Section 1

Introduction

Inspecting rocks at the Yarra River, by Chris Kapa. Image courtesy of Melbourne Water

1.1 The Victorian environmental watering program

The Victorian environmental watering program is the ongoing collaborative management of water available under environmental entitlements and used to improve the health of Victoria's rivers and wetlands and the native plants and animals that depend on them.

This seasonal watering plan previews the potential environmental watering that may be delivered across Victoria under the program in the coming year.

In this section ...

- **Who is involved in the Victorian environmental watering program?**
- **What is the program aiming to achieve?**
- **What is the role of the VEWH?**
- **How does the Victorian environmental watering program fit within broader integrated catchment and waterway management?**
- **Where can I find more information about the Victorian environmental watering program?**

1.1.1 Who is involved in the Victorian environmental watering program?

The Victorian environmental watering program involves a range of groups and organisations. Relationships between local communities, waterway managers, storage managers, environmental water holders and land managers are the foundation of the program.

Many public authorities collaborate to deliver the program. These authorities are referred to as program partners.

Waterway managers (catchment management authorities [CMAs] and Melbourne Water) are the regional planning and delivery arm of the program. In consultation with local communities, waterway managers develop proposals for environmental watering in rivers and wetlands in their region. Waterway managers also order environmental water from storage managers and monitor the outcomes.

Storage managers (largely water corporations) deliver water for all water users, including waterway managers and environmental water holders.

Environmental water holders (the Victorian Environmental Water Holder [VEWH], Commonwealth Environmental Water Holder [CEWH] and the Murray–Darling Basin Authority [MDBA]) commit environmental water to different rivers and wetlands. They work together to ensure the coordinated delivery of water available under different environmental entitlements and often have to prioritise across large regions (such as northern Victoria).

Public land managers (such as Parks Victoria, Department of Environment, Land, Water and Planning [DELWP] and Traditional Owner land management boards) are closely involved in environmental water planning and delivery for public land (such as state forests and national parks). Their responsibilities include controlling infrastructure (such as pumps, outlets, gates and channels) and public signage. Some environmental watering also occurs on private land, in partnership with landholders or corporations.

To effectively manage environmental water, it is important to understand the environmental values of Victoria's rivers and wetlands. This understanding draws on the knowledge of local communities and scientists.

Local communities help identify the important environmental values in each region and help monitor the success of environmental watering. Local communities are often actively involved with local rivers and wetlands and bring important environmental, cultural, social and economic perspectives to the program.

Traditional Owners and their Nations in Victoria have a deep and enduring connection to Victoria's rivers, wetlands and floodplains. Many program partners have strong relationships with Traditional Owner Nations in their region and are working to improve relationships to better support Aboriginal Victorians' aspirations and incorporate Traditional Owners' objectives into environmental water management.

Scientists provide indispensable advice about how environmental water will support native plants and animals in the short and long terms and work with waterway managers to monitor, evaluate and report on the outcomes of environmental watering.

Citizen scientists are increasingly monitoring the outcomes of environmental watering. In some regions, Birdlife Australia volunteers help monitor environmental watering outcomes at wetlands and Waterwatch volunteers collect water-quality information to inform management decisions for some rivers. In Gunbower Forest, Barapa Barapa Traditional Owners are also monitoring environmental watering outcomes.

1.1.2 What is the program aiming to achieve?

The Victorian environmental watering program seeks to collaboratively manage environmental water to improve the health of river and wetland systems including their biodiversity, ecological functioning, water quality and other uses that depend on environmental condition. This benefits plants, animals and broader environmental health, improves recreational opportunities, sustains healthy Country for Aboriginal communities and improves the quality of water available for irrigators and the urban water supply.

1.1.3 What is the role of the VEWH?

The VEWH is an independent statutory authority set up under the *Victorian Water Act 1989* to manage Victoria's environmental water entitlements to achieve environmental benefits for Victoria's rivers, wetlands and floodplains.

The role of the VEWH is to:

- make decisions about the most effective use of the environmental water entitlements, including for use, carryover and trade (see section 1.4.2)
- commit water and authorise waterway managers to implement watering decisions (see section 1.3.2)
- work with storage managers and other water holders to coordinate and optimise environmental outcomes from the delivery of all water (see section 1.4)
- commission projects to demonstrate the ecological outcomes of environmental watering at key sites and to help improve environmental water management
- publicly communicate environmental watering decisions and outcomes.

The VEWH consists of three part-time commissioners, supported by a small team.

The commissioners are Denis Flett (Chairperson), Geoff Hocking (Deputy Chairperson) and Chris Chesterfield (Commissioner). Commissioners were appointed by the Governor in Council on the recommendation of the Minister for Water.

In late 2017, the VEWH Commission will be strengthened with the appointment of a fourth Commissioner: an Aboriginal Victorian.

1.1.4 How does the Victorian environmental watering program fit within broader integrated catchment and waterway management?

The VEWH operates within Victorian Government policy. Key policy documents influencing the VEWH from a Victorian context include the *Victorian Waterway Management Strategy* (VWMS) (2013), regional sustainable water strategies and *Water for Victoria - Water Plan (2016)*. Water for Victoria is a plan for a future with less water as Victoria responds to the impact of climate change and a growing population. The actions in the plan support a healthy environment, a prosperous economy with growing agricultural production and thriving communities. Implementing the actions in the plan will improve the operation of the water and catchment management industry, including the VEWH.

Water for Victoria recognises that protecting and improving waterway health is a long-term commitment needing coordinated action. Integrated catchment management is a holistic way of managing land, water and biodiversity from the top to the bottom of a catchment. Although better-integrated catchment management will greatly benefit Victoria's waterways, the full benefits of strategic, long-term investments in waterway health may not be realised for 30 years or more. *Water for Victoria* identifies 36 priority waterways for large-scale projects over this timeframe and many of these waterways are planned for environmental watering in this Seasonal Watering Plan.

Complementary water management activities are often needed to optimise environmental watering outcomes. These include invasive species control, riparian (streamside) land management, sustainable agriculture, sustainable land-use planning and development, integrated urban water management and other waterway management activities (such as providing fish passage and improved in-stream habitat, for example snags). A lack of fish passage due to dams and weirs continues to be a problem in some Victorian rivers where environmental flows aim to increase the breeding success and recruitment of native fish. Figure 1.1.1 shows examples of complementary waterway management activities in Victorian waterways that receive environmental water.

In most systems, water for the environment is delivered using existing infrastructure (such as dam outlet gates and water supply channels) built for and still used for the supply of water for agriculture, industry and communities. Permanent and temporary pumps are also used in some cases to deliver environmental water to wetlands. Capacity constraints with these types of infrastructure and the need to avoid flooding on private land restrict the size and timing of environmental water deliveries. In some systems, these constraints mean only a fraction of the required environmental water can be delivered to waterways, which significantly reduces the environmental outcomes that can be achieved.

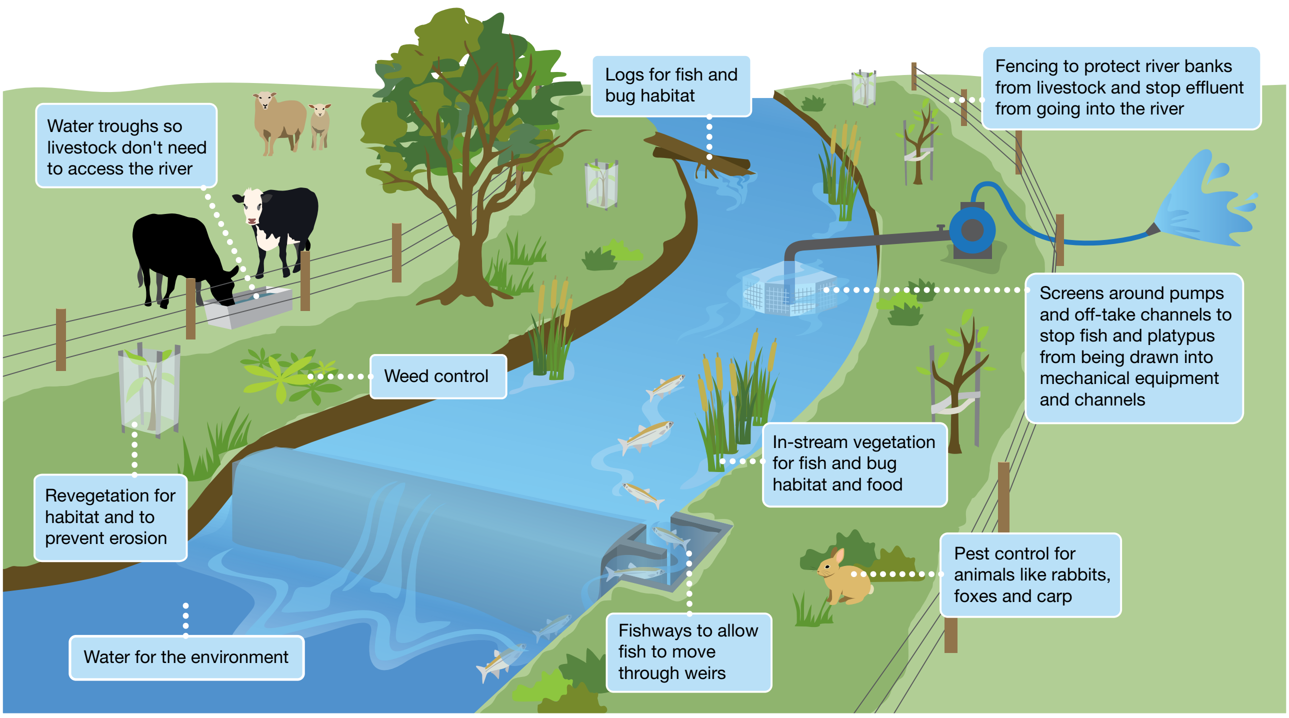
Victoria's environmental water management program is integral to the success of the following three strategies and plans.

Our Catchments, Our Communities (2016) is Victoria's first statewide strategy for integrated catchment management. Its aims are more effective community engagement, better connections between different levels of planning and stronger regional catchment strategies. The strategy also aims to clarify roles, strengthen accountabilities and coordination and improve monitoring, evaluation and reporting. CMAs will lead 10 new integrated catchment management projects across the state from 2016 to 2019 in collaboration with catchment management partners. Some projects involve environmental watering actions.

Protecting Victoria's Environment – Biodiversity 2037 (2017) aims to ensure Victoria has a modern and effective approach to protecting and managing Victoria's biodiversity. Providing water for the environment is essential to supporting Victoria's biodiversity. The plan will be implemented together with the outcomes of reviews of the *Flora and Fauna Guarantee Act 1988* and Victoria's native vegetation clearing regulations.

The *Basin Plan 2012* for the Murray–Darling Basin is another key reform influencing the VEWH's operations, particularly its planning and reporting framework in northern and western Victorian systems which form part of the basin. The VEWH continues to work closely with the Victorian Government and other agencies to implement the *Basin Plan 2012*.

Figure 1.1.1 Examples of complementary management actions



1.1.5 Where can I find more information about the Victorian environmental watering program?

There is more information about the program on the VEWH website at vewh.vic.gov.au, or contact the VEWH on (03) 9637 8951 or by email to general.enquiries@vewh.vic.gov.au.

You can get more detailed information about environmental watering in your region by contacting your local waterway manager using the contact details in section 6.3.

Environmental watering fact sheets

The VEWH's fact sheets answer questions about environmental watering. They are:

- What is environmental water?
- Why is environmental watering important?
- What does environmental watering aim to achieve?
- What does environmental watering involve?
- How do we know if environmental watering is successful?
- What is environmental water trading?

The fact sheets are on the VEWH website, or you can get hard copies by emailing general.enquiries@vewh.vic.gov.au.

1.2 The seasonal watering plan

The seasonal watering plan is a statewide plan that guides environmental watering decisions in Victoria. It provides program partners, stakeholders and communities with a sense of what to expect during the water year.

In this section ...

- **What does 'seasonal' mean?**
- **How does the seasonal watering plan fit into the planning process?**
- **Who contributes to the seasonal watering plan?**
- **Can the seasonal watering plan be changed?**
- **What kinds of changes don't require a formal variation of the plan?**

The plan previews the potential environmental watering that could be implemented using water available under all environmental water entitlements held in Victoria. This includes water available under the VEWH's environmental water entitlements and water held by other environmental water holders (see section 1.4.1).

The plan for the upcoming water year is released by 30 June each year. The 2017–18 plan and any variations are valid for this water year (1 July 2017 to 30 June 2018) or until the subsequent seasonal watering plan is released.

1.2.1 What does 'seasonal' mean?

'Seasonal' refers to the variability of climatic conditions in a given year. Environmental watering objectives and water availability may differ depending on seasonal conditions, so it is important that environmental water planning considers the range of potential seasonal condition or water availability scenarios that may unfold, ranging from drought to very wet (see Figure 1.2.1). This scenario planning provides a guide for the VEWH and waterway managers throughout the year when it comes to deciding what environmental watering to go ahead with.

For each river and wetland system, the potential environmental watering under each water availability scenario is explained under 'Scenario planning' in the relevant chapter.

Figure 1.2.1 Examples of environmental watering objectives under different planning scenarios

Drought

Main objective: PROTECT

- Avoid critical loss
- Maintain key refuges
- Avoid catastrophic events

Dry

Main objective: MAINTAIN

- Maintain river functioning with reduced reproductive capacity
- Maintain key functions of high-priority wetlands
- Manage within dry-spell tolerances

Average

Main objective: RECOVER

- Improve ecological health and resilience
- Improve recruitment opportunities for key animal and plant species

Wet to very wet

Main objective: ENHANCE

- Restore key floodplain and wetland linkages
- Enhance recruitment opportunities for key animal and plant species

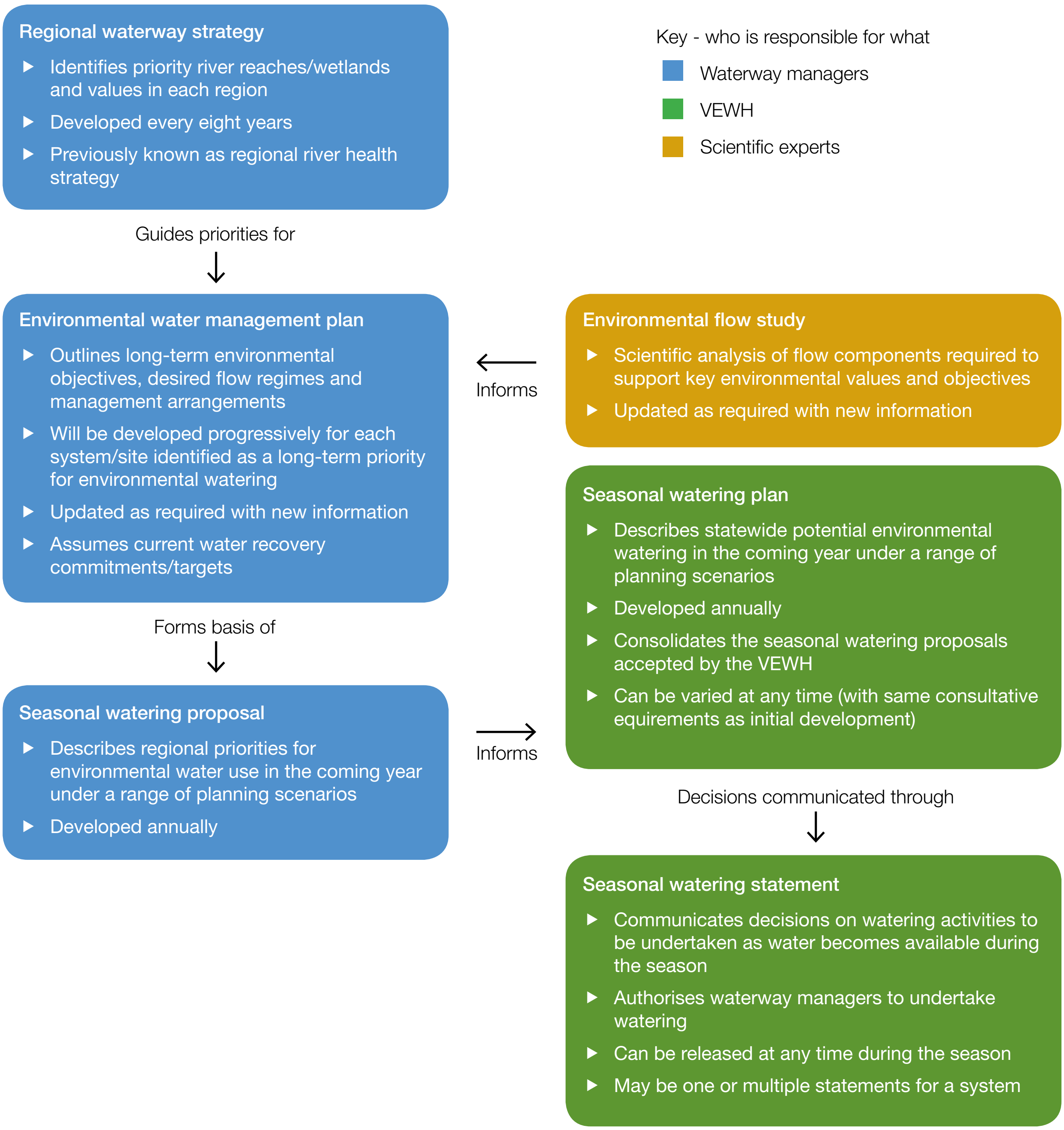
1.2.2 How does the seasonal watering plan fit into the planning process?

Each year, waterway managers scope the potential environmental watering actions for their regions for the coming year in seasonal watering proposals. The proposals draw on environmental flow studies and on longer-term plans (such as environmental water management plans, regional waterway strategies and regional catchment strategies). The proposals incorporate information and advice from local communities.

This seasonal watering plan is a collated summary of the seasonal watering proposals.

The different stages of environmental water planning, including the different strategies and plans, are shown in Figure 1.2.2. There is more information about each of these strategies and plans at vewh.vic.gov.au.

Figure 1.2.2 Victorian environmental watering program planning framework



1.2.3 Who contributes to the seasonal watering plan?

Stakeholder engagement on potential environmental watering actions occurs during the development of regional seasonal watering proposals. The level and method of engagement varies across the state, reflecting the differing systems, watering actions and stakeholders. In some regions, formal environmental water advisory groups provide the opportunity for waterway managers and interested community members to discuss potential environmental watering in their system or locality for the coming year. In other systems, engagement occurs one-on-one between waterway managers and interested stakeholders. The most interested stakeholders tend to be Traditional Owners, irrigators, farmers, members of recreational groups and members of local environmental groups.

