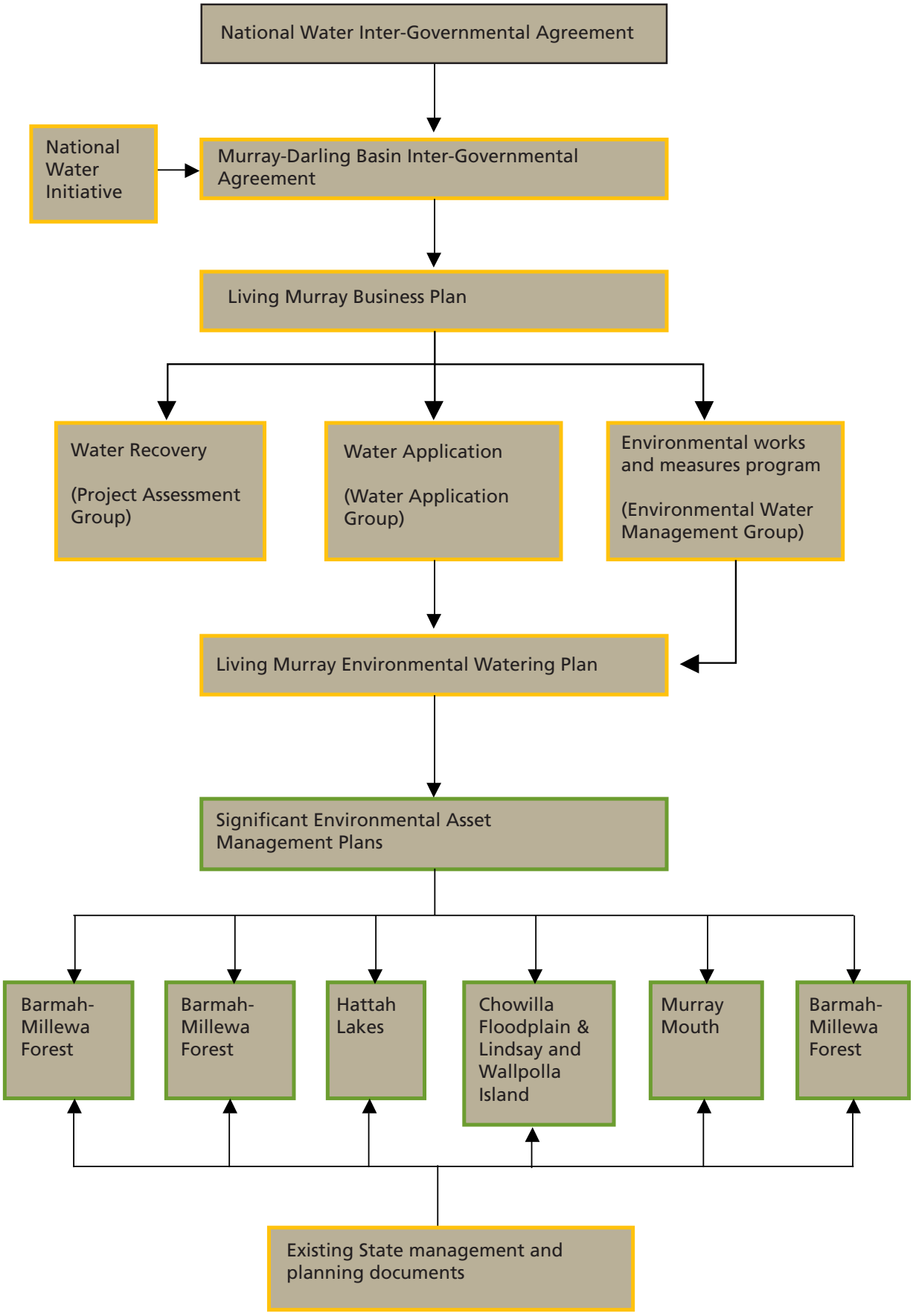


Table 15.4 Asset managers and their agencies for the six Significant Ecological Assets.

Significant Ecological Asset	Organisation	Position
Barmah–Millewa Forest		
NSW	State Forests of NSW	Regional Manager, Riverina
Victoria	Victorian Department of Sustainability and Environment	Regional Manager, North East
Gunbower–Koondrook–Perricoota Forests		
NSW	State Forests of NSW	Regional Manager, Riverina
Victoria	Victorian Department of Sustainability and Environment	Regional Manager, North West
Hattah Lakes		
Victoria	Victorian Department of Sustainability and Environment	Regional Manager, North West
Chowilla, Lindsay–Wallpolla		
NSW	NSW Department of Infrastructure, Natural Resources and Planning, Albury	Regional Manager, Murray and Murrumbidgee
Victoria	Victorian Department of Sustainability and Environment	Regional Manager, North West
South Australia	SA Department of Water, Land and Biodiversity Conservation	Program Leader Environmental Flows, Strategic Policy Division
Lower Lakes, Murray Mouth and Coorong		
South Australia	SA Department of Water, Land and Biodiversity Conservation	Program Leader Environmental Flows, Strategic Policy Division
River Murray Channel		
NSW component of the River Murray Channel	NSW Department of Infrastructure, Natural Resources and Planning, Albury	Regional Manager, Murray and Murrumbidge

Source: MDBC (2005a)

- works expansion—involving the construction of weirs and regulators such as those at Hattah Lakes to hold water in wetlands for longer periods to ensure completion of bird breeding events or the construction of fish passages as shown in Figure 15.9;
- site specific actions—such as the management of rain rejection flows at Barmah-Millewa through a range of engineering approaches or policy instruments such as water pricing; and
- pre-releasing water—move adequate volumes from storages to allow a subsequent release when further inflows are expected to spill the dam. The advantage of this action is the release is controlled thereby limiting possible risks. The released flows generally remain within the river channel.

Figure 15.8 Levee bank.

Figure 15.9 Torrumbarry Weir Fish Ladder.

All of the above actions are only implemented when a flow trigger point is reached. Triggers include flows of a particular size and duration that might initiate part or all of an ecological response to the environmental flow. A non-flow trigger is set off by other factors such as dryness of wetland, where a "health warning" is breached for a given area. The scale and impact on the river system of actions identified can vary considerably. For example, enhancing natural freshes or flush (refer to glossary) and floods depends on receiving above channel capacity flows at key points for each site across the river system. In contrast, other actions may only involve flows remaining within the main river channel and its anabranches.

Decision Making Framework for Implementing Environmental Flows

The allocation of water to the six SEA sites is influenced by complex administrative and operational arrangements for water management at both the state and Commonwealth levels, some of which existed prior to The Living Murray Initiative. Implementation of The Living Murray First Step Decision is based on a decision-making framework, which identifies the various decision making groups such as the EWG, the Murray-Darling Basin Commission and their responsibilities as well as the relevant jurisdictions and their responsibilities. The framework is designed to:

- identify if an action proposed is resource neutral or otherwise—that is, there is no increase or decrease in the resource as a result of the proposed action;
- identify the amount of environmental water available for application at the SEAs;
- establish a clear relationship between the EWG and existing jurisdictional arrangements; and
- provide an approach for allocating water between competing actions.

Figure 15.10 outlines the decision making framework for identifying water available for delivery to a significant site and for prioritising the delivery of water between sites where a trade-off arises. This framework identifies the different types of water and the responsibilities of the EWG for implementation of the decisions. Each Asset Environmental Management Plan must identify the flow requirements that have the potential to meet The Living Murray First Step objectives and a set of actions that can be instigated if an opportunity arises to water a significant site. Triggers signal where an opportunity exists and then activate an assessment of which site would benefit most from the type of flow volume.

Once a trigger is activated a series of decision points identify the type of water available and where responsibility lies. As part of this process the water is assessed as to whether it is The Living Murray Water and available for use at SEAs. River Murray Water determines the type and volume of surplus flows available (decision point 10, Figure 15.10) and works with the EWG to determine the environmental water requirements. Water is then classed as either state environmental (decision point 13), consumptive water use only (decision point 14) or shared environmental water (decision point 15) (MDBC 2005a).

When The Living Murray Water is available each SEA site may compete for this water. In these situations trade-offs are made between the sites and are based on a set of trade-off criteria—see Box 15.3 below. Environmental water is only supplied where an opportunity to achieve environmental outcomes is clearly identified—even if water is available. This may be due to the volume of water not being adequate to water the site or the pattern of delivery being insufficient to meet a flow requirement. In some situations, no trigger may be set off.

Box 15.3 Criteria for assessing environmental water across Significant Ecological Assets

Criteria are based on a two step process.

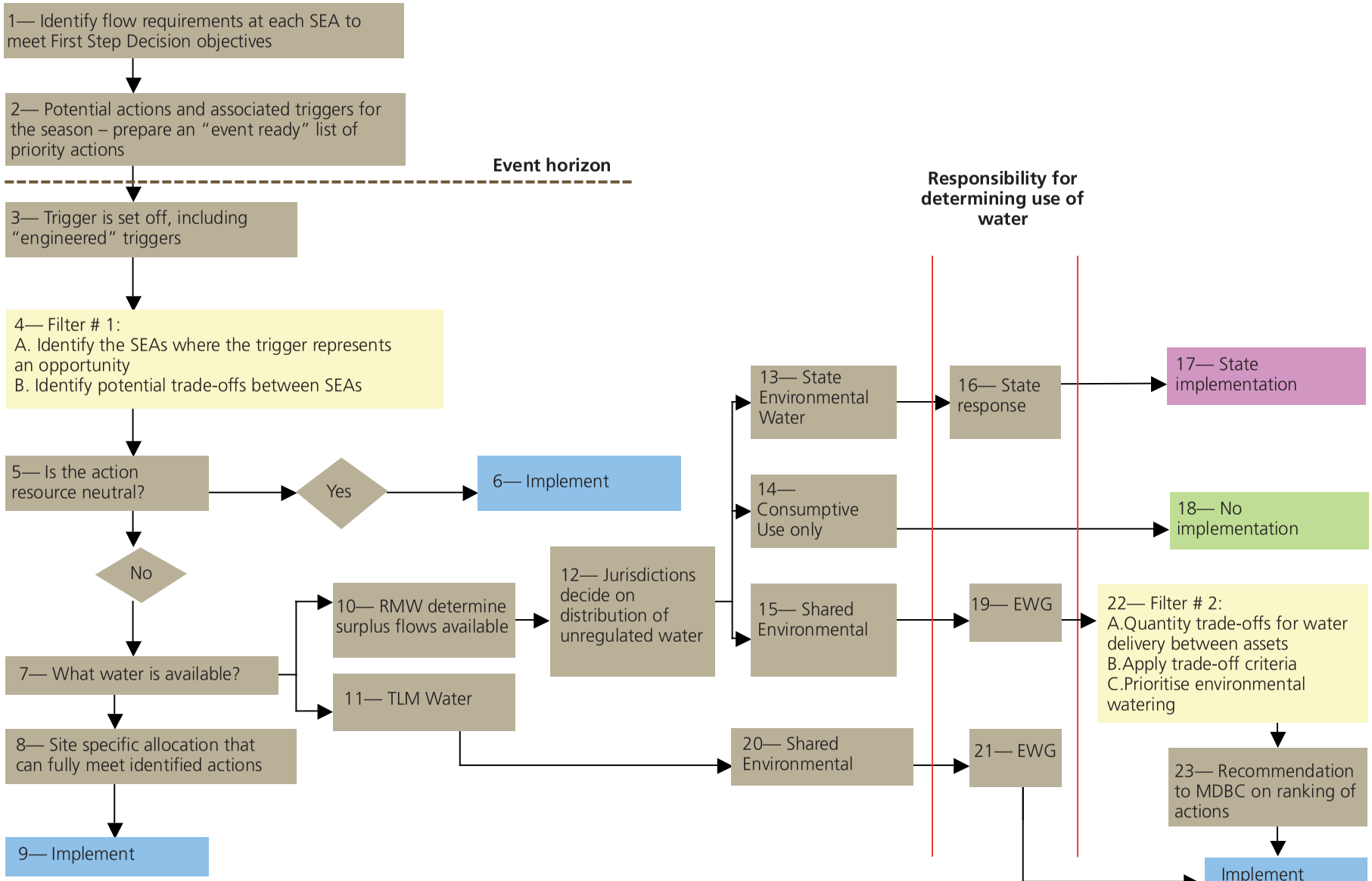
Step One assesses whether competing environmental watering actions are consistent with The Living Murray First Step decision objectives.

Step Two applies the following criteria to assess the proposed actions:

- significance of the predicted ecological outcomes;
- watering history of a site, including the number and magnitude of recent watering events;
- identification of any ecological costs of the action, including off-site impacts such as salt mobilisation and whether the use of water at one site will limit the water available for actions at downstream sites;
- distribution of water between competing actions on consumers (mainly irrigators); and
- financial costs associated with a proposed action, for instance the cost of pumping.

Source: MDBC (2005a).

Figure 15.10 Decision framework for distributing water to the six significant ecological assets.



Source: MDBC, 2005a.
Notes: RMW = River Murray Water; TLM = The Living Murray; EWG = Environmental Watering Group; MDBC = Murray-Darling Basin Commission.

Victorian Arrangements for Environmental Water Flows

River health is a fundamental factor determining water allocations for environmental outcomes in Victoria. River health is a term used to describe the ecological condition of a river and is more than just the river's flora and fauna and the quality and quantity of the water—see Victoria's *River Health Strategy, 2002*. Determining the health of a river system involves consideration of the diversity of the habitats and biota, the effectiveness of connectivity (see chapter 4) and the maintenance of ecological processes. All are influenced by the flow regime of a river.

Environmental Water Reserve

The *Water (Resource Management) Act 2005* provides the legislative framework for water management in Victoria. The Environmental Water Reserve (EWR) is established under this legislation (see above for Victoria's allocation framework and rights to water) which formally defines it as water set aside for the environment through:

- environmental entitlements—volumes of water in regulated river systems to be granted to the environment. Under this legislation new entitlements are held by the Minister for Environment with existing bulk entitlements that are held by the Minister for Environment to be given equivalent legal status as a result of amendments to the *Water Act 1989*;
- obligations on entitlement holders—relating to flow volumes that an entitlement holder must allow to flow pass before they can divert any water. In most cases these are flows that are in excess of entitlement holders' needs and/or rights. This component of the Environmental Water Reserve does not include water set aside for future consumptive purposes in a river basin and which is not yet allocated under a formal entitlement;
- management plans—such as a streamflow management plan; and
- other legislation—such as the *Murray-Darling Basin Act 1993* and the *Groundwater (Border Agreement) Act 1985*.

The Environmental Water Reserve is designed to maintain the rights of existing consumptive entitlement holders. As such the water reserve:

- maintains the environmental values of the water system and the other water services that depend on environmental condition;
- sustains biodiversity, ecological functioning and water quality; and
- holds equivalent legal status to that of consumptive water entitlements and is held by the Crown.

A substantial portion of the Environmental Water Reserve is achieved through limiting the volume of water for consumption. These limits take various forms—conditions on bulk entitlements, surface and groundwater licences, rules established in water management plans, caps on water use such as permissible annual volumes and sustainable diversion limits. In some regulated rivers, these limits may be extended with a specific water allocation for the environment. Where this is the case, the environmental allocation is held as a bulk entitlement. The water reserve is enhanced by recovering water from consumptive use (see above).

Management of the Environmental Water Reserve

Under the *Water (Resource Management) Act 2005* the Environmental Water Reserve must be managed in accordance with the objectives specified in the Act, which are:

- achieving ecological objectives for the protection and/or restoration of priority river, wetland and aquifer assets,
- integrating programs of river, wetland, and aquifer restoration aimed at achieving ecological objectives,
- achieving the most effective use of environmental water, the greatest level of environmental benefits possible and minimising as far as possible any adverse impacts on water users, and
- engaging communities, particularly where these are likely to be affected by the water management regime.

Under the *Water (Resource Management) Act 2005* Catchment Management Authorities are responsible for the operational management of the Environmental Water Reserve within their catchment region. Catchment Management Authorities jointly oversee the development of long-term operating strategies for water recovered and held in storage to optimise use of the water for their catchment region. In the case of this Investigation the Catchment Management Authorities with this responsibility are North East, Goulburn Broken, North Central and Mallee. Overall coordination across the six SEAs sites resides with the Murray-Darling Basin Ministerial Council. Each of these strategies identifies the ecosystem for the watering event such as a river reach or individual wetland areas, how and under what conditions the ecosystem will be watered, how much (if any) of the allocation is tradeable and the circumstances under which it could be traded. In developing an operating strategy, Catchment Management Authorities liaise with the ecosystem managers, neighbouring authorities, DSE and other key stakeholders. Strategies require the approval of the Minister for Environment and the Minister for Water.

Management of the Environmental Water Reserve differs depending on how the water reserve is provided. When provided wholly or partly through conditions on a bulk entitlement or licence or through sustainable diversion limits, the input of management is relatively passive. It involves integrating environmental flows that are provided into a more substantial program of river management. In contrast, where the water reserve is provided through bulk entitlement for the environment held in storage, management input is more active and extensive.

Victorian Environmental Flow Allocations

Environmental flows operate within two contexts, both of which can occur separately or concurrently. Some environmental flows operate under Victorian conditions prior to the development of The Living Murray while others operate within the framework provided by The Living Murray and the First Step Decision. Table 15.5

Table 15.5 Victorian Environmental Water Allocations (EWAs) available in the River Murray system and Victorian tributaries.

