



Australian Government



MURRAY-DARLING BASIN AUTHORITY

Gunbower Forest

Environmental Water Management Plan

February 2012

Gunbower Forest

Environmental Water Management Plan

February 2012

© Copyright Murray–Darling Basin Authority (MDBA), on behalf of the Commonwealth of Australia 2012.

This work is copyright. With the exception of photographs, any logo or emblem, and any trademarks, the work may be stored, retrieved and reproduced in whole or in part, provided that it is not sold or used in any way for commercial benefit, and that the source and author of any material used is acknowledged.

Apart from any use permitted under the *Copyright Act 1968* or above, no part of this work may be reproduced by any process without prior written permission from the Commonwealth. Requests and inquiries concerning reproduction and rights should be addressed to the Commonwealth Copyright Administration, Attorney General's Department, National Circuit, Barton ACT 2600 or posted at <http://www.ag.gov.au/cca>.

The views, opinions and conclusions expressed by the authors in this publication are not necessarily those of the MDBA or the Commonwealth. To the extent permitted by law, the MDBA and the Commonwealth excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this report (in part or in whole) and any information or material contained within it.

Australian Government Departments and Agencies are required by the *Disability Discrimination Act 1992* (Cth) to ensure that information and services can be accessed by people with disabilities. If you encounter accessibility difficulties or the information you require is in a format that you cannot access, please contact us.

Murray–Darling Basin Authority

Postal Address: GPO Box 1801, Canberra ACT 2601

Office location: Level 4, 51 Allara Street,
Canberra City, Australian Capital Territory

Tel: (02) 6279 0100, international + 61 2 6279 0100
Fax: (02) 6248 8053, international + 61 2 6248 8053

E-mail: info@mdba.gov.au

Website: <http://www.mdba.gov.au>

For further information contact the Murray–Darling Basin Authority office on (02) 6279 0100

Cover image: Gunbower Forest in December 2010.

Photographer: David Kleinert©MDBA

This report may be cited as: Gunbower Forest:
Environmental Water Management Plan 2011

MDBA Publication No. 221/11

ISBN (on-line) 978-1-921914-78-2

ISBN (print) 978-1-921914-79-9

Contents

About this plan	1
Summary	2
1. The Living Murray	4
The Living Murray icon site environmental water management plans	5
Planning context and legislation framework	5
Agreements	5
Commonwealth legislation	6
Victorian legislation	6
Planning strategies	8
Governance and planning arrangements	8
2. Icon site description	10
Description of key ecological assets of the icon site	11
Values of the icon site	12
3. Ecological objectives and water requirements	16
The Living Murray First Step icon site objectives	16
Water requirements	16
Climate and rainfall in the Murray–Darling Basin	21
Current condition	21
Antecedent hydrological conditions	22
Past management actions and activities	22
4. Water delivery	23
Prioritising water requirements	23
The Living Murray modelling	24
The Living Murray works	24
Operating regimes for environmental watering actions	27
Meeting objectives for wetlands	28
Meeting objectives for river red gum communities	28
Meeting objectives for waterbirds	29
Enhancement of natural high flows	29
Water accounting and measurement	32
Evaluation and management of potential risks	32
5. Environmental monitoring	33
River Murray system-scale monitoring	33
Icon site condition monitoring	33
Intervention monitoring	35
Groundwater monitoring	36
6. Community consultation and communication	37
Communication Plan	37
Community engagement	37
7. Indigenous engagement	38
Agreements	38

8. Adaptive management and reporting	40
Assess	41
Design	41
Implementation	41
Monitoring	41
Evaluation	41
Adjust	41
Assess	41
Design	41
Reporting	41
Appendix A: Victorian icon site governance arrangements	42
Relevant agencies	42
Joint management arrangements	44
Appendix B: Threatened flora list	45
Appendix C: Threatened fauna list	46
Schedules	47
Schedule 1: Condition Monitoring Plan	47
Schedule 2: Operating strategy	47
Schedule 3: Risk Management Plan	47
Schedule 4: Communications Plan	47
List of figures and tables	48
Figures	48
Tables	48
Abbreviations and acronyms	50
Glossary	51
References	53

About this plan

This environmental water management plan consists of:

- i. A long-term strategic plan, (per Clause 117 of the The Living Murray Business Plan), which outlines the icon site's environmental water requirements and how to broadly achieve them with a combination of environmental water and works and measures.
- ii. Schedules detailing operational information about the icon site such as Operating, Condition Monitoring, Risk Management and Communication Plans. These Schedules will be added to the environmental water management plan as they become available and updated to reflect learnings from the operation of works, the results of environmental waterings and the latest science.

The environmental water management plans provide context for an icon site's water planning, delivery, monitoring and consultation processes. While the environmental water management plans include proposed operating strategies, annual water planning and implementation will be responsive to changing water resource conditions, opportunities and environmental priorities throughout the season and from year to year.

This environmental water management plan and associated schedules have been prepared by TLM partner governments in consultation with the relevant stakeholders. The MDBA would like to acknowledge the significant contribution of all those involved in the development of the environmental water management plans.

Summary

The Living Murray (TLM) Initiative is one of Australia's most significant river restoration programs. The program is delivered by six partner governments as outlined in the Murray–Darling Basin Intergovernmental Agreement (2004), which is facilitated through a formal governance framework coordinated by the Murray–Darling Basin Authority (MDBA) and ultimately overseen by the Murray–Darling Basin Ministerial Council. This overarching framework is underpinned by state-based governance arrangements.

Almost 500 GL (long-term Cap equivalent) has now been recovered through TLM. This water will be used at six icon sites to improve environmental outcomes: Barmah–Millewa Forest; Gunbower–Koondrook–Perricoota Forest; Hattah Lakes; Chowilla Floodplain and Lindsay–Wallpolla Islands; Lower Lakes, Coorong and Murray Mouth; and the River Murray Channel.

Gunbower Forest is part of the Gunbower–Koondrook–Perricoota icon site. It is located on the mid-Murray floodplain in northern Victoria. The forest supports a range of vegetation types, including wetlands, river red gum (*Eucalyptus camaldulensis*) communities, black box (*E. largiflorens*) and grey box (*E. microcarpa*) woodland. The health of the forest and the native fauna it supports is closely tied to local hydrology, which has been significantly altered by regulation of the River Murray and water extraction. Floods now occur less frequently and are reduced in duration and magnitude.

More frequent flooding of the forest through managed environmental releases has the potential to maintain and enhance Gunbower Forest's ecological, cultural, social and economic values.

An environmental watering management plan has been produced for each icon site with the aim of describing TLM ecological objectives and targets and the site-specific watering regimes, works and water delivery arrangements. This plan supersedes the Icon Site Environmental Management Plan 2006–07.

The ecological objectives for Gunbower Forest are to:

- achieve healthy wetlands and river red gum communities
- provide conditions for successful waterbird breeding events at least three times every 10 years
- maintain healthy populations of native fish in the wetlands.

The works developed for Gunbower Forest to achieve the ecological objectives include two main components:

- Lower landscape works: a series of wetland regulators that target the lower landscape component of the forest to fill and top up wetlands using relatively small volumes of water.
- Hipwell Road Channel: a channel and associated works to deliver large volumes of water to the mid and upper landscape components, to water large areas of river red gums and create the conditions required for large colonial waterbird breeding events.

In addition to these works, a range of options for improving fish movement between the forest, Gunbower Creek and the River Murray have been investigated.

Development of an operating strategy for the proposed works at Gunbower Forest is supported by hydraulic modelling and ecological and engineering investigations to achieve the best results with the available environmental water, taking into account climate change scenarios.

The use of TLM environmental water is subject to a prioritisation process outlined in the Annual Environmental Watering Plan based on the volume of water available. The plan includes a flexible decision framework to guide prioritisation of environmental watering actions, icon site environmental watering proposals developed by the icon site managers with jurisdictional agencies, water availability forecasts and management objectives for water resource scenarios.

Annual monitoring will be undertaken to determine the progress made towards achievement of the ecological objectives for the icon site. This will occur primarily through the icon site condition monitoring program; however, additional monitoring activities will be undertaken during and following watering events. Monitoring of specific risks associated with environmental water delivery will also occur as required.

The Environmental Watering Management Plan promotes an adaptive management approach through 'learning by doing'. Ecological information collected during and after environmental watering events will be incorporated into the icon site operating strategy to ensure that it remains relevant and effective.

The Environmental Watering Management Plan recognises the importance of ongoing community consultation and communication in the delivery of the plan's components. Community and stakeholder engagement activities have been underway since 2005 to inform key stakeholder agencies and the local community about The Living Murray program at Gunbower Forest. Activities include information days, field trips, community meetings and media releases, as well as development of fact sheets, calendars and other communication resources.

A particular effort has been made to engage Indigenous communities with an interest in Gunbower Forest. The Traditional Owners of Gunbower Forest are represented on the Icon Site Management Committee and local Indigenous groups have attended field trips and meetings to learn about TLM and to share their own cultural knowledge regarding the forest with icon site staff. Cultural heritage management plans will be developed for all TLM construction works at Gunbower Forest, which will facilitate ongoing Indigenous engagement.

1. The Living Murray

The Living Murray Initiative is one of Australia’s most significant river restoration programs. Established in 2002, TLM is a partnership of the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory; it is coordinated by the Murray-Darling Basin Authority (MDBA). The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians.

The Living Murray aims to improve the environmental health of six icon sites chosen for their significant ecological, cultural, recreational, heritage and economic values:

- Barmah-Millewa Forest
- Gunbower-Koondrook-Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay-Wallpolla islands (including Mulcra Island)
- River Murray Channel
- Lower Lakes, Coorong and Murray Mouth.

Through its First Step water recovery initiative, TLM has acquired a water portfolio consisting of environmental water entitlements. As of May 2011, there was 478.97 gigalitres long-term Cap equivalent (LTCE), with another 7.1 GL to be recovered in 2011-12. The actual volume of water available against these entitlements depends on the allocations. This portfolio will be used to achieve environmental objectives at the icon sites. Regulating structures, water delivery channels and fishways, known as works and measures, will deliver and manage the environmental water at the icon sites. On-ground works for each icon site will be progressively constructed from 2010 to 2012. The success of the environmental watering against the objectives will be monitored using fish, birds and vegetation as an overall indicator of the icon site’s health.

The Living Murray will seek to align itself to the requirements of the Basin Plan Environmental Watering Plan, once finalised.

Further information on TLM is available on the MDBA website at ←www.mdba.gov.au/programs/tlm.→



Figure 1.1: Location of The Living Murray icon sites

The Living Murray icon site environmental water management plans

The Gunbower Forest Environmental Water Management Plan establishes priorities for the use of TLM water within the icon site, and identifies environmental objectives and targets (where appropriate), water delivery options and regimes for the site that can use TLM water portfolio.

Development of the environmental water management plans has been coordinated by the MDBA in consultation with the Environmental Watering Group to ensure a consistent approach to planning and management across the icon sites.

This revision builds on previous iterations of the Gunbower Environmental Water Management Plan (previously known as 'environmental management plans') and incorporates consultation, research into icon site key species, learning from water behaviour modelling and outcomes from previous environmental watering. The Gunbower Environmental Watering Management Plan reflects the larger volume now held in The Living Murray water portfolio, and uses TLM works and measures (as construction is completed) and monitoring information gathered at the icon site.

Planning context and legislation framework

The Australian Government and the jurisdictions of Victoria, New South Wales and South Australia have comprehensive legislative frameworks addressing natural resource and environmental management. For activities associated with management of TLM icon sites, including construction of works under TLM, the principal pieces of legislation and planning strategies are detailed below.

Agreements

Ramsar Convention on Wetlands of International Importance

The Ramsar Convention on Wetlands of International Importance (the Ramsar Convention) is an international treaty with the broad aim of halting the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. For wetlands to be listed as Ramsar wetlands, they need to be representative, rare or unique in terms of their ecological, botanical, zoological, limnological or hydrological importance. Ramsar-listed wetlands

can be natural, artificial, permanent or temporary swamps, marshes, billabongs, lakes, salt marshes or mudflats classified as wetlands.

Signatories to the Ramsar Convention, including Australia, are required to formulate and implement their planning so as to promote the conservation of wetlands included in the Ramsar list, and as far as possible the wise use of all wetlands in their territory. Ramsar wetlands in Australia are protected under the *Environment Protection and Biodiversity Conservation Act 1999* as a matter of national environmental significance (Department of Sustainability, Environment, Water, Population and Communities 2009a).

Bilateral migratory bird agreements

Over the past 30 years Australia has signed three bilateral migratory bird agreements in an effort to conserve migratory birds in the east Asian and Australian regions: China–Australia Migratory Bird Agreement (signed in 1986); Japan–Australia Migratory Bird Agreement (signed in 1974); and the Republic of Korea–Australia Migratory Bird Agreement (came into effect in 2007).

These agreements protect terrestrial, water and shorebird species that migrate from Australia to Japan or China. The Japan–Australia Migratory Bird Agreement also provides for cooperation on the conservation of threatened birds, while the Republic of Korea–Australia Migratory Bird Agreement ensures conservation of migratory birds and collaboration on the protection of migratory shorebirds and their habitat (Department of Sustainability, Environment, Water, Population and Communities 2011b).

Murray–Darling Basin agreements

The Murray–Darling Basin Ministerial Council established TLM in 2002. In 2004, the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory signed the Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin, which gave effect to a funding commitment (made in 2003) of \$500 million over five years for TLM. The Living Murray program's First Step aimed to recover 500 GL of water for the River Murray and focused on improving the environment at the six icon sites. A supplementary Intergovernmental Agreement was signed in 2006 which provided increased funding of \$200 million to The Living Murray.

The role of the Intergovernmental Agreement on Murray–Darling Basin Reform, signed by the Council of Australian Governments, is to:

- promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water and other natural resources of the Murray–Darling Basin (Council of Australian Governments 2008).

This Agreement was the foundation for the Water Act 2007, which established the MDBA whose role is to manage the Basin’s water resources through the development of a Basin plan.

Commonwealth legislation

Water Act 2007

The Intergovernmental Agreement on Murray–Darling Basin Reform was the foundation for the federal *Water Act 2007*, which established the MDBA, whose role is to manage the water resources of the Murray–Darling Basin in an integrated, consistent and sustainable manner. The Water Act requires the MDBA to prepare and oversee a Basin Plan, which will be a legally enforceable document that provides for the integrated and sustainable management of water resources in the Basin.

The Basin Plan’s Environmental Watering Plan will provide a strategic framework for coordinated environmental water planning and environmental watering throughout the Murray–Darling Basin. In the future, TLM will align with the Environmental Watering Plan with the development of Basin states’ annual and long-term environmental watering plans through the annual environmental water prioritisation processes.

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (including natural, historic or Indigenous places) —defined in the EPBC Act as matters of national environmental significance. There are eight matters of national environmental significance to which the EPBC Act applies.

The EPBC Act aims to balance the protection of these crucial environmental and cultural values with our society’s economic and social needs by creating a legal framework and decision-making process based on the guiding principles of ecologically sustainable development.

Native Title Act 1993

Section 24KA of the *Native Title Act 1993* requires that native title claimants are notified of any future act consisting of the grant of a lease, licence, permit or authority under legislation that relates to the management or regulation of surface or subterranean water.

Victorian legislation

The principal Acts listed in this section operate in conjunction with other state legislation that deals with the management and conservation of Victoria’s natural resources and outlines obligations relating to obtaining approvals for structural works within TLM icon sites.

Aboriginal Heritage Act 2006

The *Aboriginal Heritage Act 2006* provides for the protection of Indigenous cultural heritage in Victoria. The Act also provides for the introduction and management of a system of Registered Aboriginal Parties that allows Indigenous groups with connection to country and others to be involved in decision-making processes around cultural heritage. Regulations enabled under the Aboriginal Heritage Act require a cultural heritage management plan to be prepared when undertaking high impact activities in culturally sensitive landscapes.

Environmental Effects Act 1978

The *Environmental Effects Act 1978* aims to ensure that development occurs in an ecologically sustainable manner and provides for assessment of any project or development that could have significant effects on the environment. The Environmental Effects Act enables the Victorian Minister for Planning to decide whether an environmental effects statement should be undertaken for proposed projects. Projects should be referred to the minister if they meet any referral criteria, as set out in ministerial guidelines (Department of Sustainability and Environment 2006). A project can be referred by the proponent, a statutory authority or any minister.

Flora and Fauna Guarantee Act 1988

The aim of the *Flora and Fauna Guarantee Act 1988* is to conserve threatened flora and fauna species and communities, and to manage potentially threatening processes. The Flora and Fauna Guarantee Act provides for the establishment and maintenance of lists of threatened species, potentially threatening processes and excluded species, which are those not to be conserved because they constitute a serious threat to human welfare (i.e. human disease organisms).