Land managers and storage managers also consider and endorse the seasonal watering proposals to ensure planned watering aligns with land and storage management objectives and can feasibly be delivered through planned system operations.

For each system, there is a summary of the engagement activities waterway managers undertook when developing seasonal watering proposals (see sections 2 to 5).

1.2.4 Can the seasonal watering plan be changed?

Under the Victorian *Water Act 1989*, the VEWH can only authorise use of environmental water where it is consistent with a seasonal watering plan. This is to ensure transparency about what environmental watering is planned and how it is managed.

However, to also ensure flexibility to adapt to changing conditions, under the Act the VEWH can vary any section of a seasonal watering plan. This could be to incorporate new knowledge or to address any circumstances not identified before the start of the water year.

The VEWH makes all variations publicly available at vewh.vic.gov.au as separate attachments to the original seasonal watering plan. You can email general.enquiries@vewh.vic.gov.au for a hard copy.

1.2.5 What kinds of changes don't require a formal variation to the seasonal watering plan?

Changes that do not require a variation to the seasonal watering plan include:

- minor operational adjustments to specific environmental watering actions
- environmental water being used for environmental emergency management situations
- small volumes of environmental water being used for technical investigations
- facilitating the delivery of water held by other water holders for downstream objectives
- environmental watering actions that continue beyond the year of the plan (even if there are unforeseen delays releasing the following year's plan).

As the VEWH cannot anticipate the specifics of these changes, it cannot include further details about them in this plan.

Minor operational adjustments

Minor operational adjustments to environmental watering actions may occur from time to time and do not require a formal variation to the seasonal watering plan. For example, the targeted river reaches, flow rates, timing and durations detailed in sections 2 to 5 may need to be adjusted slightly due to changes in predicted rainfall or other water orders, or delivery infrastructure constraints. In all cases, environmental watering actions will still aim to optimise the environmental outcomes achieved.

Environmental emergency management situations

Environmental water may be needed for an environmental emergency management situation. This may include reducing the impact of natural blackwater or bushfire events, preventing fish deaths or mitigating the effects of blue-green algae blooms. It could also include smoothing the transition to or from a high-natural-flow event (for example, supplementing natural flows with environmental water to provide a more gradual rise and fall to minimise the threat of river banks slumping).

Small technical investigations

There may be instances where a small volume of environmental water may be used for research and development purposes or small-scale infrastructure testing. Such instances are considered on a case-by-case basis and must aim to enhance knowledge and improve environmental water management. It must not compromise the potential to achieve the environmental objectives in the seasonal watering plan.

Facilitating the delivery of water held by other water holders for downstream objectives

Some water held by other water holders is stored in Victorian storages and is sometimes called on to meet downstream demands beyond the scope of this plan (such as for the Coorong, Lower Lakes and Murray Mouth area in SA). Delivery of this water is sometimes needed at a time and flow rate that was not scoped in the seasonal watering plan. The VEWH facilitates and authorises such deliveries, provided the risk of adverse impacts on Victoria's rivers, wetlands and floodplains and other risks are appropriately managed.

Environmental watering actions that continue beyond the year of the plan

Nature doesn't keep to strict timelines, so some potential environmental watering scoped in a seasonal watering plan may begin before, or continue beyond, the year of the plan. This means environmental watering actions that start either before July 2017 or continue after June 2018 are still consistent with the plan, especially if there turn out to be unforeseen delays releasing the *Seasonal Watering Plan 2018–19*.

1.3 Implementing the seasonal watering plan

The seasonal watering plan scopes potential environmental watering for the coming year, but many factors influence decisions about what environmental water is actually committed and delivered.

In this section ...

- **How do program partners decide which watering actions are delivered?**
- **When does the VEWH commit and authorise its water for use?**
- **How does the VEWH prioritise different watering actions when there is not enough environmental water available?**
- **Do seasonal conditions affect how environmental water is used?**
- **How are shared recreational, cultural and economic benefits considered in environmental watering?**
- **How are risks managed?**

Some factors that influence decisions about committing and delivering environmental water are:

- seasonal conditions, weather forecasts and catchment conditions
- river and system operations (such as unregulated flows, catchment inflows, storage levels, other water users' needs and potential delivery constraints)
- ecological or biological factors and triggers (such as plant and animal responses to natural flows or temperature)
- water availability
- risks associated with an environmental watering action
- the opportunity to deliver shared benefits.

It is important there is flexibility to respond to these different factors, as they can significantly influence the environmental outcomes that can be achieved.

1.3.1 How do program partners decide which watering actions are delivered?

As the season unfolds, many of the uncertainties associated with seasonal conditions, water availability and operational context become clearer and this clarity informs decisions about what environmental watering should proceed. Many on-ground factors do not become clear until very close to the anticipated time of delivering the water.

To guide environmental watering decisions, a flexible and adaptive approach is adopted that involves the environmental water management stakeholders. This process of review and adjustment ensures that environmental water is used in an efficient and seasonally appropriate manner to optimise ecological outcomes across the state.

Waterway managers, environmental water holders, storage managers and land managers all help decide which watering actions are or can be delivered during the year. Decisions are often made collaboratively, as each program partner has a role in approving the delivery of environmental water (as explained in section 1.3.3).

If decisions are required as a result of unforeseen or consequential changes to planned watering during the season, further scientific or community input may be sought to inform decision-makers.

The VEWH regularly publishes updated information about current and anticipated environmental watering actions on its website at vewh.vic.gov.au.

1.3.2 When does the VEWH commit and authorise its water for use?

The VEWH aims to commit as much water as is sensibly possible, as early as possible, to provide waterway managers with as much certainty as possible to proceed with the planned environmental watering actions.

The VEWH (like other environmental water holders) can commit its water at any point before or during the water year. The VEWH commits water via seasonal watering statements, which authorise waterway managers to use environmental water. The VEWH publishes seasonal watering statements on its website at vewh.vic.gov.au.

The VEWH can make a seasonal watering statement at any time of the year. Depending on the nature of the system and the entitlement being used, it may make one or multiple statements for a particular system. Before issuing a seasonal watering statement, the VEWH must be sure the required delivery arrangements (including any risk management measures) are in place and any costs it must meet are acceptable.

Where many environmental watering actions planned across different systems require access to the same environmental water entitlement, decisions to commit water to particular actions may require more thorough consideration. This may require prioritisation of one river or wetland over another. Section 1.3.3 has further information about how prioritisation decisions are made.

In some instances, the VEWH may commit water very close to the anticipated delivery time. This may be necessary because the water demand arises at short notice due to environmental, operational or weather conditions triggering the need for environmental water. For example, if colonial waterbirds start nesting in Barmah Forest, this may trigger a need for environmental water to maintain shallow flooding long enough for the birds to breed and fledge.

There may also be instances where no environmental water is committed to a particular site. For example, there could be an ecological trigger or seasonal conditions that show watering should not proceed, or there may not be enough water for the planned watering action.

The CEWH and MDBA (through the Living Murray program) commit water for use in Victoria with similar logic to that outlined above. The VEWH then formally authorises the use of that water through seasonal watering statements.

Can environmental water holders change their minds after a seasonal watering statement has been issued?

The VEWH may withdraw a seasonal watering statement at any point during the year, in consultation with the waterway manager and storage manager for that river or wetland system. It might do so, for example, to address emerging risks or changes in operating conditions or water availability.

Similarly, a waterway manager or storage manager may decide, in consultation with the VEWH, not to proceed with an environmental watering action after a seasonal watering statement has been issued. This could occur as a result of environmental triggers indicating the water was no longer required, resourcing constraints or new information that the potential environmental or public risk of watering was too high.

Platypus at the Tarago River, by Keith Chalmers

1.3.3 How does the VEWH prioritise different watering actions when there is not enough environmental water available?

In any given year, the need for environmental water as outlined in the seasonal watering plan can be higher than the available water, so it is important to consider where water is most needed and how it can be used most efficiently to achieve the best environmental outcomes.

A shortfall in supply might arise because of:

- significant, high-value environmental water demands
- drought or low water availability.

To meet a shortfall, the VEWH may look to use tools such as carryover and trade (as explained in section 1.4.2). If there is still a shortfall of water, the VEWH, in collaboration with waterway managers and other water holders if relevant, must prioritise environmental watering actions.

Many factors influence prioritisation decisions (such as the previous watering history in that river or wetland, environmental or public risk considerations and seasonal conditions in the region). Prioritisation decisions can be very hard and often involve trading off one watering action against another.

In deciding to prioritise one environmental watering action and site over another, the VEWH always seeks to optimise environmental outcomes across the state.

What criteria are used to guide prioritisation decisions?

Figure 1.3.1 shows the criteria considered when making the trade-off decisions and prioritising the range of potential environmental value from watering actions. Waterway managers provide information about how different watering actions meet these criteria, and about opportunities for shared benefits, in their seasonal watering proposals.

Figure 1.3.1 Criteria for prioritising environmental watering actions

Prioritisation criteria	Types of factors considered
Extent of benefit	▶ Size of the area being watered ▶ Expected ecological outcomes ▶ Expected scale of response ▶ Conservation status of the species that will benefit
Likelihood of success	▶ Evidence to support the desired outcomes will be achieved ▶ External threats that may affect getting the desired results
Longer-term benefits	▶ Value added to previous watering investment at the site ▶ Longer-term environmental benefits expected ▶ Ability to sustain these values into the future
Urgency of watering needs	▶ History of watering at the site ▶ Potential for irreversible damage if the watering does not occur ▶ Potential for species loss at a local or greater scale ▶ Risks associated with not delivering the water
Feasibility of the action	▶ Capacity of infrastructure to meet the delivery requirements ▶ System or operational constraints ▶ Flexibility in the timing of delivery ▶ Feasibility of management actions in mitigating external threats
Environmental or third party risks	▶ Adverse environmental outcomes that may arise ▶ Third-party risks associated with the event ▶ Effectiveness of actions to manage third-party and environmental risks
Costs of the watering action	▶ Costs to deliver and/or manage water ▶ Costs of interventions for managing external threats and risks
Efficiency of water use	▶ Volume of water needed to achieve the desired outcomes ▶ Volume and timing of return flows that may be used at downstream sites (see section 1.4.2) ▶ Alternative supply options such as use of consumptive water en route or augmenting natural flow events ▶ Risks of spills from storages in the upcoming water year and any carryover water (see section 1.4.2) that may be available

Who is involved in the prioritisation process?

Waterway managers, environmental water holders, storage managers and communities (recreational user groups, environmental groups, Traditional Owners and farming groups) all have a role in prioritising environmental watering actions, depending on the nature and scale of the decision being made. There is a list of partners and stakeholders engaged in developing the seasonal watering proposal for each system in this plan.

Waterway managers are best-placed to advise about the extent and significance of an environmental watering action and about the highest priorities in their region.

The VEWH and other environmental water holders determine the highest watering priorities across regions and have a mandate to commit environmental water to particular watering actions and sites over others. The VEWH's decisions are intended to provide the best-possible environmental outcomes for the state. The VEWH makes these decisions in consultation with waterway managers, which are the primary environmental watering representatives of their regions, and with other program partners as relevant.

Advice from storage managers is generally the key to understanding the feasibility of delivering a watering action, including the flexibility of delivery timing and operational constraints.

Land managers provide consent to environmental water delivery on their land and will advise on delivery feasibility in light of land management activities, public access and the risks and benefits of the environmental watering action.

The annual prioritisation process is informed by longer-term site prioritisation by waterway managers in consultation with their communities. This prioritisation is detailed in plans such as regional catchment strategies, regional waterway strategies and environmental water management plans. These plans draw on community and scientific knowledge and prioritise sites for environmental watering (and other river health activities) that have high environmental, cultural, social and economic value to the community.

Additional input from the community about prioritisation of environmental watering is provided annually where needed.

1.3.4 Do seasonal conditions affect how environmental water is used?

In the same way rainfall patterns influence how people water their gardens or paddocks, different climatic conditions influence how environmental water is managed.

Seasonal conditions drive what water will be available during the water year and the environmental watering objectives to be pursued (as explained in section 1.2.1). Waterway managers take seasonal conditions into account when prioritising the environmental water needed at each particular site. These are known as planning scenarios and describe the range of watering actions that may occur under drought to very wet climatic conditions.

Waterway managers work with the program partners to decide how to optimise the ecological outcomes they can achieve using environmental water by considering factors including:

- the environmental objectives under each climatic scenario including consideration of any essential environmental water needs
- how rainfall, natural flooding or the delivery of water for consumptive users may contribute to the achievement of the environmental objectives
- how environmental water may be used to build on natural flows or irrigation deliveries to meet the environment's needs
- natural climatic cues that might occur that increase the likelihood of achieving a particular ecological outcome.

Planning scenarios are presented in the seasonal watering plan and provide the basis for the adaptive management of environmental water as the season unfolds. They also provide an early indication of the amount of water that may be used at different sites and whether the VEWH may need to trade water during the season to meet identified environmental needs (as explained in section 1.4).

Figure 1.3.2 provides an example of how different planning scenarios may influence decisions about how environmental water is managed in a given year.

Water delivery to Lake Elizabeth, by North Central CMA

Figure 1.3.2 Example planning scenarios for a river system under a range of climatic conditions

Planning scenario	Drought	Dry	Average	Wet to very wet
Expected Catchment Conditions	No unregulated flows	One or two brief unregulated flow peaks in winter/spring	One to three unregulated flow peaks plus extended low flows in winter/spring	Extended unregulated high flows with some overbank flooding in winter/spring
Environmental Objectives	Protect critical refuge habitat for native fish	Maintain native fish habitat	Encourage fish movement and spawning Improve habitat for water bugs Support the establishment and maintenance of bank vegetation	Encourage movement and spawning of native fish Enhance condition and extent of bank vegetation Where possible, provide opportunities for the exchange of nutrients and carbon between the river and floodplain
Potential Environmental Watering	Provide low flows and trigger-based freshes to maintain water quality in deep refuge pools	Provide summer/autumn low flows to manage water quality and maintain connectivity	Provide year-round baseflows to maintain habitat connectivity and support fish movement	Maintain year-round low flows and seasonal freshes to encourage the recovery of in-stream and bank vegetation and trigger the spawning and movement of native fish
		Extend the duration of flow peaks to freshen water quality in deep pools	Extend the duration and/or magnitude of peaks to provide spawning cues for fish	Where possible, maintain connectivity and the exchange of nutrients between the river and floodplain
			Provide seasonal freshes to support the establishment of bank vegetation	Slow the recession of natural peaks to avoid bank slumping and erosion
				Top up natural flows if needed, to meet targets for winter base flows and spring peaks

1.3.5 How are shared recreational, cultural and economic benefits considered in environmental watering?

Environmental water is essential for maintaining and improving the health of rivers, wetlands and floodplains. The plants, animals and broader health of these waterways provide shared benefits for recreation, cultures and economies. For example, environmental watering can improve conditions for fishing, camping and canoeing; sustain healthy Country and totem species for Aboriginal communities with a continuing connection to rivers, wetlands and floodplains; and improve water quality which can deliver economic benefits for irrigators.

In planning for environmental watering, the primary purpose is to optimise environmental benefits. Where consistent with this purpose, program partners also consider whether additional social, cultural and economic benefits can be achieved.

These shared benefits of environmental water can sometimes be actively optimised by making decisions around the storage, delivery and use of environmental water that support community events (such as local fishing, waterskiing or rowing competitions).

When planning for and delivering environmental water, the VEWH and program partners look for opportunities to achieve these shared benefits in both the short and long-term, where environmental outcomes are not compromised. Longer-term community benefits may sometimes require short-term community inconvenience. For example, floodplain watering in Gunbower Forest may inconvenience campers one year due to limited access, but this watering will increase the health of the forest in the longer term, which benefits tourism and recreational opportunities.

Waterway managers work with communities to identify the environmental, social, cultural and economic values of waterways through regional catchment strategies, regional waterway strategies, environmental water management plans and seasonal watering proposals. These values for each system are summarised in sections 2 to 5. Program partners will continue to work with stakeholders to look for opportunities to achieve shared benefits from environmental watering.

1.3.6 How are risks managed?

Risk management is an integral part of environmental watering. Program partners consider it throughout environmental water management (that is, during long-term and annual planning, implementation and review).

VEWH in collaboration with its program partners has developed a risk management framework which addresses interagency risk, respects the risk management practices of each partner, documents roles and responsibilities in operating arrangements and is applied as part of program management.

The seasonal watering proposals on which this *Seasonal Watering Plan 2017–18* is based identify potential risks associated with the specific watering actions proposed for the coming water year. As part of developing the proposals, partners jointly assess risks and identify and commit to mitigation actions. Due to the shared nature of these risks, a collaborative approach is the best way to manage environmental watering risks.

Table 1.3.1 shows the main shared risks of environmental watering. Program partners consider and reassess these and other potential risks as the season unfolds and planned watering actions are due to commence.

Some risks may only eventuate at the time of delivery. For example, if there is significant rain forecast, there is a risk it could cause nuisance flooding if combined with a scheduled environmental watering action. To avoid this, risks are always reconsidered by program partners within the specific environmental and operational contexts of a watering action to inform decisions about whether delivery should proceed. Any measures or actions required to mitigate the risks identified are implemented as agreed by the responsible program partner. Watering actions will not be implemented if an unacceptable risk to the public or the environment is identified.

Even with best-practice risk management controls, there may be unintended impacts from environmental watering or situations where environmental watering cannot occur as planned. If so, it is essential partners work together to respond to risks and then learn and adapt their management of risks. The VEWH has developed an agreed approach to incident management to help program partners report, investigate and respond to risks.

Table 1.3.1 Main shared risks of environmental watering

Type of risk	Example mitigating actions
Environmental watering contributes to third-party impacts	• Identify and understand water system capacities and monitor water levels at key locations to inform daily water release decisions and ensure impacts do not eventuate. • Consider potential catchment run-off from forecast rainfall before deciding on the timing of environmental water releases. • Implement a communication strategy which may include media releases, public notices and signage before environmental watering, to ensure people are informed of significant environmental water deliveries and can adjust their behaviour accordingly. This includes early liaison with potentially affected stakeholders. • Restrict access by closing gates and tracks.
Inability to achieve or demonstrate ecological outcomes from environmental watering	• Undertake intervention monitoring within available resources to identify the ecological response. • Conduct research to better understand environmental watering responses. • Communicate the outcomes of monitoring and incorporate learnings into future environmental watering. • Consider the need for complementary works to help achieve environmental watering outcomes as part of integrated catchment management, and the likely timeframe for ecological responses to all management actions.
Environmental watering has negative effects on the environment (for example blackwater, bank erosion and the spread of weeds)	• Monitor environmental watering outcomes and reassess future deliveries and/or scientific recommendations if necessary. • Plan the timing, frequency, duration and variability of environmental watering to limit conditions that are favourable to non-native plants and animals or which have negative effects.