Allocation name	Year approved	Volume and main conditions	Main purpose
Barmah–Millewa Forest EWA	1993	100 GL/yr annually plus 50 GL about 8 years in 10 shared by NSW and Victoria (provision to carryover up to 700 GL)	Barmah–Millewa Floodplain watering
Barmah–Millewa Overdraw	2001	100 GL can be overdrawn to extend an environmental release when there is sufficient water in Vic-NSW storages	Barmah–Millewa floodplain watering
Victorian Murray Wetlands Bulk Entitlement	1987	27.6 GL/yr (2.6 GL/yr allocated to Hird and Johnsons Swamps)	Wetland watering along the Murray and salinity control
Goulburn River Bulk Entitlement	1995	80 GL in November in wet years between Lake Eildon and Goulburn Weir. Minimum passing flows released below Lake Eildon and Goulburn Weir	Spring flush In-stream habitat maintenance, water quality
Campaspe River Bulk Entitlement	1999	Minimum passing flows released below storages and weirs	In-stream habitat maintenance, water quality
Loddon River Environmental Reserve Bulk Entitlement	2005	2 GL/yr Minimum passing flows and summer freshes released below storages and weirs	Loddon wetlands in the Boort-Appin area In-stream habitat maintenance, water quality

Source: DSE (2004i)

outlines Victorian environmental flow allocations over recent years, with some such as the Barmah-Millewa allocations are frequently used in association with The Living Murray water.

Over the last two decades Victoria has instigated a number of environmental flows outside the allocations of The Living Murray framework. Table 15.5 provides a summary of environmental water allocations, the locations for those flows and the purposes for the flows. In Victoria, the Minister for Environment holds an allocation of 27.6 GL a year to provide water for flora and fauna maintenance for areas such as at Hird Swamp, Johnson Swamp, Lake Elizabeth, Lake Murphy, McDonald's Swamp, Cullens Lake, Round Lake, Golf Course Lake and the Cardross Basins. The water allocated under the environmental water entitlement varies from year to year with natural fluctuations in environmental water requirements.

Environmental Flow Events in Victoria

Each year, subject to the seasonal allocation, Victoria contributes 50 GL of its entitlement to the River Murray water resource to the Barmah-Millewa Forest Environmental Water Allocation for the purposes of periodically enhancing natural flood events in the forest. If the seasonal water sales to Victorian Murray irrigators reach 30 percent of their entitlement, the state contributes an additional 25 GL of sales entitlement to the Barmah-Millewa Forest Environmental Water Allocation account. New South Wales also contributes to this account. After Victoria's 2004/05 contribution, the state had accumulated a total of 175 GL in the account, all of which was carried over for use in 2005/06. This account was used in the late 2005 flooding of Barmah-Millewa Forest.

In 2005–06, unused water entitlements (5.6 GL) by irrigators and water authorities was donated to the environment for Forest Bend/Nangiloc, Johnsons Bend and Nyah State Forest.

During 2004–05 the emergency Red Gum Watering Project was initiated using environmental water from the Minister's allocation (the River Murray Flora and Fauna Reserve Bulk Entitlement) and surplus flows to target trees exhibiting signs of major water stress. This occurred at a number of anabranches and wetland sites along the River Murray including Burra Creek, Lindsay River, Chalka Creek and Potterwalkagee Creek. DSE managed the project in partnership with Parks Victoria and the Mallee Catchment Management Authority.

In 2004–05, a total of 27,590 ML of the River Murray Flora and Fauna Reserve Bulk Entitlement was used to supply water to these areas of environmental significance, including areas that are not classified as SEAs such as native fish habitat (Murray hardyhead) at

Cardross Lakes, near Mildura, protection of significant waterfowl habitat and aquatic vegetation communities at McDonald Swamp and Hird Swamp in the Kerang Lakes region. Other areas to benefit from these flows include Round Lake, Lake Murphy, Lake Elizabeth and Richardsons Lagoon.

There are four key significant ecological asset sites identified under The Living Murray First Steps Decision within the study area: Barmah-Millewa Forest; Gunbower and Koondrook-Perricoota Forest; Hattah Lakes; and Lindsay-Wallpolla and Chowilla Floodplain. The Murray Channel is also a significant ecological site with significant influences on the River Red Gum Forests associated with the study area but because it is formally in NSW, it is not considered here.

The following briefly describes each of these sites, the consequences of river regulation on these sites and current environmental flow practices within the sites.

Significant Ecological Asset Site 1: Barmah-Millewa Forest

The Barmah–Millewa Forest covers a total area of 66,615 hectares, with the Barmah Forest area in Victoria covering 28,500 ha. It is the largest area of river red gum forests in the River Murray system and largest in Australia. It includes the floodplains of both the Murray and Edward Rivers. The site is Ramsar listed and of international significance and in 1992 was included on the Register of the National Estate. Map D shows the location of Barmah–Millewa Forest in relation to the length of the River Murray and other Significant Ecological Assets.

The Barmah–Millewa system is dominated by the Barmah Choke, which has been the dominant factor in the creation of the unique forest and wetland ecology and river flow and flood patterns we see today (see chapters 2 and 3 for details of its formation). Today there is increasing evidence that the maintenance and health of the wider River Murray system is directly linked to the health of Barmah–Millewa (see chapters 4 and 5).

Chapter 5 provides a detailed description of vegetation communities associated with Barmah–Millewa Forest. Suffice to say that there is a wide range of vegetation communities existing within Barmah, all of which have evolved in association with the unique natural flow and flood regimes of the River Murray. Table 15.6 describes the importance of different flood frequencies, duration and seasonality for specific vegetation communities prior to regulation.

Flow and Flood Regime Changes due to River Regulation

River regulation has significantly changed the river flow regimes for Barmah–Millewa Forest. These changes are described in the Box 15.4. Note: these changes while having similarities with other sites along the River Murray have characteristics that are specific to Barmah–Millewa Forest.

Ecological Impacts of Regulation

The most visible sign of environmental degradation resulting from river regulation are changes in vegetation type and spatial distribution. Table 15.7 outlines the main changes to vegetation communities for Barmah Forest, resulting from changed flood regimes. Of particular note is the decline in distribution of Moira grass. This grass is dependent on inundation for short periods of time followed by lengthy dry periods. In contrast, giant rush prefers wetter conditions over longer periods of time. Summer irrigation flows that provide constant low levels of inundation favour giant rush. As a result moira grass is declining in distribution at Barmah Forest. It is estimated that since 1930, 1200 hectares or 30 percent of area of Moira grass has been lost to river red gum spread and a further 1200 hectares lost to giant rush encroachment.

River regulation (as well as some past and current land-use activities within the study area) have impacted on the fauna of Barmah–Millewa Forest, particularly in

Table 15.6 Flood frequencies of the major Barmah–Millewa forest floodplain vegetation communities before regulation.

Vegetation community	Flood frequency (% of years with inundation)	Duration (months)	Season (ideal)
Giant rush	1:1 to 1:1.3 (75% to 100%)	2 to 30	May
Moira grasslands	1:1 (100%)	2 to 18	September
River red gum forest	1:1 to 1:1.4 (70% to 100%)	1 to 18	Winter–spring
River red gum forest woodland	1:1 to 1:2 (50% to 100%)	1 to 18	Winter–spring
River red gum forest/black box woodland	1:2 to 1:3.3 (30% to 50%)	0.5 to 1	Winter–spring

Source: MDBC (2005b).

Box 15.4 Changes to flow regimes of the Barmah–Millewa forest from river regulation

Reduced flooding in spring	The frequency, duration and variability of winter–spring flooding have been reduced by river regulation. The frequency of floods in the range 42-78 GL/day peak magnitude has more than halved. The duration of floods that inundate River Red Gum Forests has reduced from 5 months per year to 2 months per year. The mean length of the period between floods has increased 2.5 times, while the maximum length of the dry period has increased six-fold.
Unseasonal flooding in summer and autumn	The forest receives unseasonal flooding due to "rain rejection" events. The Edward River, which flows through the Millewa Forest, has also been affected by river regulation, with flows at or near channel capacity for much of the year.
Reduced variability	Flow is at near channel capacity of 330–350 GL/month (Barmah Choke limit) for approximately eight months of the year. Regulation reduced flow variability (particularly during winter/spring). Under natural conditions, average monthly flows vary between 100GL/month and 980 GL/month, whereas current average monthly flows vary between 110 GL/month and 400 GL/month.
Reduced annual volume	Downstream of Yarrawonga, diversions reduce annual flow by 25% compared to natural conditions.
Increased summer volume	Use of the river for delivery of water to downstream irrigation areas means that summer flow is 19% greater than natural.

Source: MDBC (2005b).

relation to wetlands. Chapter 5 provides details of the biodiversity of the Barmah area. Suffice to say that Barmah–Millewa is a significant area for colonial nesting waterbirds, fish and macroinvertebrates and a number of threatened species. All of which are dependent on flood regimes consistent with natural conditions for breeding.

Ways of Addressing Changes Resulting from River Regulation

A set of operating rules have been jointly developed by NSW, Victoria and the Murray-Darling Basin Commission to administer the allocation of water to Barmah–Millewa Forest. These are outlined in Box 15.5. These rules and triggers underpin all actions and decisions associated with environmental flows for Barmah–Millewa Forest.

As well as the highly prescriptive operating rules and triggers, various delivery techniques are used or being considered to address the adverse effects of river regulation on the biodiversity of Barmah–Millewa Forest. Most of these involve using the existing regulating structures such as the eight primary regulators, two secondary regulators and at least twenty-seven tertiary regulators. All these structures are operated by DSE with funding assistance from River Murray Water. Goulburn-Murray Water maintains the regulating structures on behalf of River Murray Water.

Table 15.7 Impact of hydrological changes on vegetation communities of Barmah Forest

Vegetation community	Impact due to river regulation
Rushlands	• Giant rush has established over 1.5% of Barmah forest, in some areas that previously were grasslands. This is largely due to regular summer inundation, and reduced frequency/period of inundation of winter/spring flooding • Suggestions that some wetlands are prone to silting and drying out more readily than they were in the previous 20 years
Grasslands	• Grassland areas declined from 13.5% in 1930 to 5.2% in 1979. This decrease is linked to river regulation and the invasion by river red gums onto grasslands
River red gum forest	• Natural regeneration of red gum dependent on occurrence and timing of flooding. The ideal conditions are on the spring recession of winter flooding • High river levels associated with summer irrigation supplies have led to tree death due to waterlogging

Source: MDBC (2005b).

Box 15.5 Operating rules for the Barmah Millewa Forest Environmental Water Allocation

No.	Agreed rule or Trigger
1.	The GL of high-security water has the same security as Victoria's water right along the Murray. This will be augmented with 50 GL of lower security water (25 GL from each State), which is not allocated until Victoria's seasonal allocations along the Murray reach 100% of water right plus 30% of "sales", and is then allocated fully. It should be allocated in 75 to 80 years out of 100. The use of Victorian allocations to define security will be replaced by the use of independent triggers as soon as these can be developed and agreed to by the two states.
2.	Each state's share of the allocation is stored on their respective sides of the storages.
3.	All the water allocated is carried over if not used, with the maximum volume of the allocation being 700 GL (this could be say 150 GL allocated in the current year, plus 550 GL carried over).
4.	When Hume Dam physically spills, the first water spilt is the Barmah–Millewa kitty, though up to 200 GL, if kitty contains that much, will be retained
5.	Allowance has been made for the allocation to be overdrawn by up to 100 GL to ensure adequate water is available for forest watering, provided there is sufficient water in storage. This is proposed that sufficient water will be defined by the Commission, to ensure each state can underwrite the overdraw. Possible definitions include: more than 2,000 GL of water stored in Dartmouth, each state having more than 700 GL stored in Dartmouth, or each state having more than 50 GL in excess of the mandatory reserve for the following year.
6.	Each state's share of the Barmah–Millewa environmental allocation can be borrowed for consumptive use by that state, subject to clearly defined borrowing and payback rules to be agreed between the states and endorsed as part of these arrangements. Any water borrowed by either of the states must be paid back Initially, Victorian water users can borrow when their general security allocations would otherwise be less than 30%, only to the extent necessary to get these allocations to 30%. The water must be repaid as soon as borrowing is not needed for this. Both states agree that the above borrow and payback triggers will be adopted as operational guidelines during the interim period. However, each state reserves its position to alter the application of these triggers in special or exceptional circumstances, and in such circumstances to consult on the matter through the Commission. The idea that water paid back can not be spilled until one year after it is paid back is to be further investigated and considered for possible adoption.
7.	In principle, credits may be allowed to the environmental allocation for water returning from the forest to the river, where this returning water is not surplus to requirements—the operational details to be agreed between the States.
8.	Releases for the Barmah–Millewa forest will be made to top up the Yarrawonga flow using target flows similar to the following: • If there is a flood ≥ 500 GL/m from September through to November, then maintain at 400 GL in December (if sufficient volume in the allocation); • If there is a flood ≥ 500 GL/m in September or October and kitty is ≥ 400 GL (including overdraw), keep at 500 GL/m till November and 400 GL in December; • If 4 years pass with no release, and no flood of ≥ 500 GL/m in September to November and 400 in December, try for 500 GL/m in October and November and 400 GL in December; • If 3 years pass with no month from August to November with ≥ 660 GL, then if a release starts in October or November, the target flow increases to 660 GL at Yarrawonga.
9.	The above operating practices for releases can be varied and refined from time to time, by agreement between the managers of the forest water in consultation with water managers in the two states, and with the agreement of the Murray-Darling Basin Commission.

Source: MDBC (2005b).

One proposal being investigated to achieve environmental outcomes for Barmah–Millewa Forest is by-passing Lake Mulwala (diverting flows coming down the River Murray via the Edward River system) to prevent unseasonal flooding of Barmah–Millewa wetland system by rain rejection flows (see first section of this chapter). Such a proposal focuses on engineering solutions to the problem and requires considerable capital investment. This proposal is referred to in the Living Murray Environmental Watering Plan, 2005.

A second proposal involves the possibility of acquiring land for a Hume–Yarrawonga Easement to improve the flooding regime of the River Murray system downstream of Hume Dam. This involves the acquisition of flow rights over private land, thereby enabling temporary unregulated flows at rates of up to 45 GL per day to flow downstream from the Hume Dam. This would provide increased operational flexibility for control of flooding of the Barmah–Millewa system and increase the volume of water available downstream of Barmah forest.

A third is the Lower Goulburn proposal. This involves rehabilitation of the floodplain of the lower Goulburn River as it enters the River Murray to a more natural flow regime through the development of a levied floodway of approximately 10,500 ha. Implementation of this proposal would involve purchasing approximately 9700 ha of land from landholders. It would also achieve increased flows into the River Murray system and back flow into the Barmah Lakes (similar to natural flood regimes). An added benefit would also be the enhanced flooding of Gunbower forest.

Figure 15.11 Environmental flows in Barmah Millewa Forest.

Ecological Asset Site 2: Gunbower and Koondrook–Perricoota Forests

Gunbower and Koondrook–Perricoota Forests lie west of Echuca and Torrumbarry Weir (see Map D). Like Barmah–Millewa Forest, the Gunbower and Koondrook–Perricoota Forests straddle the River Murray with Koondrook–Pericoota in NSW and Gunbower forest located in Victoria. Some irrigation occurs on Gunbower Island, although the majority of the Island is state forest covering an area of 19,931 ha. The forest is managed

Table 15.8 Flood frequencies of the major Gunbower forest floodplain vegetation communities before regulation.

Vegetation community	Flood frequency (% of years with inundation)	Duration (months)	Season (ideal)
Watercourses	Varies	Varies	Varies
Permanent wetlands	Some always wet	Some always wet	–
Semi-permanent wetlands	1:1 (100%)	Dries out only after 2 dry years	Spring
Temporary wetlands	1:1.4 to 1:5 (20% to 70%)	Range from 5 months to 4–6 weeks depending on community	Late winter to spring
River red gum forest with flood dependent understorey	1:1 to 1:1.14 (70% to 90%)	5 months	Spring
River red gum forest with flood-tolerant understorey	1:2.2 (45%)	1 to 2 months	–
Black box	1:10 (10%)	1 month	–
Grey box	1:20 (5%)	1 month	–

Source: MDBC (2005b).

by DSE Forests while the eastern end of the forest (9712 ha) is a proclaimed Wildlife Sanctuary and land between the River Murray and the River Track is part of the River Murray Reserve, managed by Parks Victoria (see chapter 9).

Over thousands of years, Gunbower forest has been influenced by the impact of the Cadell Fault and Barmah Choke which limits river flow downstream of Barmah forest. The maximum flow from the River Murray into the forest is only 30 GL per day. Major flooding of Gunbower forest is dependent on the inflows from the Goulburn Broken river systems and to a lesser extent the Campaspe River system. Maximum flooding of Gunbower forest is only achieved when flooding of the River Murray is synchronised with floods coming down these two tributaries.

The Gunbower and Koondrook–Pericoota Forests are the second largest river red gum forests in Victoria and were Ramsar listed in 1982 and are also internationally significant for their biodiversity values. Details of the conservation and biodiversity of the forests are described in chapter 5. Vegetation communities throughout the forests have adapted to the cycles of wet and dry associated with the natural flow regimes of the River Murray. This relationship of the water flow across seasons and the types of vegetation communities is summarised in Table 15.8.