Figure 1.2: Scarred tree on Spur Creek protected under the Aboriginal Heritage Act (photo by Melanie Tranter, North Central CMA)

The Act directs that action statements (brief management plans) are to be prepared for listed species to track the progress of management actions, and recovery plans are to be prepared for species also listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

Forests Act 1958

The *Forests Act 1958* governs forest management in Victoria. This Act and associated regulations are supported by Victoria's five regional forest agreements. Under the Act's provisions, detailed forest management plans are developed for each area following a complex assessment process that considers all forest values. These management plans provide for the control, maintenance, protection and taking of forest produce and fire management in state forests.

Planning and Environment Act 1987

The *Planning and Environment Act 1987* establishes a framework for planning the use, development and protection of land in Victoria in the present and long-term interests of all Victorians. Local planning schemes are enabled under this Act.

The Planning and Environment Act enables the Gannawarra and Campaspe planning schemes. Under these schemes, planning permits are required for proposed TLM works in these areas, with applications prepared and submitted to the relevant councils.

Murray–Darling Basin Act 1993

The *Murray–Darling Basin Act 1993* enables the Murray–Darling Basin Agreement 2008, which was entered into by the Australian Government and the governments of New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory with regard to the water, land and other environmental resources of the Murray–Darling Basin. This Act provides for the referral of selected powers under the Victorian Constitution that enable the Australian Government to manage specific aspects of water resource management with the Basin.

National Parks Act 1975 and Parks Victoria Act 1998

In Victoria, national parks are managed by Parks Victoria. Under the *Parks Victoria Act 1998*, Parks Victoria's responsibilities are to provide services to the state and its agencies for the management of parks, reserves and other public land. Under s. 27 of the *National Parks Act 1975*, works by a public authority within a park reserved and managed under the provisions of the Act are subject to consent by the minister. A condition of this consent is that the proposed works comply with the management objectives and strategies for the park.

Water Act 1989

The *Water Act 1989* governs the way water entitlements are issued and allocated in Victoria. The Act defines water entitlements and establishes the mechanisms for managing Victoria's water resources. Part 10 of the Water Act (Vic.) establishes waterway management and general river health management as the responsibility of catchment management authorities and Melbourne Water (where applicable). For TLM works, s. 67 of the Water Act (Vic.) identifies catchment management authorities as the responsible authorities for issuing licences for conducting works in a designated waterway.

Planning strategies

Regional catchment strategies

The *Catchment and Land Protection Act 1994* established overarching strategic documents aimed at halting biodiversity decline through the implementation of priority programs, including those that protect and manage wetlands. The catchment management authorities are responsible for coordinating the implementation of the Regional Catchment Strategy and its sub-strategies and action plans under the *Water Act 1989* (Vic.).

Victorian Northern Region Sustainable Water Strategy

Regional sustainable water strategies were legislated through 2005 amendments to the Water Act (Vic.) and fulfil Victoria's commitment to the National Water Initiative to carry out open, statutory-based water planning. Sustainable water strategies take a long-term view of water resource planning and, as such, they guide the development, integration and implementation of management plans prepared by water corporations and catchment management authorities operating within each region.

Victorian River Health Strategy

The Victorian River Health Strategy was released in 2002 with the statewide objective of achieving healthy rivers, streams and floodplains that meet the environmental, economic, recreational and cultural needs of current and future generations. The Victorian River Health Strategy provides the policy direction and planning framework for communities to work in partnership with government to manage and restore Victoria's rivers over the long term.

Regional river health strategies

These strategies were established as a part of the Victorian Government's response to the Victorian River Health Strategy. They provide regional frameworks for catchment management authorities, as regional caretakers, to achieve regional river health outcomes.

Native vegetation management: A framework for action

The *Native vegetation management: A framework for action* was released in 2002. The framework establishes the strategic direction for the protection, enhancement and revegetation of native vegetation across the Victorian landscape.

Improving the quality and amount of native vegetation in Victoria is critical to maintaining land and water health. The framework's main goal is to achieve a reversal, across the entire landscape, of the long-term decline in the extent and quality of native vegetation, leading to a net gain.

Governance and planning arrangements

The Living Murray is a joint initiative and is managed collaboratively by partner governments. The Murray–Darling Basin Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin (Council of Australian Governments 2004) outlines the governance arrangement for implementing TLM. The 2004 intergovernmental agreement is complemented by The Living Murray Business Plan, which provides operational policies to guide TLM implementation.

The groups with a direct role in TLM governance are the Murray–Darling Basin Ministerial Council, Murray–Darling Basin Authority (MDBA), Basin Officials Committee, TLM Committee and the Environmental Watering Group (see **Figure 1.3** for TLM governance structure)

While MDBA plays a key coordination role at a TLM-wide level, management and delivery of TLM activities at the icon sites are primarily undertaken by relevant agencies in the jurisdictions where the icon sites are located. The ultimate responsibility to ensure the icon sites at Gunbower–Koondrook–Perricoota Forest are successfully governed lies with the North Central Catchment Management Authority, as the manager of these icon sites.

The Department of Sustainability and Environment coordinates delivery of TLM across all Victorian icon sites. A statewide governance framework has been developed, with a state steering committee and state construction committee to ensure high-level engagement of stakeholder agencies (see **Appendix A**).

Catchment management authorities are responsible for river health and environmental water management in Victoria. The North Central Catchment Management Authority coordinates delivery of TLM at the icon site level, working in partnership with Parks Victoria (the land manager),

supported by a number of icon site-specific committees. These committees comprise relevant agency and community representatives. More information about the roles and responsibilities of individual committees and groups is available in Appendix A of this report.

Table 1.1 summarises the key organisations involved in the delivery of TLM activities in Victoria. Interstate coordination for the Gunbower–Koondrook–Perricoota icon site occurs through the integrated coordinating committees, Technical Advisory Committee and Community Reference Group.

Table 1.1: Key agencies involved in delivery of TLM at Gunbower Forest

Agency	Role
Department of Sustainability and Environment	Project proponent for TLM in Victoria
North Central Catchment Management Authority	Icon site manager; responsible for: <ul style="list-style-type: none"> • delivery of environmental water and ecological monitoring • ecological investigations and development of concept designs for TLM water management infrastructure.
Goulburn–Murray Water	Victorian constructing authority responsible for the construction, operation and maintenance of TLM infrastructure on behalf of MDBA.

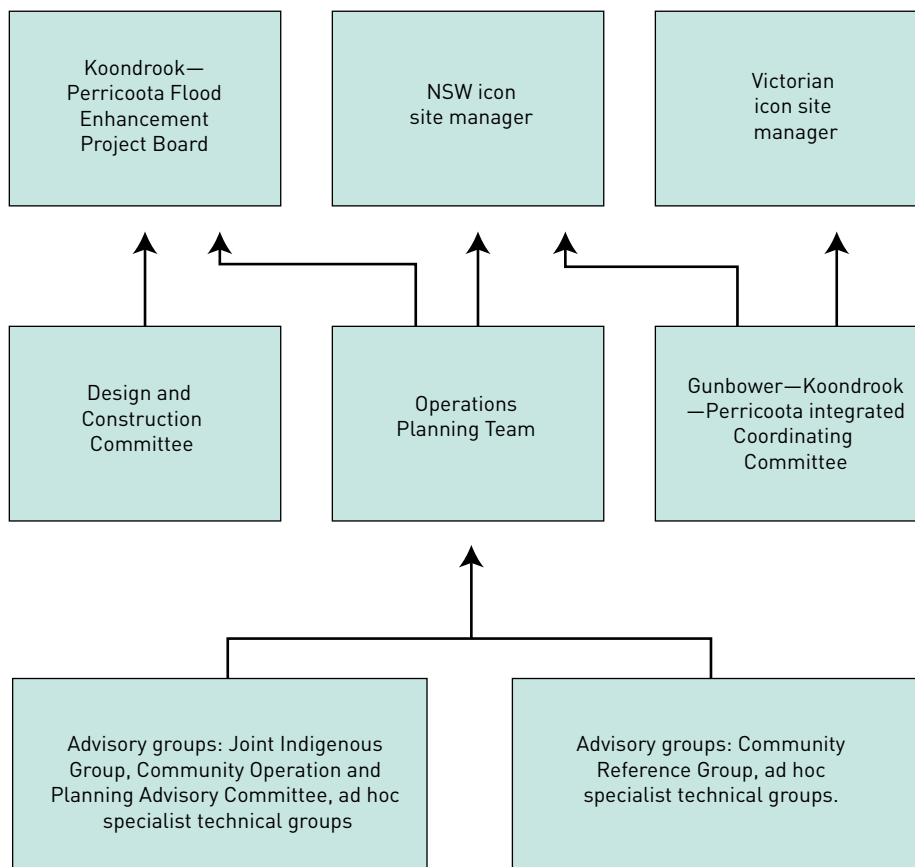


Figure 1.3 The Living Murray governance structure (MDBA)

2. Icon site description

Gunbower Forest is located on the mid-Murray floodplain in northern Victoria (see **Figure 2.1**). Together with Koondrook–Perricoota Forest in New South Wales, it forms part of a broader floodplain system recognised as the Gunbower–Koondrook–Perricoota icon site under The Living Murray (TLM).

Gunbower Forest is situated on Gunbower Island, bounded by the River Murray to the northern boundary, and by private land and Gunbower Creek to the south. The forest extends from the township of Torrumbarry in the south to Koondrook in the north, and forms the backdrop for both the Cohuna and Gunbower communities.

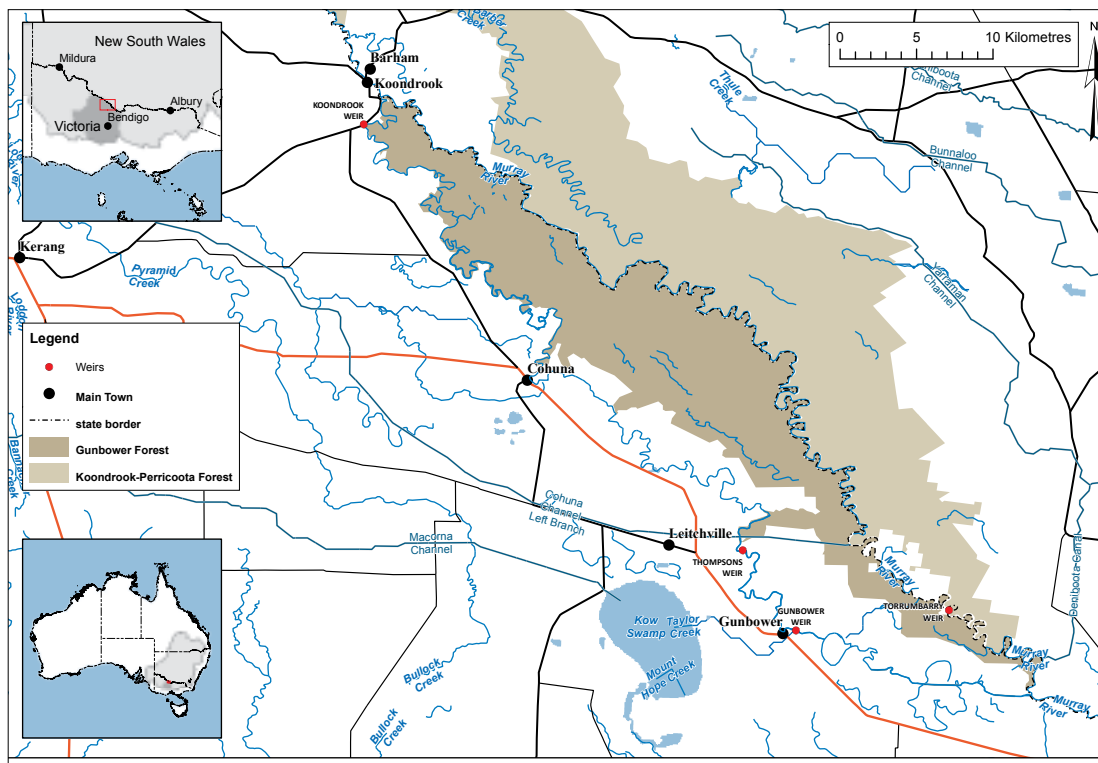


Figure 2.1: Gunbower–Koondrook–Perricoota icon site

Gunbower Forest spans approximately 20,000 hectares and is a combination of state forest (8,843 ha), national park (8,892 ha) and River Murray reserve (1,666 ha). Gunbower State Forest is managed by the Department of Sustainability and Environment, with all remaining land under the management of Parks Victoria. The land tenure boundaries are shown in **Figure 2.2**.

The Koondrook–Perricoota Forest is located opposite Gunbower Forest on the New South Wales floodplain (see **Figure 2.1**). The Koondrook–Perricoota Forest covers approximately 30,000 ha and is managed by Forests NSW as a state forest.

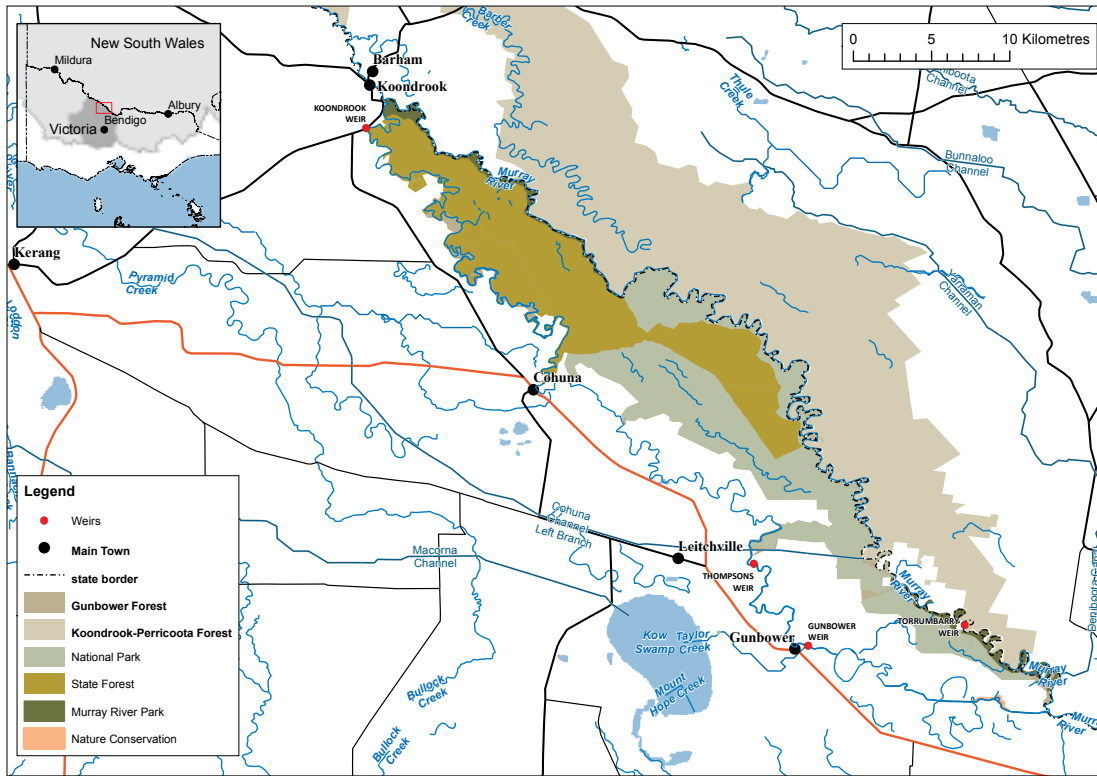


Figure 2.2: Map of land tenure boundaries

Description of key ecological assets of the icon site

To assist in the management of flora and fauna communities, Gunbower Forest has been divided into several water management areas (see **Table 2.1** and **Figure 2.3**). Its management areas are defined by vegetation type, and water requirements and the ecological values they support. The water requirement of each management area is outlined in Chapter 3.

Table 2.1: Water management areas in Gunbower Forest

Water management area	Area (ha)*	Percentage of forest
Permanent wetlands	382	2
Semipermanent wetlands	992	5
River red gum with flood-dependent understorey	8,423	45
River red gum with flood-tolerant understorey	4,309	25
Black box woodland	3,126	14
Grey box woodland	1,768	9

* The balance of forest area is made up of watercourses and temporary wetlands

The distribution of each water management unit across Gunbower Forest is shown in **Figure 2.3** below. While they are illustrated as discrete units, the actual on-ground boundaries are less defined because each water management area transitions from one type to another.