1.4 Managing available environmental water

Environmental water entitlements are held in 15 water supply systems across Victoria. Sections 2 to 5 detail where the water made available under these entitlements may be delivered in 2017–18.

In this section ...

- **How much water is available to use as part of the Victorian environmental watering program?**
- **What options are available to effectively and efficiently manage environmental water?**

To the extent possible, the VEWH and other environmental water holders try to avoid water supply shortfalls by efficiently using environmental water and by using tools such as carryover and trade. However, if despite these measures there is still a shortfall of water, the VEWH in collaboration with waterway managers (and other water holders if relevant) must prioritise environmental watering actions.

1.4.1 How much water is available to use as part of the Victorian environmental watering program?

VEWH environmental water entitlements

Environmental water is made available under the environmental water entitlements held by the VEWH. Table 1.4.1 shows the entitlements held by the VEWH as at 30 June 2017, including those held in trust for the Living Murray program. The VEWH's environmental water entitlements can be viewed at waterregister.vic.gov.au/water-entitlements/bulk-entitlements.

The water available to use under these entitlements varies from year to year depending on entitlement rules, seasonal conditions (including rainfall and run-off in the catchments) and the water already available in storages.

Leisure activities by the Yarra River, by Chris Kapa. Image courtesy of Melbourne Water

Table 1.4.1 Environmental water entitlements held by the VEWH (as at 30 June 2017)[1]

<table>
<tr><th>System</th><th>Entitlement</th><th>Volume (ML)</th><th>Class of entitlement</th></tr>
<tr><td colspan="4">Gippsland Region</td></tr>
<tr><td rowspan="2">Latrobe</td><td>Latrobe River Environmental Entitlement 2011</td><td>N/A[2]</td><td>Unregulated</td></tr>
<tr><td>Blue Rock Environmental Entitlement 2013</td><td>18,737[3]</td><td>Share of inflow</td></tr>
<tr><td>Thomson</td><td>Bulk Entitlement (Thomson River – Environment) Order 2005[4]</td><td>10,000
8,000[3]</td><td>High
Share of inflow</td></tr>
<tr><td>Macalister</td><td>Macalister River Environmental Entitlement 2010</td><td>12,461
6,230</td><td>High
Low</td></tr>
<tr><td colspan="4">Central Region</td></tr>
<tr><td>Yarra</td><td>Yarra Environmental Entitlement 2006[4]</td><td>17,000
55</td><td>High
Unregulated</td></tr>
<tr><td>Tarago</td><td>Tarago and Bunyip Rivers Environmental Entitlement 2009</td><td>3,000[3]</td><td>Share of inflow</td></tr>
<tr><td>Werribee</td><td>Werribee River Environmental Entitlement 2011</td><td>N/A[3]</td><td>Share of inflow</td></tr>
<tr><td>Moorabool</td><td>Moorabool River Environmental Entitlement 2010[4]</td><td>7,086[3]</td><td>Share of inflow</td></tr>
<tr><td>Barwon</td><td>Barwon River Environmental Entitlement 2011[5]</td><td>N/A[2]</td><td>Unregulated</td></tr>
<tr><td colspan="4">Western Region</td></tr>
<tr><td>Wimmera and Glenelg</td><td>Wimmera and Glenelg Rivers Environmental Entitlement 2010[4,6]</td><td>40,560
1,000</td><td>Pipeline product
Wetland product</td></tr>
<tr><td colspan="4">Northern Region</td></tr>
<tr><td rowspan="6">Murray</td><td>Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999</td><td>29,782
3,894
40,000</td><td>High
Low
Unregulated</td></tr>
<tr><td>Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah–Millewa Forest Environmental Water Allocation</td><td>50,000
25,000</td><td>High
Low</td></tr>
<tr><td>Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray</td><td>9,589
101,850
34,300</td><td>High
Low
Unregulated</td></tr>
<tr><td>Environmental Entitlement (River Murray – NVIRP Stage 1) 2012</td><td>25,083[7]</td><td>High</td></tr>
<tr><td>Bulk Entitlement (River Murray – Snowy Environmental Reserve) Conversion Order 2004</td><td>29,794</td><td>High</td></tr>
<tr><td>Water shares – Snowy Environmental Reserve</td><td>14,671
6,423</td><td>High
Low</td></tr>
<tr><td rowspan="6">Goulburn</td><td>Goulburn River Environmental Entitlement 2010</td><td>8,851
3,140</td><td>High
Low</td></tr>
<tr><td>Environmental Entitlement (Goulburn System – Living Murray) 2007</td><td>39,625
156,980</td><td>High
Low</td></tr>
<tr><td>Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012</td><td>34,428[7]</td><td>High</td></tr>
<tr><td>Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004</td><td>30,252
8,156</td><td>High
Low</td></tr>
<tr><td>Water Shares – Snowy River Environmental Reserve</td><td>8,321
17,852</td><td>High
Low</td></tr>
<tr><td>Silver and Wallaby Creeks Environmental Entitlement 2006[4]</td><td>N/A</td><td>Passing flow only</td></tr>
</table>

Table 1.4.1 Environmental water entitlements held by the VEWH (as at 30 June 2017)[1] *continued*

System	Entitlement	Volume (ML)	Class of entitlement
Northern Region			
Campaspe	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126 5,048	High Low
	Campaspe River Environmental Entitlement 2013	20,652 2,966	High Low
Loddon	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005[4]	10,970 2,024	High Low
	Environmental Entitlement (Birch Creek – Bullarook System) 2009[4]	100	N/A[7]
	Water Shares – Snowy River Environmental Reserve	470	High

1 *While the VEWH does not hold any entitlements in the Maribyrnong system, water allocation was purchased in this system together with Melbourne Water in 2014–15, 2015–16 and 2016–17.*

2 *Use of these entitlements depends on suitable river heights, as specified in both the Latrobe and Barwon environmental entitlements (rather than a permitted volume).*

3 *Water is accumulated continuously according to a share of inflows (Blue Rock Reservoir 9.4 percent, Tarago Reservoir 10.3 percent, Werribee system 10 percent, Moorabool system 11.9 percent, Thomson Reservoir 3.9 percent) and this volume represents the maximum that can be stored at any time. The actual volume available in any year varies according to inflows.*

4 *In addition to volumetric entitlement, the entitlement also includes passing flows.*

5 *A new environmental entitlement of 1 GL for the upper Barwon River is awaiting approval and may be available for use in 2017–18.*

6 *In addition to volumetric entitlement, the entitlement also includes unregulated water.*

7 *This entitlement volume is equal to one-third of the total water savings from the Goulburn-Murray Water Connections Project Stage 1, as verified in the latest audit (including mitigation water).*

8 *Allocation against this entitlement is made subject to specific triggers, as specified in the entitlement.*

Water donations

The VEWH may receive water donations from individuals, community groups and other organisations. This water could be used for environmental watering in the water year it was donated (including for actions identified in the seasonal watering plan), or it could be carried over for use in the future (see section 1.4.2 for more information about carryover). Some donors may identify a specific use for the water they donate (such as environmental watering in a specific wetland or to protect a certain tree species). The VEWH considers the costs and benefits of each donor proposal and may authorise a donation if it considers the donation environmentally beneficial.

Water available from other environmental water holders

In northern and western Victoria, the VEWH coordinates with other environmental water holders to deliver environmental outcomes at the broader Murray–Darling Basin scale. One of the VEWH's important roles is to coordinate with Murray–Darling Basin environmental water holders (the CEWH, MDBA and program partners in NSW and SA) to optimise the benefits of all environmental water delivery in Victorian waterways. The seasonal watering plan considers the use of all water holders' water held in Victorian river systems.

Usually, when Commonwealth or Living Murray water is to be delivered in Victoria, the CEWH and MDBA transfer the agreed amount of water to the VEWH. That amount then becomes part of the Victorian environmental water entitlements until used or transferred back.

Table 1.4.2 shows the environmental water entitlements held by the CEWH and MDBA in Victoria. The CEWH and MDBA also hold water in NSW and SA, which could potentially be made available for environmental watering in Victoria.

Table 1.4.2 Environmental water entitlements held in Victoria by other water holders (as at 31 March 2017)

System	Volume (ML)	Class of entitlement
Living Murray entitlements (held by MDBA)		
Murray	12,267	High-reliability water share
Goulburn	5,559	High-reliability water share
Commonwealth environmental water holdings		
Ovens	70	High-reliability water share
Murray	320,779 25,489	High-reliability water share Low-reliability water share
Broken	253 4	High-reliability water share Low-reliability water share
Goulburn	276,175 29,435	High-reliability water share Low-reliability water share
Campaspe	6,547 395	High-reliability water share Low-reliability water share
Loddon	3,356 527	High-reliability water share Low-reliability water share
Wimmera-Mallee	28,000	Low-reliability product

Environmental watering by nongovernment agencies

In 2007, the Murray Darling Wetlands Working Group (MDWWG) and The Nature Conservancy (both nongovernment organisations) partnered to own and manage the Environmental Water Trust. To date, the MDWWG has been very active in wetland protection and management in NSW through partnerships with state and federal governments. In 2017–18, the MDWWG plans to partner with Goulburn Broken CMA to deliver environmental water to wetlands in Victoria for the first time. The wetlands are on private land and the deliveries are outside the Victorian environmental water holdings and are therefore not specifically covered by the *Seasonal Watering Plan 2017–18*.

For more information about the MDWWG and the Environmental Water Trust, see www.murraydarlingwetlands.com.au and environmentalwatertrust.org.au.

1.4.2 What options are available to effectively and efficiently manage environmental water?

Other water sources

Environmental water is not the only type of water that can support river, wetland and floodplain health. Waterway managers and environmental water holders in consultation with storage managers consider the potential for environmental watering objectives to be met by other types of water. The timing of environmental releases can also be coordinated with other sources of water to achieve greater benefits than an environmental release alone could produce. Other sources of water can include:

- **system operating water** (including passing flows) which maintains a baseflow in many rivers to which environmental water can be added
- **heavy rainfall** (resulting in unregulated flows) which can naturally meet an environmental objective, so water available under environmental water entitlements is not needed
- **alterations to the timing and route for delivery of consumptive water** which, if possible without detriment to consumptive water users, can achieve environmental objectives.

These types of water are considered in the development and implementation of the seasonal watering plan to ensure effective system operations and efficient use of environmental water, and to achieve the optimal benefit to the environment.

Return flows

In some systems, environmental water delivered through upstream sites can be used again downstream. This helps to ensure environmental water is used efficiently and effectively to achieve optimal environmental benefits, as the Goulburn River example below illustrates.

This reuse policy, known as return flows, is available in many systems across northern Victoria. It increases the efficiency of environmental water use and helps reduce the volume of water needed to be recovered for the environment from consumptive water users.

The VEWH's access to return flows is enabled through rules in its environmental water entitlements. Reuse of return flows is also available to the CEWH and MDBA when the VEWH delivers water on their behalf.

Where possible, return flows are reused to provide benefits at Victorian environmental sites. If not needed in Victoria, the VEWH, Living Murray and CEWH return flows will continue to flow across the border to SA where they will be used to provide environmental benefits at sites such as the Coorong, Lower Lakes and Murray Mouth area.

Goulburn River: reusing return flows

Environmental water is delivered in the Goulburn River to provide environmental benefits (such as stimulating fish to breed and promoting the growth of vegetation on river banks). The water flows down the Goulburn River and into the River Murray. The VEWH can apply to the resource manager (Goulburn-Murray Water) to have the volume of environmental water that reached the River Murray re-credited in its accounts as a return flow. This water can then be reused at a priority environmental site in Victoria (such as at Hattah Lakes near Mildura) or used for River Murray environmental outcomes in SA. If the water is to be reused in SA, the VEWH trades the re-credited return flow volume to environmental water holders in SA.

Carryover

Some entitlements allow the VEWH to carry over unused water to the following water year. This means that water allocated in one year can be kept in storages for use in the following year, subject to certain conditions.

Carryover provides flexibility and enables environmental water to be delivered when it is of the greatest value to the environment. For example, carryover can help ensure environmental water holders can meet high winter and spring demands when there is a risk there will be little water available under entitlements at the beginning of the water year.

Carryover can also be used to set water aside to maintain key refuge areas and avoid catastrophic events in drought periods, as the Wimmera and Glenelg systems example below illustrates.

Using carryover to manage risks in dry periods in the Western Region

The VEWH will carry over water from 2016–17 to support water deliveries over the next few years if there is a return to dry conditions, but a better example of strategic use of carryover comes from two years ago.

Inflows to waterways and storages in the Western Region were extremely low in 2014–15. Weather forecasts suggested that conditions would remain very dry leading into 2015–16, with a high likelihood of low water availability.

As a result, program partners weighed up the opportunity cost of carrying water over for future use against using it in that season. They decided to reduce, and in some waterways temporarily cease, environmental watering in the Wimmera and Glenelg systems in autumn 2015 to ensure there was sufficient water available to meet essential needs in 2015–16 through carryover.

Although there were environmental risks associated with ceasing deliveries, they were preferable to the risk of not being able to provide flows in the following summer, when risks to native fish and other animals from poor-quality water were likely to be much more significant.

This proved to be a good decision. By summer 2015–16, low inflows to the system meant there was insufficient allocation available to provide refuge habitat for fish and other aquatic biota. Waterway managers were however able to call on the water carried over to meet these needs.

Although there was a decline in water quality, the waterway managers were able to provide habitat at critical times and to minimise the risk of fish kills.

Great egrets at Black Swamp, by Catarina Gregson

Water trading

Water trading allows the VEWH to move water to the systems where it is most needed and to smooth out some of the variability in water availability across systems and across years. The VEWH can trade water allocated to its entitlements by:

- administrative water transfers between the VEWH's entitlements
- administrative water transfers with other environmental water holders
- purchasing water allocation
- selling water allocation.

Administrative water transfers are the most common trades the VEWH undertakes. These occur between the VEWH's entitlements (or accounts) to move water to where it is most needed. Other environmental water holders also transfer their water to the VEWH for delivery in Victoria. These types of water trades are often referred to as administrative water transfers as there is no financial consideration associated with the trade.

The VEWH can also buy or sell water allocation where it is in line with its statutory objectives: that is, if it benefits the environment. The VEWH has bought or sold a small amount of water allocation each year since it was established in 2011. The wet conditions across Victoria in 2016–17 allowed the VEWH to sell 20 GL of water from the Goulburn and Murray systems in 2017.

Water has been purchased to enhance environmental outcomes in systems where insufficient environmental water was available, and it has been sold where foreseeable environmental demands could be met.

The VEWH can use revenue raised from the sale of a water allocation to:

- purchase water to meet shortfalls in any Victorian system
- invest in monitoring or technical studies that will improve future environmental water management
- invest in small structural works and other on-ground activities that will improve the performance of Victoria's environmental watering program.

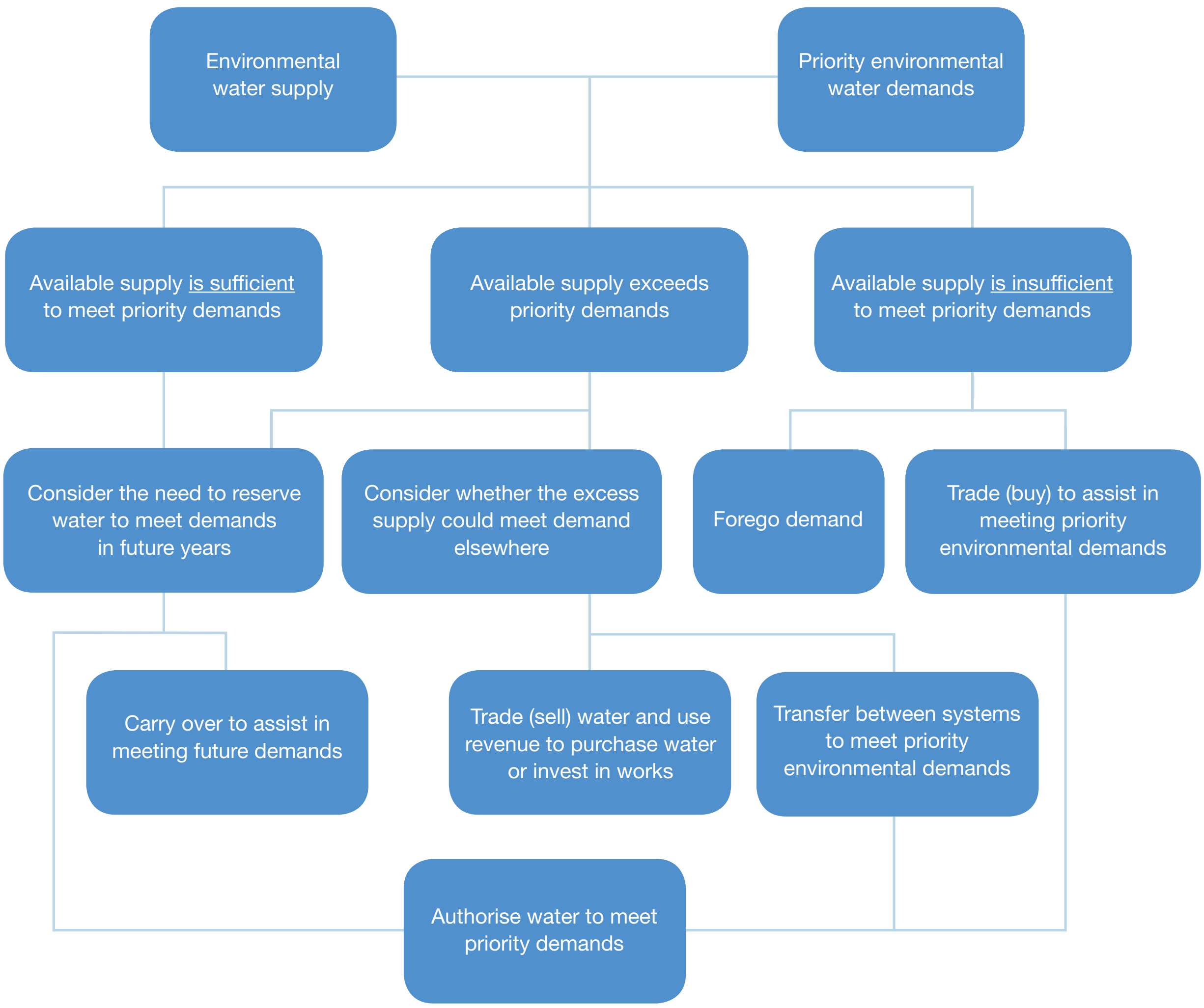
Subject to the approval of the Minister for Water, the VEWH can also trade its water entitlements (referred to as a permanent trade). However, it has not undertaken permanent trades to date.