Flow and Flood Regime Changes due to River Regulation

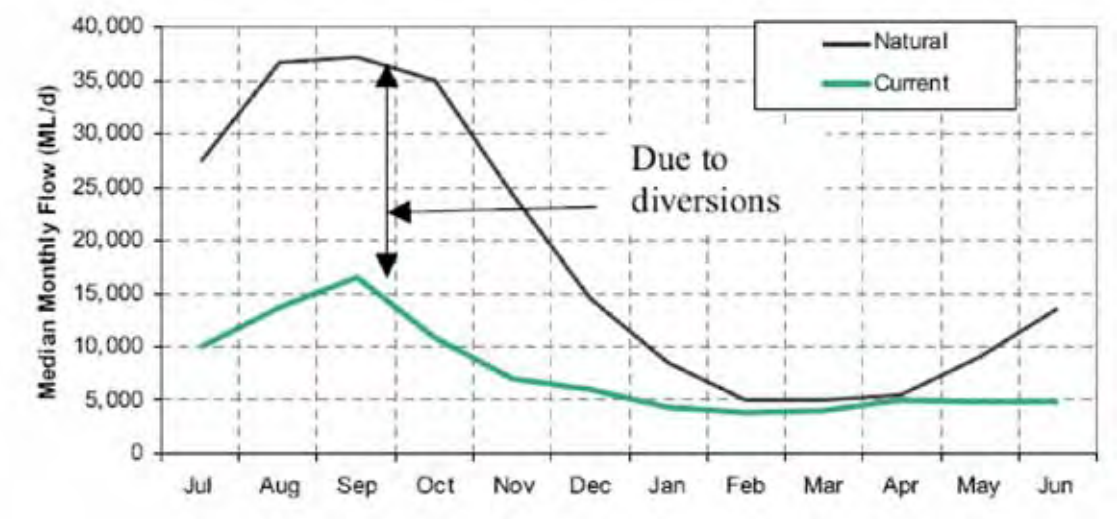
The major river flow and flood characteristic altered by river regulation in Gunbower forest is the reduction in frequency of medium sized spring floods (see chapter 4). A comparison of the natural and current monthly flows in the river is shown in Figure 15.12. In particular note flows have declined in frequency downstream of Torrumbarry Weir by over 25 GL per day.

Table 15.9 Impact of environmental changes on vegetation communities of Gunbower Forest.

Vegetation community	Known or expected stresses
Watercourses	• Reduced connectivity between wetlands and river. • Reduced fish breeding. • Loss of diversity of habitats within forest.
Permanent wetlands	• Loss of wetland type - flooded less and therefore those which remain would be now shallower and smaller.
Semi-permanent wetlands	• Extent of wetlands has declined. • Number of sites has declined. • Reduction in permanence. • Red gums encroaching. • Loss of grebes, terns, herons and egrets. • Alterations to littoral fringe.
Temporary wetlands	• Colonisation by red gum and weeds such as Noogoora burr and thistles. • Wet period too short to promote aquatic plants. • Wetland-adapted plants and animals out-competed by those with short-life cycles, rapid growth and maturity.
River red gum forest with flood-dependent understorey	• Extent has declined to a narrower zone around wetlands. • There has been an increase in weed species (thistle, fleabane, aster, Noogoora burr). • Decline in population of flood-dependent species.
River red gum forest with flood-tolerant understorey	• There has been an increase in weed species (such as horehound). • Probable increase in abundance of true terrestrial plants. • Reduction in red gum productivity and associated benefits to herbivores and insectivores.
Black box	• Box is tolerant of long dry spells, so possibly no significant changes. • Possibly has encroached on red gum with flood-tolerant understorey in response to declining flood frequencies.
Grey box	• Probably no change in water regime.

Source: MDBC (2005b).

Figure 15.12 Changes in median monthly flow patterns between natural and current flows at Torrumbarry Weir.



Source: MDBC (2005b).

Gunbower and Koondrook–Perricoota Forests are downstream of some of the River Murray's major water storages and three of the major diversion points on the River (located at Yarrawonga–Mulwala Canal and Yarrawonga Main Channel and the Torrumbarry Weir–National Channel, see Map 15.2 Channel network). This area is also downstream of the Edwards River off-take and inflows from the Broken, Goulburn and Campaspe Rivers. Gunbower Creek is maintained at top of bank level during the irrigation season—August to May by the weirs at Gunbower, Cohuna and Koondrook which result in extended high flow periods in the forest, particularly during summer and early autumn.

Torrumbarry Weir is the major physical structure directly influencing the flow and flood regimes of Gunbower forest. The weir creates a head of water (increases the water height) to increase the flow of water into the main channels of Gunbower forest. Levees are used on the outside areas of the forest to protect adjacent farmland from these small and medium sized floods. Prior to their construction water flows would have entered the lower areas of the floodplains and returned to the River Murray near Koondrook. Today, irrigation supply offtakes associated with Torrumbarry Weir limit the maximum flow at the downstream end of the forest system to around 32 GL per day. Flows into Gunbower Forest commence when the flow in the River Murray is approximately 13.7 GL per day and as the river rises, flows enter other parts of the forest.

Unseasonal rain rejection flows are delivered to the forest via three outlet structures on Gunbower Creek: Shillinglaws Regulator and two smaller structures at Reedy Lagoon and Black Swamp. Gunbower Creek has varying channel capacity, from 900–1000 ML per day to 4000 ML per day depending on the location along the creek.

Ecological Impacts of Regulation

Table 15.9 summarises the major ecological consequences of changed water regimes for Gunbower forest for which the Gunbower and Koondrook–Perricoota Asset Plan is designed to address—see chapter 5 for further details of the biodiversity of this area.

Ways of Addressing Changes Resulting from River Regulation

There are two environmental watering strategies currently employed at Gunbower forest to address changed flow regimes. The first includes limiting the extent of rain rejection flows into the forest during summer and the second increases the occurrence of medium sized flows through the use of flow regulating structures. These operate within the context of Gunbower's unique hydrology and geomorphology characteristics.

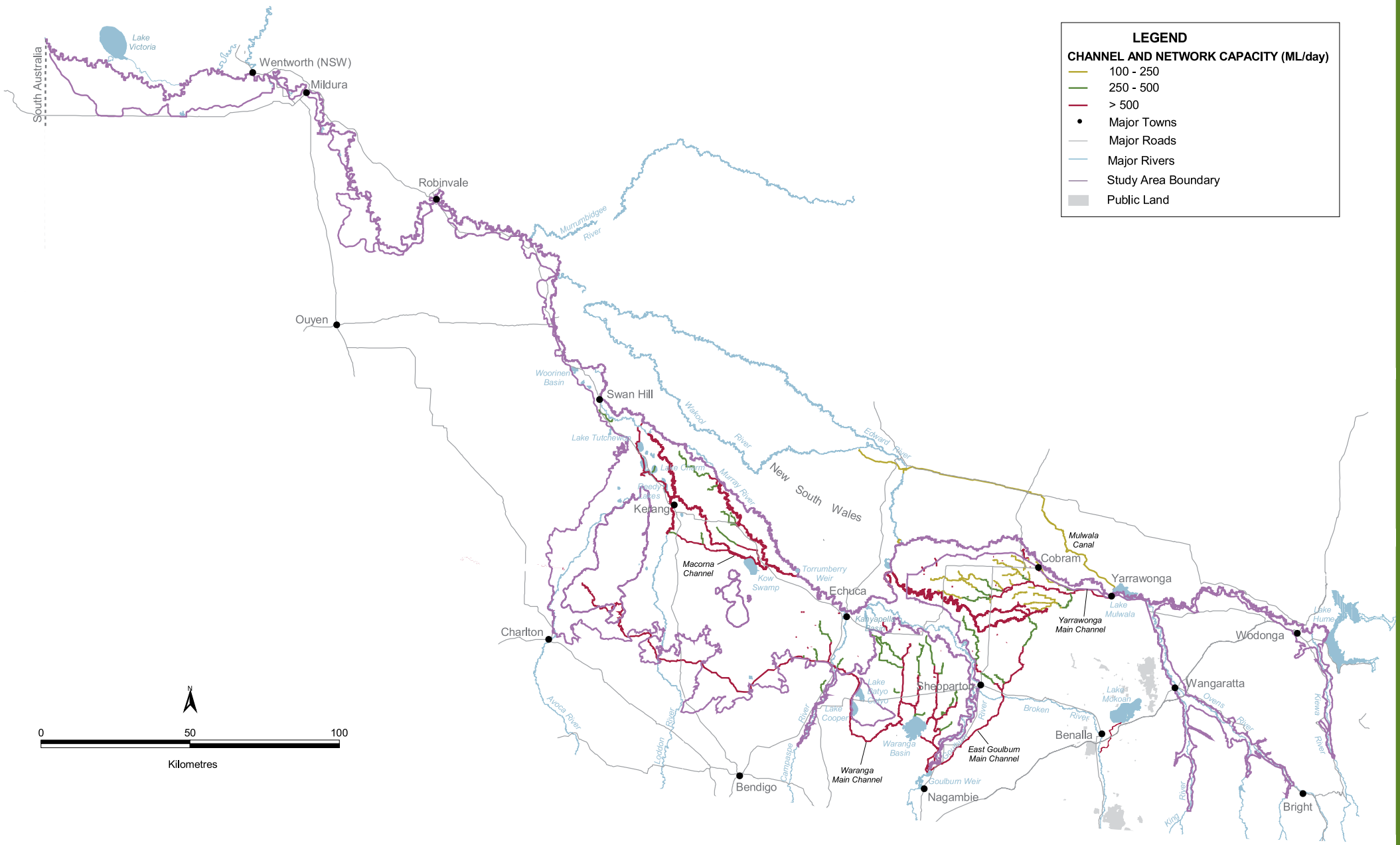
A current delivery method for Gunbower forest is enhancing naturally occurring floods. This involves supplying additional water on top of a naturally occurring flood. This has the advantage of temporarily restoring the connection between the river and floodplain.

In Gunbower forest the preferred delivery method is managed environmental flows, which have logistical advantages. For example, managed floods provide greater scope to monitor the flood event and allow for monitoring systems to be in place several months before inundation. It also enables several months notification to forest and water users of the likely change in conditions of the forest and provides flexibility for transferring Environmental Water Allocations between storages. A further benefit of managed floods is that they require less water than enhanced flooding practices.

Within Gunbower forest specific environmental flow management options include:

- using existing regulator network;
- managing water flows in the upper end of the forest to overcome the higher elevation constraint of this

Map 15.2 Irrigation channel network.



area—this involves the use of greater volumes of water which are often sourced by piggy backing on floods down the Goulburn River system;

- physically deepening and widening the channels between the river and the river track—river reserve;
- raising Torrumbarry Weir pool—although the benefits of this approach do not go to areas with a high priority for water management.

Ecological Asset Site 3: Hattah Lakes

The Hattah Lakes system lies within the adjacent Hattah–Kulkyne National Park and the Murray–Kulkyne Park. Unlike Gunbower and Barmah, Hattah does not have any association with NSW. Combined the parks have an area of 49,500 ha.

The Hattah Lakes system is an extensive floodplain consisting of at least 18 shallow lakes, streams and temporary swamps and bordered by riverine forests. These systems are located approximately 15 km from the River Murray and are mostly fed by Chalka Creek, connected to the River Murray—see Map D.

Under natural conditions, the majority of the lakes in this system were semi-permanent. The Hattah Lakes consist of a wetland system linked by interconnecting anabranch creeks to the River Murray. Today, these lakes are Ramsar listed. Details of the fauna and flora of the Hattah Lakes system are provided in chapter 5. Under natural conditions flooding of Hattah Lakes occurred through direct overflow from the River Murray as well as backflow from the creek systems scattered through the lake system. Ideal flood conditions for Hattah Lakes occur when floods inundate the lakes for several months of the year before periodic drying. Water requirements for the major vegetation communities in Hattah Lakes vary. For flood dependent species, flood depth, flood duration, flood frequency and seasonality are all important.

Flow and Flood Regime Changes due to River Regulation

The *Mallee Catchment Management Authority Draft Integrated Water Management Plan* identifies primary and secondary flows paths. Primary flows are flows to lakes that occur as an off take from the Chalka and Cantala distributaries. Approximately 12 of the 18 lakes in Hattah Lakes receive these primary flows. Secondary flows are those that occur as a result of `spillover' from other lakes or tributaries within the system onto the floodplain of the wetland system. However, one of these lakes (Lake Kramen) receives primary flows from the River Murray and Chalka Creek and secondary flows from Lake Nip Nip and Lake Tullamook (through sheet flooding as a result of exceptional flood events).

The overall sequence of flood events is complex and involves a complicated inter-dependency between lakes and flows, filling and emptying of each lake depending on its position in the system, its area, and its depth. Lake Lockie is the first lake to receive floodwaters, several days after they first enter Chalka Creek. All the southern lakes are then filled from Lake Lockie, typically taking another three weeks for water to reach the furthest lakes. After Lake Lockie, water flows into Lakes Hattah and Little Hattah, followed by Lake Bulla, and then, in order, Lake Arawak, Lake Marramook, Lake Brockie, Lake Boich, Lake Tullamook, Lake Nip Nip and finally, Lake Kramen. Lake Lockie is believed to deliver flow to Lake Roonki—see chapter 2 and 3.

The northern part of the system, Lakes Mournpall, Yerang, Yelwell and Konardin, receive water both directly from Chalka Creek, and via Lake Lockie. Lake Bitterang is the last of the lakes to fill, with floodwaters only reaching it over a month after the beginning of flooding, and then only if the flood level is sufficiently high. When the lakes are full, floodwaters also spread over surrounding floodplains, including an area of black box flats to the west and south-west of Lake Lockie. Lake Kramen fills by overland flow from the Murray in a very high river. Lake Cantala is fed by a minor anabranch of the Murray River.

The lakes only fill during high flow events in the River Murray, with a flood of at least 152 GL per day required for all of the lakes to fill. Water retained in lake basins after floodwaters recede is gradually lost through evaporation. Most lakes are shallow, and dry up within two years if not refilled, but Lake Hattah may retain water for three years, and Lake Mournpall for up to seven years.

The hydrology of the Hattah Lakes system has altered in response to the construction of locks and weirs along the River Murray, and the inlet channel, at Chalka Creek, has undergone deepening and widening. A regulator on Chalka Creek at Messengers Crossing is used to delay flow recession from the lakes, helping to increase the duration of inundation. Channels (with regulators) have been constructed between Lake Lockie and Lake Hattah and between Lake Hattah and Lake Little Hattah.

The River Murray headworks storage and diversions have resulted in an overall reduction of mean annual flow at Euston Weir to 50 percent of pre-regulation volumes. River regulation has also reduced the frequency and magnitude of small-to medium-sized floods to the lakes. Flows in spring are considerably less than under natural conditions. Under natural flow regimes the lakes usually contained water for most of the time albeit extremely shallow for most of the time. The Hattah Lakes system under current conditions presents a trade-off between the frequency of wetting and the duration of wetting. While the frequency of events may have increased, the reduced `commence to flow' threshold allows water to drain from the lakes faster than under natural conditions. The regulator at Messengers Crossing on Chalka Creek reduces this problem. The changes in flow regimes at Hattah Lakes are summarised in Box 15.6.

Ways of Addressing Changes Resulting from River Regulation

Chapter 5 provides details of the fauna and flora for this area. It also describes the ecological changes resulting from river regulation. Table 15.10 provides an outline of the preferred flood regimes for the various species in Hattah Lakes. The purpose of environmental flow watering events is therefore to attempt to achieve these flood requirements or if not, minimise the effects of river regulation of flow regimes.

At Hattah Lakes the environmental managers face a major physical constraint—the problem of initiating flows into the Hattah Lakes system through the higher

Box 15.6 Summary of the Changes in Flow Regimes of the Hattah Lakes

Reduced duration of flooding	The flooding behaviour of the lakes system has been altered, both in terms of volume of water delivered to the lakes and the timing of its delivery. A reduction in the duration of flooding and inundation has occurred since regulation. For Lake Hattah, the depth of water retained in the lake has been reduced from 2.8 m to 1.8 m. This means that the average time taken for the lake to dry out after filling has reduced from 26 months to 17 months. Other lakes in the system have experienced a similar shift, with the depth of water retained in Lake Lockie being reduced from 1.2 m to 0.4 m. This has resulted in the average time to dry out being reduced from 12 months to two months.
Reduced frequency of flooding	The frequency, duration and volume of water delivered to the Lakes system has been significantly reduced through time. Modelling of natural and current conditions indicates that under current conditions, the number of floods in 100 years is 57 for Lake Hattah and 11 for Lake Kramen. Under natural conditions, the number of filling events in 100 years is 86 for Lake Hattah and 23 for Lake Kramen. It is important to note that Lake Hattah is one of the first lakes to flood, while Lake Kramen is one of the last (when a large flow event occurs).
Reduced annual volume	The annual volume of water in the lakes is inversely proportional to the percentage of time that the lakes are dry. Modelling of natural and current conditions of the Hattah Lakes system indicates that for Lake Lockie, the proportion of the time that the lake is dry is 72% of the time under current conditions, compared to 9% of the time under natural conditions. Even though Lake Lockie is one of the first lakes to receive water, it has a low capacity and is relatively shallow. Other lakes in the system indicate a similar comparison between natural and current conditions. For example, under natural conditions, Lake Hattah is estimated to be dry 2% of the time compared to 25% under current conditions. As a result of modifications to the Chalka Creek channel, including the installation of regulators, the critical flow volume to achieve flooding between lakes has been reduced in most cases. For example, the critical flow between Lake Lockie and Lake Hattah has been reduced from 48.9 GL/d to 36.7 GL/d.

Source: MDBC (2005b).

Table 15.10 Preferred flood requirements for vegetation species, Hattah Lakes.