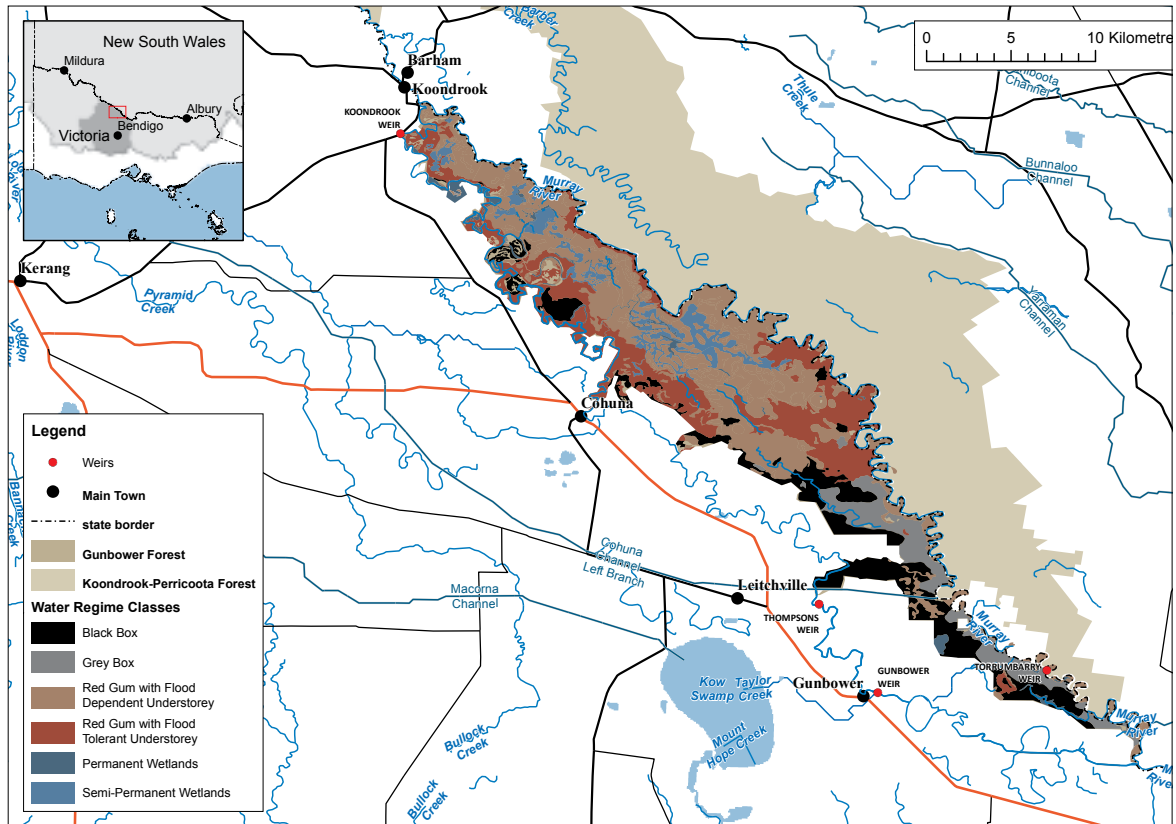


Figure 2.3: Key water management areas in Gunbower Forest

Values of the icon site

More frequent flooding of the forest through managed environmental releases has the potential to enhance its ecological, cultural, recreational and economic values.

The forest contains a large and highly diverse wetland system. This includes rare wetland types; for example, 8% of the state’s remaining freshwater meadow is found in Gunbower Forest.

Ecological values

Gunbower Forest is designated a wetland of international importance under the Ramsar Convention, being recognised as a site of special value for the genetic and ecological diversity it maintains and for supporting large numbers of waterbirds during flood times.

Together with the Koondrook–Perricoota Forest, Gunbower contains one of the largest remaining stands of river red gum forest, and is home to some of the tallest river red gums in the state.

More than 230 species of native flora and 143 species of native fauna have been recorded at Gunbower Forest. A large number of these species are of state and national conservation significance (**Appendix B**).

A number of vegetation communities of conservation significance occur within Gunbower Forest. This includes the state-listed river red gum – grassy woodland ecological community and the federally listed inland grey box woodlands within the Gunbower Forest National Park.

Important feeding, nesting and breeding habitat for more than 22 waterbird species is provided by the Gunbower Forest, which is one of only two known breeding sites for intermediate egrets (*Ardea intermedia*) in Victoria. The site is listed on the Register of the National Estate for its value as a waterfowl breeding area and is also subject to migratory bird agreements with China and Japan.

Gunbower Creek forms the southern border of the forest and is also a waterway of significant value (North Central Catchment Management Authority 2008). The creek provides quality habitat for a range of fish, including threatened species such as Murray cod (*Maccullochella peelii*) (see **Figure 2.4**), trout cod (*M. Macquariensis*) and freshwater catfish (*Tandanus tandanus*) (North Central Catchment Management Authority 2010).



Figure 2.4: Murray cod, a threatened species found in Gunbower Creek (photo Gunther Schmida © MDBA)

Indigenous values

Local Indigenous communities have had, and continue to have, a strong connection to the Gunbower Forest region. The Traditional Owner groups of Gunbower Forest are members of the Barapa Barapa and Yorta Yorta nations: these are the people of the country.

Today, the Indigenous community of the region identifies a number of values associated with the forest, including:

- archaeological sites — burial mounds, scarred trees, artefact scatters, middens and hearths
- biodiversity values — the Indigenous community understands and appreciates indicators of forest and river health
- ecological values — associated with wetlands, river red gum forest, open box ridges (black and grey box), open plains, sandhills and Murray pine (*Callitris glaucophylla*); for example, wetlands are seen as nurseries and river red gums the 'guardians of the river, stabilising the river banks while providing habitat both in and out of the water systems

- commodities and/or economic values — associated with medicinal plants, food plants, fish species and edible fauna such as kangaroo (*Macropodidae*), emu (*Dromaius novaehollandiae*) and ducks (*Anatidae*).

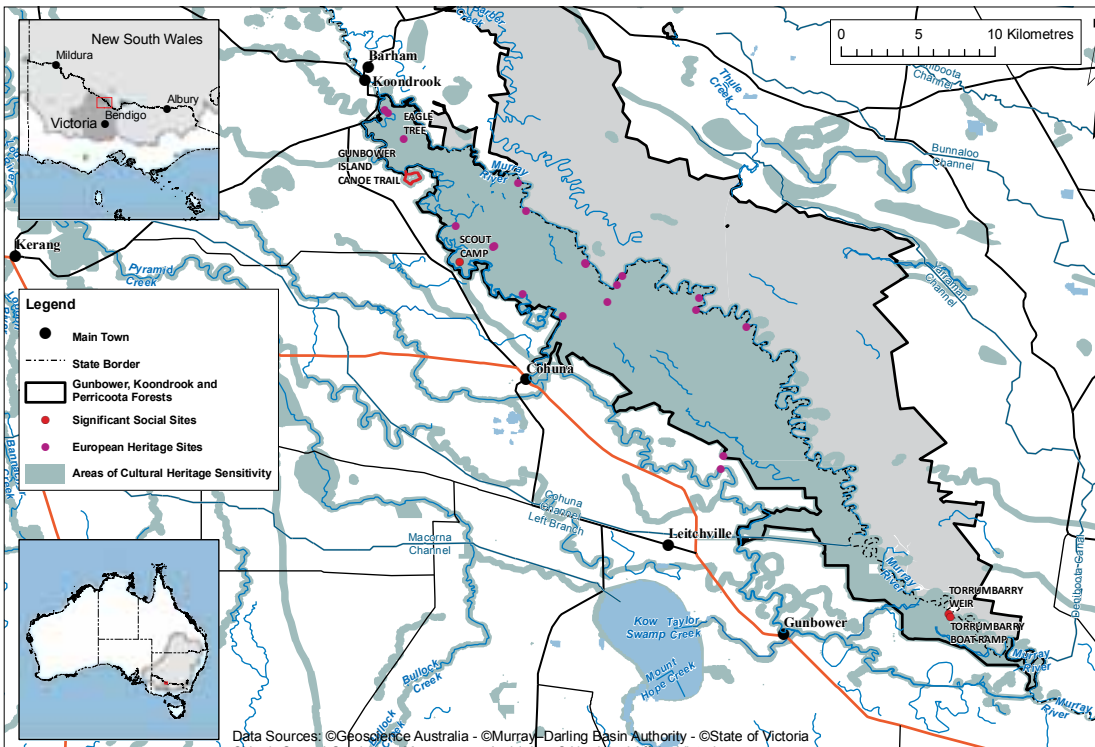
Heritage values

Evidence of European heritage is also common in Gunbower Forest. Early activities included grazing, logging, a boat-building and nursery business, beekeeping, gum (resin) collecting and recreation (Kaufman 2010). Remnants of these activities occur throughout the forest (**Figure 2.5**) and have been extensively mapped (see **Figure 2.6**). All archaeological sites in Victoria more than 50 years old are protected by the *Heritage Act 1995* (Vic.) and planning scheme heritage overlays.



Figure 2.5: Remains of European activities, Gunbower Forest (Photo by David Kleinert)

While not archaeological sites, two large trees have become important to the local communities: the 'Eagle Tree' near Koondrook and the 'Big Tree' near Cohuna. These trees are highly regarded by local communities as expressions of their long connection to the river red gum forests.



Note: other social and heritage assets exist that are not shown on this map.

Figure 2.6: Key social and heritage assets in Gunbower Forest (Kaufman 2010; Long 1996; Pardoe 2008; Rhodes 1996)

Social values

Gunbower Forest provides social value to the local community and broader public through recreational activities and industry promotion.

The most popular areas are along the River Murray and at Torrumbarry Weir, where a caravan park is located. Peak times for camping are the Christmas and Easter periods and, to a lesser extent, the Melbourne Cup weekend. An estimated 20,000 to 30,000 people camp in Gunbower Forest during peak periods (Sinclair Knight Merz 2010).

Boating is popular on the River Murray and its tributaries. Canoeing and kayaking are common modes of travel for birdwatchers. A canoe trail has been established around Gunbower Island, Safe's Lagoon and Gunbower Creek. Power boating is popular for sightseeing, but more commonly for fishing, waterskiing and wakeboarding on the River Murray (Sinclair Knight Merz 2010).

Recreational fishing is a widespread activity in and around Gunbower Island. The most prevalent fish species include brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), Murray cod and golden perch (*Macquaria ambigua*). Closed seasons and bag limits exist for many species (Sinclair Knight Merz 2010).

Horse-riding, four-wheel driving and trail-bike riding are also popular on Gunbower Island. The extensive range of tracks across the island provides many options for drivers and riders to enjoy the bush. They are required to use only made roads to avoid damaging the forest.

Some hunting of feral animals such as pigs, foxes, hares and rabbits is encouraged in the state forest because it helps to reduce pressure on native fauna (Sinclair Knight Merz 2010). A game licence and a firearms licence are required for this activity.

Economic values

Gunbower Forest provides a variety of direct and indirect economic values to the local community. The direct economic values include timber production, apiculture (beekeeping), recreation and tourism.

Timber harvesting within the state forest is currently managed by the Department of Sustainability and Environment. The local community also benefits from forest resources by accessing firewood and generating revenue from selective logging.

The high number of tourists visiting the forest has resulted in some nearby businesses supplying a range of services and supplies to campers, and becoming dependent on this seasonal income (Sinclair Knight Merz 2010). During peak times, local shop revenue increases by 30% because of tourist activity (Sinclair Knight Merz 2010).

Water supplied by Gunbower Creek supports irrigated agriculture on the private land adjacent to the creek, including private land located on Gunbower Island. Water is delivered through Gunbower Creek at the Cohuna and Koondrook weirs to supply water to the west of Gunbower Island. This industry creates further jobs and revenue within the local economy (Sinclair Knight Merz 2010).



Figure 2.7: Kayaking in Gunbower Creek – a popular recreational activity (Photo by Melanie Tranter, North Central CMA)

3. Ecological objectives and water requirements

The Living Murray First Step icon site objectives

Based on an understanding of the Gunbower–Koondrook–Perricoota icon site’s characteristics and ecological requirements First Step Decision interim ecological objectives were developed and approved by the Murray–Darling Basin Ministerial Council in 2003.

The First Step Decision ecological objectives developed for the Gunbower–Koondrook–Perricoota icon site were to:

Maintain and restore a mosaic of healthy floodplain communities as indicated by:

- 80% of permanent and semipermanent wetlands in healthy condition
- 30% of river red gum forest in healthy condition
- successful breeding of thousands of colonial waterbirds at least three years in 10
- healthy populations of resident native fish in wetlands.

Since these objectives were approved by Ministerial Council in 2003, jurisdictional agencies have continued to review and refine the First Step Decision interim objectives to develop refined ecological objectives for icon sites. These refined ecological objectives reflect eight years of learning’s from the delivery of environmental water, monitoring, modelling and consultation activities and scientific research, and enable a clearer, more effective, evaluation of environmental responses to environmental water delivery.

In consultation with communities, the First Step Decision objectives that relate to Victorian environmental water management plans have been extended to develop overarching objectives. These overarching objectives better reflect the specific icon site values that the environmental waterings aim to protect, as well as relevant jurisdictional management plans and obligations.

The objectives for the Gunbower environmental water management plan are in **Table 3.1**. In addition to the overarching objectives, more detailed objectives have been developed to guide icon site management. Targets to measure progress towards these objectives are under development for this icon site. The targets

for vegetation and fish have been set for 2025, which represents an approximate 10-year timeframe for the operation of The Living Murray infrastructure works. The targets for waterbird breeding and recurrence of native fish species have been set to a longer timescale (2030), to allow time for the recovery of food and habitat resources needed for successful large-scale breeding to occur and the random migration events of native fish species.

Water requirements

The health of flora and fauna communities in Gunbower Forest is closely tied to the local hydrology. The provision of a managed water regime to meet the water requirements of the different vegetation communities underpins the ability to achieve the refined targets established for Gunbower Forest. The water requirements for the Gunbower Forest icon site are described in **Table 3.2**.

Gunbower Forest contains a diverse range of permanent and semipermanent wetlands, connected by shallow flood-runners to create large wetland complexes. Before river regulation, permanent wetlands would have received inflows in 96% of years, typically constricting to remnant pools before refilling (URS 2001).

Permanent wetlands in Gunbower Forest are surrounded by a semipermanent wetland fringe that flood less often (6 to 9 years in 10) and for shorter periods (5 to 8 months). Flooding typically occurs in the winter–spring period (URS 2001).

Two key river red gum communities are recognised for the purposes of water management in Gunbower Forest: river red gum forest with flood-dependent understorey, and river red gum woodland with flood-tolerant understorey. Together they represent almost 80% of the forest area.

The lower lying flood-dependent understorey areas comprise plants that rely on flooding to complete their life cycle, including species of rushes and sedges (North Central Catchment Management Authority 2007). The river red gum woodland with flood-tolerant understorey occurs at higher elevations and is predominantly characterised by grassland species, which tolerate intermittent flooding.

Table 3.1: Specific outcomes and targets for First Step Decision objectives

Vision: To maintain and improve Gunbower Island by enabling native plants and animals to flourish, restoring the floodplain's health for future generations		
Icon site ecological objectives		Targets
Overarching objectives	Specific objectives	
Vegetation Increase area of healthy permanent and semi permanent wetlands Ensure maintenance of healthy river red gum communities Maintain black box and grey box communities	Promote functioning floodplain and wetland ecosystems that are resilient under a range of climatic conditions. Successful recruitment of wetland and floodplain vegetation resulting in a structurally diverse landscape. Provide suitable habitat for wetland and floodplain dependant fauna, e.g. waterbirds, macroinvertebrates, frogs and fish. Facilitate an increase in abundance of threatened flora species	80% of wetlands in healthy condition by 2025 (sustainable intact floristic assemblage) 30% of river red gum forest in healthy condition by 2025 (sustainable intact floristic assemblage and tree canopy cover >60%)
Waterbirds Provide suitable feeding, breeding and refuge habitat for waterbirds, including colonial nesting species	A suite of waterbirds present including waterfowl, colonial waterbirds and other wetland dependant species. Successful waterbird breeding events that are proportionate to the scale of flooding across the forest A contribution to population recovery of threatened waterbird species by supporting frequent recruitment events. Provide refuge and feeding grounds for waterbirds in drier years.	Successful breeding of thousands of colonial waterbirds at least three years in 10 by 2030
Fish Maintain healthy populations of native fish in wetlands and increase opportunities for riverine fish to access floodplain resources	Increase in the abundance of native fish species so that each exhibits a robust population structure, with a focus on the recovery of threatened species Restore presence of locally extinct fish species to Gunbower Island. Allow for movement of native fish in and out of habitat types (creek, river, wetlands and floodplain) for feeding and breeding.	Increase of 10% in the current population of native fish species by 2025 By 2030, presence of two native fish species currently considered locally extinct Range of age/size classes of each species
Frogs Increase the diversity and abundance of native frog species within the forest	Restore resident populations and breeding events of native frogs, especially threatened species.	By 2030, presence of one native frog species currently considered locally threatened or extinct.

Overbank flooding is required to create extensive inundation in river red gum woodlands. The frequency of inundation varies from seven to nine years in 10 for the lower-lying areas to three years in 10 at higher elevations.