Figure 1.4.1 shows the key considerations that guide the VEWH's use, carryover and trade decisions.

There is more information about the VEWH's trading activity, including its annual trading strategy, on its website at vewh.vic.gov.au.

Christiane Jaeger canoeing in her favourite wetlands, courtesy Christiane

Figure 1.4.1 Key considerations guiding use, carryover and trade decisions



Transferring between regions to meet priorities

Wet conditions in 2016–17 meant the VEWH did not need to transfer water between regions to address specific needs or shortfalls, but it made transfers to meet high-priority water demands during the last dry period.

In 2014 and again in 2015, there was not enough environmental water to provide spring freshes in the Thomson River to encourage the migration of juvenile Australian grayling. In both those years, the VEWH decided to transfer environmental water from the Yarra system to the Thomson system to deliver on this environmental watering priority.

Australian grayling spawn in downstream reaches of coastal river systems. The juvenile fish then spend time in the sea before migrating back upstream. Flows of specific duration and magnitude are required to trigger both the spawning and the returning migration. In recent years, there have been regular spawning opportunities for Australian grayling in the Thomson River, and monitoring showed that successful spawning and recruitment of Australian grayling had occurred. Until the flow event in 2014, there had been no flows since 2010 to trigger the return of juvenile Australian grayling to the upstream reaches.

Unused environmental water had been carried over in the Yarra system from previous years, and there was sufficient water remaining to provide the planned environmental watering in the Yarra system that year. A risk assessment determined that the transfer posed a low risk to achieving environmental outcomes in the Yarra system but would provide benefits in the Thomson system.

These transfers are an example of how water may be prioritised across different regions. It also shows how use, carryover and trade decisions can optimise the value of available water across the state to achieve environmental outcomes.

Section 2
Gippsland Region

2.1 Gippsland Region overview

There are four systems in Gippsland that can receive water from the VEWH's environmental entitlements: the Latrobe (including the Latrobe River and lower Latrobe wetlands), Thomson, Macalister and Snowy systems.

The landscape

The Macalister and Thomson rivers are tributaries of the Latrobe River. The Macalister River flows into the Thomson River at Riverslea, and the Thomson River joins the Latrobe River a short distance downstream near Sale. The Latrobe River then flows past the Latrobe wetlands (Sale Common, Heart Morass and Dowd Morass) before entering Lake Wellington.

The Snowy River flows south from the Snowy Mountains in NSW and into Victoria and Bass Strait. Storages in the Snowy Mountains Hydro-electric Scheme are connected to the Murray and Murrumbidgee systems via a network of tunnels, pipelines and aqueducts. The system is used for electricity generation and to transfer water from the Snowy River to supply irrigated agriculture in the Murray–Darling Basin.

Environmental values

The Latrobe River and lower Latrobe wetlands (Dowd Morass, Heart Morass and Sale Common) support native vegetation and animals of high conservation significance including threatened waterbirds (such as the freckled duck and intermediate egret) and frogs (such as the green and golden bell frog).

The Thomson and Macalister rivers support several species of native fish including the threatened Australian grayling as well as the common galaxia, tupong and short-finned eel. The Snowy River supports Australian grayling, Australian bass and estuary perch.

Community considerations

Traditional Owners and their Nations in the Gippsland Region had and continue to have a deep connection to its rivers, wetlands and floodplains. The VEWH acknowledges the Traditional Owners of Gippsland and pays respect to their Elders past, present and future. It recognises that water has significant cultural importance and value for Traditional Owners and Aboriginal Victorians.

Traditional Owner groups in and around the Gippsland Region (including for areas where there is no environmental water management) include the Bidwell Maap, Bolga, Boon Wurrung (Bunurong), Jaitmatang, Gunaikurnai (representing the Brataualung, Brayakaulung, Brabralung, Krauatungalung and Tatungalung family clans), Monaro-Ngarigo, Taungurung, Waywurru, Wiradjuri and Yuin peoples, among others.

The West Gippsland CMA has been building relationships with Traditional Owner groups in the region, including Boon Wurrung (Bunurong), over the last few years. They are working towards understanding how environmental water management in the West Gippsland area can better support Aboriginal aspirations.

The Latrobe River is used for electricity generation, irrigation, industrial use and town water supply as well as for recreational fishing. Hunters and birdwatchers use the lower Latrobe wetlands and the Thomson and Snowy rivers are popular for canoeing and kayaking. The Macalister River is part of the Macalister Irrigation District, which draws community attention to its water quality, erosion and vegetation condition. It's also popular for birdwatchers.

Year by year and case by case, the VEWH and its program partners consider opportunities raised by communities to use environmental water to provide additional social, cultural and recreational benefits (for example, releasing environmental water increases the enjoyment of people camping by a waterway, or publicising an environmental water release in advance provides more opportunities for kayakers). Where possible, the VEWH and its program partners incorporate such opportunities into watering decisions, as long as they do not compromise environmental outcomes or increase demand on the water holdings.

When the VEWH plan to use water for the environment, the potential social, economic, aboriginal cultural, and recreational benefits for communities, which could arise from the water's use are considered. Some scoped opportunities for shared community benefits of environmental water in the Gippsland Region for 2017–18 include:

- timing planned flows over long weekends in the upper Thomson River (where there is an overlap with migratory fish spawning and recruitment seasons), to increase whitewater rafting opportunities for kayakers and canoeists
- improving amenity and wetland health to benefit walkers, cyclists, birdwatchers, hunters and campers around the lower Latrobe wetlands
- releasing environmental flows to support downstream migration and recruitment of Australian bass in the Thomson and Macalister rivers, and estuary perch in the Thomson River, increasing opportunities for recreational anglers.

The VEWH's ability to deliver these benefits depends on climate, water available and the way the system is being operated to deliver water for other purposes (such as to homes, farms or businesses).

For more information about scoped opportunities for shared community benefits in 2017–18, contact the VEWH or the relevant waterway manager.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental water planning and releases need to be part of an integrated approach to catchment management. Many of the environmental objectives in this Seasonal Watering Plan will not be fully met without simultaneously addressing excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of streambank vegetation and invasive species, to name just a few issues.

Victorian and Australian government agencies, community groups and private landowners implement many programs to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments. Activities in the Gippsland Region that are planned and implemented to coordinate with environmental water management include:

- work to protect and enhance streambanks along priority reaches of rivers and their tributaries including fencing to exclude stock, revegetation of riverbanks, invasive species control and waterway stabilisation
- work with farmers in the Thomson and Macalister areas on grazing and soil management, and on nutrient and water-use-efficiency projects that help improve water quality and river health
- planning for a fishway on the Thomson River to improve fish passage near the heritage-listed Horseshoe Bend Tunnel and to open up an extra 85 km of habitat for migratory fish including Australian grayling (which environmental water releases target). If the fishway is not built, the ability to meet environmental water objectives for Australian grayling will be limited. The innovative fishway design and construction techniques will protect and enhance the site's important heritage, environmental, recreational and cultural values
- a weed and willow control program in the Snowy River catchment, which has led to 200 km of the river being willow-free: native vegetation is now flourishing and provides a valuable food source and habitat for animals.

For more information about integrated catchment management programs in the Gippsland Region refer to the West Gippsland and East Gippsland regional catchment strategies and waterway strategies.

Seasonal outlook 2017–18

Environmental water available for use in the Latrobe, Thomson and Macalister systems is held in Blue Rock Reservoir, Thomson Reservoir and Lake Glenmaggie respectively.

The Thomson system receives a secure annual allocation (which is available on 1 July each year) as well as a share of the annual inflows to the Thomson Reservoir. The total volume of environmental water available in the Thomson system has recently been bolstered by the recovery of an additional 8 GL of environmental water (3.9 percent of inflows to Thomson Dam). In the Latrobe and Macalister systems, water availability depends more on seasonal conditions. Most inflows occur in winter and spring, so more will be known about likely allocations early in 2017–18.

Under moderate streamflow forecasts, environmental water is expected to be available to achieve the highest-priority watering actions in the Latrobe, Thomson and Macalister rivers. Additional environmental water may be sought via transfers from within the Gippsland system or from another region, if seasonal allocations are not adequate to meet critical environmental outcomes.

The Latrobe wetlands receive most water from natural and unregulated flows. Water can also be actively diverted from the Latrobe River into Sale Common, Heart Morass or Dowd Morass when river levels are high.

Planning and delivery of environmental water in the Snowy system is managed by the NSW Department of Primary Industries, which consults the Victorian and Australian governments and stakeholder groups about environmental water released to the Snowy River.

Aerial view of the upper Latrobe, by David Stork

2.2 Latrobe system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

The Latrobe system (which includes the Latrobe River and lower Latrobe wetlands) is one of the most modified rivers in Victoria, yet it still supports plant and animal species of high conservation significance including several threatened vegetation types and waterbird, fish and frog species. The Latrobe River also provides an essential source of freshwater to the Ramsar-listed Gippsland Lakes site, of which the lower Latrobe wetlands are an important component.

Engagement

Table 2.2.1 shows the partners and stakeholder organisations with which West Gippsland CMA engaged when preparing the Latrobe system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the West Gippsland Regional Catchment Strategy and West Gippsland Waterway Strategy.

Table 2.2.1 Partners and stakeholders engaged in developing the Latrobe system seasonal watering proposal

Partner and stakeholder engagement
• Wetlands Environmental Taskforce, a registered environmental organisation that purchases and restores wetlands in Australia • Field and Game Australia • Latrobe Valley Field Naturalists Club • irrigators and farmers • Southern Rural Water • Parks Victoria • VEWH

2.2.1 Latrobe River

The Latrobe River originates on the Mount Baw Baw Plateau and flows into Lake Wellington, the westernmost point of the Gippsland Lakes.

Environmental values

The upper Latrobe River is relatively intact and contains some continuous stands of river red gums and a tall shrub layer. The banks along the lower reaches support stands of swamp scrub, an endangered vegetation type that is characterised by swamp paperbark and tea tree. Mature river red gums grow adjacent to the lower Latrobe wetlands and provide nesting habitat for sea eagles and other birds of prey that hunt in the wetlands. The Latrobe River contains native estuarine and freshwater fish species including black bream, Australian bass, Australian grayling and short- and long-finned eel.

The lower Latrobe River flows through the Latrobe Valley and is very degraded due to historic river management practices. Most snags have been removed from the river and many sections have been artificially straightened. These actions have reduced much of the habitat on which aquatic plants and animals depend.

Social, cultural and economic values

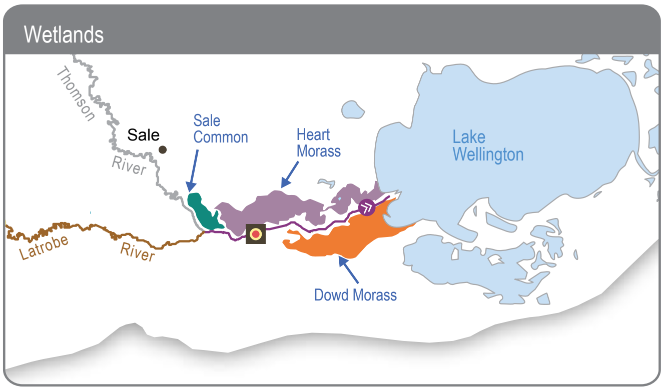
Despite the recent closure of Hazelwood Power Station, the Latrobe Valley remains central to Victoria's energy industry, and water from the Latrobe River is essential for electricity generation. The lower Latrobe River is commercially fished for eel and carp. It also contains black bream and estuary perch, which are favoured by recreational fishers. The waterways in the Latrobe system hold significance for Traditional Owners. Waterways and wetlands in the region contain important ceremonial places and for thousands of years the Latrobe River provided resources such as food and medicines to the Gunaikurnai people. Many of the region's wetlands are popular with walkers, birdwatchers and hunters.

Environmental watering objectives in the Latrobe River

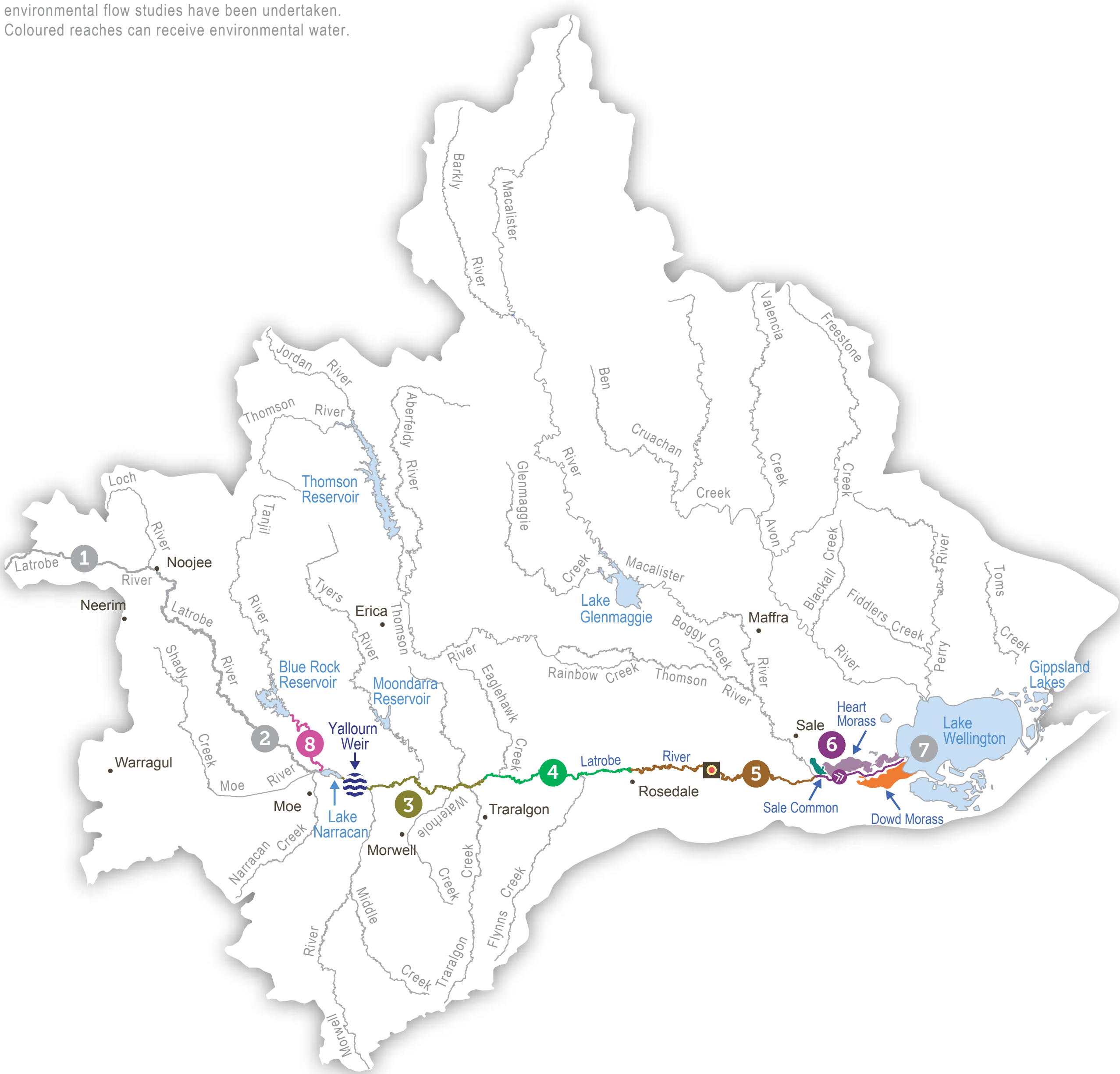
Form in-stream bars to help stabilise the structure and condition of the river channel, helping reduce the load of sediment and nutrients flowing into the Gippsland Lakes
Establish native plants on bars and lower parts of the banks to stabilise the river channel
Improve habitat for native fish including black bream and estuary perch

Figure 2.2.1 The Latrobe system

Reach 1 Upstream of Willow Grove
Reach 2 Willow Grove to Lake Narracan
Reach 3 Lake Narracan to Scarnes Bridge
Reach 4 Scarnes Bridge to Rosedale
Reach 5 Rosedale to Thomson River confluence
Reach 6 Downstream of Thomson confluence
Reach 7 Lake Wellington
Reach 8 Tanjil River
Water infrastructure
Measurement point
Town
Indicates direction of flow



Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.



System overview

Environmental water is supplied to the Latrobe River from Blue Rock Reservoir on the Tanjil River. The reservoir also supplies water for other entitlement holders including electricity generators in the Latrobe Valley.

The Latrobe River from Rosedale to the Thomson River confluence (reach 5) is the priority for environmental watering because it contains endangered plant communities that have good potential for recovery.

Recent conditions

Unregulated flows associated with above-average rainfall in winter and spring 2016 met the environmental targets for low flows and freshes between July and October. Simultaneous high flows in the Thomson River and upper Latrobe River caused minor flooding in the lower Latrobe River in July 2016. High inflows to Blue Rock Reservoir meant that the maximum environmental allocation of 18,737 ML was reached in August. This meant the West Gippsland CMA was in a good position to deliver environmental water for the remainder of the year.

Summer and autumn 2017 had below-average rainfall. Summer low flows were below the recommended environmental flow requirements and freshes were infrequent. A planned environmental flow release from Blue Rock Reservoir to relieve environmental stress associated with unnaturally low flows in February was cancelled because of concern that increased flows would flush poor-quality water into the Tanjil River and compromise the local town supply. This is a good example of the challenges of managing environmental water deliveries to rivers that are used for multiple purposes (such as water supply, industry and recreation).

An autumn fresh of 1,300 ML/day was delivered in April and May 2017. The release was coordinated with releases in the Macalister and Thomson rivers to create a flow that was large enough to flush the salt wedge that forms in the lower Latrobe River each summer.

Scope of environmental watering

Table 2.2.2 shows potential environmental watering actions and their environmental objectives.