Species	Ideal flood requirements
River red gum	Winter–spring flooding every 1 to 2 years for a duration of 4 to 7 months (no more than 24 months)
Tall flat sedge	Flooding for 135 to 200 days per year, at depths less than 60 cm
Spiny flat sedge	Flooding for 2 to 6 months (optimal 3 mths) to a depth less than 10 cm
Cane grass	Frequency 1:2 to 1:5 for a duration of up to 6 months
Spiny mudgrass	Annual–biannual flooding, 3 to 10 months duration
Water couch	Summer flooding for 4 to 8 weeks at a depth not less than 10 cm
Submerged macrophites	Annual flooding, variable duration
Fish	Flood frequency every 1 to 2 years for short lived species; some permanent water for permanent residents
Colonial nesting water birds	Inundation for 5 to 8 months following winter–spring flooding and inundation of 7 to 10 months following autumn flooding
Ducks	Flooding for between 3 to 7 months (optimal)–up to 5 months to reach peak breeding and 2 months fledging time

Source: MDBC (2005b).

Chalka Creek relative to the River Murray channel. This requires high flows and volumes before flows commence. Only very large floods result in all the Hattah Lakes being flooded. Smaller floods that have a recurrence interval of every several years result in 30 percent to 50 percent of the Lakes being flooded. Utilising these smaller flood events that occur relatively frequently is just as important as managing the less frequent larger flood in Hattah Lakes.

There are four major delivery methods for watering Hattah Lakes:

- manipulating Euston Weir and upstream storages such as Torrumbarry Weir and Hume Dam;
- pumping additional water into the lakes from the River Murray—see Figures 15.13 and 14 for examples of pumping for environmental flows and flooding resulting from pumping. Currently, this method is still in its infancy but was used in the 2005–06 with a high degree of success;
- improving water management within the Lakes system through the use of regulators to manipulate flows to specific sites at specific times and for retention of water once an area is flooded; and
- topping up or enhanced flows. These involve piggy backing off inflows to the River Murray from its tributaries such as the Murrumbidgee and Goulburn rivers to increase the overall volume of water in the system.

Figures 15.13 and 14: Pumping and Flooding.

Another specific action that could be implemented at Hattah Lakes is the deepening of Chalka Creek in order to provide flows to the Hattah Lakes at lower river discharge levels. Installing a pump station at Chalka Creek to pump water into Chalka Creek and the Hattah Lakes is also an option. This allows an increase in flood frequency as well as duration and magnitude of floods.

Ecological Asset Site 4: Lindsay–Wallpolla and Chowilla Floodplain

Features of Lindsay–Wallpolla and Chowilla Floodplain

The Chowilla Floodplain and Lindsay–Wallpolla Islands Significant Ecological Asset (SEA) comprises three separate locations: Lindsay Island in Victoria; Wallpolla Island in Victoria; and the Chowilla Floodplain, which spans South Australia and New South Wales and the NSW section of the Chowilla Floodplain. Under the SEA arrangements Lindsay Island and Wallpolla Island systems are a single group—in reality however, they are separated by approximately 40 river kilometres.

Lindsay and Wallpolla Islands are formed on the southern side of the River Murray (Victoria) by a series of anabranches that leave and then rejoin the river, leaving the islands situated between the anabranch channels and the main stem. Wallpolla Island covers an area of 9,200 ha and Lindsay Island has an area of 15,000 ha. The main anabranch forming Wallpolla Island is Wallpolla Creek and the main anabranch forming Lindsay Island is Lindsay River. Lake Wallawalla is a shallow, permanent riverine lake located off the lower Lindsay River and is part of Lindsay Island. Potterwalkagee Creek is another anabranching channel that is located between Lindsay and Wallpolla Islands, and it forms Mulcra Island (2156 ha). Thus, Lindsay Island and Wallpolla Island are linked by Mulcra Island, and although it has ecological values, Mulcra Island is not part of the Significant Ecological Asset.

Wallpolla Island is a state forest while Lindsay Island is part of the Murray-Sunset National Park. The Victorian Government and the Mallee Catchment Management Authority have identified both the Lindsay and Wallpolla Islands as high ecological value areas. Lindsay Island, Wallpolla Island and Lake Wallawalla are listed under the Directory of Important Wetlands and are nationally significant. The anabranches of the islands are also important native fish breeding habitats. Although the areas of permanent and semi-permanent wetland in each site are small, they support species that are of national, state and local importance. Lake Wallawalla is considered to be a `high value' wetland system.

Flood flows from the River Murray are crucial to the environmental condition of the Lindsay–Wallpolla system. The health of this system is threatened by river regulation. Due mainly to reduced frequency of medium-sized floods. The seasonal pattern of river flow remains largely unchanged.

The islands are located in the far northwest of Victoria just downstream of Mildura–Wentworth. Wallpolla Island is located downstream of Wentworth Weir (Lock 10) and upstream of Lock 9. Lindsay Island is located just downstream of Lake Victoria and between Lock 6 and Lock 7 (approximately 700 km from the River Murray Mouth). Frenchmans Creek flows from the River Murray to Lake Victoria, diverting some water from Wallpolla Island, while the Rufus River runs from Lake Victoria into the Lindsay Island system. One of the largest channels within this system is Mullaroo Creek, which diverges from the River Murray just upstream of Rufus River, crosses the island from east to west, and then joins the Lindsay River.

Lake Wallawalla is a quasi-circular deflation basin located on the southern point of the system with a surface area of 828 ha. It is a significant source of groundwater recharge to the Lindsay Island system. It is separated from the main floodplain area of Lindsay River by a levee that impedes the natural flood path (the Mail Route Road). The Mail Route Road acts as an impediment to medium-sized floods, with several small culverts allowing limited flow. Under natural conditions, this would have made a continuous connection with the floodplain. Black box communities surround the lake, with extensive sand dune deposits to the south-east. During flood inundation, Lake Wallawalla becomes a wetland and is a significant site for bird breeding.

Table 15.11 below describes the water volumes required before water will commence to flow into Lindsay-Wallpolla Islands systems and hence is a major determinant of when and how environmental flows are implemented.

Flow and Flood Regime Changes due to River Regulation

The major changes from river regulation for Lindsay–Wallpolla flow regimes are: reduced flood frequency; reduced flood duration; and reduced annual volume and changes to seasonality (see Box 15.7). Of the water that flows from the River Murray into the Lindsay–Wallpolla Island systems, some is lost to groundwater recharge and evaporation, but the majority is returned to the River Murray downstream.

As described above the Lindsay-Wallpolla Island system has an extensive range of vegetation communities and hence habitat types. Each of these require their own unique flooding regime. Table 15.12 describes the water flow requirements for different vegetation groups within Lindsay–Wallpolla Islands.

Ways of Addressing Changes Resulting from River Regulation

Flows in this section of the River Murray follow a seasonal pattern similar to that prior to river regulation, with maximum flows in winter and spring, and minimum flows in autumn. However, the actual volume for the seasonal pattern is lower with regulation. A range of methods deliver environmental flows to Lindsay–Wallpolla Islands, all of which are linked to the specific geomorphology of the area (see chapters 2 and 3). These can be grouped as either the use of weirs and structures such as regulators and or the use of pumping.

Table 15.11 Flow thresholds for landscape feature inundation for Lindsay and Wallpolla Islands

Stage	Lindsay Island	Wallpolla Island
Stage I Very Low <20 GL/d	Creeks are extensively ponded. Water levels and creeks in backwater controlled by Lock 6.	Creeks are ponded. Water levels in Wallpolla Ck and creeks to the west are controlled by Lock 9. Virtually no through flow.
Stage II Low 20-35 GL/d	Major creeks begin to flow as inactive anabranches become connected to the River Murray upstream resulting in a change from ponded to flowing.	Creeks become connected to the River Murray weir pool and flowing. If sufficient head occurs, Finnigans, Sandy, Moorna and Dedmans creeks will flow. Very few inundated areas occur west of Moorna Ck. Anabranches become connected at Thompsons Ck to the River Murray in the north, and Wallpolla Ck to the River Murray in the south.
Stage III Small 35-60 GL/d	A few anabranches begin to form, e.g. along Mullaroo Ck and River Murray at Toupnein Island, and some backwaters begin to expand. A network of small channels associated with or near River red gum forests forms.	The number and complexity of flow paths is increased as small, unnamed creeks begin to flow and may connect to other small creeks—Sandy Ck to Finnigans Ck, Moorna Ck to Wallpolla Ck, Dedmans Ck to Wallpolla Ck. Occasional filling of backwater creeks.
Stage IV Medium 60-115 GL/d	Backwaters continue to expand (e.g. Oscars Ck) off Pollards Island, south of Toupnein Ck and centre of Lindsay Island. The terraces of the Lindsay River become flooded. Additional flow paths begin to form and existing filled creeks join up.	Backwaters that are expanding are off the main eastern creeks e.g. Sandy, Finnigans, Thompson and Wallpolla Creeks. Wallpolla Ck connects to Willipenance Ck. Anabranches become active off Wallpolla Ck. Floodplain inundation begins to occur north of Wallpolla Ck and west of Moorna Ck.
Stage V Large >115 GL/d	Flow paths continue to spread out and coalesce, more overbank flows from the River Murray, landscape features begin to be submerged and individual flow paths or landscape features (e.g. creeks and terraces) are difficult to distinguish.	Flow changes occur as expanding backwaters begin to coalesce with the area between Moorna Ck and Dedmans Ck becoming inundated (anabranches merge with the River Murray to return flows to the river).

Source: MDBC (2005b).

Box 15.7 Changes in flow regimes of Lindsay–Wallpolla Islands based on an analysis of the 109 year flow record

Reduced flood frequency	Downstream of Wentworth Weir, under current conditions, the frequency of flood events with peaks greater than 10 GL/d has been reduced. Small flood events that are above regulated flow (peaks between 20 GL/d to 40 GL/d) now occur approximately 56 – 86 times per year rather than approximately 106 – 117 times per year. However, it is the frequency of events larger than this (classed as 'medium-sized' events) that have suffered the greatest impact under current conditions. This is due to the dampening effect of lock and weir operation. For these events (peaks between 50 GL/day to 100 GL/d) frequency has been at least halved under current conditions. For floods with peaks >100 GL/d the frequency is less than one third of the natural frequency. In contrast to the reduced frequency of floods with peaks >10 GL/d, it should be noted that the frequency of small in-channel events with a peak of <10 GL/d has doubled.
Reduced flood duration	For the Lindsay–Wallpolla Islands, the greatest change in event duration has been for flows up to 10 GL/d. The median duration of events below 10 GL/d has been reduced from 258 days to 46 days. Flows above 20 GL/d and below 115 GL/d suffered the greatest decrease in the duration of events as a result of river regulation. Larger flood events (greater than approximately 115 GL/d) have been relatively unaltered.
Reduced annual volume and changes to seasonality	For flows up to approximately 20 GL/d, the seasonal pattern has largely been retained, with the exception that more low flows occur in winter than could be expected under natural seasonal conditions. For higher events, up to 60 GL/d, seasonality has shifted, now occurring one to two months later in the season. For larger events (> 60 GL/d) the onset of flooding has been slightly delayed. At the South Australian border, current median flow is 39% of natural (Gippel & Blackham 2002). Mean flow is 46% of the natural volume.

Source: MDBC (2005b).

Table 15.12 Table Water Management Unit Flow Requirements.

Water Management Unit	Duration	Frequency	Timing
River red gum	3 to 8 months	1 in 2 years	Spring to early summer
Black box woodland	2 to 6 months	1 in 5 years	Spring to early summer
Lignum shrubland	3 to 12 months	1 in 8 years	Spring to autumn
Open areas	Increase	Increase	
Permanent wetlands	Increase water level variability, provide a low water phase Assess individual wetlands for requirements		
Wetlands connected by 60 GL/day (individual medium sized wetlands)	Evaluate water regime needs		
Wetlands connected by 60-115 GL/day	Decrease	Increase	–
	Maintain flood duration		
Connected by >15 GL/day	Increase	Maintain	–
Lake Wallawalla			
Herbfield zone	2 to 4 months	1 in 3 years	Spring
Red gum zone	Minimum of 6 months	1 in 2 to 5 years	Late Winter/Spring/ early Summer
Black box zone	2 to 4 months	1 in 3 to 5 years	Not critical
Active channels connected to weir pools	Reduce	Reduce	
Active channels drier than natural	–	Increase	–

Source: MDBC (2005b).

In some situations, water from Lake Victoria could be used to achieve water spills onto the floodplain, for floods less than 50 GL per day because of the outlet constraint of Lake Victoria. Water could be supplied from Lake Victoria through Rufus Creek to `top up' smaller floods for the western end of Lindsay Island system (Wallpolla Island is just upstream of Lake Victoria). This method has the potential to increase flood frequency or duration of medium-sized events that allow connectivity of the anabranches.

Existing weirs and regulators on channels could be further enhanced to manage flows through a range of active channel habitats. These structures provide operational flexibility in that they can be used to facilitate flooding and prevent flooding combined with extending the time for flood inundation and the timing of the flood. Levees could be used in conjunction with weirs to pond water, but the negative effect of interfering with the distribution of waters from natural floods was considered to be sufficient reason to reject this method. The construction of fish passages also falls under this category.

Pumping is carried out in the Chowilla and Lindsay–Wallpolla as an emergency measure for isolated wetlands that have not been watered for a long time. Pumping also has the potential to water areas of floodplain, such as Black Box, which are located on high elevation areas. It can also be used for filling wetland systems to simulate flooding. There are, however, arguments against pumping because of the high ongoing cost and intensive management required and the need for the construction of levees to pool the water and prevent run-off.

Successes from Environmental Flows

A range of benefits for Victoria's significant ecological sites from environmental flows has already been achieved. Figures 15.16, 17 and 18 illustrate some of the ecological benefits of environmental flows. In the 2005–06 season, Victoria provided half of the 510 GL environmental water released for Barmah–Millewa, 19GL for Gunbower, 6 GL for Hattah lakes site (to fill over 220 ha of lakes and creek systems), 10 GL for the wetlands on Lindsay–Wallpolla (over 700 ha), and over 5 GL for other sites along the Murray channel. Of this water, 20 GL was targeted specifically at arresting the decline in river red gum condition.

In Barmah forest environmental watering opportunities to date, have resulted, in breeding events by colonial waterbirds including egrets, spoonbills, herons, ibis, cormorants and darters. Native fish have also spawned including Murray cod, silver perch, and smaller species such as Murray hardyhead and smelt. There has been widespread and prolific breeding by frogs (including threatened species such as growling grass frog) along with vigorous growth from wetland plants and river red gums. Surveillance from aerial flights following environmental watering has shown an increase in river red gum crown cover and extensive new leaf growth. Further discussion of biodiversity and forestry benefits associated with environmental water flows can be found in chapters 5, 10 and 14.

Gunbower forest over recent years has received environmental flows. In 2005–06 Gunbower received 19 GL of water sourced from Victorian surplus flows and Victoria's Flora and Fauna Environmental Water Allocation. There have been major

Figure 15.15 Pumping structures for environmental flows directly from river.

Figures 15.16 and 17 Environmental flow achievements.

ecological responses in the forest in response to these waterings. The most significant response is recruitment by a colony of endangered great egrets. Colonies of other wetland birds have also responded to the forest watering, including yellow billed spoonbills, darters, sacred ibis and cormorants. Over 200 colonial waterbirds bred in Gunbower forest during this period. Fish living in the wetlands and creeks such as golden perch, fly-specked hardyhead, crimson spotted rainbow fish, gudgeons and Australian smelt also responded to the waterings.

The wetland plants, which provide habitat for birds, frogs and fish, responded, resulting in a dense tree and vegetation cover at Gunbower forest. River red gums in areas where environmental water has been provided are displaying new growth. Other animals which were noted are tortoises, invertebrates (valuable fish and bird food) and also snakes, probably feeding on the frogs.

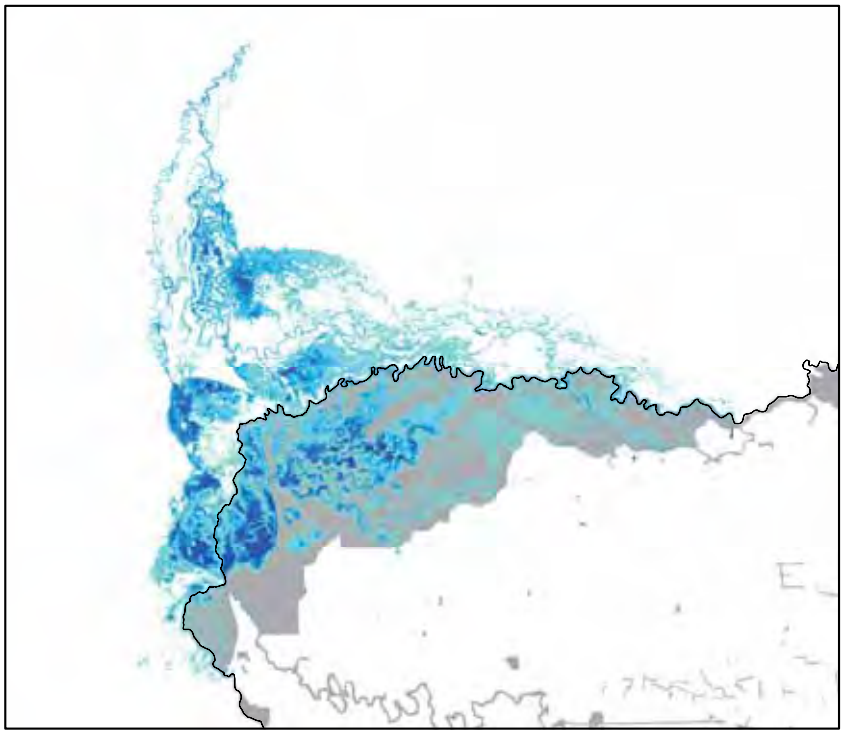
Maps 15.3 and 15. 4 illustrate the increase in flood distribution with increases in water volume for both Barmah–Millewa and Gunbower and Koondrook–Perricoota Forests. Both of these flooding events were associated with the successful environmental flow events in late 2005 and illustrate the greater flood spread and the increase likelihood of achieving greater connectivity between floodplain systems and the River Murray—see chapter 4.