The relationship between flood requirement and vegetation type is best represented through the 'landscape logic' conceptual model (see **Figure 3.2**). This model is based on work by Ecological Associates (2003) which considers the relationship between River Murray flows, inundation within the forest and vegetation distribution.

The ability to meet the refined targets for waterbirds and native fish is closely tied to understanding their behavioural patterns as well as meeting the water requirements of the different habitats they use.

Waterbird breeding events are highly dependent on flooding to create the necessary foraging habitat (food resources) and nesting materials (habitat resources). Waterbird-carrying capacity and breeding success requires widespread flooding across the suite of water management areas shown in **Figure 3.3**.

The water requirement for native fish differs between species, depending upon their reason for entering the floodplain (e.g. feeding, residence or breeding). Inundation of wetland and river red gum flood-dependent understory areas provides critical feeding and breeding areas for some smaller native fish species (Water Technology et al 2007).



Figure 3.1: Sedges found in the river red gum forest with flood-dependent understory (Photo by Melanie Tranter, North Central CMA)

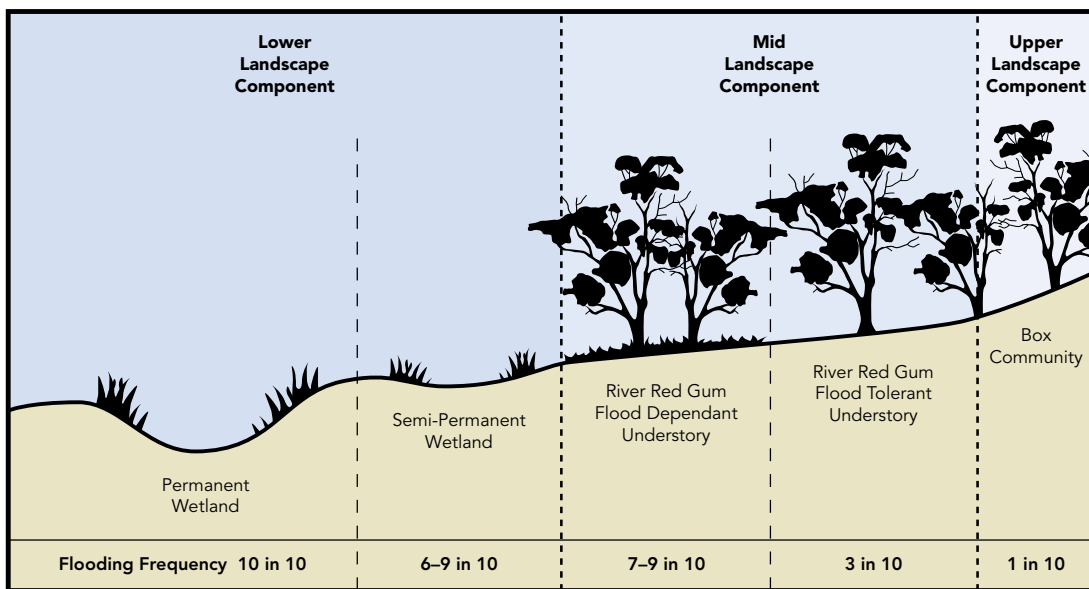


Figure 3.2: Schematic representation of the Landscape Logic approach (North Central CMA)

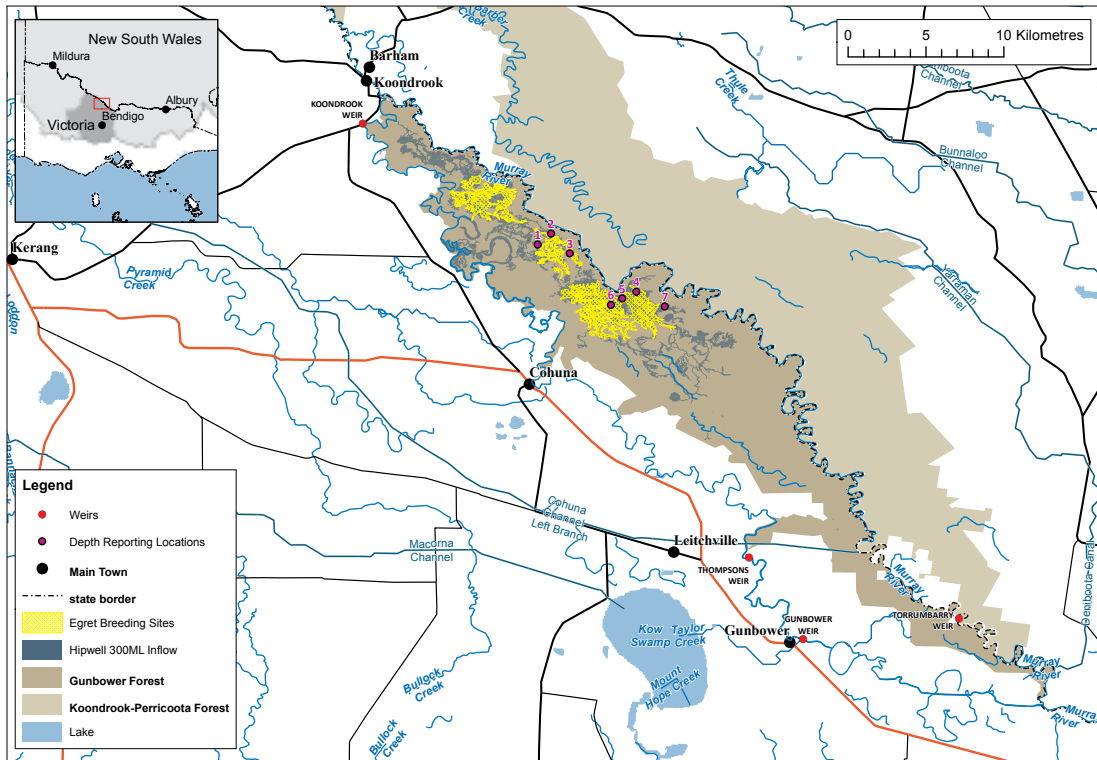


Figure 3.3: Key water management areas of Gunbower Forest that support waterbird breeding events

Table 3.2: Water requirements for the icon site environmental objectives

First Step Decision objective	Refined target (if developed)	Vegetation community	Required water regime							
			Area flooded (ha)	Flow rate (ML/day)	Duration (days)	Timing	Frequency (years in 10)	Maximum time between events	Water availability scenario	Works or other mechanisms to assist meeting objectives
80% of permanent and semipermanent wetlands in healthy condition	A sustainable intact floristic assemblage across 80% of wetlands by 2025	<ol style="list-style-type: none"> 1. Wetland communities. 2. Fringing river red gum. 3. Floodplain creeks. 	Up to 2,500	100 – 1,000	Variable (depends upon inflow rate)	Late winter/ early spring	6–9	2 years	Extreme dry–dry–median	Lower landscape regulators, Hipwell Road Channel
30% of river red gum forest in healthy condition	A sustainable intact floristic assemblage across 30% of river red gum forest by 2025. Tree canopy cover greater than 60% across 30% of river red gum forest by 2025.	<ol style="list-style-type: none"> 1. River red gum forest. 	Up to 4,700	1,600	90 days	Winter/ spring	6–7*	3 years	Dry–median–wet	Hipwell Road Channel
Successful breeding of thousands of colonial waterbirds at least 3 years in 10	Provide conditions to support colonial waterbird breeding events 3 years in 10. By 2030, able to support breeding events in the thousands.	<ol style="list-style-type: none"> 1. Wetlands. 2. Fringing river red gum. 3. River red gum forest. 	2,500 – 4,700	300 – 1,000 (following river red gum watering)	Variable depending upon species breeding.	Spring/ summer	3	5 years	Median–wet	Hipwell Road Channel, Yarran and Little Gunbower Creek regulators
Healthy populations of resident native fish in wetlands	A 10% population increase in current native fish species assemblage by 2025. Presence of 2 native fish species [#] currently considered locally extinct by 2030	<ol style="list-style-type: none"> 1. Wetlands. 2. Fringing river red gum. 3. River red gum forest. 4. Floodplain creeks. 	Meeting the water requirements of wetlands, river red gum communities and colonial nesting waterbirds will also meet the water requirements for fish objectives. No specific flows are recommended.						All	Fishways on key structures throughout the Gunbower system.

* The lower range of water requirements for the river red gum with flood-dependent understorey has been adopted as most of the flooding occurs within this management area.

[#] Seven species of native fish have disappeared from Gunbower Forest, but are still present in the region and could return (without active reintroduction) if flooding regimes were restored.

Climate and rainfall in the Murray–Darling Basin

Historically, the climate of the Murray–Darling Basin has been variable. Climate change science indicates a likely increase in this variability, resulting in more frequent and extreme floods and droughts (MDBA 2010a). Consequently, river storages and the use of environmental water will be managed according to these varying river flows.

Between 1996 and 2010, the Murray–Darling Basin was in a drought characterised by below-average rainfall in autumn and winter and few wet periods. This drought was significantly drier than the Federation Drought (mid-1890s to early 1900s) and the droughts of the World War II era (c. 1937–1945).

Beginning in spring 2010, and continuing through the summer of 2010–11, widespread, above average rainfall across the Murray–Darling Basin broke the long standing drought. This rainfall was associated with the development, beginning in 2010, of a moderate to strong La Nina event making 2010 the wettest year on record for the Murray–Darling Basin.

Current condition

Over the past decade, drier conditions have resulted in a shift towards more terrestrial vegetation types across Gunbower Forest. This change is most pronounced in the understorey species composition of the river red gum communities, which are exhibiting significant loss of plant diversity and weed invasion (Australian Ecosystems 2009).

The extent of river red gum with flood-dependent understorey has decreased and is now restricted to a narrow zone around the wetlands (Ecological Associates 2002). This has resulted in an increase in the area of river red gum forest with flood-tolerant understorey, which now extends into the lower parts of the forest and is encroaching on formerly open wetlands (Australian Ecosystems 2009). At higher elevations, river red gums are being replaced by the less flood-dependent black box woodlands (Ecological Associates 2003). Monitoring of canopy condition since 2005 has recorded an ongoing decline in eucalypt canopy health (Australian Ecosystems 2008).

Lack of flooding has also affected floodplain productivity and access to food and habitat by native fauna, leading to a decline in populations of these species and their resilience to additional stressors (Horrocks et al 1989). This is most evident for colonial waterbird populations — the extended periods between large floods that support large-scale breeding opportunities pose a key threat to the viability of existing populations.

Ecological processes required to sustain native fish populations, such as connectivity to the floodplain for breeding and recruitment, have also been hindered (Ecological Associates 2010). Regulated flows in Gunbower Creek are providing limited opportunity for breeding in the larger bodied native fish, as demonstrated by the low population numbers detected through surveys of the creek.



Figure 3.4: Box woodland near Spur Creek, a less flood-dependent vegetation community (Photo by Melanie Tranter, North Central CMA)

Antecedent hydrological conditions

Gunbower–Koondrook–Perricoota Forest is located in an area of low rainfall and high evapotranspiration. The average annual rainfall is less than 400 millimetres per year with evapotranspiration of around 1,700 mm/y. This creates a significant water deficit and stressor to the forest, particularly in years where there are no forest inflows to maintain health of vegetation communities.

The hydrology of the Gunbower Forest has changed substantially because of the regulation and diversion of River Murray flows, resulting in a reduction in the frequency and duration of flooding.

Recent modelling (MDBA 2010a) demonstrates that, under current river operations, intervention is needed to maintain functioning floodplain ecosystems within Gunbower Forest. This need is expected to increase based on the 2030 median climate change scenario (see **Table 3.3**).

Table 3.3: Modelled average frequency of flood events in 10 years

Flood event	Natural conditions	Current conditions	Median climate change conditions
>25 GL/day for 1 month	8.7	4.2	3.7
>35 GL/d for 2 months	5.7	2.3	1.5
> 35GL/d for 3 months	4.5	1.5	0.9

Source: MDBA 2010b

Past management actions and activities

Until recently, most of Gunbower Forest (about 85%) was managed as state forest, and was subject to timber harvesting under the Mid-Murray Forest Management Area Plan, which requires that timber is harvested using sustainable yield principles. As previously discussed, almost 9,000 ha of the forest was recently declared a national park.

Grazing of domestic stock is another historical and continuing use of the forests. For many years, grazing was continuous and stock numbers were managed based on the condition of the cattle. More recently, grazing has been used to generate beneficial changes in the composition of groundcover species.

Beekeeping is also an important forest-based activity in this area. River red gums are fairly reliable producers of heavy blossom, which often produces high flows of nectar and large quantities of pollen.

Weed control programs have been carried out in the forest to enhance the ecological integrity of sites containing threatened flora and nesting sites of threatened fauna, as well as other areas identified in the Mid-Murray Forest Management Area Plan conservation guidelines.

4. Water delivery

Prioritising water requirements

The Living Murray (TLM) Annual Environmental Watering Plan was developed by the Environmental Watering Group. The plan includes a flexible decision framework to guide prioritisation of environmental watering actions, as well as icon site environmental watering proposals, water availability forecasts and management objectives for water resource scenarios (see **Table 4.1**).

Throughout the year the Environmental Watering Group recommends environmental watering actions to the Murray–Darling Basin Authority (MDBA) for approval. These recommendations are based on

the Annual Environmental Watering Plan and the volume of water available in TLM’s environmental water portfolio.

Priority areas for watering within Gunbower Forest are developed by the North Central Catchment Management Authority as the delegated environmental water manager. These areas may be on a small (wetland basis) or larger scale (forest flooding). Decisions regarding annual watering are guided by long-term operating plans and regional committees, and take into account a range of factors such as seasonal conditions and frequency of prior flooding.

Table 4.1: Objectives under different water availability scenarios

Objectives and priorities	Water availability scenario			
	Extreme dry	Dry	Median	Wet
Ecological watering objective	Avoid irretrievable loss of environmental assets.	Ensure priority wetlands have maintained their basic functions.	Ecological health of priority wetlands have been protected or improved.	Improve the health and resilience of aquatic ecosystems.
Management objective	Avoid critical loss of species, communities and ecosystems. Maintain key refuges. Avoid irretrievable damage or catastrophic events.	Maintain key functions of high priority wetlands. Manage within dry-spell tolerances. Support connectivity between sites.	Enable growth, reproduction and small-scale recruitment for a diverse range of flora and fauna. Promote low-lying floodplain-river connectivity. Support medium flow river and floodplain functional processes.	Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna. Promote higher floodplain – river connectivity. Support high flow river and floodplain functional processes.
Priority water management area to be watered	Permanent wetlands.	Permanent and semipermanent wetlands.	River red gum with flood-dependent understorey (moderate area). Permanent and semipermanent wetlands.	River red gum with flood-dependent understorey (maximum area). River red gum with flood-tolerant understorey. Black box (minor area). Permanent and semipermanent wetlands.
Example of priority locations in Gunbower Forest	Reedy Lagoon and Black Swamp.	As for extreme dry and: Little Gunbower Wetland Complex and Little Reedy Wetland Complex.	As for dry and: River red gum forest from Spur Island downstream to Chinaman Bend. Wetlands (as in dry).	As for median.

The Living Murray modelling

Modelling completed in 2008 found that the environmental water requirements of the floodplain icon sites (with the exception of Barmah-Millewa and the Lower Lakes, Coorong and Murray Mouth and River Murray Channel icon sites) could largely be met by a combination of the proposed TLM works, the 500 GL of recovered TLM water and 70 GL long-term Cap equivalent (LTCE) of River Murray Increased Flows.

This modelling was based on a number of assumptions including the use of unregulated flow events for environmental watering actions. It was also agreed as a modelling principle that return flows could be used to water at multiple environmental sites. There are a number of constraints to the implementation of this principle which TLM are currently working to resolve.

Further modelling is also planned to allow greater optimisation of works and measures to achieve icon site ecological objectives as we gain a greater understanding of operating.

The Living Murray works

Due to the different water requirements of the forest's vegetation communities, the works developed for Gunbower Forest include two main components:

- Lower landscape works — a series of wetland regulators that target the lower landscape component of the forest to fill and top up wetlands using relatively small volumes of water. Works include refurbishing existing regulators within the forest, constructing new regulators and decommissioning of a single regulator. These regulators deliver water from either Gunbower Creek or the River Murray (when flows exceed 14,000 ML/d).
- Hipwell Road Channel — a major channel and associated works to deliver large volumes of water to the mid- and upper landscape components, to water large areas of river red gums and create conditions required for large colonial waterbird breeding events. The channel delivers water from Gunbower Creek to the forest.

In addition to these works, a range of options for improving fish movement between the forest, Gunbower Creek and the River Murray have been investigated. Fishways will be constructed at priority sites as part of the overall works package.