Table 2.2.2 Potential environmental watering actions and objectives for the Latrobe River

Potential environmental watering	Environmental objectives
Spring/summer freshes (1,300 ML/day for 2–4 days in September–February)	• Increase vegetation diversity, condition and abundance along lower banks and increase recruitment of in-stream vegetation
Autumn/winter freshes (1,300 ML/day for 2–4 days in March-August)	
Winter/spring low flows (690–1,500 ML/day in June–November)	• Form in-stream bars (elevated deposits of sediment and gravel in the river channel)
Summer/autumn low flows (up to 690 ML/day in December–May)	• Provide in-stream habitat for aquatic biota (especially waterbugs, fish and vegetation)

Scenario planning

Table 2.2.3 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The long-term aim for the Latrobe River is to rehabilitate vegetation and improve the channel structure. Spring freshes help to achieve these objectives by accelerating the growth of established riparian vegetation and increasing the recruitment of new plants, which in turn stabilises banks and increases habitat.

Climate and rainfall from July to November is an important consideration in deciding when to use environmental water to meet vegetation objectives. In a drought or dry year there is likely to be only a small contribution from unregulated flows, so delivery freshes in spring and summer are a high priority to maintain riparian vegetation. A secondary priority under drought and dry scenarios is to deliver high-magnitude winter low flows in June to assist with formation of in-stream bars and to prevent encroachment of terrestrial vegetation.

Inflows during an average or wet year are likely to cause Blue Rock Reservoir to spill, which should meet the main environmental flow objectives for spring. Under such circumstances, environmental water that would normally be used for spring freshes can be reserved to meet other objectives in late summer and autumn.

Table 2.2.3 Potential environmental watering for the Latrobe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Small contributions from unregulated reaches and tributaries of the Latrobe River with little opportunity for freshes to occur naturally • Consumptive demand from Blue Rock Reservoir will be very high and regular releases to the Tanjil River will contribute substantially to low flows	• There will be some unregulated flows that contribute to low flows and freshes, but extended periods of high flows will be absent and freshes will be infrequent • Consumptive demand from Blue Rock Reservoir will be high and contribute to low flows	• Unregulated flows will provide low flows and multiple freshes, most likely in winter and spring • Some spills are likely and there will be releases for consumptive users which will partly contribute to low flows	• Multiple spills from Blue Rock Reservoir will provide extended durations of high flows and overbank flows • No significant releases from consumptive entitlements in Blue Rock Reservoir are likely
Expected availability of environmental water	• 16,200 ML	• 18,200 ML	• 18,700–23,200 ML	• 18,700–31,200 ML
Potential environmental watering	• 1 spring/summer fresh • 1 autumn/winter fresh • Winter/spring low flows	• Up to 3 spring/ summer freshes • Up to 2 autumn/ winter freshes • Winter/spring low flows • Summer/autumn low flows	• Up to 3 spring/ summer freshes • Up to 3 autumn/ winter freshes • Winter/spring low flows • Summer/autumn low flows	• Up to 4 spring/ summer freshes • Up to 4 autumn/ winter freshes • Winter/spring low flows • Summer/autumn low flows
Possible volume of environmental water required to achieve objectives	• 12,300 ML	• 11,200 ML	• 15,900 ML	• 0–11,000 ML

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

2.2.2 Lower Latrobe wetlands

The lower Latrobe wetlands are Sale Common, Dowd Morass and Heart Morass. The wetlands are on the floodplain of the Latrobe River between its confluence with the Thomson River and Lake Wellington.

Environmental values

The lower Latrobe wetlands (Dowd Morass, Heart Morass and Sale Common) are an important component of the internationally recognised Gippsland Lakes Ramsar site and provide habitats for a variety of waterbirds. Colonial waterbirds (such as royal spoonbill and straw-necked and Australian white ibis) breed in spring among the swamp paperbark trees at these wetlands. Migratory shorebirds (such as sandpipers) feed on the mudflats that are exposed as the wetlands draw down and dry over summer. Waterfowl and fish-eating birds (such as egrets) use available open-water habitat at the wetlands year-round.

Saltwater intrusion from the Gippsland Lakes is a constant threat to environmental values in Dowd Morass and Heart Morass. Rising sea levels from climate change will continue to exacerbate that threat. Although Heart Morass's vegetation has been degraded by many years of grazing, much wetland on private property is now recovering with the aid of restoration programs. The establishment and growth of aquatic vegetation is affected by carp in all wetlands. An invasive aquatic weed, Brazilian milfoil, has colonised much of the fringe of Sale Common, whereas its spread to Heart Morass and Dowd Morass is probably limited by salinity in those wetlands.

Social, cultural and economic values

Sale Common is a state game refuge located close to the city of Sale that provides an excellent opportunity to observe native plants and animals. Dowd Morass is a state game reserve commonly used by hunters. Heart Morass consists of mostly private landholdings and is also used by hunters. An appropriate water regime in the lower Latrobe wetlands increases waterbird abundance and provides opportunities for birdwatching and hunting when the wetlands are in a wet phase.

The lower Latrobe wetlands hold significance for Traditional Owners. Waterways and wetlands in the area contain important ceremonial places and for thousands of years the lower Latrobe wetlands have provided resources such as food and medicines to the Gunaikurnai people.

Environmental watering objectives in the lower Latrobe wetlands

Increase dispersal and germination of wetland plants
Provide habitat for waterbirds
Reduce the abundance of carp, particularly at Sale Common and Dowd Morass

System overview

River regulation and water extraction from the Latrobe, Thomson and Macalister rivers has reduced the frequency of small and medium-sized floods that naturally inundate the lower Latrobe wetlands. Construction of levees and drains and the filling in of natural depressions have also altered water movement into and through the wetlands. The drainage and flooding regime in all three wetlands is now managed to some extent by using regulators connected to the Latrobe River.

Recent conditions

Although inflows to the wetlands were infrequent and small-scale in 2016–17, inflows from the Latrobe River to Sale Common, Dowd Morass and Heart Morass did occur in winter. The 2016–17 summer and autumn was quite mild, and the wetlands' levels have not receded as much as they did the previous year.

In Sale Common, there was an excellent environmental response in winter. Filling began slowly in June, providing clear water that prompted good growth of aquatic vegetation. Vegetation growth was helped by the low abundance of carp, which were screened from the wetland. A larger overbank flow in July inundated the wetland with more turbid water and lots of carp, but it also triggered the largest breeding event of black swans locals have seen in a decade.

A combination of low water levels in Dowd Morass, a strong easterly wind and a high tide caused saltwater intrusion from Lake Wellington to Dowd Morass in May 2016. Salinity increased in Dowd Morass to almost half that of seawater (19,000 EC), threatening the condition of swamp paperbark that ibis and spoonbill use for nesting. Regulators to Dowd Morass from the Latrobe River are old and were not designed to manage environmental water. On their own, the regulators cannot provide the necessary volume of freshwater from the Latrobe River to dilute salt build-up in Dowd Morass. Large natural inflows in July eventually reduced salinity to about 4,000 EC and the main regulator to Dowd Morass has remained open all year to allow as much mixing as possible. Despite this, salinity levels remained higher than the desired threshold. New regulators for managing environmental flows in Dowd Morass and Heart Morass have been designed and will be constructed when funding is available.

Although salt water intruded into Heart Morass in 2016, the impacts were not severe because levees protected it from Lake Wellington and the wetland was partially filled with environmental water from the Latrobe River in autumn 2016. The environmental water provided in March–May 2016 was the first delivery to Heart Morass under the *Lower Latrobe Wetlands Environmental Entitlement 2010*. The delivery was made with the agreement of private property owners in the wetland, and it provided great benefit for swans that fed on the wetland plants that germinated as a result of the delivery.

Scope of environmental watering

Table 2.2.4 shows potential environmental watering actions and their environmental objectives.

Table 2.2.4 Potential environmental watering actions and objectives for the lower Latrobe wetlands

Potential environmental watering	Environmental objectives
Sale Common	
Fill or partial fill (July–November)	• Increase the growth and recruitment of wetland plants, particularly tall marsh, aquatic herbland and aquatic sedgeland • Provide feeding and breeding habitat for wetland animals, particularly waterbirds and frogs
Fill or partial fill (any time)	• Control invasive plants and algae
Partial or complete drawdown (year-round, primarily August–March)	• Oxygenate surface soils, break down accumulated organic matter and cycle nutrients • Increase the growth and recruitment of wetland plants across the wetland bed • Reduce the abundance of European carp
Fill or partial fill (February–May)	• Provide feeding and sheltering habitat for wetland animals, particularly waterbirds and frogs • Restrict the spread of giant rush
Dowd Morass and Heart Morass	
Fill or partial fill (Dowd Morass: July–November) (Heart Morass: July–December)	• Trigger colonial waterbird breeding • Reduce salinity • Increase the growth and recruitment of wetland plants, particularly swamp scrub, tall marsh, aquatic herbland and brackish herbland • Provide feeding and breeding habitat for wetland animals, particularly waterbirds and frogs
Partial or complete drawdown (year-round, primarily August–March)	• Oxygenate surface soils, break down accumulated organic matter and cycle nutrients • Increase the growth and recruitment of wetland plants, particularly swamp shrub, tall marsh, aquatic herbland and brackish herbland • Reduce the abundance of European carp
Fill or partial fill (February–May)	• Provide feeding habitat for wetland animals, particularly waterbirds
Fill or partial fill (any time)	• Control salinity and reduce the risk of acid sulphate soils

Scenario planning

Table 2.2.5 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Natural flows are very influential in the Latrobe wetlands. In a drought and dry year, all three wetlands are likely to draw down and may dry completely. Partial drawdowns will occur in an average year, but if conditions are wet the ability to manage drawdown is diminished, and uncontrolled flows will provide widespread inundation throughout the year.

The approach in 2017–18 will be to allow water levels to fluctuate according to natural seasonal conditions. Some small-scale flooding and controlled drainage may be managed to mimic and amplify the natural conditions and improve environmental outcomes. Partial fills or top-ups may be delivered at any time to mitigate risks of high salinity and activation of acid sulphate soils, or to provide habitat and breeding opportunities for waterbirds.

Table 2.2.5 Potential environmental watering for the lower Latrobe wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No natural inflows from the Latrobe River, and wetlands are likely to dry completely	• Minor natural inflows from the Latrobe River at any time of the year	• Moderate winter and spring flows in the Latrobe River are likely to fill or partially fill the wetlands; expect minor drawdown in summer	• Major flows in the Latrobe River in winter/spring and possibly autumn/winter are likely to fill all wetlands
Sale Common				
Potential environmental watering[1]	• Complete drawdown (July–June) • Fill or partial fill (any time)	• Partial drawdown (August–April) • Fill or partial fill (any time) • Fill or partial fill (February–May)	• Fill or partial fill (July–November) • Fill or partial fill (February–May) • Fill or partial fill (any time) • Partial drawdown (August–March)	• Fill (July–November) • Fill or partial fill (February–May) • Fill or partial fill (any time) • Partial drawdown (December–March)
Possible volume of environmental water required to achieve objectives	• 0–1,300 ML	• 0–2,600 ML	• 0–2,600 ML	• 0 ML
Dowd Morass				
Potential watering actions[1]	• Complete drawdown (July–June) • Fill or partial fill (any time)	• Fill or partial fill (any time) • Partial drawdown (August–April) • Fill or partial fill (February–May)	• Fill or partial fill (July–November) • Fill or partial fill (any time) • Partial drawdown (August–March) • Fill or partial fill (February–May)	• Fill (July–November) • Partial drawdown (December–March) • Fill or partial fill (February–May) • Fill or partial fill (any time)
Possible volume of environmental water required to achieve objectives	• 0–5,800 ML	• 0–11,600 ML	• 0–11,600 ML	• 0 ML
Heart Morass				
Potential watering actions[1]	• Complete drawdown (July–June) • Fill or partial fill (any time)	• Fill or partial fill (any time) • Partial drawdown (August–April) • Fill or partial fill (February–May)	• Fill or partial fill (July–December) • Fill or partial fill (February–May) • Fill or partial fill (any time) • Partial drawdown (August–April)	• Fill (July–December) • Fill or partial fill (February–May) • Fill or partial fill (any time) • Partial drawdown (December–March)
Possible volume of environmental water required to achieve objectives	• 0–7,100 ML	• 0–14,200 ML	• 0–14,200 ML	• 0 ML

[1] *Potential watering actions are listed in priority order for each scenario. The order and timing may vary within scenarios depending on inter-seasonal variability.*

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

2.3 Thomson system

Waterway manager – West Gippsland Catchment Management Authority

Storage managers – Melbourne Water (Thomson Reservoir), Southern Rural Water (Cowwarr Weir)

Environmental water holder – Victorian Environmental Water Holder

The Thomson River flows from the slopes of the mountains of the Baw Baw Plateau to join the Latrobe River south of Sale. The major tributaries of the Thomson River are the Aberfeldy, Jordan and Macalister rivers, with most unregulated flows originating from the Aberfeldy River.

Environmental values

The Thomson River supports seven species of migratory fish that need to move between the sea and freshwater environments during parts of their life cycle. The threatened Australian grayling is the most significant of these species and is one of the species targeted with environmental flows in the Thomson River. Australian grayling spawn in response to autumn high flows, and the eggs and juveniles spend time at sea before returning to the freshwater reaches of coastal rivers.

The composition and condition of riparian vegetation varies throughout the Thomson River catchment. The vegetation is intact and near-natural upstream of Thomson Reservoir in the Baw Baw National Park. Between Thomson Reservoir and Cowwarr Weir it is mostly in good condition but is moderately infested with blackberry and gorse. Downstream of the Cowwarr Weir, the vegetation is degraded due to stock access and widespread weed invasion.

Social, cultural and economic values

Thomson Reservoir is the largest storage in Melbourne's water supply system and also supplies water to irrigators and towns in Gippsland.

The Thomson River is highly valued for recreation downstream of the Thomson Reservoir to upstream of Cowwarr Weir. The area is popular for camping, kayaking and canoeing. Avid kayakers, canoeists and outdoor recreation operators often take advantage of the whitewater conditions provided with environmental water releases in the upper reaches of the Thomson River.

Waterways in the Thomson system including the Thomson River continue to hold significance for Traditional Owners. Rivers and wetlands in the region contain important ceremonial places and for thousands of years the Thomson River has provided resources such as food and materials to Traditional Owner groups (such as the Gunaikurnai people).

Environmental watering objectives in the Thomson system

Protect and increase populations of native fish, specifically Australian grayling, by providing pool habitat and flows for fish to move upstream and downstream, and to cue spawning
Scour silt build-up in the river bed to improve the quality of in-stream habitat for aquatic plants and animals
Increase recruitment and growth of native riparian vegetation

System overview

Environmental water in the Thomson system is held in Thomson Reservoir. A new environmental entitlement in the Thomson system which will provide an additional 3.9 percent of Thomson Reservoir inflows per year will become available for the first time in 2017–18. This extra environmental water will help meet more of the environmental flow objectives for the Thomson River and will provide benefits to native fish including Australian grayling, tupong and Australian bass.

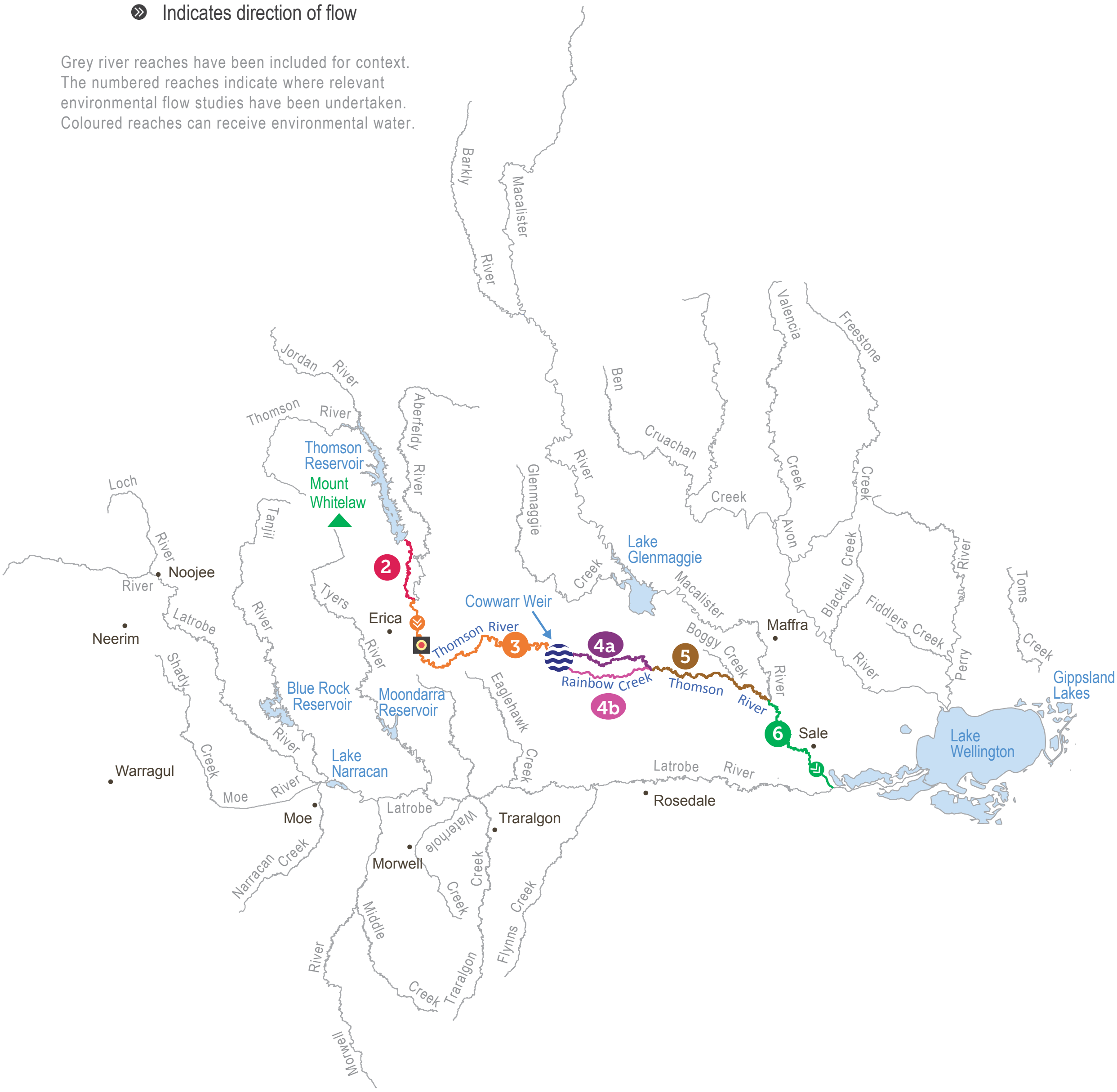
Reach 3 of the Thomson River (from the Aberfeldy River confluence to Cowwarr Weir) is the highest priority for environmental watering due to its heritage river status, relatively intact native riparian vegetation, high-quality in-stream habitat and low abundance of exotic fish species.