During April to June 2005 and September to December 2005, environmental water was delivered to the Hattah Lakes system by pumping water from the River Murray into Chalka Creek. This resulted in re-wetting 20 km of

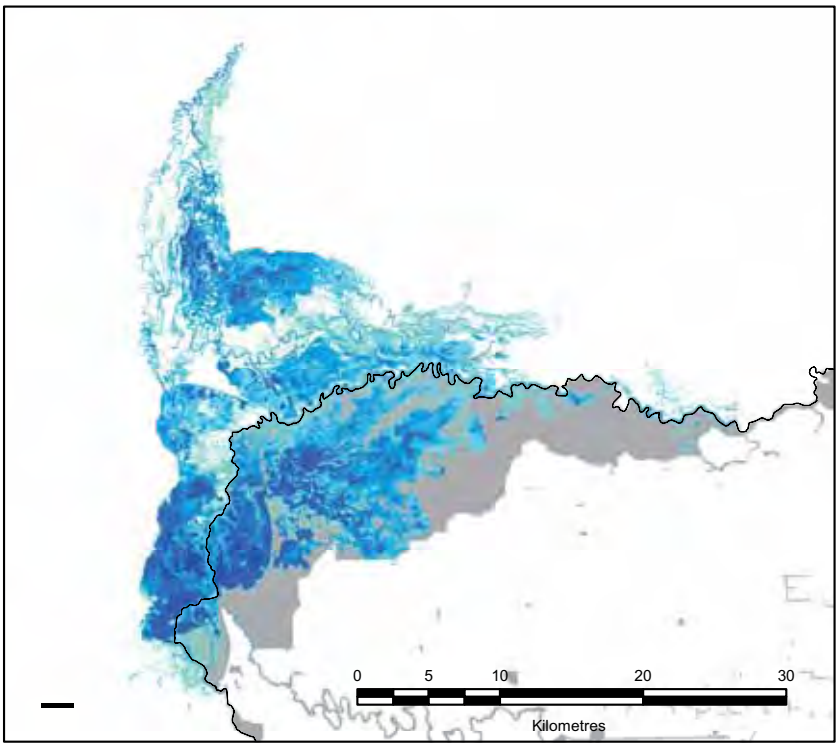
Maps 15.3 Distribution of Environmental Flows at Barmah-Millewa 2005-06.

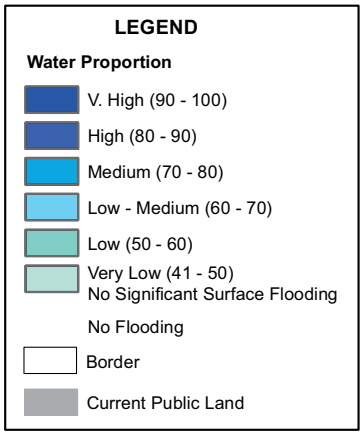
Flood Mapping in the Barmah-Millewa Forests October - November 2005
(period of high released flows) Spot -4 satellite imagery

14th October 2005 (peaked Yarrawonga 3-4 October 17,000 ML/day)



25th November 2005 (peaked Yarrawonga 12-13 November 28,000 ML/day)

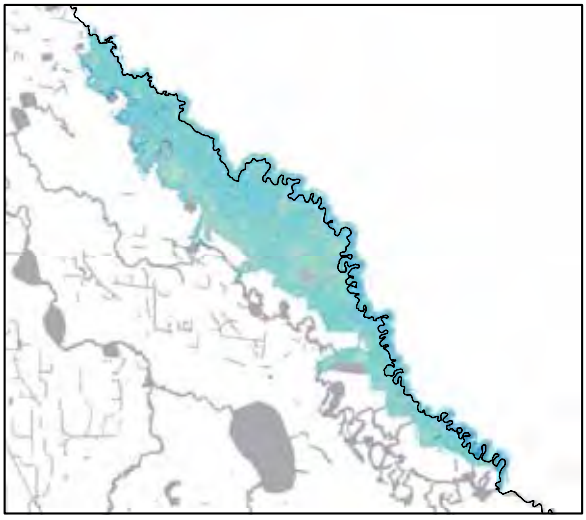




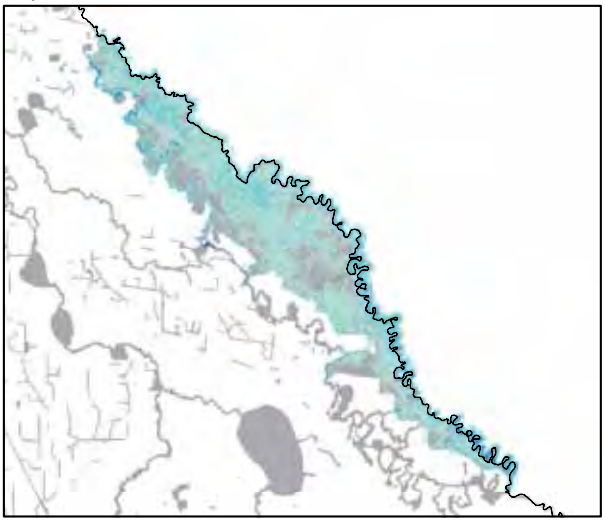
Maps 15.4 Distribution of Environmental Flows at Gunbower and Koondrook–Perricoota Sites 2005-06.

Flood mapping in the Gunbower State Forest July 2004 - March 2005
(period of high release flows) Landsat 5 Satellite imagery

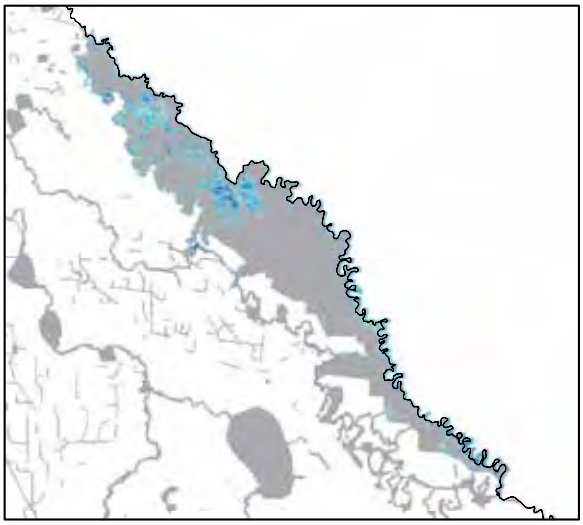
July 2004



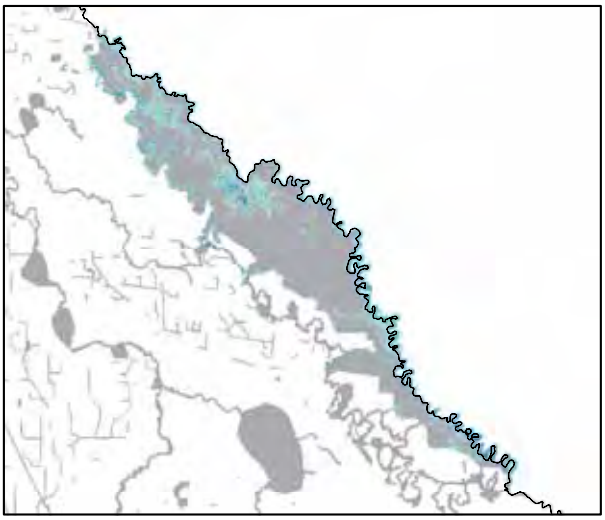
September 2004



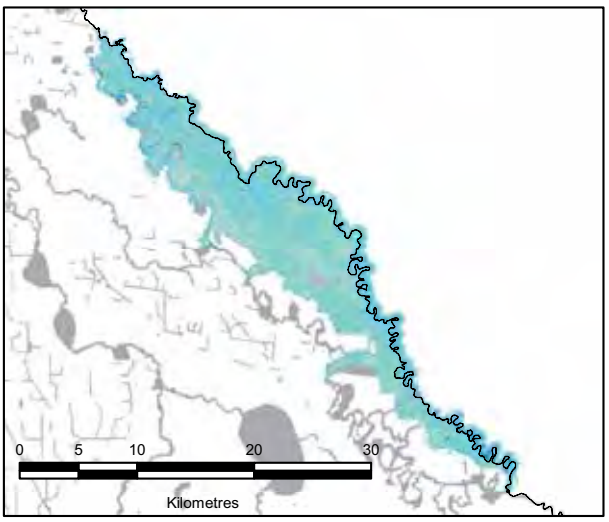
November 2004



February 2005



March 2005



LEGEND

Water Proportion

- V. High (90 - 100)
- High (80 - 90)
- Medium (70 - 80)
- Low - Medium (60 - 70)
- Low (50 - 60)
- Very Low (41 - 50)
- No Flooding
- Border
- Current Public Land

Chalka Creek and filling three lakes for the first time since 2002, resulting in growth and regeneration of river red gums along the creek. Murray cod, silver perch, golden perch and smaller native fish species were found in the lakes, most probably pumped into the system as larvae. Thousands of waterbirds were and are present, including a number of threatened species such blue billed duck, freckled duck and blue winged shovellers. There was also an explosion in the frog population, and many tortoises also enjoyed the flooding. Australasian grebes and waterfowl species successfully bred on the lakes for the first time since 2001.

In 2005–06, environmental water was delivered to parts of the Chowilla Floodplain. Sites included Kulkurna, Werta Wert, Lake Littra, Twin Creek, Pilby Creek, Chowilla Loop, Chowilla Oxbow, Copper Mine Waterhole, Brandy Bottle Waterhole, Punkah Creek and Monoman Island Depression. The area watered is estimated at over 800 ha. Across all sites, 50–90 percent of the stressed trees have responded positively to the increase in available fresh water. Thousands of waterbirds inhabited the wetlands, including state listed species.

During 2005–06, 22 sites on Lindsay, Mulcra and Wallpolla Islands received environmental water from pumping and by temporarily raising the upstream pool level of Lock 8. Approximately 1,800 ha was watered. Significant environmental outcomes included increased vigour of river red gums, and growth and flowering of black box. In addition, over 30 species of waterbirds were present on Mulcra and Wallpolla Islands.

SUMMARY

Although considerable research and knowledge exist around environmental flows, more knowledge is needed for specific sites and the fate of the water after it leaves the creek and anabranches and moves across the plain. Successful management of environmental flows requires instant action when water becomes available as well as being able to ensure that there is sufficient water over adequate time to achieve nesting requirements of birds, fish, amphibians etc. Further research is also required on the connectivity between waterways and floodplains and the effect this has on the lifetime reproductive success of aquatic species.

The current infrastructure approach is derived from, and remains geared towards delivering water for irrigation. Further knowledge about managing environmental flows will assist in adapting this technology towards environmental goals. The current adaptive management procedures and processes in place are dependent on responses to specific locations rather than an integrated plan across the system. Further development of successful environmental water flows will require ongoing commitment from management and government authorities.

Climate change is likely to reduce the total amount of water available from each river basin in the future for use by humans and by the environment. Consequently, there will be increasing pressure on these declining water resource stocks. The influence of climate change on water availability is discussed in depth in chapters 4, 5 and 19.

Increased competition for access to a declining resource will generate considerable political and economic discussion in the future. In the current water allocation framework the burden of sacrifice is born equally across all users with the environment having equal status to all other users. However, will this policy framework be sufficiently robust to withstand the increasing demands for the decreasing stock of water resources at an operational level?

Figures 15.18 Australian white ibis nesting in a river red gum forest.

16 Earth Resources

Currently earth resources such as road and building construction materials are accessed throughout the study area. New research and technology developments suggest that the area may also contain minerals including gold and heavy mineral sands.

A detailed description of the geology and geomorphology of the River Red Gum Forests study area is provided in chapters 2 and 3. This chapter describes the earth resources and highlights the active exploration and mining tenements within the study area particularly industrial minerals such as mineral sands and gypsum (McHaffie & Buckley 1995; Campbell et al. 2003) (Map 16.1). More generally, sand and gravel deposits in the vicinity of the major river systems may be significant sources of construction materials for local communities. There are also areas of brown coal near the surface in the Kerang-Torrumbarry area that are currently not economic to extract. The central part of the study area has Bendigo-style gold deposits buried under a cover of more recent sediments (Phillips & Hughes 2003). Copper, gold, molybdenum, tin, nickel, iron, bentonite, platinum group elements and base metals (e.g. lead, copper and zinc) may also be present in economic quantities.

Currently, the earth resources tenements on Crown land within the study area are:

- Two petroleum exploration permits;
- 17 mining exploration licences comprising:
  - > three for mineral sands;
  - > two for gypsum;
  - > 12 for gold/silver/platinum;
- Four mining licences for extraction of gypsum;
- Four work authorities - three for sand or gravel, and one for granite extraction; and
- 8 pipeline licences associated with mining and resource extraction activities.

In addition to existing tenements, the study area may contain more extensive areas of extractive materials, mineral sands, base metals and potential for economic gold deposits (Map 16.2).

MINERAL POTENTIAL

Gold

Gold-bearing bedrock is well exposed in the central portion of what is known as the Bendigo Zone (see chapter 2). The Bendigo Zone is a distinct geological strip running north-south through central Victoria. Within the study area, this zone is covered by younger sediments from near Swan Hill to Echuca, and outside the study area south to Werribee and a point about 20 km south of Colac. More recent Cainozoic rocks cover the northern third of the zone (see Map 2.1).

Most of the viable gold has been extracted from the exposed portion of the Bendigo Zone although this is currently being re-evaluated (e.g. Bush et al. 1995).

Preliminary estimates of gold potential within the Bendigo Zone of the study area suggest that up to 300,000 kg of gold resource may be present (GeoScience Victoria DPI in-house estimate) worth an estimated $6 billion to $8+ billion at current gold prices ($830 AUD per oz).

The main gold-prospective area within the study area lie under surface sediments and are not exposed on the surface. About 60 percent of this Bendigo Zone 'under cover' area is lies within the River Red Gum Forests study area, although a considerably lower percentage of this area is public land.

The Victorian Government recently commenced the three year *Delivering Gold Undercover* project to attract exploration and development and invest in data and technologies for identifying gold north of the golden triangle in central Victoria, in the 'under cover' area (DIIRD 2005). This initiative is aimed at encouraging new areas of gold exploration, where an additional 2,270,000 kg gold resource has been estimated (GeoScience Victoria DPI in-house estimate).

The likelihood of finding economically viable gold deposits in the study area outside the Bendigo Zone is low (Phillips & Hughes 2003). However, gold has been found in some areas in east in the past; notably the Ovens River, which yielded around 15,000 kg (current value over $300 million). The Kiewa valley has also been worked in the past and may still contain gold deposits. It is likely that not all the gold was extracted and developments in mining technology may make this area (and similar alluvial systems) of economic interest in the future.

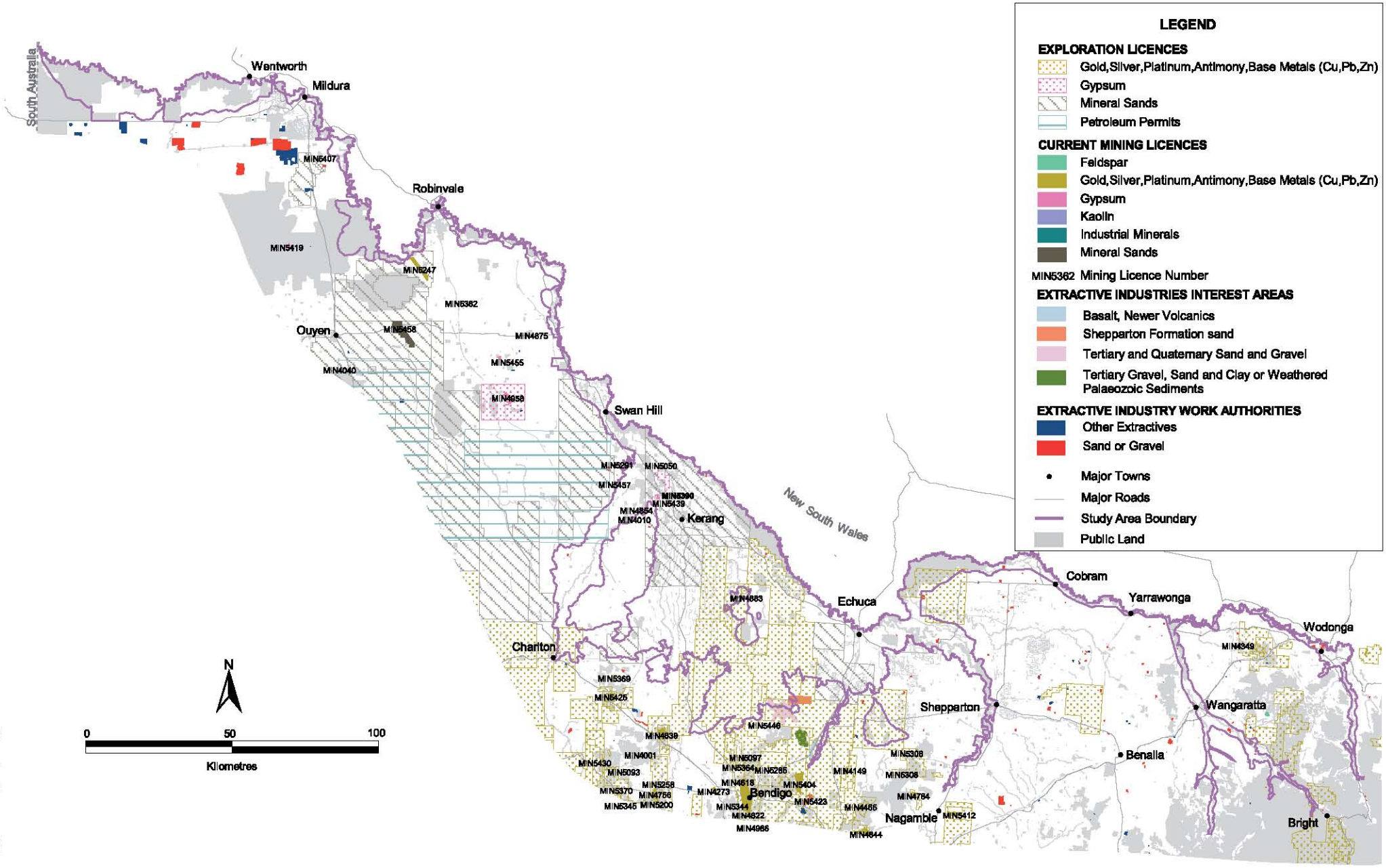
Mineral Sands

Mineral sands contain a group of minerals which are rich in the elements titanium and zirconium (the main elements of economic interest at present). In places these deposits contain economic concentrations of heavy minerals such as ilmenite, rutile and zircon. The titanium-bearing minerals are primarily used for producing paint, but could also be used to produce titanium metal. The zirconium-containing mineral (zircon) is mostly used as a high-temperature refractory in lining furnaces for smelting and casting metals, but also has other uses.