The location of infrastructure built or planned for construction is shown in **Figure 4.1**. The contribution of these works packages to achieving the targets established for Gunbower Forest is shown below (see **Table 4.2**).

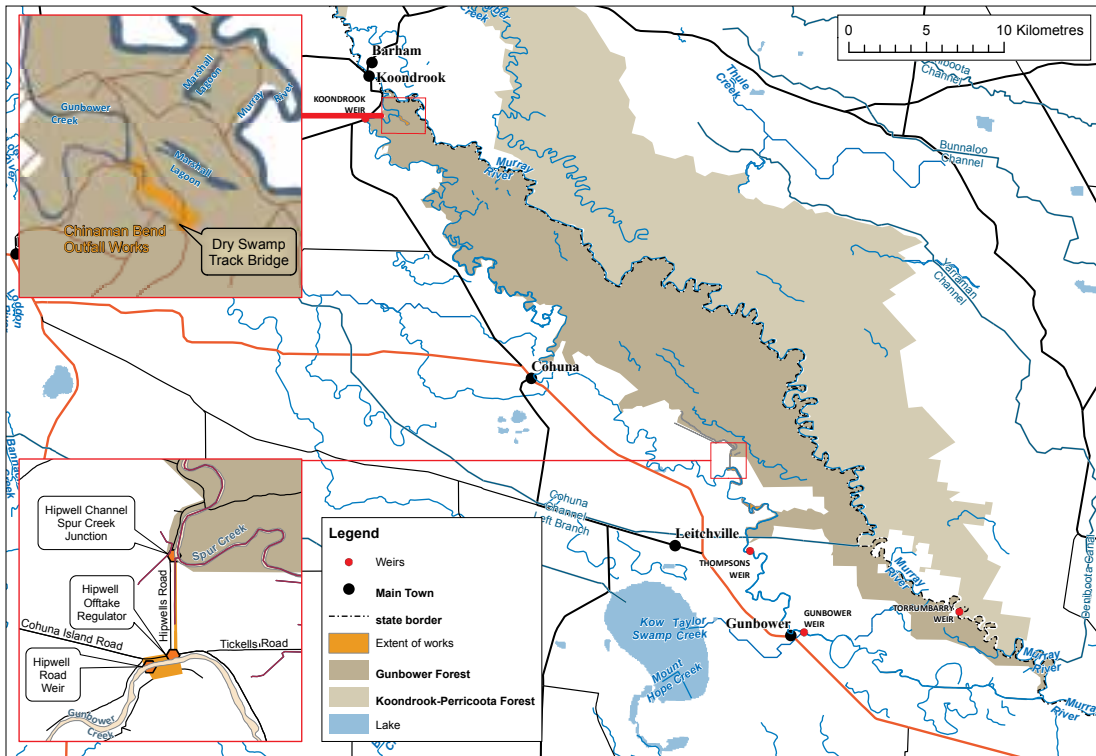


Figure 4.1: Map of completed and proposed works

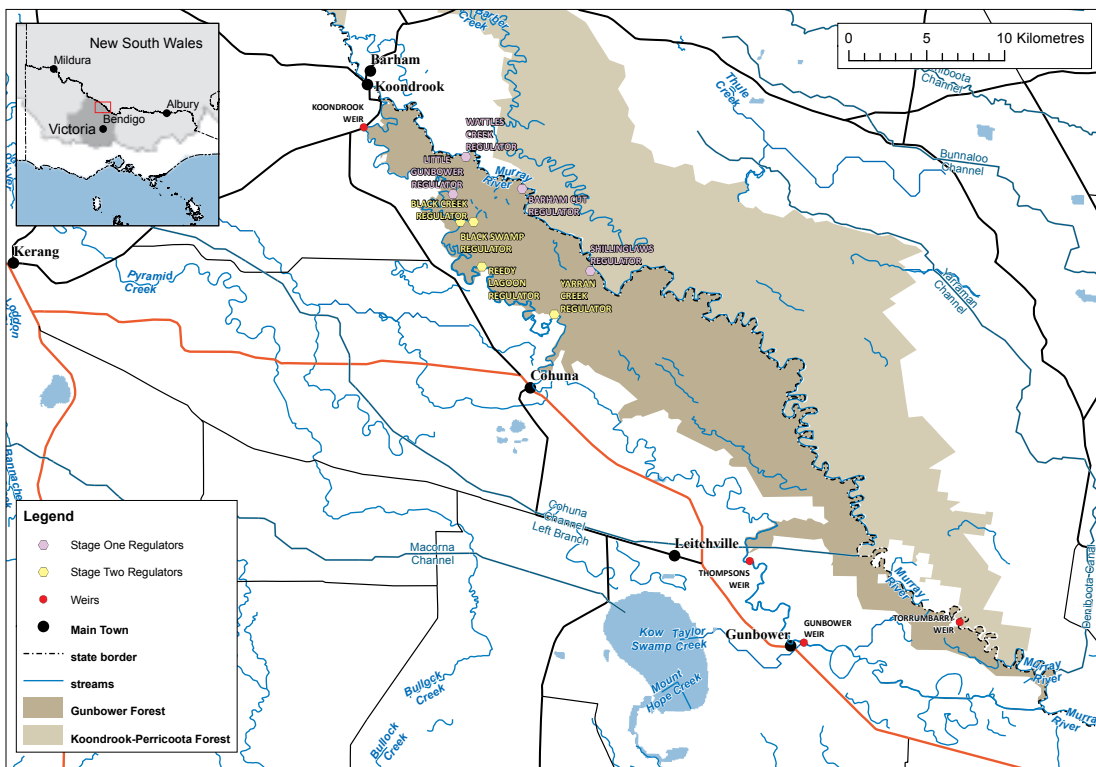


Figure 4.2 Map of Stage One and Stage Two Regulators



Figure 4.3: Shillinglaws regulator constructed in 2006 on the River Murray (Photo by Melanie Tranter, North Central CMA)

Table 4.2: Status of structures and contribution to the ecological objectives for Gunbower Forest

Works	Status	Target area	Primary function	Supply point
Lower landscape works				
Little Gunbower Regulator (new regulator)	Complete (2005–06)	Little Gunbower wetland complex	Meet the water requirements of the semipermanent wetland areas, maintain water levels under small waterbird breeding colonies and provide connectivity between different systems.	Gunbower Creek
Yarran Regulator (refurbishment and new fishway)	Construction underway. Completion in 2011.	Little Reedy Wetland, including Whistler and Cockatoo lagoons.	Fishway at Yarran Regulator will provide passage from the forest back into Gunbower Creek, providing a primary exit location for large and medium sized native fish.	Gunbower Creek
Black Swamp Regulator (refurbishment)	Construction underway. Completion in 2011.	Black Swamp	Meet the higher water requirements of the permanent wetlands within the forest.	Gunbower Creek
Reedy Lagoon Regulator (replacement)	Construction underway. Completion in 2011.	Reedy Lagoon		
Shillinglaws Regulator (refurbishment)	Complete (2005–06)	Little Reedy Wetland	Gates can be opened to allow inflow of water to the forest at River Murray flows of 1,500 ML/d or to prevent forest draining.	River Murray
Barham Cut Regulator (refurbishment)	Complete (2005–06)	Little Gunbower wetland complex		
Wattles Regulator (decommissioned)	Complete (2005–06)	Lower forest	During managed events, the closed gates maximise flood extent and duration, and provide cues for native fish to leave the forest.	
Hipwell Road Channel				
Weir and fishway on Gunbower Creek; levee banks; increase channel capacity; regulator and fishway	Detailed designs in progress. Construction expected to commence 2011.	River red gum forest from Spur Island downstream to Chinaman Bend.	Broadscale inundation of river red gum communities and wetlands, promoting colonial waterbird breeding events by enhancing foraging habitat and nesting areas.	Gunbower Creek (gravity).
National Channel offtake fishway	Construct new fishway at National Channel offtake	Expected to progress with Hipwell Road Channel (subject to funding).	Gunbower Creek	Enable fish passage between the River Murray and Gunbower Creek. River Murray (gravity)

Hipwell Road Channel

The Hipwell Road Channel involves a package of works to allow up to 1,650 ML/d to be transferred from Gunbower Creek to Spur Creek, which will then distribute the water through Gunbower Forest.

Operated at its maximum capacity, the channel will mimic a natural flood of around 38,000 ML/d and inundate approximately 5,000 ha, or 25%, of Gunbower Forest. Under larger flows such as this, the forest will act as a through-flow system, with large volumes of the water delivered returning to the River Murray.

Table 4.3: Hipwell Road works and functions

Works components	Function
Weir on Gunbower Creek, downstream of Hipwell Road offtake	Raise the water level in Gunbower Creek by approximately 60 cm so that 1,650 ML/d can be diverted.
Fishway on new weir	Enable fish passage across the new weir on Gunbower Creek.
Levee banks on Gunbower Creek upstream of new weir	Contain high flows within Gunbower Creek and avoid unintended flooding of private land.
Hipwell Road Channel	Increase capacity of existing channel to provide inflow of 1,650 ML/d. Connect Gunbower Creek to Spur Creek (within the forest) so that environmental water can be delivered into the forest.
Regulator on Hipwell Road Channel	Allow water entry to the Hipwell Road Channel to be controlled — if the regulator is open, environmental water can be delivered into the channel; if the regulator is closed, the channel will remain dry.
Fishway on Hipwell Road Channel Regulator	Enable fish passage across the regulator on the Hipwell Road Channel, so that fish can move from Gunbower Forest back into Gunbower Creek when floods subside.

Additional works to complement the Hipwell Road Channel include erosion control works where the water enters and exits the forest, establishing alternate supply points for irrigators affected by the works and mitigating potential flood risks for private landholders in the vicinity of the Spur Creek outfall.

Operating regimes for environmental watering actions

This section of the environmental water management plan provides a broad description of the proposed operating regimes to maximise ecological outcomes from the use of The Living Murray Water portfolio and works. To meet the proposed operating regimes a combination of unregulated and regulated environmental water may be used. While this environmental water management plan focuses on the use of environmental water from The Living Murray's Water Portfolio, there may also be other sources of environmental water available to meet the proposed regimes.

Water management infrastructure in Gunbower Forest will be operated to provide the water regime required to achieve ecological objectives for the icon site. The broad operating strategy to achieve these objectives is summarised below (see **Table 4.4**).

A detailed operating strategy will be prepared by June 2011 and attached as Schedule 2 of this environmental watering management plan when complete. This detailed strategy will describe how the Gunbower Forest suite of works will be operated to achieve the targets set for the site.

Managed floods will aim to provide a dynamic water regime that varies in depth, duration, frequency and season. Therefore, actual operation will vary between events, depending upon water management areas being targeted. The desired variation in the watering regime may be achieved by:

- using different regulators in different events to vary the part of the forest inundated
- varying the inflow rate delivered through the hipwell road channel
- varying the timing and duration of inflows
- providing inflows on more than one occasion during a particular event to mimic the rise and fall of natural inflows to these areas.

The feasibility of delivering water through Gunbower Creek during the irrigation season has been assessed (Sinclair Knight Merz 2009), with the finding that current water demand at Gunbower Forest can be met in most years. Opportunities to acquire delivery shares to provide greater security of accessing capacity in the irrigation season are being investigated to minimise the risk of a failed bird breeding event as a result of interruption to supply.

Meeting objectives for wetlands

The operating strategy for wetlands aims to replicate the pre-regulation cycle of wetting and drying. More frequent drying phases may be adopted if required to manage carp and aquatic weed invasion (see 'Evaluation and management of potential risks' below for information on risks).

The lower landscape works regulators release water directly to these wetlands and will be used to top up wetlands following a river red gum watering event or to re-wet them following a drying regime. The wetlands may be fully or partially filled, depending upon the objectives for each season.

The ecological benefit is expected to be greatest when flow is delivered in late winter or in spring, allowing a drying phase to occur over summer and autumn, as would have occurred under natural conditions.

Once the wetland reaches the maximum inundation extent, the regulators will usually be closed to retain water and extend the duration of inundation.

During wetland watering, the regulators located on effluents that drain to the River Murray (Shillinglaws and Barham Cut) will typically be closed. This will allow the duration targets to be achieved without the need for an extended (five- to eight-month) inflow period.



Figure 4.4: Reedy Lagoon after receiving environmental flows, 2006 (Photo by Kathryn Stanislawski, North Central CMA)

Meeting objectives for river red gum communities

Managed floods delivered to the river red gum forest areas aim to increase the frequency and duration of natural flooding to meet the specific water requirements of these communities. The Hipwell Road Channel will be the mechanism for watering red gums and will be operated to mimic a variable flooding regime.

A key driver in the operating strategy for the river red gum communities is the ability to access capacity in the irrigation system to deliver environmental water to the site. The maximum inflow rate through the Hipwell Road Channel (1,650 ML/d) is also the maximum capacity of Gunbower Creek. Therefore, the Hipwell Road Channel can only be run at peak flows when there is no irrigation demand on the creek.

The operating strategy aims to maximise the inundation extent in the river red gum forest by running the Hipwell Road Channel at peak flow outside the irrigation season (i.e. between 15 May to 15 August). Some opportunistic delivery may also occur during spring periods.

The draft operating strategy aims to maintain flooding within the forest for at least 60 days.

Meeting objectives for waterbirds

The water requirements of waterbirds are variable because different species have different requirements and each event varies. This variability will be described in the detailed operating strategy.

The strategy incorporates a filling, holding, drawdown and minimum inflow phase (see **Figure 4.5**). This strategy will ensure flooded conditions into the warmer months, allowing fish populations to increase, providing food for the later-breeding piscivorous waterbird species.

The filling phase builds flow gradually up to the target inflow; typically this will be combined with river red gum forest watering and will build to peak inflow of 1.65 GL/d in winter. The holding phase will maintain the peak inflow, maximise the potential future food resources and provide cues to encourage breeding behaviour. The drawdown phase seeks to create a slow recession in water levels, avoiding birds abandoning nests because of a perceived lack of water. The minimum inflow phase aims to maintain water in colonial breeding sites as well as food resources.

Enhancement of natural high flows

Inflows through Hipwell Road Channel will be used to enhance natural high flows that enter Gunbower Forest from the River Murray (known as 'hybrid events'). All opportunities to use natural high flows will be sought, because it is likely they will result in a greater environmental benefit compared to fully managed flood events.



Figure 4.5: Conceptual diagram of the waterbird breeding operating scenario



Figure 4.6: Royal spoonbill (*Platalea regia*) wading for food in Reedy Lagoon (Photo by David Kleinert)

Benefits of using natural high flows include:

- Barham Cut and Shillinglaws regulators can be opened to capture unregulated flow events without drawing on environmental water allocations
- opportunities to extend the duration of flood events greater in magnitude than can be replicated through Hipwell Road Channel (i.e. >38 GL/day)
- provision of climatic cues for waterbirds increasing the likelihood of a successful breeding event
- greater floodplain inundation surrounding Gunbower Forest creating a greater food resource for waterbirds
- provision of flow cues for native fish to move onto the floodplain
- lower environmental water use
- greater connectivity between the forest and River Murray, which is a source of carbon, seed propagules and native fish.

Options for enhancing natural flow events will be described in the operating strategy, which will be developed and attached as a schedule to this environmental water management plan.