At Cowwarr Weir, the Thomson River splits in two and water can move down the old Thomson River course (reach 4a) and Rainbow Creek (reach 4b). The preference is to pass environmental water down the old Thomson River course to enable fish migration, as Cowwarr Weir prevents migration through Rainbow Creek. The passing flows are split two-thirds down reach 4a and one-third down 4b throughout the year to avoid impacts on Rainbow Creek irrigation customers.

Figure 2.3.1 The Thomson system

Reach 2 Thomson River: Thomson Dam to Aberfeldy River
Reach 3 Thomson River: Aberfeldy River to Cowwarr Weir
Reach 4a Old Thomson River: Cowwarr Weir to Rainbow Creek
Reach 4b Rainbow Creek: Cowwarr Weir to Thomson River
Reach 5 Thomson River: Rainbow Creek/Old Thomson confluence to Macalister River
Reach 6 Thomson River: Macalister River to Latrobe River
Water infrastructure
Measurement point
Town
Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.



Recent conditions

Climatic conditions have varied significantly over the last two years. The 2015–16 water year had below-average rainfall and was very dry. The 2016–17 water year had average to above-average rainfall throughout the winter and spring and below-average rainfall in summer and autumn. These conditions contributed to high and frequent irrigation demands during summer for the last two years.

Environmental water releases in recent years have focussed on providing autumn and spring freshes for spawning and recruitment opportunities for native fish species including Australian grayling, tupong and Australian bass. Low flows have also been provided to enable fish to move between habitats along the river. Wet conditions in winter and spring 2016 meant some of the planned environmental water deliveries were not needed because the objectives were met by unregulated flows. Two spring freshes, two winter freshes and one bankfull event were provided via unregulated flows in 2016–17.

An autumn fresh was provided in 2016 with a reduced magnitude (600 ML/day peak flow rather than 800 ML/day) to test whether Australian grayling would spawn at a lower flow. Monitoring during the event detected very little spawning and therefore the autumn fresh in autumn 2017 and the planned fresh for autumn 2018 will deliver peaks of 800 ML/day, which is known to trigger Australian grayling spawning behaviour.

Scope of environmental watering

Table 2.3.1 shows potential environmental watering actions and their environmental objectives.

Table 2.3.1 Potential environmental watering actions and objectives for the Thomson system

Potential environmental watering	Environmental objectives
Spring freshes (1–2 freshes of 800 ML/day for 4 days each in September–October)	• Encourage recruitment of juvenile migratory fish species from the estuary and ocean
Spring low flows (230 ML/day from October–November)	• Provide improved passage along the river to enable localised fish movement between habitats
Autumn freshes (1–2 freshes of 800 ML/day for 4 days each in April–May)	• Provide a downstream migration and spawning cue for migratory fish species including Australian grayling
Autumn/winter low flows (230 ML/day from May–June)	• Provide improved passage along the river to enable localised fish movement between habitats
Winter freshes (up to 4 freshes of 800 ML/day for 4 days in June–August)	• Provide a migration and spawning cue for migratory fish species including tupong and Australian bass • Maintain/increase riparian vegetation
Summer/autumn freshes (up to 7 freshes of 230 ML/day for 4 days in December–April)	• Maintain/enhance the native fish community structure by providing habitat • Maintain/increase submerged aquatic vegetation • Scour sediment exposing fresh habitat areas • Maintain/enhance habitat for waterbugs

Scenario planning

Table 2.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The highest environmental water priorities in the Thomson River in 2017–18 include autumn and winter high flows to provide cues for migration and spawning of Australian grayling and other migratory species, spring freshes to trigger recruitment of juvenile diadromous fish species to move into the river from the estuary or the sea, and autumn/winter low flows to connect pool habitats and allow fish to move along the river to access food and other resources. The priorities apply to the drought and dry scenarios. Under average or wet conditions, many of the environmental flow objectives will likely be met by unregulated flows. Under those circumstances, environmental water may be used to deliver spring freshes and additional winter freshes to increase migration and recruitment opportunities.

Table 2.3.2 Potential environmental watering for the Thomson system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flows very limited • Large volumes of consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows and freshes • Moderate volumes of consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows, freshes and high flows • Some consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows, freshes and sustained high flows • Minimal consumptive water released from storage
Expected availability of environmental water	• 17,000–20,000 ML	• 20,000–23,000 ML	• 23,000–26,000 ML	• 26,000–>29,000 ML
Potential environmental watering – tier 1 (high priorities)	• 1 autumn fresh • Spring and autumn low flow • 1 winter fresh • 1 summer fresh	• 1 autumn fresh • Spring and autumn low flow • 1 winter fresh • 1 summer fresh	• 1 autumn fresh • Spring and autumn low flow • 1 winter fresh • 1 spring fresh • 1 summer fresh	• 1 autumn fresh • Spring and autumn low flow • 2 winter freshes • 1 spring fresh • 1 summer fresh
Potential environmental watering – tier 2 (lower priorities)[1]	• 1 spring fresh • Increase duration of autumn low flow	• 1 spring fresh	• 1 winter fresh • Increase duration of autumn low flow	• 1 winter fresh • Increase duration of autumn low flow
Possible volume of environmental water required to achieve objectives[2]	• 14,600 ML (tier 1) • 6,200 ML (tier 2)	• 16,900 ML (tier 1) • 3,900 ML (tier 2)	• 20,500 ML (tier 1) • 4,420 ML (tier 2)	• 23,600 ML (tier 1) • 4,580 ML (tier 2)
Priority carryover requirements	• 5,400 ML			

1 *Tier 2 actions are lower-priority actions to be considered if water is available.*

2 *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 2.3.3 shows the partners with which West Gippsland CMA engaged when preparing the Thomson system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the West Gippsland Regional Catchment Strategy and West Gippsland Waterway Strategy.

Table 2.3.3 Partners engaged in developing the Thomson system seasonal watering proposal

Partner engagement
• Southern Rural Water • Melbourne Water • VEWH

2.4 Macalister system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

The Macalister River flows from Mt Howitt in the Alpine National Park to join the Thomson River south of Maffra. The river meanders in a south-easterly direction through predominantly forested, confined valleys and narrow floodplains upstream of Lake Glenmaggie to cleared, wide, alluvial floodplains downstream. The Macalister River is regulated by Lake Glenmaggie, the major water-harvesting storage and Maffra Weir, a small diversion weir located further downstream in the Maffra township. Both storages divert water for irrigation, urban and industrial purposes. Environmental water is stored in Lake Glenmaggie.

Environmental values

There are seven migratory native fish species in the Macalister River that move between freshwater and marine environments to complete their life cycle. These are the Australian grayling, short- and long-finned eel, tupong, Australian bass, short-headed lamprey and common galaxias. Platypus and water rat are widely distributed through the Macalister River and its tributaries.

The riparian vegetation corridor is fragmented. Immediately downstream of Lake Glenmaggie, the vegetation is in good condition and includes remnant river red gums. It is degraded elsewhere. The cover of in-stream vegetation and non-woody plants that colonise the fringes of the river (such as reeds, sedges and rushes) have declined in recent years. The decline may be due to a combination of increased water turbidity, erosion and lack of an appropriate water regime to encourage plant growth.

Social, cultural and economic values

The Macalister Irrigation District is the major economic driver in the area and water from the Macalister system is highly valued by the local community. As a result, there is a genuine interest in the health of the Macalister River, particularly around water quality, erosion and vegetation condition. People also use the river for recreational fishing and birdwatching. The waterways in the Macalister system including the Macalister River continue to hold significance for Traditional Owners. Waterways and wetlands in the region contain important ceremonial places and for thousands of years the Macalister River provided resources such as food and medicines for the Gunaikurnai people.

Environmental watering objectives in the Macalister system

Increase the range and population size of native fish species including Australian grayling and other native migratory fish
Improve vegetation communities including macrophytes (large water plants) in the river channel Improve fringing woody vegetation in the riparian zone
Increase the abundance and number of waterbugs
Maintain the form of the river bank and bed

System overview

Before Lake Glenmaggie was built, the Macalister River would regularly receive high and medium flows in winter and spring. Although Lake Glenmaggie regularly spills, these flows are now less common as they are harvested by the storage. A notable impact of irrigation and water harvesting is reversed seasonality of flows between Lake Glenmaggie and Maffra Weir, where summer flows are higher than natural due to the delivery of irrigation water. Winter flows are lower-than-natural because a high proportion of the inflows are harvested. Downstream of Maffra Weir, most flows are diverted for irrigation in summer and autumn. The changed hydrology restricts fish migration, limits the growth and recruitment of in-stream and riparian plants and reduces the quality of in-stream habitat.

Maffra Weir is a major barrier to fish movement and environmental flows that target migratory fish objectives mainly focus on reach 2, which is downstream of the weir. All other objectives apply to both reaches 1 and 2.

Figure 2.4.1 The Macalister system

Recent conditions

The last two years have seen the Macalister River experience very different climatic conditions. 2015–16 was very dry, with average to below-average rainfall in winter and a dry summer. In contrast, 2016–17 had average to above-average rainfall throughout the winter and spring, followed by a dry summer. Irrigation demands over summer and autumn have been relatively high. Environmental water deliveries over the last two years have mainly been used to provide autumn freshes to trigger Australian grayling spawning, winter freshes for migration and spawning of Australian bass and tupong, and low flows to provide connectivity between habitats for fish movement.

High rainfall in winter and spring 2016 resulted in Lake Glenmaggie spilling from July to November. The river experienced two bankfull flows in this period, the first bankfull flows in the Macalister River since 2012. These events help to disturb and reset dominant riparian vegetation. The floods also inundated some floodplain habitats, which provided food and breeding opportunities for turtles, frogs and some waterbirds.

All planned environmental watering events for 2016–17 were achieved, either through managed delivery of environmental water or through spill releases from Lake Glenmaggie.

Scope of environmental watering

Table 2.4.1 shows potential environmental watering actions and their environmental objectives.

Table 2.4.1 Potential environmental watering actions and objectives for the Macalister system

Potential environmental watering	Environmental objectives
Macalister River reaches 1 and 2	
Autumn/winter low flows (90 ML/day in May–July)	• Provide habitat for waterbugs • Provide passage for fish to undertake localised movements • Maintain water quality in pools and connectivity for fish, platypus and water rats • Maintain areas of slow-moving water for submerged aquatic vegetation
Spring fresh (1,500 ML/day for 3 days in September–October)	• Trigger upstream migration and recruitment for juvenile fish • Trigger upstream migration for lampreys and eels • Provide variability in water levels and wet the fringing woody vegetation • Scour sediment exposing fresh habitat areas • Provide food and habitat for waterbugs
Macalister River reach 2	
Autumn fresh (350 ML/day for 4–5 days in April–May)	• Trigger downstream migration and spawning of Australian grayling
Winter fresh (700 ML/day for 4–5 days in June–August)	• Trigger downstream migration and spawning of tupong and Australian bass
Spring/summer fresh (700 ML/day for 5 days in September–December)	• Trigger upstream migration and recruitment for juvenile fish • Trigger upstream migration for adult lampreys and eels
Summer/autumn fresh (140 ML/day for 3 days in December–May)	• Provide sufficient depth to allow fish to move throughout the reach • Flush pools to maintain water quality for waterbugs

Scenario planning

Table 2.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The highest-priority use of environmental water in 2017–18 will be to provide flows that trigger migration, spawning and recruitment of native migratory fish species. These flows will specifically target Australian grayling, Australian bass and tupong, which all need to move between freshwater and the sea to complete their life cycles.

In a drought scenario, an autumn fresh will be provided for Australian grayling and a winter fresh will be provided for tupong and Australian bass. The VEWH expects enough environmental water will be available to provide autumn and winter low flows and a summer fresh if needed to improve water quality and allow fish to move between habitats in the river. Autumn flows remain a high priority when conditions are dry because these are the most impacted flows in reach 2, where most water is diverted for irrigation.

If extra environmental water is available under dry and average scenarios, it will be used to deliver spring freshes, to provide recruitment opportunities for juvenile Australian grayling, tupong and eels and adult short-headed lampreys to migrate upstream from estuarine and marine habitats. Under wet conditions, environmental water may be used to extend the duration and/or magnitude of managed flow events to optimise ecological outcomes.

Carrying over some water into July 2018 is a high priority under all scenarios to ensure there is sufficient water to maintain low flows through reaches 1 and 2 outside the irrigation season and to continue the winter fresh through to the next year if required.

Table 2.4.2 Potential environmental watering for the Macalister system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Passing flows at Maffra Weir reduced	• Possible spills from Lake Glenmaggie in spring, minor flood levels may occur • Passing flows at Maffra Weir may be reduced	• Regular spills from Lake Glenmaggie in spring, minor to moderate flood levels may occur	• Large and frequent spills from Lake Glenmaggie, moderate to major flood levels may occur
Expected availability of environmental water	• 13,100 ML	• 16,400 ML	• 18,400 ML	• 22,900 ML
Potential environmental watering – tier 1 (high priorities)	• 1 autumn fresh • 1 winter fresh • Autumn/winter low flow • 1 summer fresh	• 1 autumn fresh • 1 winter fresh • Autumn/winter low flow • 1 summer fresh • 1 spring fresh	• 1 autumn fresh • 1 winter fresh • Autumn/winter low flow • 1 summer fresh • 1 spring fresh	• 1 autumn fresh • 1 winter fresh • Autumn/winter low flow • 1 spring fresh
Potential environmental watering – tier 2 (lower priorities)[1]	• 1 spring fresh	• N/A	• Increase magnitude of spring fresh	• N/A
Possible volume of environmental water required to meet objectives[2]	• 9,800 ML (tier 1) • 3,400 ML (tier 2)	• 13,300 ML (tier 1)	• 15,200 ML (tier 1) • 6,600 ML (tier 2)	• 19,800 ML (tier 1)
Priority carryover requirements	• 3,100 to 3,200 ML			

[1] *Tier 2 actions are lower-priority actions to be considered if water is available.*

[2] *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Orange threadtail damselfly at Bellbird Corner, Macalister River, by Duncan Fraser

Risk management

In preparing its seasonal watering proposal, West Gippsland CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 2.4.3 shows the partners and stakeholder organisations with which West Gippsland CMA engaged when preparing the Macalister system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the West Gippsland Regional Catchment Strategy and West Gippsland Waterway Strategy.

Table 2.4.3 Partners and stakeholders engaged in developing the Macalister system seasonal watering proposal

Partner and stakeholder engagement
• VRFish • Environment Victoria • Maffra & Districts Landcare Network • Native Fish Australia • Macalister Irrigation District irrigators and diverters • Gurnaikurnai Land and Waters Aboriginal Corporation • Wellington Shire Council • Southern Rural Water • VEWH • Gippsland Water

2.5 Snowy system

Waterway managers – New South Wales Department of Primary Industries (Water) and East Gippsland CMA

Storage manager – Snowy Hydro Limited

Environmental water holder – Victorian Environmental Water Holder and New South Wales Department of Primary Industries (Water)

The Snowy River originates on the slopes of Mount Kosciuszko. It drains the eastern slopes of the Snowy Mountains in NSW before flowing through the Snowy River National Park in Victoria and emptying into Bass Strait.

Environmental values

Construction and operation of the Snowy Mountains Hydro-electric Scheme has previously diverted 99 percent of the Snowy River's mean annual natural flow at Jindabyne, which has caused changes to the structure and function of the river, reduced the opening of the Snowy River entrance to Bass Strait and resulted in a decline in environmental values.

Despite the reduction in flows, the Snowy River supports many environmental values. The upper reaches and tributaries of the Snowy River contain freshwater species such as river blackfish and Australian grayling). The lower reaches support species such as estuary perch and Australian bass that move between saltwater and freshwater systems. The estuary contains estuarine and saltwater species such as flathead, mulloway and black bream. The floodplain wetlands of the Snowy River near Marlo provide feeding and breeding areas for wetland and migratory birds.

Social, cultural and economic values

The Snowy Mountains Hydro-electric Scheme provides substantial economic value as a major generator of renewable electricity, and Snowy water supports irrigated agriculture in NSW and Victoria. The Snowy River and its estuary are a drawcard for the many tourists who enjoy camping, boating, swimming and recreational fishing.

The waterways of the Snowy system including the Snowy River hold significance for Traditional Owners in the region include the Monaro-Ngarigo, Bidwell Maap, Southern Monaro (Monaro-Ngarigo / Yuin / Bolga), Wongalu and Wiradjuri peoples. In recognition of the Traditional Owners, five high-flow releases in 2017–18 have been named:

- Djuran (running water)
- Waawii (water spirit)
- Billa Bidgee Kaap (big water season)
- Wai–Garl (river blackfish)
- Bundrea Nooruun Bundbararn (waterhole big lizard).

The Snowy River is also an iconic and culturally significant Australian river made famous by Banjo Patterson's poem *The Man from Snowy River*.

System overview

There are four major dams and multiple diversion weirs in the upper Snowy River catchment that divert water to the Murrumbidgee and River Murray valleys. Downstream, the hydrological effects of the Snowy Scheme are substantial, but are partly alleviated by the contribution of flows from tributaries (such as the Delegate River in NSW and the Buchan River in Victoria).

The Victorian, NSW and Commonwealth governments have recovered water to help restore damage done by decades of limited flow. Victorian environmental water available for use in the Snowy system is held in the Murray, Goulburn and Loddon systems. This water is made available for environmental flows in the Snowy River via a substitution method, whereby Victorian environmental water replaces water that was earmarked for transfer from the Snowy to Victoria to support irrigation needs.

Recent conditions

In the 2016–17 water year, 132,300 ML of environmental water was released to the Snowy River. Two east-coast low-pressure systems in June and July 2016 brought substantial rainfall to the Snowy River catchment and both events coincided with planned high-flow environmental releases. Both releases were rescheduled to avoid increasing floods in Victoria. The undelivered environmental water was accrued and used for a high-flow event in early summer.

In combination there were six high-flow events that delivered over 54,000 ML to the Snowy River in winter, spring and early summer. These flows helped maintain the opening of the Snowy River estuary at Marlo and reduce salinity in the upper reaches of the estuary.