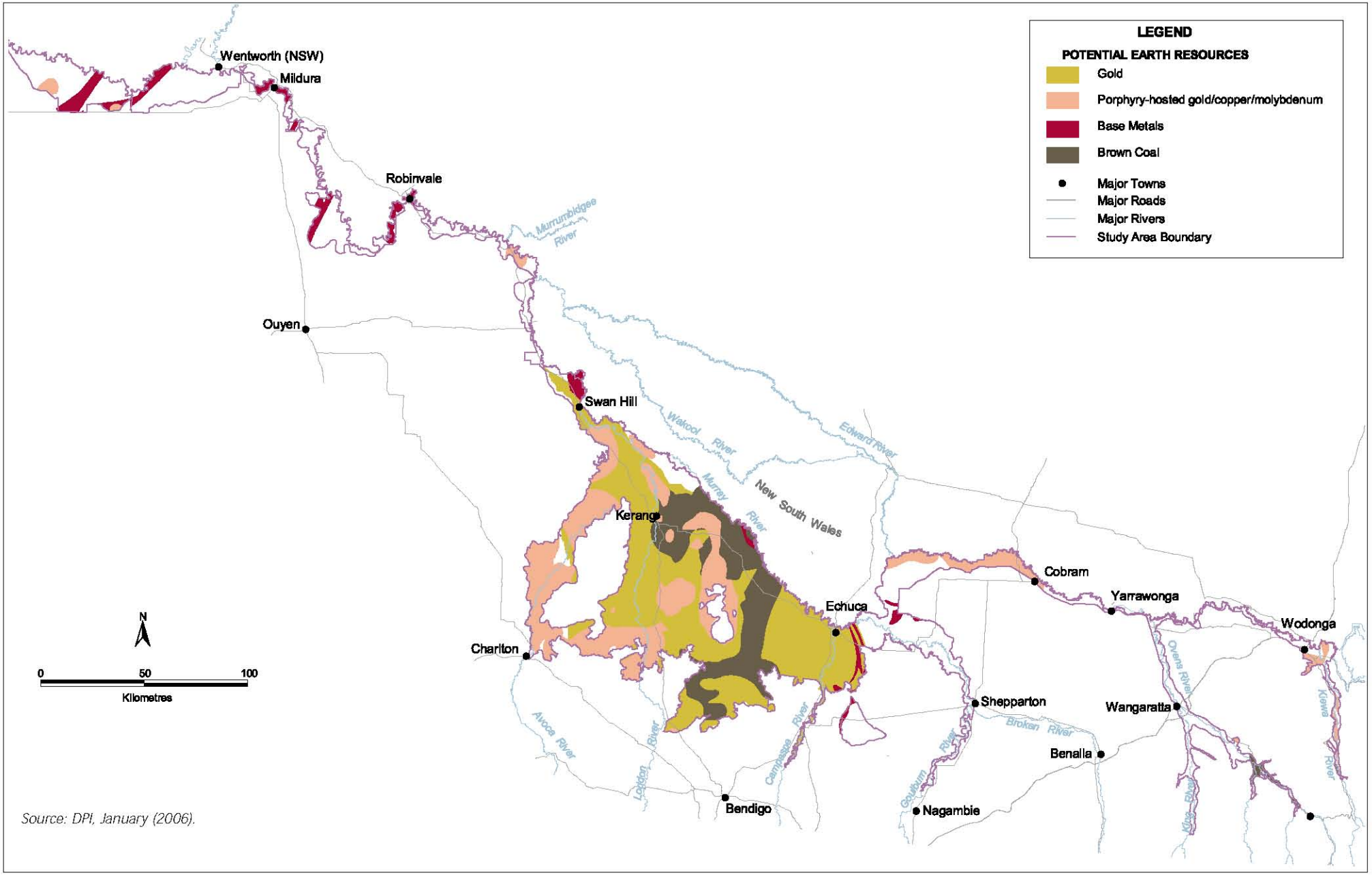
Past drilling found deposits close to the Murray Basin margin near Kerang, Boort and in an area through to Edenhope and Casterton. The Wemen deposit near Robinvale was discovered in 1995 and was the first to be mined with operations commencing in 2001 (Campbell et al. 2003). Economic deposits have been identified near Ouyen (KWR deposit) and exploration indicates that the Murray Basin may contain other world-scale heavy mineral sand deposits (Campbell et al. 2003).

There are currently three exploration licences for mineral sands within the study area. These are primarily in the western portion of the study area where the late Miocene-early Pliocene shallow sea deposited sand dunes and strandlines—the Parilla Sand—containing heavy minerals (Brown & Stephenson 1991; Campbell et al. 2003).

Map 16.1 Existing work authorities, exploration permits and extractive mineral licences within the study area.



Map 16.2 Potential mineral resources within the study area.



Source: DPI, January (2006).

Gypsum

Victorian gypsum deposits occur typically in Quaternary lakes and aeolian dunes located in northwest Victoria. Major deposits are located between Kerang and Swan Hill, within the River Red Gum Forests study area, and the Raak Plains to the west of Hattah (Olshina 1999; Buckley 2003; Campbell et al. 2003). Gypsum mined in Victoria is mostly used as soil conditioner, for plaster and plasterboard and in the construction industry. Currently there are two exploration licences and four mining licences to extract gypsum in the study area.

Other Minerals

Porphyry—a variety of granite—can sometimes contain copper, gold and molybdenum. Two such deposits are known in east Gippsland (both currently sub-economic). Granitic rocks within the study area may be found to contain porphyry systems in the future.

Ultra-mafic rocks (i.e. rocks with a volcanic origin that are often rich in certain minerals) are known to host base metal deposits, for example those in the West Coast Mine District of Tasmania. The Tasmanian terrain hosts many major mines, and has produced between 700 and 1000 million tonnes of ore-grade rock. It is unlikely that deposits of this magnitude would remain in Victoria, however there may be smaller base metal deposits within the study area. A reasonable estimate of the potential value of base metal resources within the study area is between $150 and $300 million (GeoScience Victoria DPI in-house estimate).

A large bentonite clay deposit is currently being worked at Arumpo, in NSW, north of Robinvale and 70 km east of Mildura (McHaffie & Buckley 1995). This deposit has reserves of up to 70 million tonnes with a current value in the range of $10 to $40 per tonne, depending on quality. Its proximity to the River Red Gum Forests study area, in an area of similar geology, implies a significant potential for such deposits in this region.

Petroleum

Hydrocarbons have been detected in most Mesozoic age sedimentary basins within Victoria. The largest economic accumulations of oil and gas in Victoria are found within sections of the southern rift Gippsland and Otway Basins, which have produced commercial quantities for over 30 years.

The River Red Gum Forests study area contains at depth, Mesozoic sediments of the Murray Basin (see chapter 2). To date exploration for petroleum has been limited despite new data acquisitions by the Minerals and Petroleum Division of DPI. Generally the amount is small and only detected by sophisticated equipment. Two petroleum exploration permits are currently held. Lack of appropriate rock structures and poor petroleum generation conditions, combined with the expensive nature of petroleum investigations, have limited exploration in the Murray Basin and favoured continued exploration in the southern rift basins (Bernecker et al. 2003).

Energy Resources

A large area of brown coal—equivalent to about 2,000 km^2 and one third the size of the Latrobe Valley coalfields—occurs in seams up to 40 metres in the centre of the River Red Gum Forests study area near Kerang, Torrumbarry and Echuca (Holdgate 2003). This resource is buried up to 100 metres deep and is not regarded as economic to extract at the moment. Future changes in energy costs or advances in technology (e.g. coal-to-liquid fuels and 'clean coal' technology) may enhance the economic viability of this deposit.

Very little is known about other resources such as geothermal energy potential within the study area.

ECONOMIC VALUE OF CURRENT INDUSTRY

Extractive Industry

Extractive industries produce crushed rock, sand, gravel and clay, mostly for building, construction and road-making, as well as stone blocks and slabs for decorative use in buildings, paving and monuments. Crushed rock is used as aggregate for road surfacing and road base construction, bedding materials for dam construction and pipe laying, and armour stone for embankments. Each such application requires stone of defined size and properties, with basaltic rocks the most widely used material in Victoria (i.e. bluemetal is used extensively in construction industries). Stone can be cut to specific proportions for use in building (especially for cladding), construction (paving) and monuments (dimension stone). Decorative stone is increasingly used for the manufacture of bench-tops and other furniture.

The industry is of significant economic importance as a provider of essential materials for housing and infrastructure. In general, stone resources are sought close to where they will be used to reduce transport costs. The value of extractive materials produced within the study area, as reported by licensees, is shown in Table 16.1.

Mining of Minerals and Petroleum

Within Victoria the production of gold, brown coal and petroleum has long been a significant producer of wealth, with mineral sands production of increasing importance. The economic value of products extracted from mining licences within the River Red Gum Forests study area is shown in Table 16.2.

Value to the Community

Earth resources operations vary greatly in their economic, environmental and social impacts. There are over 800 extractive industry operations registered in Victoria producing almost 40 million tonnes of material per annum. The industry occupies sites in metropolitan, regional and rural areas with more than 75 percent of quarries located outside the greater Melbourne region. The industry is characterised by a mix of some large operators and many medium and small operators, some employing only one or two people. Many of the smaller operators are based in remote localities.

The industry directly employs over 2200 people, with a flow-on effect of an additional 2–3 people indirectly employed for every direct job. The extractive industry is widely distributed across the region and has provided employment over many decades making it an important employer in many rural and regional communities.

Table 16.1 Value of extractive production from licences within the study area.

Date	Tonnes Produced	Dollar Value ($)
11 years (94/95 to 04/05)	11,221,760	90,598,980
Average over 11 years	1,010,160	8,236,270
2004/2005 total	1,289,260	12,547,850

Source: DPI, January (2006).

Table 16.2 Value of mining production from licences within the study area.

Date	Cubic Metres Produced	Dollar Value ($)*
9 years (total) (96/97 to 04/05)	414,930	-
Average over 9 years	46,100	-
2003/04-2004/05 data	71,140	236,910

Source: DPI, January (2006).

* Dollar value: the dash indicates there are no data for this period.

Transport costs typically make up most (up to 25 percent) of the price of materials and so proximity to market is important. Minimising transport distance also reduces the environmental impact and energy consumption associated with the movement of large quantities of construction materials.

MINING METHODS AND ADMINISTRATIVE FRAMEWORK

Open-cut and underground mining are the two major mining operations likely to be used within the study area:

Economically viable deposits of mineral sands, coal, extractive industry material (sand, gravel, etc) and some industrial minerals (e.g. gypsum or clay minerals such as bentonite and kaolinite) are most likely be extracted using open-cut methods. Open-cut mines vary from modest pits for small sand quarries or gypsum mines to large pits for mineral sands or extensive clay deposits.

Gold and base metals are likely to be accessed underground through shafts or declines unless there is a major deposit overlain by relatively thin cover, in which case open-cut methods are more economic.

Research on remote mining could significantly enlarge the window of economically viable resources at depth. Remote mining extracts resources with robotic devices and modified drilling equipment operated from the surface and does not require the mine to be free of water or ventilated (or made safe for people). When and if such techniques become commercially available, they may be able to access ore deposits which are currently out of reach for intractable geotechnical or other reasons.

The Department of Primary Industries (DPI) regulates a number of primary industries to achieve agreed social, economic and environmental outcomes. For example, the Minerals and Petroleum Division (MPD) within DPI ensures that mining, petroleum, extractives, pipeline and geothermal operations meet health, safety and environmental requirements. This responsibility is carried out with the support of other government agencies which administer associated legislation, including the Department of Sustainability and Environment, the Department of Infrastructure, the Environment Protection Authority, WorkCover and local government.

The principal Acts administered by MPD as a regulator for earth resources activities are the *Mineral Resources Development Act 1990, Extractive Industries Development Act 1995, Geothermal Energy Resources Act 2005, Petroleum Act 1998,* and the *Pipelines Act 1967*. The *Pipelines Act 1967* regulates the construction and operation of major transmission pipelines such as those used for oil and gas which, as infrastructure, would be distinguished from regulations for extractive and mining activities.

The *Mineral Resources Development Act 1990* provides the legislative framework to develop and regulate the mineral exploration and mining industry. This Act applies to all minerals, including gold, coal, and mineral sands. The Act establishes the system for resource allocation and approval of mineral exploration and development, including compensation, rehabilitation and royalty requirements. Additionally, it defines the term 'restricted Crown land' that is used under various acts, to control exploration or production of earth resources (see land use arrangements discussion below).

Earth resources legislation contains a number of specific measures that seek to minimise the impacts of earth resources activities on the environment. The key tools are summarised below.

Regulated Activities

Before any activities (such as exploration, mining or actual extraction of material or energy) can be undertaken, companies must have an exploration or mining licence, or permit for extraction of the resource in accordance with the relevant legislation, and also have obtained a 'work authority' or permit. In order to gain a work authority a company must demonstrate that it has:

- an approved work plan (addressing safety and environmental matters)
- entered into a rehabilitation bond
- met any planning requirements
- obtained any other consents and authorities required, and
- obtained the landowner's consent with regards to an appropriate site and an agreement with the landowner for compensation for extraction activity.

Work Plans

Resource companies must submit work plans for approval prior to the granting of consent to undertake activity within a licensed area. DPI is responsible for assessing and approving these work plans. Work plans provide detailed regulatory information about the proposed operation—particularly its health, safety and environmental management (including rehabilitation). A typical draft work plan covers the following areas:

- description of proposal
- site location, infrastructure and resource assessment
- site details (location of crushing plants, on-site offices and transport 'haulage' routes, sludge ponds, and geographical features like water courses, vegetation and topography)
- details of operation
- environmental, and occupational health and safety controls
- rehabilitation plan
- dust and noise emission control
- drainage and discharge control (including storm water management)
- erosion control and ground water protection
- removal or restoration of native vegetation
- noxious weeds and pests control
- internal buffers, screening and roads
- progressive and final rehabilitation
- fencing and security.

Rehabilitation

The above Acts prevent a licence holder from operating unless they have an approved rehabilitation plan and have provided an approved rehabilitation bond. The *Mineral Resources Development Act 1990* also requires any potential long term degradation of the environment to be taken into account while the *Extractive Industries Development Act 1995* requires the rehabilitation plan to take into account the need to protect or conserve native vegetation and protected flora and fauna.

Rehabilitation bonds are financial securities provided prior to the commencement of works. The bond guarantees that rehabilitation will be undertaken. Bonds must be high enough to fund any rehabilitation work necessary as a result of approved works. This ensures that any costs of rehabilitation are borne by the licensee and not the community.

Native Vegetation

All resources industries are subject to Victoria's Native Vegetation Framework *Native Vegetation Management—A Framework for Action* (DNRE 2002) and DPI administers this through licences and work plan conditions in consultation with the Department of Sustainability and Environment. A proponent must have the significance of any native vegetation to be removed assessed, and ensure that the proposal is consistent with Victoria's Native Vegetation Framework e.g. through rehabilitation and offsets.

Planning Requirements and Environment Effects Statements

All resources industries are subject to planning requirements under the *Planning and Environment Act 1987* although some activities such as exploration do not require planning approval. Planning approval focuses on land use issues, including the appropriate location of operations. If significant risks to the environment are anticipated, or there are significant levels of public concern, proposed projects under all Acts may be subject to rigorous public assessment and review under the *Environment Effects Act 1978*. Normally this would only be done for major projects with significant risks.

Native Title

Mining and extractive activities on Crown Land, including the grant of occupancies, may be considered 'future acts' under the *Native Title Act 1993* which triggers consultation processes with Native Title claimant groups. Proposed activities require assessment for implications under this Act prior to work commencing. DPI will not grant an exploration or mining licence on Crown land that may be subject to or has an existing native title claim until the future act provisions under the *Native Title Act 1993* have been satisfied. Guidelines by DPI for industry and native title claimants assist with this process.

LAND USE UNDER EARTH RESOURCES LEGISLATION

Specific extractive industry operations are governed by the legislation described above. The implications for these activities on Crown land are explored in more detail below.