Table 4.4: Operating regimes contribution to the ecological objectives

First step decision objective	Vegetation community area inundated (ha)	Works or other mechanisms to assist meeting objectives	Frequency (years in 10)	Duration (months)	Water availability scenario	Estimated volume required (GL)	Estimated volume used (GL)
Preferred operating scenario[^]							
80% of permanent and semipermanent wetlands in healthy condition	210 ha permanent wetlands	Water delivered to fill and top up wetlands from Gunbower Creek via: <ul style="list-style-type: none"> • Little Gunbower Regulator • Black Swamp Regulator • Reedy Lagoon Regulator. 	9–10	9–12 [Note: water delivery is not constant.]	All	5.0	5.0
	823 ha semipermanent wetlands	Water delivered to fill and top up wetlands from Gunbower Creek via: <ul style="list-style-type: none"> • Little Gunbower Regulator • Yarran Regulator. 	7	5–8 [Water delivery ongoing if through flow** maintained.]	All	90**	25
30% of river red gum forest in healthy condition	3646 ha river red gum flood-dependent understorey* and river red gum flood-tolerant understorey	Water delivered from Gunbower Creek via Hipwell Road Channel (peak inflow = 1,650 ML/day).	6	4 [Delivered at peak for 2 months.]	Median-wet	110	34
Successful breeding of thousands of colonial waterbirds at least 3 years in 10	4710 ha river red gum flood-dependent understorey*, river red gum flood-tolerant understorey, black box woodland, and permanent and semipermanent wetlands	Water delivered from Gunbower Creek via Hipwell Road Channel (peak inflow = 1,650 ML/day, then maintained at ~300 ML/day).	3	4–10 [Delivered at peak for 2 months then maintained during breeding event.]	Median-wet	210	56
Healthy populations of resident native fish in wetlands	1,300 ha permanent and semipermanent wetlands	As above for wetland objectives. Shillinglaws and Barham Cut regulators used to fill wetlands if Murray flows >14,000 ML/d; also for releases to allow fish to return to the river.					
Minimum operating scenario^{^^}							
80% of permanent and semipermanent wetlands in healthy condition	80 ha permanent wetlands	Water delivered to fill and top up wetlands from Gunbower Creek via: <ul style="list-style-type: none"> • Little Gunbower Regulator • Black Swamp Regulator • Reedy Lagoon Regulator. 	9–10	9–12 [Note: water delivery is not constant.]	All	1.2	1.2
	500 ha semipermanent wetlands	Water delivered to fill and top up wetlands from Gunbower Creek via: <ul style="list-style-type: none"> • Little Gunbower Regulator • Yarran Regulator. 	7	5–8 [Note: water delivery is not constant.]	All	5–10	5–10
30% of river red gum forest in healthy condition	3051 ha river red gum flood-dependent understorey* and River red gum flood-tolerant understorey	Water delivered from Gunbower Creek via Hipwell Road Channel (peak inflow = 920 ML/d).	6	4 [Delivered at peak for 2 months.]	Median-wet	55	30
Successful breeding of thousands of colonial waterbirds at least 3 years in 10+	4,082 ha river red gum flood-dependent understorey*, river red gum flood-tolerant understorey, permanent and semipermanent wetlands	Water delivered from Gunbower Creek via Hipwell Road Channel (peak inflow = 900 ML/day, then maintained at ~300 ML/day).	3	4–10 [Delivered at peak for 2 months then maintained during breeding event.]	Median-wet	135	50
Healthy populations of resident native fish in wetlands	1000 ha permanent and semipermanent wetlands	See above for wetland objectives. Shillinglaws and Barham Cut regulators used to fill wetlands if Murray flows >14,000 ML/d; also for releases to allow fish to return to the river.					

[^] Preferred operating scenario aims to meet requirements of vegetation communities and associated biota (optimal frequency and duration) over the greatest area possible with works.

^{^^} Minimum operating scenario aims to meet requirements of vegetation communities and associated biota over a smaller area, but maintains optimal frequency and duration. No flow through is provided for wetland watering.

* River red gum flood-dependent understorey.

** Assumes flow through to minimize water quality issues, particularly in light of recent blackwater events throughout the Murray system. If no flow-through, volume required = 30 GL.

• Still aiming for breeding events in the thousands, however, note that peak inflow has been reduced, which will decrease the area of river red gum flood-dependent understorey that is flooded. This will reduce available food resources within the forest and may reduce the size of breeding events.

Source: Adapted from Water Technology 2010, as presented in the Hipwell Road Channel investment proposal. Note: figures are estimates only and are subject to change for individual watering events and seasons.

Water accounting and measurement

Water accounting methodology will be developed and agreed in advance by The Living Murray (TLM) Committee and the Basin Officials Committee. Consistency of water accounting methodology will be sought wherever possible. Where relevant, water accounting will be consistent with the Water Accounting Conceptual Framework and Australian Water Accounting Standards.

The best available, most appropriate and cost-effective measurement technique will be used to determine environmental water use. The appropriateness of the measurement technique is likely to differ depending on icon site and event. For example, under dry conditions, environmental water pumped into Hattah Lakes is likely to be measured using a meter while return flows are measured via a gauging station; under wet conditions, environmental water returning from Barmah-Millewa Forest will need to be modelled.

Although **Table 4.5** shows that large volumes are required to water river red gums and support colonial waterbird breeding events, the actual volumes used are relatively small. Around 70% of total inflows are returned to the River Murray during these events.

Evaluation and management of potential risks

To maximise project outcomes, it is essential to identify any risks so that mitigation actions can be adopted.

Table 4.6 provides a preliminary summary of the risks and mitigation strategies common to both natural and managed flood events. A detailed risk assessment will be completed by June 2011 and incorporated as schedule 3 into this plan.

Table 4.5: Water use of different operational scenarios

Scenario	Inflow (GL)	Outflow (GL)	Evapotranspiration (GL)	Soil seepage (GL)	Floodplain storage (GL)	Net water consumption per event (GL)
Wetland watering	29.4	7.2	9.4	12.5	0.5	22.3
River red gum watering (1.65 GL/d)	110.6	76.9	15.7	17.2	0.8	33.7
Bird breeding (1.65 GL/d)	209.9	154.2	28.7	21.7	5.3	55.7

Source: Water Technology 2009

Table 4.6: Summary of risks and mitigating actions

Topic	Risk	Rating	Mitigating actions	Risk rating with mitigating action
Flora	River red gum encroachment into wetlands.	High	Physical removal of red gum saplings.	Moderate
	Giant rush colonisation.	Low	Monitoring, water regime management and burning (if required).	Very low
	Introduction of aquatic and floodplain weeds.	Very high	Monitoring, water regime management and glyphosphate application (if required)	High
Waterbirds	Bird breeding events of the desired size fail to occur or are interrupted.	High	Monitoring and water regime management. Acquisition of delivery shares.	Moderate
Native fish	Low fish migration from Gunbower Forest back to Gunbower Creek and River Murray.	High	Management of flow recession, monitoring and review operations plan.	Moderate
	Reduced migration and spawning downstream of Torrumbarry Weir	Moderate	Monitoring and flow management downstream of Torrumbarry Weir. Peak diversions during winter months.	Low
	Promotion of non-native species	Very high	Optimising flood conditions for native fish.	Very high
Water quality	Blackwater and blue-green (cyanobacteria) algae.	Moderate	Monitoring and water regime management. Avoid large volumes of return flow during warmer months.	Low
	Salinity	Low	Regular groundwater monitoring and water regime management.	Very low
Social values	Short term access restrictions, negative perceptions about environmental watering	Moderate	Active communication with relevant groups.	—
Cultural heritage	Damage to cultural heritage sites	Low	Active communication with relevant groups. Monitoring condition of known sites within flooded areas.	Very low

5. Environmental monitoring

Different monitoring methods are used to assess progress toward the icon site ecological objectives. These include River Murray system-scale, icon site condition and intervention monitoring. The Living Murray(TLM) Outcomes Evaluation Framework (Murray–Darling Basin Commission 2007) outlines the rationale for these monitoring methods, which are summarised below.

River Murray system-scale monitoring

Conducted annually, River Murray system-scale monitoring and evaluation focuses on the system’s ecological health, measuring improvements relating to fish, waterbirds and vegetation.

Icon site condition monitoring

Condition monitoring assesses each icon site’s condition in relation to its ecological objectives. Condition monitoring is typically conducted on a medium-frequency basis (months to years), depending on the rate of change. Condition monitoring includes standard methodologies for monitoring fish, birds and vegetation, as well as icon site-specific methods for monitoring other ecological objectives (see **Schedule 1**). These monitoring activities have been classified into three categories — A, B and O:

- ‘A’ category monitoring activities are undertaken at all icon sites using agreed standardised methodologies:
 - fish condition monitoring using the Murray–Darling Basin Authority (MDBA) Sustainable Rivers Audit methodology
 - waterbird condition monitoring using a standard on-ground method to link with the annual aerial waterbird survey
 - tree condition monitoring for river red gum and black box using on-ground assessments linked to remote-sensing data.

- ‘B’ category contains icon site-specific monitoring using locally appropriate methods. This monitoring responds to unique icon site characteristics and is less easily standardised.
- ‘O’ category uses icon site monitoring related to objectives and is less easily linked to TLM ecological objectives.

Table 5.1 details how condition monitoring is used to assess progress towards achieving ecological objectives. More detail is provided in Schedule 1.

Table 5.1: Description of how condition monitoring will measure progress towards targets

Target	Monitoring methods	Measurement toward target
80% of permanent, semipermanent and temporary wetlands in healthy condition as demonstrated by a sustainable intact floristic assemblage by 2025.	Wetland vegetation surveys 15 wetland transects are located within permanent and semipermanent wetlands across the forest.	<ul style="list-style-type: none"> • Health at each site is determined by an assessment of factors including major impacts. • Each site is given a rating of very poor to excellent. • Survey sites are considered to represent the health across the whole of that vegetation community (i.e. all permanent wetlands). • Ecological indicator species are used to highlight ecological change in the ecosystems.
30% of river red gum forest in healthy condition by 2025 as demonstrated by a sustainable intact floristic assemblage and tree canopy extent and density greater than 60%.	Understorey vegetation surveys 110 understorey quadrats are located across range of vegetation types and landscape positions.	<ul style="list-style-type: none"> • Health at each site is determined by an assessment of factors including major impacts. • Each site is given a rating of very poor to excellent. • Survey sites are considered to represent the health across the whole of that vegetation community. • Ecological indicator species are used to highlight ecological change in the ecosystems.
	Stand condition monitoring On-ground surveys at 25 sites range of vegetation types and landscape positions to validate remotely sensed data imagery.	<ul style="list-style-type: none"> • Health of overstorey vegetation for a range of attributes (e.g. live basal area, crown extent, plant area index) • Each site given a rating of severely degraded to good condition.
	Tree condition monitoring On-ground surveys at 15 sites across a range of vegetation types and landscape positions.	<ul style="list-style-type: none"> • Health of overstorey vegetation condition is assessed using the attributes crown extent and crown density. • A range of condition indicators (e.g. new tip growth, bark-cracking) are also assessed).
Successful breeding of thousands of colonial waterbirds at least 3 years in 10 by 2030	Quarterly bird monitoring surveys Quarterly surveys at 11 'bush sites' and 10 'waterbird sites' for 3 consecutive years to establish baseline condition. Then quarterly on a biannual once baseline established.	<ul style="list-style-type: none"> • Uses census methodology for bush birds and wetland perimeter transects for waterbirds to count all birds observed or heard. • If evidence of breeding was observed in wetlands, nests, eggs and chicks are also recorded.
	Colonial and other waterbird monitoring surveys Undertaken during managed or natural floods to inform management and assess the contribution to the population of waterbirds.	<ul style="list-style-type: none"> • Wetland perimeter transects to count all birds observed or heard and record evidence of nests, eggs and chicks.
A 10% population increase in native fish species currently known to be present by 2025. Presence of 2 native fish species currently considered as locally extinct by 2025.	Annual fish monitoring surveys Sustainable Rivers Audit surveys at 21 sites across a range of habitat types, conducted annually in autumn to capture evidence of recruitment following spawning in spring.	<ul style="list-style-type: none"> • Health of population assessed based on species presence, abundance, age/size classes, recruitment.



Figure 5.1: Freshwater catfish (*Tandanus tandanus*) detected during fish surveys on Gunbower Creek (Photo by Anna Chatfield, North Central CMA)

Intervention monitoring

The complexity of ecological system processes makes the results of any management intervention difficult to predict. Therefore, intervention monitoring is a key component of The Living Murray environmental monitoring program. The aim of intervention monitoring is to improve understanding about the causal links between TLM environmental watering and other management actions, and ecological responses at icon sites. This knowledge enables TLM to continually adapt and improve management of icon sites and watering into the future to optimise ecological outcomes.

As TLM works are completed, measuring the volume of water used at icon sites (including timing, volume and quality of any return flows) is essential to account for and report on how TLM environmental water is used and managed. This area of monitoring was previously included in the compliance monitoring category of the Outcomes and Evaluation Framework, but is now encompassed within intervention monitoring. This change is to ensure clear linkages

between the various information requirements for managing successful watering events and informing the operation of works at icon sites. This includes systems for water measurement and accounting and monitoring risks (previously defined in compliance monitoring), and assessing ecological outcomes resulting from specific watering events or other management actions.

Operational monitoring during managed and natural flood events will also be important for real-time management. For example, waterbird monitoring will inform management of water levels under breeding colonies to support breeding events.

Flood mapping using on-ground survey, gauge-board readings (see **Figure 5.2**) and satellite imagery will assist in calibration of hydraulic models and quantification of the area flooded. This data will also enable comparison of ecological response between flooded and non-flooded areas of the forest.

Over time, it is anticipated that the need for such monitoring will decrease as knowledge gaps are filled and ecological questions answered.



Figure 5.2: Gauge-board monitoring water depths during 2008 environmental flow release (Photo by Melanie Tranter, North Central CMA)

Groundwater monitoring

Groundwater monitoring is carried out within Gunbower Forest to monitor changes in groundwater depth and salinity in response to environmental watering or natural floods.

The Gunbower Forest groundwater observation bore network includes 60 bores that were installed between 1978 and 1992 and are part of the State Groundwater Observation Network. These bores are monitored monthly and there are continuous records from 2005 to the present.

Analysis of the data collected from the bore network has provided critical information about the potential risks associated with proposed water management options on groundwater and salinity to inform the development of environmental watering options under TLM. Ongoing collection of groundwater data will remain integral to managing associated groundwater and salinity risks, particularly following the implementation of managed floods as described in the risk strategy for Gunbower Forest (see **Schedule 3**).

6. Community consultation and communication

Communication Plan

A community engagement and communication strategy was prepared in 2005 and was effective over the ensuing five years in engaging stakeholders in the Flooding Enhancement of Gunbower Forest project.

In 2009, the strategy was revised to develop a plan aimed at specifically communicating the Flooding Enhancement of Gunbower Forest project during the concept and detailed design phases (Schedule 4). The plan was developed in consultation with the Victorian Department of Sustainability and Environment, Goulburn–Murray Water, the Icon Site Community Reference Group, Icon Site Management Committee and the Gunbower–Koondrook–Perricoota Icon Site Integrated Coordinating Committee.

The Communication Plan identifies priority stakeholders and a set of targeted communication tools and actions. Importantly, the plan seeks to minimise perceived community concern and risk, while maximising understanding and ownership of the project.

The plan will be updated during the detailed design and construction phase according to specific communication needs.

Community engagement

The local community has been engaged through established groups such as the Icon Site Community Reference Group, North Central Catchment Management Authority Board, North Central Catchment Management Authority Natural Resource Management Committee, Cohuna Progress Association, Gunbower District Planning Group and local government. Field trips and presentations have been used to connect with these groups and to distribute information about the Gunbower Forest project.

Broader community engagement has occurred through newspaper articles, fact sheets, radio interviews and website updates. Three DVDs have been developed to describe the Flood Enhancement Works project, provide details about construction activities and to capture stories of people's connection to the forest.

Despite the recent drought and low irrigation allocations, the local and wider community has been generally supportive of emergency environmental watering events and construction activities at Gunbower Forest to date. It is understood that community opinion may shift and that a proactive communication and consultation program will be imperative for project success.



Figure 6.1: Community field day in Gunbower Forest

7. Indigenous engagement

Indigenous people have many social, cultural, customary and economic interests in the water resources of the River Murray.

The Living Murray (TLM) aims to maximise ecological outcomes through the delivery of environmental water and therefore cannot provide for the commercial economic interests of any of its stakeholders. However, TLM is committed to taking into account Indigenous values and objectives in its environmental water planning and management. As Indigenous communities identify objectives and strategies for achieving these Indigenous objectives they will be incorporated into Environmental Water Management Plans in the future. Indigenous consultation will be reported on in the Annual TLM Environmental Watering Report and Annual TLM Implementation Report.

Indigenous engagement is a key component of The Living Murray program at Gunbower Forest. Indigenous communities with an interest in the Gunbower Forest have been identified and recognised as the Barapa Barapa and the Yorta Yorta nations.

The peoples of these Traditional Owner groups have formed corporate structures and operate under individual pieces of legislation to protect their interests. The corporate structures and relevant legislation are:

- Yorta Yorta Aboriginal Corporation under the *Cultural Heritage Act 2006* (Vic.) where they are the Registered Aboriginal Party
- Barapa Barapa, Wadi Wadi and Wamba Wamba native title claimants under the *Native Title Act 1998* (Cwth).

Barapa Barapa native title claimants preside over the lower part of the forest, including the Dry Swamp Track Bridge. The Yorta Yorta Registered Aboriginal Party presides over the middle and upper components of the forest, including works at Hipwell Road and along Gunbower Creek. The areas of Gunbower Forest covered by the native title claim and the Registered Aboriginal Party boundary are shown in **Figure 7.1** below.

Representatives from the Yorta Yorta and Barapa Barapa peoples are members of the Icon Site Management Committee. Local Indigenous groups have attended field trips and meetings to learn about the Flooding Enhancement of Gunbower Forest

project and to share their own cultural understanding of Gunbower Forest with project staff.

Under the Aboriginal Heritage Act (Vic.), cultural heritage management plans are developed for all TLM construction works in Gunbower Forest. The Yorta Yorta and Barapa Barapa groups have expressed their preference to be consulted separately on their relevant areas and on the preparation of separate cultural heritage management plans. Representatives of the Yorta Yorta nation participated in surveying for cultural heritage material within the vicinity of Hipwell Road, while Barapa Barapa representatives assisted with similar surveys in the vicinity of the forest outfall.