Figure 2.5.1 The Snowy system

Scope of environmental watering

Environmental water releases from May 2017 to April 2018 aim to mimic the typical flow pattern of a mixed snowmelt/rainfall river system characteristic of the Snowy Mountains. The releases aim to support ecological processes in the Snowy River below Jindabyne Dam and maintain a healthy river that is much smaller than the natural channel before river regulation.

The planned environmental flows do not have direct biodiversity objectives. Their main aim is to restore physical and ecological processes that support aquatic habitats, productivity, dispersal, reproduction and recruitment. It is assumed that these processes will contribute to biodiversity outcomes in the years ahead.

Five peak flows are scheduled in winter/spring 2017. A large, flushing flow is scheduled for early October 2017 and includes an eight-hour peak, equivalent to 13,000 ML/day. Other peak flows will mimic winter rainfall events. These peak flows aim to improve the physical attributes of the river by scouring and depositing sediment and limiting the growth of riparian plants within the channel.

High flows are sustained from July–December to help mix water in the estuary for the benefit of plants and fish (such as Australian bass). Low flows will then be released until the end of the water year in April 2018.

The total volume planned for release in 2017–18 (including contributions from water savings in Victoria and NSW) is 218,500 ML.

Risk management

When weather conditions result in an increased risk of flooding, the NSW Department of Primary Industries (Water) works with the NSW State Emergency Service, the Bureau of Meteorology, East Gippsland CMA and the VEWH to provide information to the community about the management of planned releases. Releases may be cancelled or rescheduled to limit impacts to private land.

Engagement

NSW Department of Primary Industries is responsible for planning environmental flow releases in the Snowy River, and it consults East Gippsland CMA and the Victorian and Australian governments about the releases.

Aerial view of the Snowy River near the NSW-Vic border, by Liz Brown

Section 3

Central Region

3.1 Central Region overview

There are six systems that can receive environmental water in the Central Region: the Yarra and Tarago systems in the east and the Werribee, Maribyrnong, Moorabool and Barwon systems in the west.

The landscape

The Yarra River flows west from the Yarra Ranges upstream of Warburton, through the Yarra Valley and then opens out into a wider plain as it meanders through the suburbs and the city of Melbourne before entering Port Phillip Bay. The Tarago River has its headwaters in the Tarago State Forest, then flows south-west to join the Bunyip River near Longwarry North and enters Western Port Bay near Koo Wee Rup.

The Werribee River flows south-east from the Wombat State Forest near Ballan before dropping through the Werribee Gorge to Bacchus Marsh and then flowing into Port Phillip Bay at Werribee. The Maribyrnong River is fed by Jacksons Creek and Deep Creek, which join at Keilor North. It then flows south to join with the Yarra River just before discharging to Port Phillip Bay. The Barwon River flows east from the Otway Ranges towards Geelong and discharges into Bass Strait at Barwon Heads. The Moorabool River is a tributary of the Barwon River and meets it just north of Geelong. The Barwon estuary contains a system of wetlands and lakes collectively called the lower Barwon wetlands.

It is possible to move water between systems in the Central Region through trade, but most environmental water in these systems is prioritised to provide benefits in the river where it is stored. While there is no dedicated environmental entitlement in the Maribyrnong system, in the past four years water allocation has been purchased from licence holders in the system for environmental outcomes.

Environmental values

Many species of fish can be found in the Central Region including Australian grayling, river blackfish, Australian smelt, flat-headed gudgeon, black bream, Macquarie perch, Murray cod, southern pygmy perch, short-finned eel, dwarf galaxias, mountain galaxias, spotted galaxias and tupong. Platypus can be found in all the river systems and water rats and a variety of waterbugs are also present.

Wetlands in the region support some of Victoria's rarest species (such as the brolga, orange-bellied parrot, Australasian bittern and growling grass frog) and have subtropical and temperate coastal saltmarsh communities. The lower Barwon wetlands also form part of the internationally significant Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site.

Community considerations

Aboriginal Victorians and their Nations in the Central Region continue to have a deep connection to the region's rivers, wetlands and floodplains. The VEWH acknowledges the Traditional Owners in and around greater Melbourne, Ballarat and Geelong and pays respect to their Elders past, present and future. The VEWH recognises that water has significant cultural importance and value for Aboriginal Victorians.

The Traditional Owner groups in this region (including areas where there is no environmental water management) include the Boon Wurrung (Bunurong), Dja Dja Wurrung, Djagurd Wurrung, Gadubanud, Girai wurrung, Gulidjan, Gunaikurnai, Gunditjmara, Taungurung, Wadawurrung and Wurundjeri peoples, among others.

Waterways in the Central Region provide drinking water to major urban populations including greater Melbourne, Ballarat and Geelong, and water for irrigated agriculture, particularly in the Werribee catchment. The waterways in this region are also highly valued for the recreational activities they support including walking, cycling, fishing, hunting and camping. The Yarra River is a Melbourne icon and the location of many major events including the Moomba Festival, the Melbourne Festival as well as rowing regattas and dragon boat racing.

Year by year and case by case, the VEWH and its program partners consider opportunities raised by communities to use environmental water to provide additional social benefits (for example, releasing environmental water increases the enjoyment of people camping by a waterway, or publicising an environmental water release in advance provides more opportunities for kayakers). Where possible, the VEWH and its program partners incorporate such opportunities into watering decisions, as long as they do not compromise environmental outcomes or increase demand on the water holdings.

When planning to use water for the environment, the VEWH considers the potential social, economic, Aboriginal cultural and recreational benefits for communities which could arise from the water's use.

Some opportunities for shared community benefits of environmental water in the Central Region in 2017–18 include:

- potentially timing environmental flows in the Yarra River to coincide with weekends, for recreational enjoyment
- improved conditions for birdwatching and visual amenity, particularly around the billabongs along the Yarra River
- better water quality in the Werribee estuary, improving conditions for black bream and estuary perch, resulting in improved recreational fishing opportunities.

The VEWH's ability to deliver these benefits depends on climate, water available and the way the system is being operated to deliver water for other purposes (such as to homes, farms or businesses).

For more information about opportunities for shared community benefits in 2017–18, contact the VEWH or the relevant waterway manager.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental water planning and releases need to be part of an integrated approach to catchment management. Many of the environmental objectives in this seasonal watering plan will not be fully met without simultaneously addressing excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of streambank vegetation and invasive species, to name just a few issues.

Victorian and Australian government agencies, community groups and private landowners implement many programs to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments. Activities in the Central Region that are planned and implemented to coordinate with environmental water management include:

- the new fishway at Dights Falls, which enables fish to swim past the weir, benefiting 11 species of native migratory fish and unlocking vast reaches of the Yarra and its tributaries upstream
- new fishways in the Maribyrnong River for small-bodied fish and in the Werribee River for galaxids and tupong
- planning to retrofit the weir on the Moorabool River at Batesford with a fishway to allow fish passage further upstream, capitalising on the fishway recently installed on the lower Barwon tidal barrage
- continued work to protect and enhance streambanks along priority reaches in the Barwon and Moorabool catchments including willow removal, fencing to exclude stock and revegetation.

For more information about integrated catchment management programs in the Central Region refer to Melbourne Water's Healthy Waterways Strategy, the Port Phillip and Western Port and Corangamite regional catchment strategies and the Corangamite Waterway Strategy.

Seasonal outlook 2017–18

The western systems in the Central Region are generally drier than those in the east, and quite different catchment conditions can exist between each of the systems at the same time. Entitlements in the Yarra are more reliable than the other systems and therefore provide greater certainty for water availability irrespective of catchment conditions. Environmental water allocations in the Werribee, Tarago and Moorabool systems rely heavily on catchment inflows in any given year and dry conditions therefore result in lower water availability. Carryover is an important source of water to meet environmental demands in these systems in dry years.

Winter and spring are usually the wettest seasons in the Central Region and contribute most of the annual inflow to system storages. The likely environmental water allocations should therefore be evident early in the water year. If 2017–18 is very dry and there is limited environmental water available, environmental water deliveries will focus on maintaining water quality and protecting habitat for fish, platypus and other water-dependent species, particularly in summer/autumn. If conditions are closer-to-average or wet, environmental releases will aim to improve the health of the environment by increasing the quality and quantity of aquatic habitat for animals and for triggering migration, and sometimes spawning, of native fish.

Yarra River and Princes Bridge, by Zarleen Blakeley

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

The Yarra River flows west from the Yarra Ranges upstream of Warburton and through the Yarra Valley. It then opens out into a wider plain as it meanders through the suburbs and city of Melbourne before entering Port Phillip Bay. The Upper Yarra Reservoir, O'Shannassy Reservoir and Maroondah Reservoir harvest water from headwater tributaries and a pump station at Yering is used to divert water from the Yarra River to Sugarloaf Reservoir.

Environmental values

The upper Yarra River (reaches 1–3) provides habitat for a range of native fish species including the river blackfish, spotted galaxias and common galaxias, and contains good-quality riparian and aquatic vegetation. The lower river (reaches 4–6) flows through forested gorges, cleared floodplains and some highly urbanised areas, and it supports several populations of native fish including Australian grayling, Macquarie perch and tupong. Macquarie perch were introduced to the Yarra River last century, and the population is now considered one of the largest and most important in Victoria.

Billabongs are an important feature of the Yarra River floodplain between Millgrove and Yering Gorge as well as of the reach around Banyule Flats near Heidelberg. The billabongs support distinct vegetation communities and provide foraging and breeding habitat for waterbirds and frogs. Except in very high flows, most billabongs are disconnected from the Yarra River.

Social, cultural and economic values

The upper reaches of the Yarra River provide 70 percent of Melbourne's drinking water. They also provide social and recreational opportunities for the more-than four million people who live in the greater Melbourne area. Swimming and kayaking are popular in some sections, and many sections have aesthetic appeal for walkers and cyclists. The Yarra supports more than 2,450 ha of urban parklands and public open space along its corridor, which is valued by the public for its tree-dominated landscape and views of and access to the river. Private tourism and recreation industries also make use of the river aspect; for example, there are more than 10 golf courses along the river's length.

The waterways of the Yarra system (including the Yarra River) hold significance for Aboriginal Victorians and their Nations in the region. For the Wurundjeri people, who have a spiritual connection to the Yarra's lands and waterways, the river is a life source that has been etched into the landscape by the ancestral creator spirit Bunjil (meaning eagle). They name the river Birrarung (meaning shadows of the mists). Melbourne Water and the VEWH have started working with the Wurundjeri Tribe Land and Compensation Cultural Heritage Council to understand how environmental water management in the Yarra River can better support Aboriginal aspirations, particularly around caring for Country and protecting important story places and cultural resources.

Environmental watering objectives in the Yarra system

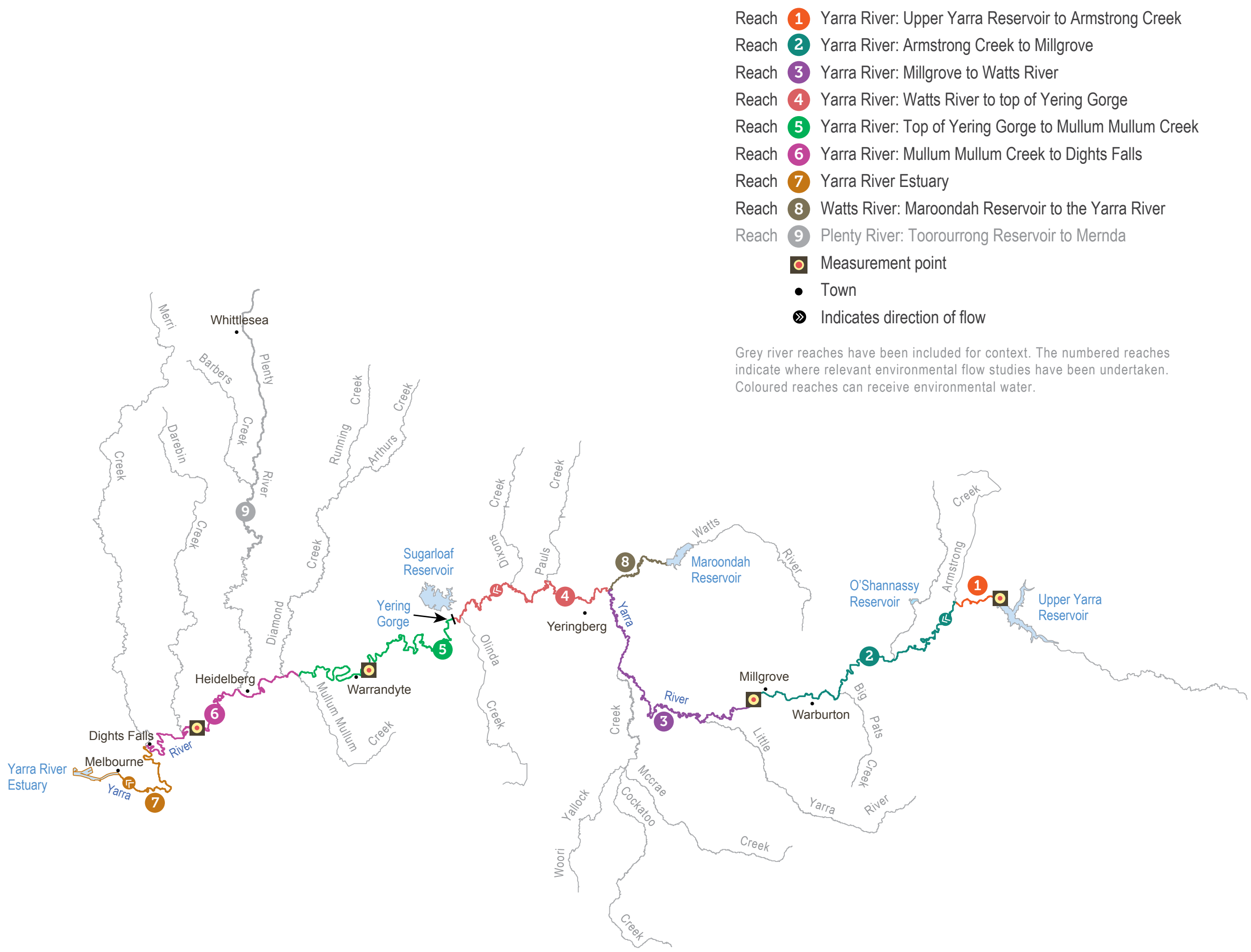
	Increase, strengthen and maintain plant life on the riverbank and in the channel, as well as on the upper Yarra floodplain and in the river's billabongs
	Protect and increase populations of native fish including threatened species (such as the Australian grayling and Macquarie perch)
	Maintain the form of the riverbank and bed Scour silt build-up and clean cobbles in the river to ensure fish, platypus and other water animals have access to healthy habitat pools and places to feed, spawn and shelter
	Protect and increase communities of waterbugs, which provide energy, break down dead organic matter and support the river's food chain
	Improve water quality in river pools, ensuring there is plenty of dissolved oxygen in the water to support water animals and bugs

System overview

Flows through the Yarra system have become highly regulated due to the construction of major water storages that capture natural run-off and allow the controlled removal of water for consumptive use. Over time, the lower Yarra River has been straightened, widened and cleared of natural debris as Melbourne has grown around its banks. The earliest recorded alterations to its course date back to 1879. Environmental watering aims to reinstate flows that support ecological processes and environmental outcomes throughout the length of the system.

Environmental water can be released from the Upper Yarra, Maroondah and O'Shannassy reservoirs. Priority reaches for environmental watering are reaches 2 and 5 and delivery of water to these reaches is expected to also achieve flow targets in neighbouring reaches. Figure 3.2.1 shows the environmental flow reaches in the Yarra system. In the upper reaches, the system is influenced by tributaries (such as Woori Yallock Creek, Watts River and Little Yarra River). In the lower reaches, urbanised tributaries (such as Olinda Creek, Mullum Mullum Creek, Diamond Creek, Plenty River and Merri Creek) provide additional water to the Yarra River.

Figure 3.2.1 The Yarra system



Recent conditions

The Yarra River catchment experienced below-average rainfall and dry conditions from 2014 to the start of the 2016–17 water year. Above-average rainfall between August and October 2016 caused a shift to average and then wet conditions. Environmental water planning mirrored these changes, with a shift from dry scenario planning at the start of the 2016–17 water year to average-wet scenario planning by spring.

Low flows during 2016–17 were consistently achieved with unregulated flows and there was no need to provide any additional environmental water. The average-to-wet conditions also allowed environmental water to be delivered to Yering backswamp and Banyule billabong. Spadonis billabong was filled naturally after works were completed to lower the adjacent riverbank.

Environmental water was mainly used in 2016–17 to deliver summer and autumn freshes to improve water quality and improve habitat for fish and waterbugs. An autumn high-flow event was also delivered in May to trigger spawning of Australian grayling.

The wet conditions experienced through much of 2016–17 and reduced demand for environmental water in 2016–17 means that more water is likely to be available to meet high-priority watering actions in 2017–18.

Scope of environmental watering

Table 3.2.1 shows potential environmental watering actions and their environmental objectives.

Table 3.2.1 Potential environmental watering actions and objectives for the Yarra system

Potential environmental watering[1]	Environmental objectives
Year-round low flows[2] (varying rates from 10–350 ML/day)	• Maintain access to riffle and pool habitat for waterbugs and fish • Allow the riverbank vegetation to dry • Limit the growth of fringing/riparian/terrestrial vegetation into the stream channel • Maintain and/or rehabilitate in-stream vegetation
Summer/autumn freshes (1–4 freshes of varying rates between 60–750 ML/day for 2–4 days each in December–May)	• Maintain habitat by scouring sediments and cleaning cobbles in faster-flowing areas • Provide access to suitable habitat and migration opportunities for native fish • Maintain flood-tolerant vegetation on the low banks • Improve water quality in pools
Winter/spring freshes (2 or more freshes of varying rates between 100–2,500 ML/day for at least 2–7 days in June–October)	• Maintain habitat by scouring sediments and cleaning cobbles in faster-flowing areas • Maintain flood-tolerant vegetation on the low banks • Provide migration opportunities for native fish • Improve water quality in pools
Targeted billabong watering	• Support the native vegetation and improve habitat availability for wetland plants and animals
Spring high flow (1 high flow of 700–2,500 ML/day for 14 days in October–November)[3]	• Promote spawning and migration of native fish species

1 *The magnitude and duration of potential environmental watering depends on the reach being targeted, with the lower range generally applying to the upper reaches (for example, reach 1) and the higher range applying to the lower reaches (for example, reach 6).*

2 *Low flows are generally provided by passing flows under the environmental entitlement, but during dry conditions it may be necessary to supplement low flows using environmental water.*

3 *A spring high flow will only be achieved with significant unregulated flow due to release constraints in the upper reaches of the system. Ceasing harvest at Yering during a natural high flow may help meet the desired flow target in reaches 5 and 6.*

Scenario planning

Table 3.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Under a dry climate scenario, environmental water releases will mainly focus on meeting the low-flow and fresh objectives throughout the year. Low flows and freshes are also a high priority under average and wet climate scenarios, but environmental water under these scenarios may also be used to deliver high flows in autumn and spring and to water priority billabongs. The autumn high flow aims to trigger Australian grayling migration and spawning and is usually a high priority, even in many dry years. Autumn high flows have been delivered naturally or via managed releases in the Yarra River in six of the last seven years. The VEWH therefore does not consider delivery of autumn high flows to be essential in 2017–18 under a dry scenario. It expects less environmental water to be used under the wet climate scenario, because many of the potential watering actions are likely to be met by natural flows.