Mining

Exempted Land

Section 6 of the *Mineral Resources Development Act 1990* exempts certain areas of land from exploration, minining and searching licences or other authorities under the Act. Licences would not be issued for these areas except under special and limited circumstances (examples of which are given below). These exempted areas include:

- and in a reference area under the *Reference Areas Act 1978;*

- land in a national park, marine national park or sanctuary, wilderness park or state park under the *National Parks Act 1975*, with the exception of pre-existing (i.e. at the time of park establishment) tenements (mining or exploration licences), and miner's rights and tourist fossicking authorities which apply in certain park areas that are subject to notices under section 32D(1) of the *National Parks Act 1975*;
- land that is an Aboriginal area or place to the extent of the terms of a permanent declaration under Section 10 or 21E of the *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act 1984*; and
- land that is a permanent archaeological area under Section 15 of the *Archaeological and Aboriginal Relics Preservation Act 1972*.

In addition to the permanent exemptions under Section 6, the Minister responsible for the *Mineral Resources Development Act 1990* has the ability under Section 7 to exempt other land from exploration or mining licences. The Minister can grant an exemption for any reason considered appropriate including (but not limited to):

- to protect land that is of significant environmental importance;
- to implement a recommendation from the Land Conservation Council; and
- to enable the orderly and optimal development of mineral resources in Victoria.

These exemptions can by revoked by the Minister at any time under Section 7(5) by notice in the Government Gazette and recorded in the mining register.

The Act establishes two further categories of Crown land—'restricted' and 'unrestricted'—with different requirements flowing as a result.

Restricted Crown Land

Under Section 44, a licensee who proposes to do work on restricted Crown land must obtain the consent of the Ministers administering the land under the *Crown Land (Reserves) Act 1978* and the *Forests Act 1958*. Schedule 3 to the *Mineral Resources Development Act 1990* states that restricted Crown land comprises:

- any land that is the subject of relevant recommendations proposing that the land be reserved under the *Crown Land (Reserves) Act 1978* for regional parks, coastal parks, marine parks, flora and fauna reserves, wildlife reserves, natural features and scenic reserves (including caves and geological reserves), bushland reserves, historic areas, public land water frontage reserves, streamside reserves, coastal reserves, national heritage parks, nature conservation reserves, and historic and cultural features reserves;
- any land subject to Government accepted relevant recommendations of the Victorian Environmental Assessment Council, or that is subject to relevant recommendations of the Land Conservation Council for which notice has been given by the Governor in Council (prior to the repeal of the *Land Conservation Act 1970*);
- any land that is an alpine resort within the meaning of the *Alpine Resorts Act 1983*;
- any land that is a heritage river area under Section 5 of the *Heritage Rivers Act 1992* or a natural catchment area under Section 6 of the *Heritage Rivers Act 1992*, other than land which is already exempted from exploration and mining activity under Section 6 of the *Mineral Resources Development Act 1990*; and
- any other Crown land (other than land exempted from exploration and mining activity under Section 6 of the *Mineral Resources Development Act 1990*) that the Minister for Resources and the Minister administering the *Crown Land (Reserves) Act 1978* and the *Forests Act 1958,* declare to be restricted Crown land for the purposes of the *Mineral Resources Development Act 1990.*

Unrestricted Crown Land

No additional consent requirements apply to unrestricted Crown land, although the Minister for Resources is required to consult with the Ministers administering the land under the *Crown Land (Reserves) Act 1978* and the *Forests Act 1958* when considering an application for a licence. Those Ministers may recommend conditions to which the licence should be made subject.

Additionally, land purchased or donated to the Crown may be unrestricted because it may not be subject to a recommendation by LCC, ECC or VEAC, or been nominated as restricted or exempted. However, other obligations and contractual arrangements may technically restrict mining activities, even on unrestricted Crown Land.

Extractives

Stone resources are owned by the landowner and extraction requires a work authority under the *Extractive Industries Development Act 1995*. The owner of Crown land is the Minister responsible for the Act under which the land is controlled or managed. The *Extractive Industries Development Act 1995* applies to the extraction or removal of stone from land for sale or commercial use in construction, building, road or manufacturing works. Under the Act, stone includes gravel, sand, soil, building stone and clay (but does not include fine clay, kaolin or salt).

Under the *Extractive Industries Development Act 1995*, the following areas are not available for production of stone:

- land in a reference area under the *Reference Areas Act 1978;*
- land in a national park, wilderness park, state park, marine national park or marine sanctuary under the *National Parks Act 1975*;
- land that is an Aboriginal place, to the extent of any terms of a declaration of preservation in force under Section 21C, 21D or 21E of the Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*; and
- land that is an archaeological area or contains relics registered under Section 10(a) of the *Archaeological and Aboriginal Relics Preservation Act 1972*.

References to restricted Crown land or exempt Crown land as defined in the Schedule 3 to the *Mineral Resources Development Act 1990* (see description above) have been recently removed from the *Extractive Industries Development Act 1995*. New provisions under

Section 11 of the *Extractive Industries Development Act 1995* provide for applications to consent to search for stone on any Crown land. The Minister responsible for the Act under which the Crown land in controlled or managed may agree, agree subject to conditions, or refuse consent but not without valid reason.

Petroleum

The Petroleum Act 1998 governs onshore exploration and development of petroleum resources in Victoria. The maximum holding permitted under a Petroleum Exploration Permit (PEP) is 12,500 square km for a period of five years. The permit can be renewed once for another five year period with a reduction in area of at least 50 percent. The Act also provides for the issue of Petroleum Production Leases (PPL) and general administrative procedures supported by the Petroleum Regulations 2000.

Petroleum exploration and production activities must not be carried out in reference areas defined under the *Reference Areas Act 1978*, or wilderness zones or wilderness parks as defined under the *National Parks Act 1975*. Written consent to undertake petroleum operations on restricted Crown land (defined under the *Mineral Resources Development Act 1990*) may be obtained from the responsible Minister. In general, written permission or consultation with the land manager or Minister responsible for the land must be undertaken prior to any significant petroleum operations carried out on Crown land, whether it is restricted or unrestricted. Other exemptions may be applied by the Minister for land that requires protection for significant environmental, commercial, economic or any other reason considered appropriate. The Minister may also revoke any exemptions issued in this way.

While the *Petroleum Act 1998* permits construction of pipelines of limited length within the permit area, the *Pipelines Act 1967* governs the control, ownership, location, construction and operation of pipelines more generally. Following a major review, the new *Pipelines Act 2005* was passed by Parliament in September 2005 and will come into effect when supporting Regulations are developed by MPD in consultation with interested stakeholders.

Geothermal Energy Resources

The *Geothermal Energy Resources Act 2005* provides the legislative framework for the development and regulation of the large-scale commercial geothermal exploration and extraction industry. This Act establishes that the heat energy within the Earth belongs to all Victorians, and is therefore vested in the Crown. Based on the *Petroleum Act 1998* model, the *Geothermal Energy Resources Act 2005* establishes the system for resource allocations and approvals required for geothermal exploration and extraction, including compensation and rehabilitation requirements.

The Act sets out permanent exemptions where a person must not carry out any geothermal energy operation on land that is a reference area, a marine national park or sanctuary, a national park, wilderness zone or park in a similar manner to the *Mineral Resources Development Act 1990*. Consent is required to carry out any geothermal energy operation on restricted Crown land (as defined above) but this is dependent on first obtaining consent of the Minister responsible for that land. Consent is also required for any land owned, vested in or managed or controlled by a water authority as defined under the Act.

In addition, the Minister can exempt land from geothermal energy operations for significant environmental reasons, to protect significant commercial or economic operations, to protect the land; or for any other reason considered appropriate. The Minister can also revoke these exemptions.

FUTURE REQUIREMENTS FOR RESOURCES

Obtaining general community consent to operate is vital for securing future access to resources. It also ensures development in accordance with principles of sustainability. Increasingly, the community expects better environmental and safety management and continues to push to minimize environmental disturbance during resource extraction. Consequently, these pressures demand that industry's performance needs to improve continually.

Earth resource operations are commonly regarded as producing large and undesired environmental impacts. Yet only a small number of operations fit this description. Extractive operations can have low environmental impacts and a small environmental footprint. In addition, extractive operations are obliged to progressively rehabilitate the land they occupy. Exploration can have little impact on the environment, particularly aerial surveys and geological mapping, for example.

Some production activities also have a relatively small ecological footprint. For example, underground mining involves tunnelling from a surface portal to extract resources (such as reef or deep lead gold), frequently hundreds of metres below the surface. An important advantage of underground mining is the high value of production relative to the generally small area of surface disturbance.

Increasingly, earth resources operations have focussed not only on economic and social gains, but also on the ability to offset any environmental impacts. For example, using reclaimed water for processing plants does not providing an environmental 'gain' but does reduce consumption of fresh water reserves.

Society's ever increasing demand for minerals and energy requires ongoing exploration and technological developments. Continued access to highly prospective areas is an important consideration in any land use planning decision-making process.

SUMMARY

Exploration, mining and extractive industry activity are currently limited on public land in the study area, but there is the potential for future expansion. 'Under cover' gold and near surface mineral sands resources offer the greatest potential. Current relatively minor uses of construction materials and dimension stones are of value, particularly for local communities.

17 Community Uses and Services

Small areas of public land throughout the study area are used for community uses and the provision of services by public utilities. Many of these areas are within townships or along major service routes, while others are located in more isolated areas.

This chapter focuses on only two public land use categories: community use areas, and services and utilities. These land use categories occupy a small proportion of public land across the study area, but how they provide community services and how they are managed are important issues for VEAC to consider. An extensive description of all other pubic land use categories can be found in chapter 9.

COMMUNITY USE AREAS

Many blocks of public land have been set aside for community uses in townships and small communities. Activities associated with these areas include education, recreation or other specific community purposes. Locally based Committees of Management are responsible for management of many of these reserves. Falling within the community use category are:

- Recreation Areas
- Parklands and Gardens
- Buildings in Public Use
- Education Areas.

Recreation Areas

Recreation relates to the various activities that people undertake during their leisure time. For a discussion of recreational and tourism use of public land more generally and in larger public blocks, refer to chapter 11.

Recreation areas are generally small reserves close to townships with facilities for organised sports with an emphasis on outdoor activities—cricket ovals and netball courts, for example. There are many recreation areas located across the study area. These networks of recreation areas are important for people's health and well-being as well as for the social vitality of local communities.

Parklands and Gardens

The parklands and gardens include small intensively used community parklands, playgrounds and ornamental gardens. Examples are municipal parks and playgrounds, public barbecue facilities, and botanic or ornamental gardens that are used for informal recreation. Parklands and gardens are located within town areas in easy reach of shops and town facilities. They are found in nearly all towns and regional cities within the study area, and are predominantly managed by local government. Most are small and highly modified, but some retain natural habitat. Some also have historical values.

Buildings in Public Use

Many public buildings such as halls, schools, libraries, museums and their associated facilities which have been principally established for community use are located on public land. These facilities are used for a range of community activities including education, recreation, meetings, community information dissemination and tourist advice. Some buildings, such as schools, are use-specific but also double as multi-purpose buildings for a range of activities. Community halls also serve a range of purposes including entertainment, indoor sports activities and meeting forums. Older buildings such as education buildings may also have historical values. These buildings may be managed by the Department of Education and Training, local government, appointed Committees of Management or community organisations (not for profit groups).

Education Areas

Environmental education is a key strategy for ensuring the long-term sustainability of natural systems across Victoria and has been an important element of government environmental policy over recent decades. Under legislation, the Victorian Commissioner for Environmental Sustainability is required to evaluate and audit all public environmental education programs in the state. Environmental education is now also a key aspect of the formal school education system as well as being a high profile area in the vocational and tertiary education sectors.

Because of its biophysical focus, environmental education frequently involves field studies and investigations, which require access to specifically allocated areas of public land. These education areas are set aside as reserves of modest size where people, usually students can study natural ecosystems, observe and practice methods of environmental analysis and field techniques associated with the natural sciences and conduct long-term experiments. Such areas are usually selected on the basis of whether the area has relatively undisturbed natural vegetation. They may have a range of facilities on site, including buildings for accommodation purposes which greatly affects how much they are used. A further description of education areas, particularly those in the study area, can be found in chapter 9.

SERVICES AND UTILITIES

There are numerous, generally small, service and utility areas in the study area. These are used for transport networks, electricity and gas distribution, communications, survey and navigation, municipal buildings and services, hospitals, public offices and justice, water and sewerage services, cemeteries and other utilities.

Transport

Roads

Victoria has an extensive and complex road network. Statewide there is approximately 196,000 km of roads (from major arterial roads to minor local roads, to forest tracks). The *Road Management Act 2004* categorises and establishes the management responsibility for all public roads in Victoria as follows:

- freeways including tollway freeways (VicRoads)
- arterial roads
- urban (local municipal council)

- non-urban (VicRoads)
- non-arterial state roads such as forest roads (relevant state agency, e.g. the Department of Sustainability and Environment)
- municipal or local roads (local municipal council).

With the exception of freeway tollways, all types of roads are found in the River Red Gum Forests study area located on public land either retained as Crown land at the time of land survey and settlement or since purchased for roads.

The primary purpose of roadside reserve management is to maintain road functionality. This frequently involves vegetation removal or trimming both of native and introduced plant species. It may also involve more extensive disturbance to land and drainage systems to maintain an existing road or for the construction of structures such as bridges (see chapter 9 for more detail). As well as these functional aspects road reserves may also protect natural, historical and community values such as biodiversity, visual amenity and recreational opportunities. VEAC is particularly interested in these reserves from a nature conservation perspective as they often provide for biodiversity values as habitat corridors linking vegetated reserves. Many unused road reserves retain native vegetation, some with rare plant species.

As part of its commitment to biodiversity conservation on major arterial roads and freeways VicRoads has a number of strategies and plans in place to guide its operations that may impact on biodiversity values. These include the:

- Roadside Habitat Values Plan
- Roadside Management Strategy
- Roadside Management Plans
- Roadsides and the Environment Strategy.

At an operational level, these plans and strategies involve detailed biological surveys on road reserves. They also involve VicRoads working with local government, particularly around the issue of native vegetation removal under the *Planning and Environment Act 1987*. Ongoing monitoring and evaluation of these plans and strategies is conducted to establish whether or not on-ground actions are achieving the strategic and management objectives, as well as VicRoads' statutory responsibilities.

Railways

Historically, rail transport has played a critical role in the expansion of Victoria's economy but today, rail's significance relative to road transport has decreased in recent decades as the road network has improved. Several rail lines were closed during the 1980s and 1990s. Some of these decommissioned lines have remained as public land and have 'rail trails' for recreational use or bushland reserves where natural values have been identified. In other places, rail reserves have been sold, usually to adjoining landowners. A systematic review of rail reserves was undertaken in the 1980s by the Victorian government. This resulted in the outstanding natural or recreational values along certain lines being identified and this land being retained as public land to protect these values (see also chapter 9). For example, the Bonegilla Station Bushland Reserve, east of Wodonga, was established partly to protect a stand of the threatened purple diuris orchid.

Railways located on the northern plains are in a highly modified biophysical environment. Plants that were once common have been removed through large-scale agricultural development and human settlement. Some threatened species and communities persist on rail reserves. In part, this is due to the management history of many rail reserves, including the exclusion of grazing, ploughing, grading, herbicide and fertiliser application and the use of fire as a management tool. Regular burning for fuel reduction was an essential part of rail reserve management for over a century. Timing of this management regime fortuitously replicated the ecological conditions necessary for some plant communities, but had negative effects on others.

Species persisting in rail reserves include the nationally endangered turnip copperburr and mountain swainson-pea, and the nationally critically endangered spiny rice-flower. Some of the best examples of Northern Plains Grassland community, listed under the Victorian *Flora and Fauna Guarantee Act 1988*, occur on rail reserves within the study area.

Informal management of these sites is important for the conservation and protection of certain threatened species and communities. The Victorian Rail Industry Environment Forum (consisting of DSE, DPI, Country Fire Authority, VicTrack, Pacific National, Australian Rail Track Corporation, Connex, and Municipal Association of Victoria) is currently developing Vegetation Management Guidelines for Rail Corridors (due to be released later in 2006). These guidelines will provide a framework for land managers and rail lessees to encourage changes to works practices, to address the interlinked issues of biodiversity conservation, prevention of weed invasion and reduction of weed impacts, management of the risk of wildfire and efficient operation of the rail network.

Gas and Electricity

In previous LCC, ECC and to a lesser extent VEAC investigations, gas and electricity utilities were important considerations for the services and utilities land use category. During these times Victoria's gas and electricity industries were managed by integrated, government-owned entities such as the State Electricity Commission and the Gas and Fuel Corporation of Victoria. Private land purchased by these entities for

their systems and infrastructure was "public land" for the purposes of LCC and ECC investigations. The supply of petroleum products, including the production of natural gas was controlled by the private sector.

In the 1990s, government changes led to the privatisation of these entities and divisions into three discrete business activities: supply, distribution and retail. Under these business arrangements the government's role changed from directly owning and managing energy businesses on behalf of the community to one of setting policy objectives and managing the statutory framework governing the energy market. Today, Victoria's energy industry is largely privately owned and operated.

Gas

Victoria's 1900 km gas distribution pipeline is owned by GasNet, a privately owned company whose core business activities are pipeline ownership, construction and operations. GasNet supplies approximately 1.4 million residential consumers and approximately 43,000 industrial and commercial users throughout Victoria. The primary function of GasNet's infrastructure is to transport gas from Esso's Longford treatment plant in southeast Victoria (which processes gas from offshore Bass Strait gas fields) and from the onshore Otway Basin to areas across Victoria as well as into parts of NSW.