The process required to develop cultural heritage management plans will be used as the key vehicle for ongoing engagement with the Traditional Owner groups of Gunbower Forest. With assistance from The Living Murray Indigenous Facilitator, written and face-to-face briefings and information days, telephone conversations and site tours will continue to be used to maintain open communication channels with Indigenous stakeholder groups.

Agreements

A memorandum of understanding between Murray Lower Darling Rivers Indigenous Nations and the Murray–Darling Basin Commission (now the Murray–Darling Basin Authority) was signed in March 2006. The memorandum of understanding provides for engagement with Traditional Owners at a strategic level along the length of the River Murray and across state boundaries, while being inclusive of formal jurisdictional arrangements.

In addition to the memorandum of understanding, input is also sought from Indigenous communities through the establishment of local Indigenous reference groups. Consultation takes an inclusive approach to ensure community knowledge, values and perspectives are considered.

The Protocols, Principles And Strategies Agreement for Indigenous Involvement in Land and Water Management between North Central Catchment Management Authority, North West Nations Clans Aboriginal Corporation and Yorta Yorta Nation Aboriginal Corporation was established in 2002. This agreement aims to provide a realistic framework and

transparent process for dialogue and meaningful involvement and engagement in natural resource management in the North Central Catchment Management Authority region.

The Yorta Yorta Co-operative Management Agreement between the Yorta Yorta Nation Aboriginal Corporation and the State of Victoria provides another mechanism for including the Yorta Yorta nation in

the management of major public lands within their traditional country. This includes Kow Swamp and specific parcels of public lands and waters along the River Murray. The agreement establishes an eight-member committee known as the Yorta Yorta Joint Body, which provides advice to the Victorian Minister for Environment on the management of designated Crown land and waters.

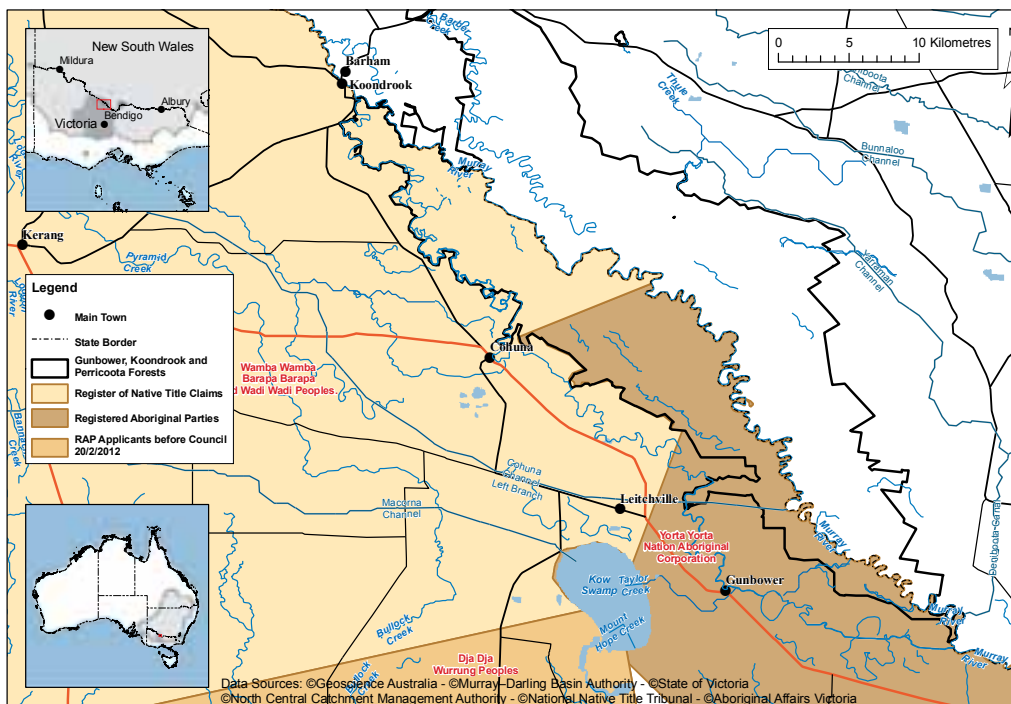


Figure 7.1: Map of traditional owner boundaries in Gunbower Forest

8. Adaptive management and reporting

An adaptive approach is critical in managing water-dependent ecosystems because it enables land managers and policy-makers to update strategies based on the outcomes of research and watering actions. This is known as 'learning by doing' and involves designing, implementing, monitoring, reporting and evaluating our work.

Environmental water management plans are constantly refined by adaptive management, which incorporates outcomes from environmental delivery, ecological monitoring, works, modelling and community consultation.

The Living Murray (TLM) Annual Environmental Watering Plan is developed at the beginning of each watering season and complements the environmental water management plan. As the season progresses, the annual water planning process responds to water availability, opportunities and environmental priorities. A flexible decision-making framework is included in the annual plan so the Environmental Watering Group can assess water priorities throughout the year according to water resource condition.

To highlight and analyse previous activities and outcomes, the Murray–Darling Basin Authority (MDBA) works with icon site managers to produce an annual TLM implementation report (as required under clause 199 of The Living Murray Business Plan), which is used by the Independent Audit Group. An annual external audit is conducted to ensure TLM is implemented at an appropriate level of transparency and accountability, and to promote public confidence in the program's efforts and outcomes. The implementation report and external audit are presented to the Murray–Darling Basin Ministerial Council.

To capture key learning and changing icon site management practices, schedules appended to the environmental watering management plan are updated as required.

The adaptive management approach to environmental watering at Gunbower Forest is shown in **Figure 8.1** and described below.

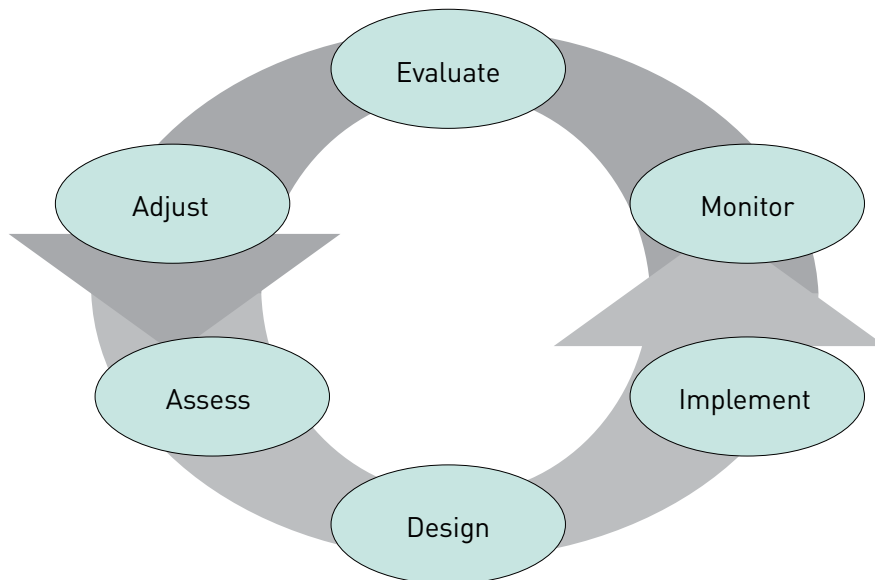


Figure 8.1: Adaptive management cycle

Assess

The ecological issues, objectives, water requirement, priority areas and actions, and associated risks for restoring the floodplain are assessed. This stage requires community and expert input.

Design

Knowledge on floodplain condition and ecology are used to develop hypotheses in terms of expected responses and set objectives and targets. Interventions are designed, including the proposed package of works and operating rules.

Implementation

The recommended interventions are implemented.

Monitoring

The monitoring program will be co-ordinated by the North Central Catchment Management Authority in conjunction with land managers. The different types of monitoring are discussed in Section 5.

Evaluation

The monitoring results will be evaluated in light of the expected outcomes – ecological response. Triggers will be identified to inform if/how management needs to adjust (e.g. the size of flood event adopted depending on water availability). Both short-term and long-term triggers will be used. Short-term triggers include water movement into or out of structures, and whether specific biota (flora and fauna) begin to appear, and longer-term triggers will include more detailed targets for ecological response.

Adjust

The Icon Site Management Committee will consider the monitoring outcomes (and any new knowledge on the issues) to determine whether changes are required to the operating strategy and to re-define the expected outcomes from the operation (i.e. the objectives).

Assess

Proposed changes will be assessed by the Icon Site Management Committee to consider if such changes still meet their expectations. Additional information provided through this step will be reviewed and considered.

Design

The program then moves back to the design stage where agreed changes are converted into changes to structural, operation or procedural plans.

Reporting

Improvements to actions and practices at the icon site (identified through the adaptive management process) will be reported to stakeholders through the existing governance arrangements described in Section 1. This environmental water management plan will be reviewed periodically to capture the key lessons and changes in icon site management practices.

The outcomes achieved against the environmental water management plans will provide evidence of the progress of The Living Murray Initiative. This information will be incorporated into the annual TLM implementation report and presented to the Murray-Darling Basin Ministerial Council. This meets the obligation to report on annual TLM progress under clause 199 of The Living Murray Business Plan.



Figure 8.2: Monitoring dissolved oxygen levels in Gunbower Creek (Photo by Melanie Tranter, North Central CMA)

Appendix A: Victorian icon site governance arrangements

In Victoria, The Living Murray program is delivered by the Department of Sustainability and Environment, which provides high-level policy input and coordinates the delivery of TLM across all Victorian icon sites.

With the exception of the Hattah Lakes, all TLM icon sites in Victoria are multi-jurisdictional. Interstate coordination for these cross-border sites occurs through the integrated coordinating committees and icon site management committees.

The chief executive officers of the Mallee, North Central and Goulburn–Broken catchment management authorities act as regional icon site coordinators for relevant icon sites. Icon site coordinators are responsible for delivering TLM at each icon site. Accordingly, the Department for Sustainability and Environment has entered into a memorandum of understanding with the Mallee, North Central and Goulburn–Broken catchment management authorities that:

- establishes a collaborative working relationship between the organisations
- sets out a common understanding of intent
- commits the organisations to sub-jurisdictional arrangements for delivery of The Living Murray Business Plan.

State water authorities (Goulburn–Murray Water and SA Water) are Murray–Darling Basin Authority-delegated constructing authorities for the icon sites. As such, they are responsible for detailed design and construction under the environmental water management plan once investment proposals have been approved by the MDBA.

Victoria has set up a TLM steering committee to oversee delivery of TLM in that state (see Figure A1). This high-level committee, which is chaired by the Department of Sustainability and Environment, comprises representatives from key agencies responsible for implementing TLM. Goulburn–Murray Water has also convened a state construction committee to oversee the detailed design and construction phases.

Specific icon site arrangements and committees for Gunbower Forest are set out below.

Relevant agencies

A range of organisations are involved in the management of Gunbower Forest, and each of these is represented on one or more of the committees or groups described below. The broad roles and responsibilities of relevant agencies are:

- Murray–Darling Basin Authority — coordinates TLM; River Management Division of MDBA will own all infrastructure constructed under TLM.
- Department of Sustainability and Environment — is responsible for implementing TLM in Victoria. The department is the project owner and site owner of all public land (including Gunbower State Forest); it also manages approval and referral processes and interaction with statutory planning processes.
- North Central Catchment Management Authority — the authority's chief executive officer is the icon site coordinator; the authority is the strategic regional planner for natural resource management.
- Goulburn–Murray Water — Victorian constructing authority for TLM; the authority operates and maintains works constructed under TLM on behalf of the MDBA.
- Parks Victoria — land manager for Gunbower National Park.

Gunbower Forest Icon Site Management Committee

The Gunbower Icon Site Management Committee comprises representatives from the Murray–Darling Basin Authority, North Central Catchment Management Authority, Goulburn–Murray Water, Department of Sustainability and Environment, Parks Victoria, the Northern Victoria Irrigation Renewal Project, Gannawarra Shire Council and Traditional Owner groups.

The committee is responsible for:

- overseeing implementation of Victoria's TLM obligations at the Gunbower Forest icon site
- providing a forum for the cooperative delivery of TLM at Gunbower Forest
- advising the icon site coordinator (the Chief Executive Officer of the North Central Catchment Management Authority) on Gunbower Forest TLM matters
- facilitating and monitoring progress of TLM delivery.

Committee members facilitate TLM implementation through their respective agencies by:

- generating support for the Flooding Enhancement of Gunbower Forest project within their own agencies and assisting to resolve issues relevant to their agency
- ensuring agency TLM commitments are fulfilled
- attending meetings with the Icon Site Management Committee and Icon Site Coordinator as required
- disseminating information on long-term obligations and annual deliverables to relevant agency officers, including engaging staff more broadly within their organisations
- providing advice to the Icon Site Coordinator on implementation, policy or legislative issues, as relevant to their respective agencies, which may affect program delivery
- providing advice regarding the progress of TLM implementation, as required
- nominating appropriate representatives from their agencies to participate on working groups as requested
- [ensuring that] their nominated working group representative participates in The Living Murray implementation in an active and timely way, and undertakes broader engagement within their organisation, including providing updates to the relevant committee member.

Icon Site Construction Committee

The Icon Site Construction Committee consists of representatives from the North Central Catchment Management Authority, Goulburn–Murray Water, River Management Division (formally River Murray Water), Department of Sustainability and Environment and the Murray–Darling Basin Authority.

The committee's objective is to:

- oversee the development of detailed designs and construction of works funded under TLM at Gunbower Forest, ensuring works are consistent with the approved investment and construction proposals and addressing any issues identified in the assessment of these documents
- foster expertise-sharing to ensure that environmental works are designed, constructed, operated and commissioned efficiently and effectively to deliver the agreed environmental functionality.

The committee is specifically required to:

- provide technical oversight
- identify and address all land management issues associated with works
- review project costs and timelines regularly
- review risks and mitigating measures
- seek endorsement from the State Construction Committee for any project changes.

While the committee sits under the State Construction Committee, it also reports to the Icon Site Management Committee.

Icon Site Technical Advisory Committee

A technical advisory committee has been established and is used on an as-needs basis. It comprises representatives from Goulburn–Murray Water, the Department of Sustainability and Environment (State Forests), Murray–Darling Basin Authority and the North Central Catchment Management Authority.

Committee membership is likely to expand during the environmental delivery program to incorporate ecological experts. This will support the committee's function as a technical panel during the implementation phase of the project and will promote the adaptive management philosophy.

Each icon site prioritises its own seasonal water requirements. These requirements are then reviewed by the Environmental Watering Group (made up of jurisdiction representatives and MDBA staff), which prioritises shared environmental water between the icon sites. These annual priorities are documented each year in The Living Murray Annual Environmental Watering Plan.

Icon Site Community Reference Group

The Gunbower–Koondrook–Perricoota Community Reference Group was established in 2006 as a requirement of The Living Murray Business Plan.

The community reference group provides a platform to seek advice and a community perspective on communication and engagement at the icon site. This function will continue throughout the implementation of TLM projects. Community reference group membership comprises six local community representatives and the Chair of the North Central Catchment Management Authority Board. The community reference group reports to the Icon Site Management Committee.

- Department of Sustainability, Environment, Water, Population and Communities (Cwlth)
- Murray–Darling Basin Authority (MDBA).

The MDBA identifies important areas where integration is required (e.g. water-sharing, opening/shutting structures, implementation of monitoring) and will ensure that this integration occurs. The committee identifies efficiencies; ensures cross-communication, consistency and information sharing; and determines priorities across the entire forest system.

Joint management arrangements

The Flooding Enhancement of Gunbower Forest project is currently coordinated with the Koondrook–Perricoota project (which is managed by New South Wales) through the Integrated Coordinating Committee, which has representatives from the separate state steering committees, including:

For ongoing management, delivery of TLM environmental water will be a collaborative effort. It is intended that process and governance arrangements will be established for the operation phase of the program to support communication between the organisations currently involved (discussed in chapter 8 of this report) and others where appropriate.