The GasNet distribution network is relatively limited in its coverage within the River Red Gum Forests study area.

Only minimal amounts of the pipeline network run under public land in the study area. Map 17.1 illustrates the gas distribution network across Victoria. It highlights that natural gas is mostly distributed around the eastern part of the study area. Where gas pipelines cross public land, the land remains public land.

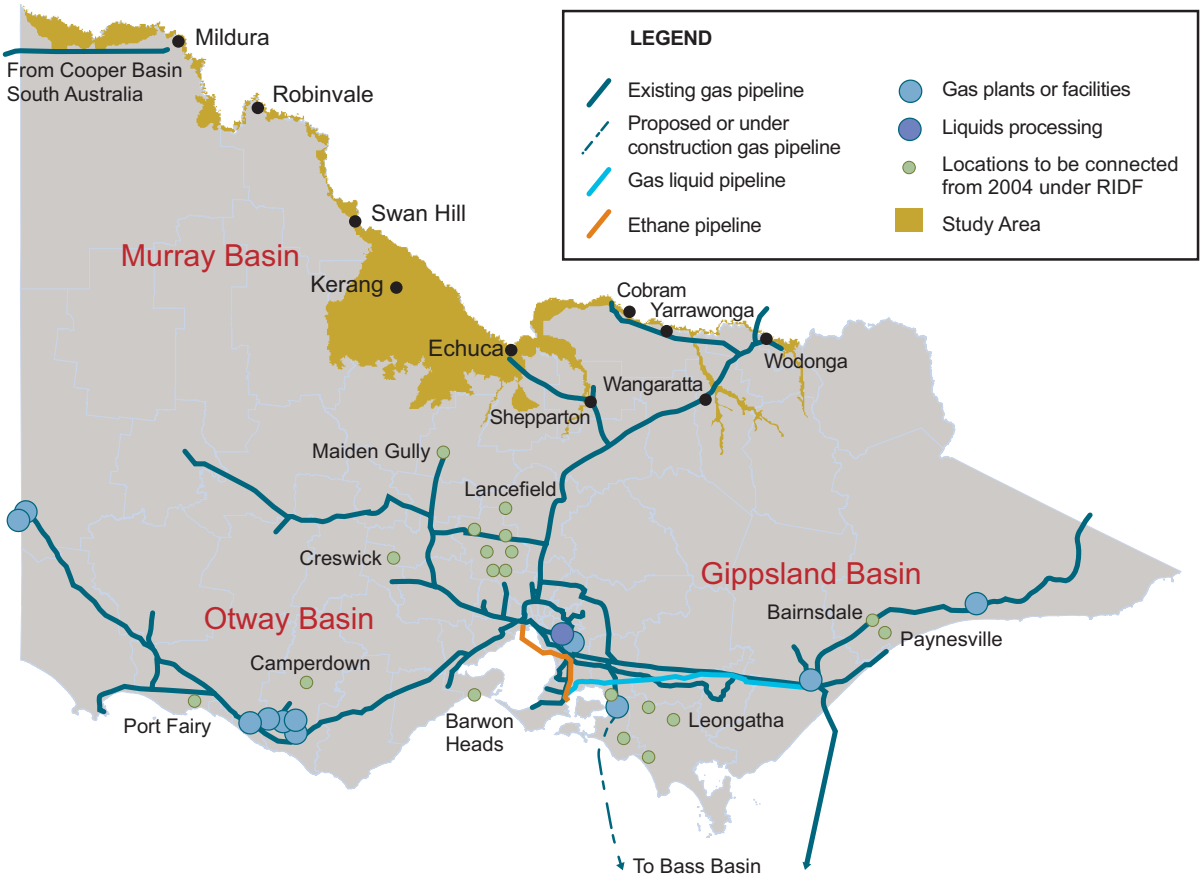
GasNet's provides high pressure transmission pipelines and associated assets, maintains services and connects the gas network to gas suppliers, distributors and directly to customers.

As part of the changes in the 1990s, the Victorian Government established the Victorian Energy Networks Corporation (VENCorp). This statutory authority has overall responsibility for the operation of the gas transmission system including:

- analysing the system capacity and security standards and controlling the flow of gas through the system on a day to day basis;
- administering the gas spot market, including all settlement functions;
- providing connection and other services to gas suppliers, distributors and directly to the connected customer; and
- administering the Market and System Operations Rules under which the Victorian gas market functions.

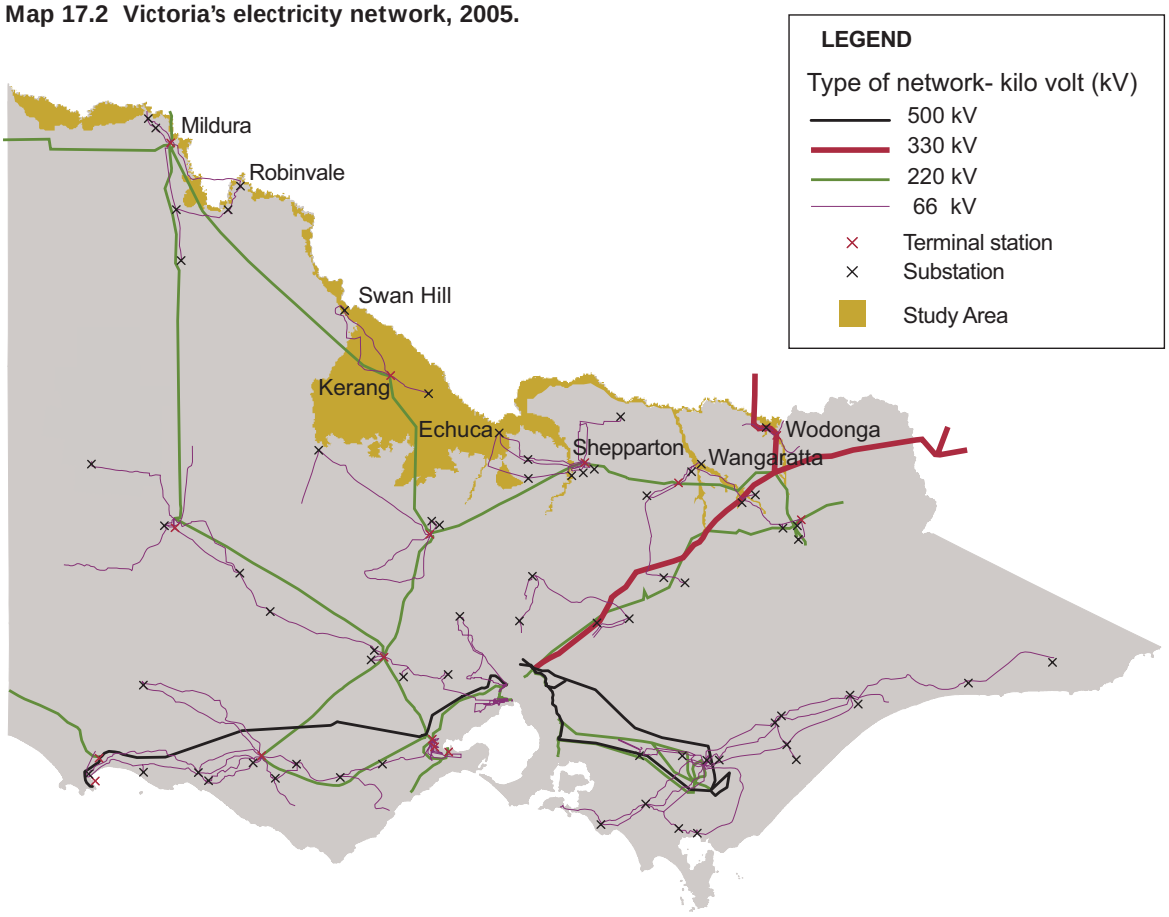
In Victoria natural gas is distributed to local areas by

Map 17.1 Victoria's natural gas networks and processing facilities, 2005.



Source: DPI 2004, Minerals and Petroleum Divisions Statistical Review; Australian Government (2004); BusinessVictoria (2006).

Map 17.2 Victoria's electricity network, 2005.



Source: Modified from DSE (2005g) and data from Sustainable Energy Authority Victoria, 2005

three private distribution companies, Multinet, Envestra (which services the major population areas around Mildura) and TXU/TRU (which the areas around Echuca, Shepparton and Wodonga). Only a minimal amount of public land in the study area is associated with the gas distribution pipelines network. Where compression stations existed on public land held by the former Gas and Fuel Corporation, this land has been transferred to GasNet and is now freehold.

Electricity

Victoria's 6000 km high voltage electricity transmission system is owned and maintained by AusNet, a wholly-owned subsidiary of Singapore Power Limited (SPIPowerNet). AusNet's core business functions are widely known as the 'pipes' and 'wires' of the electricity network. AusNet's electricity distribution network delivers electricity to approximately 575,000 supply points in an area of more than 80,000 square kilometres in Victoria, including the study area (Map 17.2).

The high voltage transmission system is largely a network of transmission conductors (cables) supported on more than 13,000 galvanised steel towers. The conductors carry electricity at extra high voltages from the power stations to 46 terminal stations around Victoria, where the voltage is lowered for distribution for local distribution companies to deliver to homes and businesses.

The corridors of land upon which AusNet's network is built are referred to as 'transmission line easements'. More than 17,500 ha of easements secure a 'right of way' for the safe transmission of power. In most cases AusNet does not own the easement land. Rather, the easement provides the right to use the land space by agreement with the original landowner. Ownership of the land remains with the landowner with the easement also allowing access for field crews to maintain the network. Under the easement right AusNet may limit the type and scope of activities on the easement, including restriction on what is grown or built on it including easements on public land.

With its transmission system, AusNet is subject to the operational control of the National Electricity Market Management Company (NEMMCO), a government based agency, owned by the state and territory governments involved in the National Electricity Market (NEM) which includes Victoria, NSW, SA and ACT. NEMMCO's role is to ensure the integrity of the system and to operate the market. VENCorp is also responsible for planning of the Victorian electricity transmission system to ensure existing and expected demands are met.

Within Victoria there are five electricity distributors. The metropolitan area is serviced by AGL Electricity, CitiPower and United Energy whilst rural areas are serviced by TXU/TRU (formerly Eastern Energy) and Powercor.

COMMUNICATIONS, SURVEY AND NAVIGATION

Communications

Statutory responsibility for communication networks throughout Australia resides with the Australian Government. Sites for these structures are favoured on the basis of their elevation and absence of physical barriers to communication frequencies. Consequently, most communication towers or structures are built on prominent hills or high points. Reliable road access and the availability of power to these sites are also important siting factors. Many communication towers and satellite dishes across Victoria are either located on public land or require access across public land. For example, within the study area, the communication structure located on Huon Hill near Wodonga requires access across public land.

Survey and Navigational Infrastructure

Trigonometrical stations and sites are often located on public land and in some cases access to the sites is through public land. Trigonometrical stations are used for land survey control points. With widespread Global Positioning Systems now in use, they are becoming less central to land surveying operations.

Municipal Buildings and Services

Municipal buildings and services are frequently located on public land. Such buildings include local government offices, depots and outbuildings.

Hospitals and Public Offices

Public building such as hospitals, public offices, police stations, courthouses and prisons are generally located on public land. Some recent prison facilities operated by the private sector are on private land. Within the study area many public buildings such as hospitals at Cobram, Echuca and Mildura are located on public land.

Water and Sewerage Services

Water

Details on land-use categories for water production, particularly the use of declared water supply catchment is presented in chapter 9. Chapters 4 and 15 refer to hydrological systems and water use and environmental flows. This section describes the public land associated with the infrastructure for the distribution of water to townships across the study area for human use and economic production purposes, and systems of channels supplying stock and domestic water to rural areas.

The water production land use category encompasses the actual water storage areas, diversion weirs, pump intakes and associated buffer areas. The Ovens River off-take supplying urban Wangaratta is such a catchment off-take point. Separate land use provisions apply to the harvesting areas—see chapter 9 for an outline of declared water supply catchments. In most cases these water supply catchments include private as well as public land.

In the context of this chapter water production land is firstly, land on which township water, storage and reticulation infrastructure is built, and secondly the stock and domestic channel distribution systems. A large number of water utilisation areas were recognised in the LCC Mallee Study (1977b) and subsequent Mallee Review (1989a), Murray Valley (1985), North-Eastern Study 3, 4 and 5 (1977a), and North-Eastern Area (Benalla-Upper Murray) Review (1986).

In the Mallee, water for urban supply is pumped from the River Murray or from channels and pipes, and stored in elevated reservoirs in townships before being distributed. In the Kerang region, water is drawn for irrigation and stock purposes from Torrumbarry weir on the River Murray, and diverted to the Loddon River, from where it flows through a series of natural lakes connected by channels. These lakes include Reedy Lakes, Racecourse Lake, Lake Charm, Lake Tutchewop, Lake Kelly and Lake William. Drainage areas such as the Kanyapella floodway, are diversions for flood waters and are included in the services and utilities land use category. Some water storages in the Kerang lakes region are linked to areas used for other purposes. Lake Tutchewop services and utilities area which is primarily used for drainage and abuts Lake Tutchewop Wildlife Reserve.

From time to time, new facilities are required and old facilities decommissioned. Consequently areas allocated to water production will occasionally require amendment. There have been many changes in the administration of water services since the 1980s, particularly the amalgamations of water authorities in the 1990s and the results of the Water White Paper, *Our Water Our Future* (DSE 2004i). All former water authorities have been restructured and the total number significantly reduced. There are two rural water authorities in the study area, First Mildura Irrigation Trust and Goulburn-Murray Rural Water (trading as Goulburn Murray Water) and two urban rural water authorities, Lower Murray Urban and Rural Water and Wimmera Mallee Water. Four regional water authorities maintain facilities for the storage and distribution of water (and management of sewage disposal) within the study area: Coliban Water; Goulburn Valley Water; and, North East Water.

All land upon which water authority assets are located, whether Crown land or freehold, is considered public land under the *VEAC Act 2001*. For example, Goulburn Valley Water has around 40 treatment plants, 27 wastewater facilities, 340 pumping stations, 92 tanks and reservoirs and operates a reclaimed water re-use facility. Goulburn Murray Water is a major holder of public land. Some key areas or sites falling within Goulburn Murray Water's portfolio include land adjacent to Green Lakes former farmland in the Kanyapella Basin Wildlife Management Cooperative Area, Lake William and Lake Little drainage areas (Mystic Park) and Yarrawonga Weir as well as numerous areas of Crown land.

Coliban Water also manages and maintains over 50 reservoirs and water storage basins, 213 water and wastewater pumping stations, 23 water treatment facilities and 16 reclamation facilities, mostly on Crown land. Similar situations exist for other water authorities such as Lower Murray Water, North East Water and Grampians Wimmera Mallee Water.

As described in chapters 4 and 15 the study area is

associated with some of Victoria's most significant irrigation regions. The most notable of these are the Shepparton, Campaspe, Rochester and Torrumbarry Irrigation Areas (see Map D). Such areas are dependent on an extensive network of irrigation channels. Some of the more extensive main channels include East and West Waranga Main Channel, with the latter also supplying stock and domestic water and the Yarrawonga channel heading south west from Lake Mulwala. These irrigation channels are located on public land, owned or managed by Goulburn Murray Water. Such areas maybe of interest in this Investigation, particularly where lakes associated with the provision of irrigation water for agricultural purposes are also important locations and sources of habitat for a variety of wetland species.

As well as the network of irrigation channels within the study area there is also a network of surface water drains. The purpose of these drains is to drain away excess surface water from irrigated land to prevent water logging, rising water tables and salinity problems. Some of the major surface drainage channels associated with the study area are the Muckatah, Mosquito, Timmering and Minchins Depressions drains. In this situation Goulburn Murray Water has easement rights rather than ownership rights over the land. A network of subsidiary drains established on public land, have been largely sold to adjoining landowners. Privately owned land associated with these subsidiary drains is not public land and hence will not be considered in this Investigation.

Sewerage

Towns and regional cities located throughout the study area are serviced by sewage treatment systems. These systems vary in scale and level of treatment. The larger urban centres have more sophisticated treatment facilities, often providing up to tertiary level treatment (to a standard suitable for environmental discharge). Smaller towns are serviced by secondary treatment plants (for removal of biological material).

Both secondary and tertiary level treatment plants utilise evaporation basins and lagoons as part of the treatment process. Basins and lagoons require large land areas for construction and operation. They also require an adequate buffer zone between the basin and the surrounding land or watercourses. This is a requirement of the Environment Protection Authority (EPA). All sewage treatment facilities require licences issued by the EPA.

Water from treatment plants is used for irrigation purposes or in some cases is discharged back into the rivers. One particular use of this irrigation water is for plantations such as those owned by Goulburn Valley Water on the northern outskirts of Shepparton.

Cemeteries

Cemeteries in the study area (other than private family cemeteries and some Indigenous burial grounds) are located on Crown land. Cemeteries operate under the *Cemeteries and Crematoria Act 2003* which replaced the *Cemeteries Act 1958*. They are managed by Cemetery Trusts, which fall under the responsibilities of the Department of Human Services. Cemeteries are zoned as public use in local government planning schemes and in some cases changes in land use or development proposals within cemeteries may require a planning permit. Land for graves within a cemetery cannot be purchased privately, only the right to burial is purchased.

Because of declining population levels in many parts of the study area many smaller cemeteries today are used less frequently for burial purposes. Often these cemeteries contain areas of relatively undisturbed native vegetation and may be important for the preservation of some plant species or communities, particularly grasslands.