- North Central Catchment Management Authority
- Murray Catchment Management Authority
- Department of Sustainability and Environment (State Forests)
- Forests New South Wales
- Goulburn–Murray Water

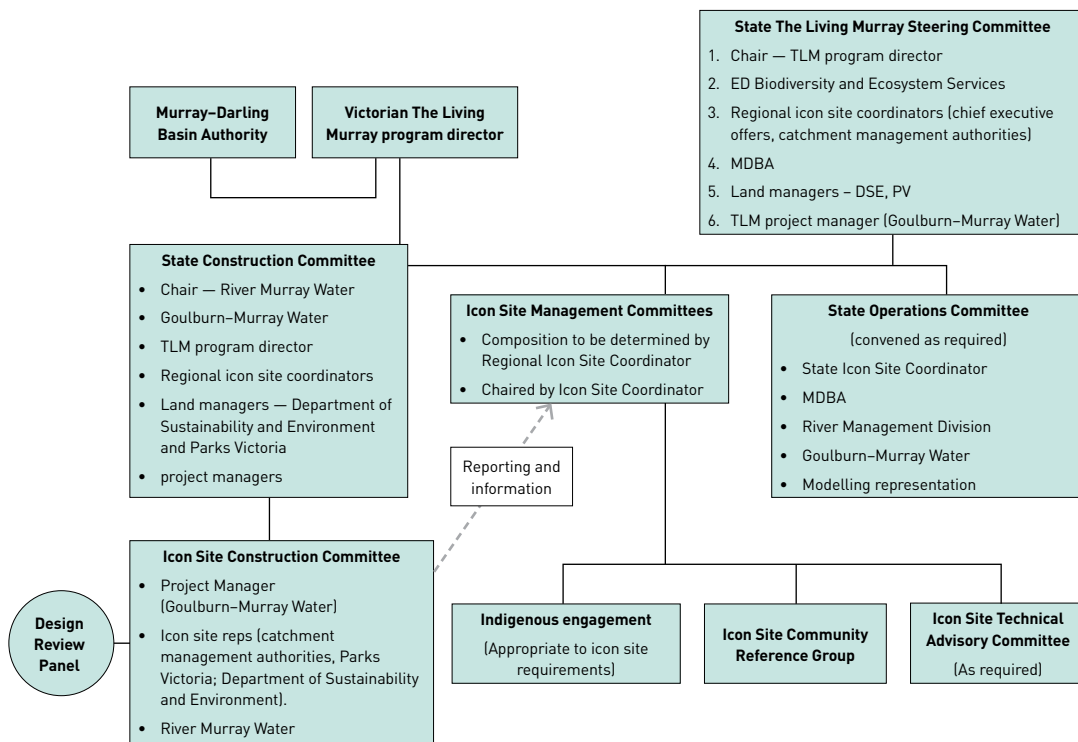


Figure A1: The Living Murray program management arrangements in Victoria

Appendix B: Threatened flora list

Common name	Scientific name	Flora and Fauna Guarantee Act 1986	Status in Victoria	Status Nationally
Buloke	<i>Allocasuarina luehmannii</i>	Listed		
Buloke mistletoe	<i>Amyema linophylla ssp. orientale</i>		Vulnerable	
Dwarf swainson-pea	<i>Swainsona phacoides</i>		Endangered	
Forde pea	<i>Poa foreana</i>		Poorly known	
Frosted goosefoot	<i>Chenopodium desertorum ssp. Desertorum</i>		Rare	
Hooked needlewood	<i>Hakea tephrosperma</i>		Vulnerable	
Long eryngium	<i>Eryngium paludosum</i>		Vulnerable	
Matted water-starwort	<i>Callitriche sonderi</i>		Vulnerable	
Native peppergrass	<i>Lepidium pseudohyssopifolium</i>		Poorly known	
River swamp wallaby grass	<i>Amphibromus fluitans</i>		Poorly known	Vulnerable
Smooth minuria	<i>Minuria integerrima</i>		Rare	
Squat picris	<i>Picris squarrosa</i>		Rare	
Three-wing bluebush	<i>Maireana triptera</i>		Rare	
Twiggy sida	<i>Sida intricata</i>		Vulnerable	
Umbrella Wattle	<i>Acacia oswaldii</i>		Vulnerable	
Western water-starwort	<i>Callitriche cylocarpa</i>		Vulnerable	Vulnerable
Winged peppergrass	<i>Lepidium monophocoides</i>	Listed	Endangered	Endangered
Woolly buttons	<i>Leiocarpa panaetiodes</i>		Rare	

Appendix C: Threatened fauna list

Common name	Scientific name	Flora and Fauna Guarantee Act 1986	Status in Victoria	Status Nationally
Mammals				
Squirrel glider	<i>Petaurus norfolcensis</i>	Listed, Action Statement prepared	Endangered	
Birds				
Apostlebird	<i>Struthidea cinerea</i>	Listed		
Azure kingfisher	<i>Alcedo azurea</i>		Lower Risk	
Barking owl	<i>Ninox connivens</i>	Listed, Action Statement prepared	Endangered	
Black-chinned honeyeater	<i>Melithreptus gularis</i>	Listed, Action Statement prepared		
Black-eared cuckoo	<i>Chrysococcyx osculans</i>		Lower Risk	
Blue-billed duck	<i>Oxyura australis</i>	Listed, Action Statement prepared	Endangered	
Brown quail	<i>Coturnix ypsilophora</i>		Lower Risk	
Brown treecreeper	<i>Climacteris picumnus</i>		Lower Risk	
Bush stone-curlew	<i>Burhinus gallarius</i>	Listed, Action Statement prepared	Endangered	
Diamond dove	<i>Geopelia cuneata</i>		Lower Risk	
Diamond firetail	<i>Stagonopleura guttata</i>	Listed	Vulnerable	
Great egret	<i>Ardea alba</i>	Listed	Vulnerable	
Grey-crowned babbler	<i>Pomatostomus temporalis</i>	Listed	Vulnerable	
Ground cuckoo-shrike	<i>Coracina maxima</i>	Listed, Action Statement prepared	Endangered	
Hardhead	<i>Aythya australis</i>		Vulnerable	
Hooded robin	<i>Melanodryas cucullata</i>	Listed	Lower Risk	
Intermediate egret	<i>Ardea intermedia</i>	Listed	Critically endangered	
Latham's snipe	<i>Gallinago hardwickii</i>		Lower Risk	
Little bittern	<i>Lxobrychus minutus</i>		Lower Risk	
Little egret	<i>Egretta garzetta</i>	Listed	Endangered	
Musk duck	<i>Biziura lobata</i>		Vulnerable	
Nankeen night heron	<i>Nycticorax caledonicus</i>		Lower Risk	
Pied cormorant	<i>Phalacrocorax varius</i>		Lower Risk	
Red-chested button-quail	<i>Turnix pyrrhоторax</i>		Vulnerable	
Royal spoonbill	<i>Platalea regia</i>		Vulnerable	
Whiskered tern	<i>Chlidonias hybridus</i>		Lower Risk	
White-bellied sea-eagle	<i>Haliaeetus leucogaster</i>	Listed, Action Statement prepared	Vulnerable	

Schedules

For copies of the following schedules visit ←www.mdba.gov.au/programs/tlm/icon_sites/emp.→

Schedule 1: Condition monitoring plan

Schedule 2: Operating strategy

Schedule 3: Risk management plan

Schedule 4: Communications plan

List of figures and tables

Figures

1.1	Location of The Living Murray icon sites	4
1.2	Scarred tree on Spur Creek protected under the Aboriginal Heritage Act	7
1.3	The Living Murray governance structure	9
2.1	Gunbower–Koondrook–Perricoota icon site	10
2.2	Map of land tenure boundaries	11
2.3	Key water management areas in Gunbower Forest	12
2.4	Murray cod, a threatened species found in Gunbower Creek	13
2.5	Remains of European activities, Gunbower Forest	14
2.6	Key social and heritage assets in Gunbower Forest	14
2.7	Kayaking in Gunbower Creek – a popular recreational activity	15
3.1	Sedges found in the river red gum forest with flood-dependent understorey	18
3.2	Schematic representation of the Landscape Logic approach	18
3.3	Key water management areas of Gunbower Forest that support waterbird breeding events	19
3.4	Box woodland near Spur Creek, a less flood-dependent vegetation community	21
4.1	Map of completed and proposed works	25
4.2	Map of stage one and stage two regulators	25
4.3	Shillinglaws regulator constructed in 2006 on the River Murray	26
4.4	Reedy Lagoon after receiving environmental flows, 2006	28
4.5	Conceptual diagram of the waterbird breeding operating scenario	29
4.6	Royal spoonbill (<i>Platalea regia</i>) wading for food in Reedy Lagoon	30
5.1	Freshwater catfish (<i>Tandanus tandanus</i>) detected during fish surveys on Gunbower Creek	35
5.2	Gauge-board monitoring water depths during 2008 environmental flow release	36
6.1	Community field day in Gunbower Forest	37
7.1	Map of traditional owner boundaries in Gunbower Forest	39
8.1	Adaptive management cycle	40
8.2	Monitoring dissolved oxygen levels in Gunbower Creek	41
A1	The Living Murray program management arrangements in Victoria	44

Tables

1.1	Key agencies involved in delivery of TLM at Gunbower Forest	9
2.1	Water management areas in Gunbower Forest	11
3.1	Specific outcomes and targets for First Step Decision objectives	17
3.2	Water requirements for the icon site environmental objectives	20
3.3	Modelled average frequency of flood events in 10 years	22
4.1	Objectives under different water availability scenarios	23
4.2	Status of structures and contribution to the ecological objectives for Gunbower Forest	26
4.3	Hipwell Road works and functions	27
4.4	Operating regimes contribution to the ecological objectives	31
4.5	Water use of different operational scenarios	32
4.6	Summary of risks and mitigating actions	32
5.1	Description of how condition monitoring will measure progress towards targets	34

Abbreviations and acronyms

GL/d	Gigalitres a day
LTCE	long-term Cap equivalent
MDBA	Murray–Darling Basin Authority (absorbed the functions of the former Murray–Darling Basin Commission in December 2009)
MDBC	Murray–Darling Basin Commission (now the Murray–Darling Basin Authority)
TLM	The Living Murray

Glossary

Aquatic ecosystem	Any water environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.
Baseline condition	An environmental quality or condition defined at a point in time and used as a benchmark for determining a change in the environmental quality or condition. For The Living Murray, the baseline condition was 2002, when the program was announced.
Basin Officials Committee	A jurisdictional committee to coordinate the management of Basin water resources between the Commonwealth, the Authority and the Basin states.
Ecological objective	An objective is a statement of the desired condition; it is not necessary to quantify an objective.
Ecological targets	A target is generated from the ecological objective and will ideally be quantitative.
Environmental water	Water that is available for the environment.
Environmental Watering Group	A jurisdictional committee that develops and implements the annual TLM Environmental Watering Plan. The Environmental Watering Group recommends annual TLM watering priorities and proposals to ensure consistency between icon sites.
Icon site environmental water management plan	A plan that details the aims, objectives and management actions at an icon site in accord with TLM. The plan is complementary to state based plans and processes.
Murray–Darling Basin Ministerial Council	Ministerial council that develops and agrees to the intergovernmental agreements, approves TLM business plans and makes key decisions (e.g. approves Natural Resource Management programs budget in the Corporate Plan).
Objective	See 'Ecological objective'.
Ramsar Convention on Wetlands of International Importance (Ramsar Convention)	An international treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands.
River Management Division	A business unit of the Murray–Darling Basin Authority responsible for operating the River Murray system in accordance with the Murray–Darling Basin Intergovernmental Agreement. River Management Division manages the River Murray system to ensure that the available water is continuously accounted for and distributed to New South Wales, Victoria and South Australia in accordance with the Murray–Darling Basin Agreement.
River Murray Increased Flows	The component of the water recovered under the Snowy Water Inquiry Outcomes Implementation Deed that is returned to the River Murray system as an environmental flow.
Target	See 'ecological target'

The Living Murray Committee	A jurisdictional committee that is responsible for implementation of The Living Murray Business Plan.
Unregulated Flow	The volume of water surplus to regulated requirements and determined by the volume of flow in the River Murray exceeding (or predicted to exceed) the inlet channel capacity for Lake Victoria and entitlement flow for South Australia
Water requirements	Includes the flow, volume, timing, duration, velocity, depth, quality or any other attribute that is required to meet the ecological target.

References

Australian Ecosystems 2009, 'Gunbower Forest spring flora survey', unpublished report for the North Central Catchment Management Authority, Bendigo.

Council of Australian Governments 2008, *The Intergovernmental Agreement on Murray–Darling Basin Reform*, viewed 10 September 2010, <www.coag.gov.au/intergov_agreements/index.cfm>.

Council of Australian Governments 2008, *Agreement on the Murray Darling Basin Reform*, viewed 2011, <http://www.coag.gov.au/intergov_agreements>

Council of Australian Governments 2004, *The Murray–Darling Basin Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin*, viewed 10 September 2010, <www.coag.gov.au/coag_meeting_outcomes/2004-06-25/docs/iga_water_overallocation_murray_darling.cfm>

Department of the Environment, Water, Heritage and the Arts 2009a, viewed 22 January 2009, <www.environment.gov.au>.

Department of Sustainability, Environment, Water, Population and Communities 2011b, *Environment Protection and Biodiversity Conservation Act 1999*, viewed 2011, <<http://www.environment.gov.au/>>

Department of Sustainability, Environment, Water, Population and Communities 2011c, *Bilateral bird agreements*, viewed 2011, <<http://www.environment.gov.au/>>

Department of Sustainability and Environment 2006, *Ministerial guidelines for assessment of environmental effects under the Environmental Effects Act 1978, Seventh edition*, Victorian Government Department of Sustainability and Environment, Melbourne, Victoria.

Ecological Associates 2003, 'Flooding enhancement of Gunbower Forest – investigation of priority options: Part A', unpublished report prepared for the North Central Catchment Management Authority, Bendigo, Victoria.

Ecological Associates 2010, 'Gunbower Forest mid-forest channel ecological benefit and risk analysis', unpublished report to the North Central Catchment Management Authority, Bendigo, Victoria.

Horrocks, G, Brown, G, Earl, G, Griffiths, R & Williams, L 1989, *Flora and fauna of Gunbower Island, Northern Victoria – ecological survey report No. 28*, Department of Conservation Forests and Lands, Victoria.

Kaufman, R 2010, 'Mid-forest channel option non-Indigenous heritage assessment including an historical archaeological survey', unpublished report to the North Central Catchment Management Authority, Bendigo, Victoria.

Kaufman, R 2010, 'Hipwell Road Channel Option – non-Indigenous heritage assessment including an historical archaeological survey', unpublished report to the North Central Catchment Management Authority, Bendigo, Victoria.

Long, A 1996, *Loddon and Avoca River catchments: Archaeological site visibility survey: Southern Murray Basin Aboriginal sites survey field report*, report to Aboriginal Affairs, Victoria.

MDBC 2007, 'The Living Murray Outcomes and Evaluation Framework', unpublished report, Murray–Darling Basin Commission, Canberra.

MDBC 2007, *The Living Murray Outcomes Evaluation Framework: A framework for monitoring and evaluating the achievement of outcomes and objectives of The Living Murray*, Murray–Darling Basin Commission, Canberra.

MDBA 2010a, *Guide to the Proposed Basin Plan – Overview*, Murray–Darling Basin Authority, Canberra.

MDBA 2010b, 'Additional hydraulic modelling of TLM interventions in Gunbower Forest', *Victoria*, unpublished report, Murray–Darling Basin Authority, Canberra.

North Central Catchment Management Authority 2007, *Interim Blueprint for Gunbower Forest — Final report*, North Central Catchment Management Authority, Bendigo, Victoria.

North Central Catchment Management Authority 2008, *Gunbower Creek Waterway Action Plan — Final report*, North Central Catchment Management Authority, Bendigo, Victoria.

North Central Catchment Management Authority 2010, *Flooding Enhancement of Gunbower Forest Project – Investment Proposal*, North Central Catchment Management Authority, Bendigo, Victoria.

Rhodes, D 1996, *Gunbower Island Archaeological Survey*, Aboriginal Affairs Victoria Occasional Report No. 48.

Sinclair Knight Merz 2009, 'Gunbower Creek and National Channel Capacity and Infrastructure Investigation', unpublished report to the North Central Catchment Management Authority, Bendigo, Victoria.

Sinclair Knight Merz 2010, 'Gunbower Forest upper forest channel — social impact assessment', unpublished report to the North Central Catchment Management Authority, Bendigo, Victoria.

The Convention on Wetlands of International Importance, viewed August 2010, <www.ramsar.org>.

URS 2001, 'Flood Enhancement study of Gunbower Forest – Scoping Study', unpublished report prepared for the North Central Catchment Management Authority, Bendigo, Victoria.

Water Technology, Ecological Associates Pty Ltd, Fluvial Systems, Lloyd Environmental 2007, 'Gunbower Creek environmental flows study — Issues paper', unpublished report to the North Central Catchment Management Authority, Bendigo, Victoria.

Water Technology 2009 'Applying modelling tools to investigate water management in the Gunbower Forest – Part b: scenario analysis report', unpublished report prepared for North Central Catchment Management Authority, Bendigo, Victoria.

Water Technology 2010, 'Gunbower Forest watering – further investigations into the Hipwell Road Channel option', unpublished report prepared for North Central Catchment Management Authority, Bendigo, Victoria.



Australian Government



**MURRAY—
DARLING**
BASIN AUTHORITY