The high security of the environmental entitlement in the Yarra system and reduced demand for environmental water in 2016–17 means there should be sufficient environmental water to achieve all the potential watering actions identified for each planning scenario in 2017–18.

A minimum of 8,000 ML carryover into 2018–19 is required (in addition to the 17,000 ML annual entitlement) to deliver the highest-priority flows if average conditions continue into the following year.

Table 3.2.2 Potential environmental watering for the Yarra system under a range of planning scenarios

<table>
<tr><th>Planning scenario</th><th>Dry</th><th>Average</th><th>Wet</th></tr>
<tr><td>Expected river conditions</td><td>• Low streamflows year-round
• Lack of unregulated freshes and high flows
• Minimum passing flow requirements are not likely to meet the minimum flow recommendations</td><td>• Minimum passing flow requirements are likely to be met
• High winter flows, with small storages likely to spill
• Unregulated flows may provide some freshes but the duration and/or magnitude will likely be less than target flows</td><td>• Minimum passing flow requirements are likely to be met
• High winter and spring flows with good variability
• Unregulated flows over summer/autumn will provide freshes and possibly high flows
• Some natural inundation of billabongs may occur</td></tr>
<tr><td>Expected availability of environmental water</td><td colspan="3">• 18,000 ML carryover
• 17,000 ML allocation
• 35,000 ML total</td></tr>
<tr><td>Potential environmental watering</td><td>• Summer/autumn low flows
• Summer/autumn freshes
• Winter/spring low flows
• Winter/spring freshes</td><td colspan="2">• Summer/autumn low flows
• Summer/autumn freshes
• Winter/spring low flows
• Winter/spring freshes
• Autumn high flows
• Targeted billabong watering
• Spring high flows</td></tr>
<tr><td>Possible volume of environmental water required to achieve objectives</td><td>• 20,000 ML</td><td>• 25,000 ML</td><td>• 8,000 ML</td></tr>
<tr><td>Priority carryover requirements</td><td colspan="3">• 8,000 ML</td></tr>
</table>

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 3.2.3 shows the partners and stakeholder organisations with which Melbourne Water engaged when preparing the Yarra system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Port Phillip and Western Port Regional Catchment Strategy and Melbourne Water's Healthy Waterways Strategy.

Table 3.2.3 Partners and stakeholders engaged in developing the Yarra system seasonal watering proposal

Partner and stakeholder engagement
• Yarra River Environmental Water Advisory Group including representatives of local government, Native Fish Australia, VR Fish, Canoeing Victoria, Whitehorse Canoe Club, Warburton Holiday Park, Wurundjeri Tribe and Compensation Cultural Heritage Council, Environment Victoria, Yarra Riverkeeper Association, Yarra Valley Water, EPA Victoria, Port Phillip and Westernport CMA and Parks Victoria • Melbourne Water (Water Supply Operations and Integrated Planning) • VEWH

Juvenile Macquarie perch about to be returned to the river, by Zeb Tonkin

3.3 Tarago system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

The Tarago River has its headwaters in the Tarago State Forest and flows into the Tarago Reservoir at Neerim, which sits in the upper reaches of the Tarago River and harvests inflow from all upstream tributaries. Downstream of the reservoir, the river flows close to the town of Rokeby before meeting the Bunyip River (of which it is a major tributary) at Longwarry North. From there, the Bunyip River flows through a straightened channel, Bunyip Main Drain, to flow into Western Port Bay. This downstream reach supplies many irrigators in the catchment.

Environmental values

The Tarago system contains several significant and threatened native plant and animal species including the Australian grayling, long pink-bells, tree geebung and swamp bush-pea. The upper catchment has healthy riparian vegetation and highly diverse in-stream habitat that supports native fish including river blackfish and mountain galaxias. While the lower catchment has been highly modified, it contains good patches of remnant vegetation and healthy populations of Australian grayling and platypus.

Social, cultural and economic values

There are several reserves, picnic areas and designated fishing locations along the length of the Tarago system as well as a popular caravan park and public land in the headwaters. These all contribute to the social and recreational value of the Bunyip and Tarago rivers. Many irrigators rely on water from the Tarago system and urban supplies are also provided from the storage.

The Tarago River runs through the traditional lands of the Kurnai and Kulin Nations which have many Traditional Owner groups. The waterways of this region were would have been a focus for Aboriginal communities before European settlement due to their permanent water supply and associated resources. Aboriginal Victorians have a continuing connection to the waterways of this region and in recent times the Robin Hood Reserve on the Tarago River has been an important meeting place for them.

Environmental watering objectives in the Tarago system

	Improve health and increase diversity of native riverside vegetation
	Protect and boost native fish populations including threatened species (the Australian grayling and river blackfish) by providing habitat and triggers for fish to migrate and spawn
	Provide habitat and food for waterbugs
	Maintain and improve foraging habitat for platypus

System overview

Water available under the Tarago environmental entitlement is stored in and released from Tarago Reservoir. Reach 2 from below the reservoir to the confluence of the Tarago and Bunyip rivers is the target reach, as it has high ecological value with a high diversity of native fish and patches of native fringing vegetation. Environmental water deliveries to reach 2 often achieve the desired flows in reach 6.

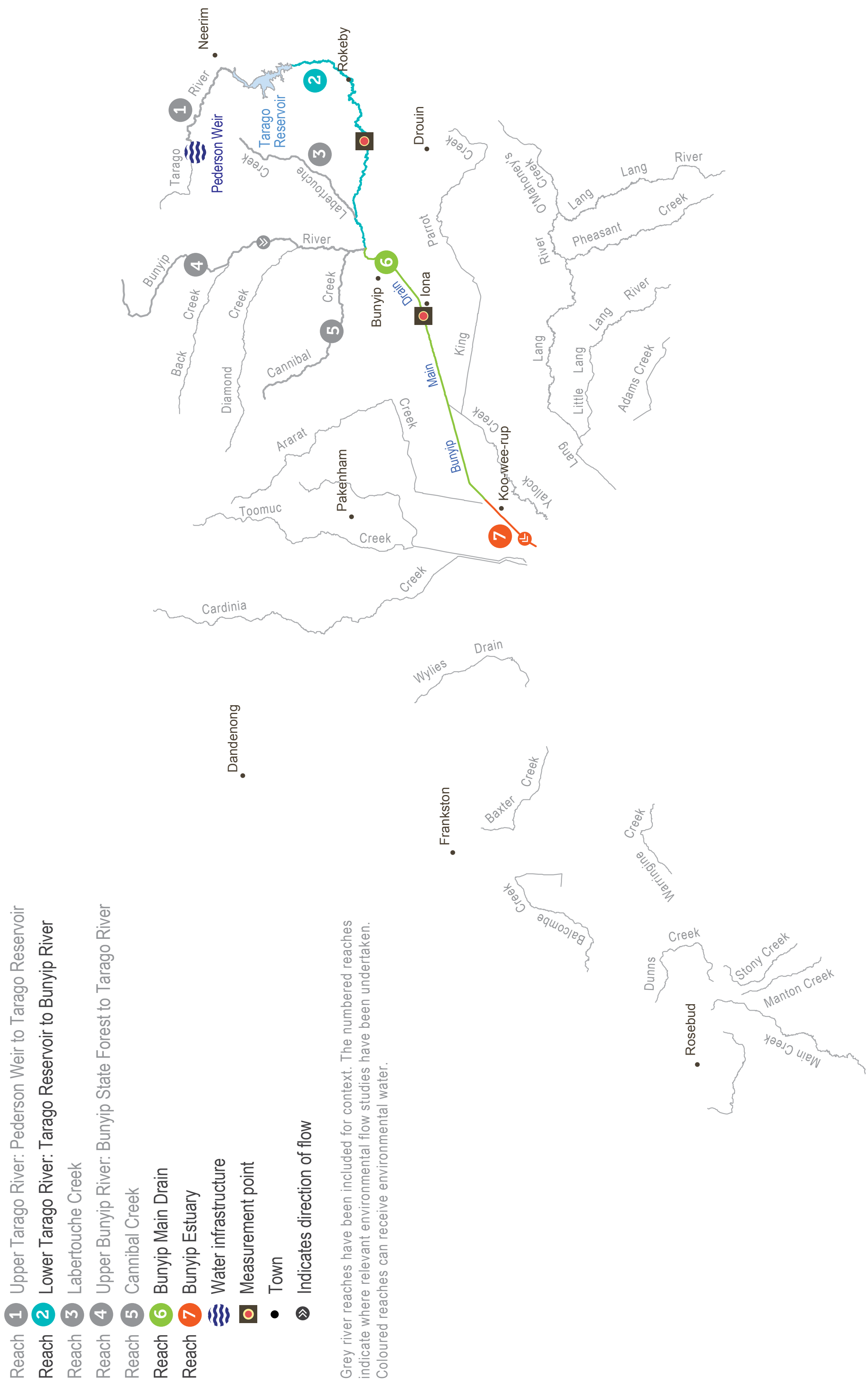
Recent conditions

Regular winter/spring rainfall caused Tarago Reservoir to spill between September and December 2016. The spills provided increased flows and variability in the river downstream of the reservoir, which achieved most of the targeted environmental flows in spring. Conditions began to dry through summer and into autumn, due to warmer weather and less rainfall.

Environmental water was released in January and March 2017 to provide two summer/autumn freshes. These events aimed to increase habitat availability for animals and clear sand bars of encroaching vegetation. A third summer/autumn fresh was delivered in May 2017, primarily to trigger migration of Australian grayling to spawn.

Monitoring results show a clear link between environmental flow releases and Australian grayling migration and spawning, with the length of the release being critical to initiate successful spawning. Other monitoring has shown environmental water releases in the Tarago River also improve the quality and quantity of food and habitat for platypus and increase opportunities for these animals to move.

Figure 3.3.1 The Tarago system



Scope of environmental watering

Table 3.3.1 shows potential environmental watering actions and their environmental objectives.

Table 3.3.1 Potential environmental watering actions and objectives for the Tarago River

Potential environmental watering	Environmental objectives
Summer/autumn freshes (5 freshes of 100 ML/day for 4 days each in December–May)	• Prevent vegetation growing on sand bars, scour holes in the riverbed, improve water quality and allow the migration to suitable habitat of aquatic species, particularly fish
Autumn high flow (1 high flow of 100 ML/day for at least 2 days during April–May)	• Trigger the downstream dispersal and spawning of Australian grayling
Spring/summer high flow (1 high flow of 280 ML/day for 4 days during October–December)	• Inundate barriers in the river to allow fish passage, specifically juvenile Australian grayling migration
Winter/spring freshes (up to 4 freshes of 280 ML/day for 3 days during June–November)	• Mobilise sand and sediment to maintain and create habitat variability for waterbugs and to maintain riparian vegetation
Summer/autumn low flows (12 ML/day [or natural] during December–May)[1]	• Maintain water quality and provide habitat for river blackfish, Australian grayling, platypus and waterbugs
Winter/spring low flows (100 ML/day [or natural] during June–November)[2]	• Inundate littoral habitats for juvenile fish • Increase the availability of riverbed habitat for waterbugs • Promote the recruitment and increase the diversity of native riparian vegetation types and prevent terrestrial vegetation encroachment

1 *Summer/autumn low flows are generally provided by passing flows under the environmental entitlement but during dry conditions it may be necessary to supplement these flows using environmental water.*

2 *Winter/spring low flows are unlikely to be delivered, as the volume required would severely affect the ability to provide other environmental flow events.*

Scenario planning

Table 3.3.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The highest-priority releases in the Tarago system are summer/autumn freshes — to allow migration to suitable habitat and improve water quality — and an autumn high flow — to provide migration cues for Australian grayling. An autumn high flow is important to deliver in most years as Australian grayling are short-lived — to around three years old — so regular successful breeding is needed. There may not be sufficient water in drought conditions to deliver the autumn high flow, but this type of flow event has been provided in six of the past seven years so not delivering it in 2017–18 does not pose a significant risk. Under wetter conditions, the VEWH expects that in addition to summer/autumn releases, it may also use environmental water to increase the magnitude or extend the duration of some unregulated events throughout winter and spring to improve habitat for waterbugs and allow fish movement along the river.

Another priority release is the spring high flow to support the movement of juvenile Australian grayling back into the Tarago system. This event can occur naturally under wet conditions, but drier springs have led to only the partial delivery of this flow in some years. Anecdotal evidence suggests that the fish move on these partial events. In 2017–18, research will focus on other aquatic values (such as the flow requirements for river blackfish, particularly flows that support successful recruitment).

The number of watering actions increases from the drought to the wet scenarios, thus increasing the volume of environmental water required. Carrying water over into 2018–19 is important under all conditions, to ensure there is sufficient water to deliver summer and autumn freshes in the following year.

Table 3.3.2 Potential environmental watering for the Tarago system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Very low streamflows • Reduced passing flows • Irrigation releases likely	• Low streamflows • Some reduction to passing flows • Irrigation releases likely	• Average streamflows • Partial freshes naturally provided • Some irrigation releases likely	• Above-average streamflows • Partial-to-full freshes naturally provided • Irrigation releases unlikely
Expected availability of environmental water	• 1,500 ML carryover • 200 ML allocation • 1,700 ML total	• 1,500 ML carryover • 500–1,000 ML allocation • 2,000–2,500 ML total	• 1,500 ML carryover • 1,000–2,200 ML allocation • 2,500–3,700 ML total	• 1,500 ML carryover • 2,200–3,500 ML allocation • 3,700–5,000 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes	• Summer/autumn freshes • Autumn high flow (partial event)	• Summer/autumn freshes • Autumn high flow • Spring high flow (partial event)	• Summer/autumn freshes • Autumn high flow • Spring high flow • Winter/spring freshes
Potential environmental watering – tier 2 (lower priorities)[1]	• Spring high flow (partial event)	• Spring high flow (partial event) • Autumn high flow (full event)	• Spring high flow (full event)	• N/A
Possible volume of environmental water required to achieve objectives[2]	• 1,000 ML (tier 1) • 800 ML (tier 2)	• 1,000–1,500 ML (tier 1) • 1,200 ML (tier 2)	• 1,500–2,700 ML (tier 1) • 1,200 ML (tier 2)	• Up to 3,500 ML (tier 1)
Priority carryover requirements	• 1,000 ML[3]			

1 *Tier 2 actions are lower-priority actions to be considered if water is available.*

2 *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

3 *Under drought conditions, the full priority carryover target cannot be met.*

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 3.3.3 shows the partners and stakeholder organisations with which Melbourne Water engaged when preparing the Tarago system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Port Phillip and Western Port Regional Catchment Strategy and Melbourne Water's Healthy Waterways Strategy.

Table 3.3.3 Partners and stakeholders engaged in developing the Tarago system seasonal watering proposal

Partner and stakeholder engagement
• Tarago and Bunyip Rivers Environmental Flow Advisory Group • VRFish and local anglers • Waterwatch members • Landcare groups • Robin Hood Reserve - Friends Group • Landholders / farmers • Baw Baw Shire and Cardinia Shire councils • Melbourne Water (Water Supply – Optimisation and Support) • Southern Rural Water • VEWH

3.4 Maribyrnong system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – N/A

Close to Tullamarine Airport, Jacksons Creek (flowing from the west) and Deep Creek (flowing from the north) join to form the Maribyrnong River at Keilor North. The river runs south through Yarraville in inner Melbourne before meeting the Yarra and flowing into Port Phillip Bay. Rosslynne Reservoir near Gisborne is the largest storage in the system and harvests water from the headwaters of Jacksons Creek.

Environmental values

The upper Maribyrnong catchment contains areas of intact streamside vegetation, which provide important habitat for native fish including migratory short-finned eels, common and ornate galaxias, flathead gudgeon, tupong and Australian smelt. There are highly diverse community of waterbugs and a significant platypus population in several reaches of the system.

Social, cultural and economic values

The Maribyrnong River is located in the western suburbs of Melbourne and provides water (primarily from Rosslynne Reservoir on Jacksons Creek) to urban and rural users.

The river provides many recreational opportunities (such as boating, fishing, cycling, walking and picnicking in the adjacent parklands). The river at Keilor provides good canoeing and has three ponding points, designed to enable children and adults to catch fish with a hand net. There are nine boat landings along the river (most notably at Canning Reserve, Maribyrnong Park and Fairbairn Park) and the rivers hosts water-based events such as the University of Melbourne intercollegiate regatta, Canoeing Victoria's Winter Marathon Series and Scouts Australia paddling events.

Fishing is popular from jetties and fishing platforms along the parks and reserves on either side of the river. A popular walking track skirts the river and bicycle tracks follow the riverbanks and cross the river via pedestrian bridges at several points along the river's length.

The waterways of the Maribyrnong system hold significance for the Wurundjeri and Boon Wurrung (Bunurong) people, who are the Traditional Owners in the region, with Aboriginal people frequenting its banks for at least 40,000 years.

Environmental watering objectives in the Maribyrnong system

Maintain or rehabilitate in-stream vegetation and reduce invasive terrestrial vegetation populations
Allow for the passage of small-bodied fish through the system
Maintain waterbug habitat by providing suitable depth over riffles
Maintain water quality, particularly dissolved-oxygen levels, by flushing pools

System overview

Rosslynne Reservoir is the only major storage in the Maribyrnong catchment, and it is located in the upper reaches of Jacksons Creek. The priority river reaches for environmental watering in the Maribyrnong system are reaches 6 and 7 (upper and lower Jacksons Creek respectively), downstream of Rosslynne Reservoir. The release capacity of 20 ML/day from Rosslynne Reservoir is a significant constraint on what can be achieved by environmental deliveries.

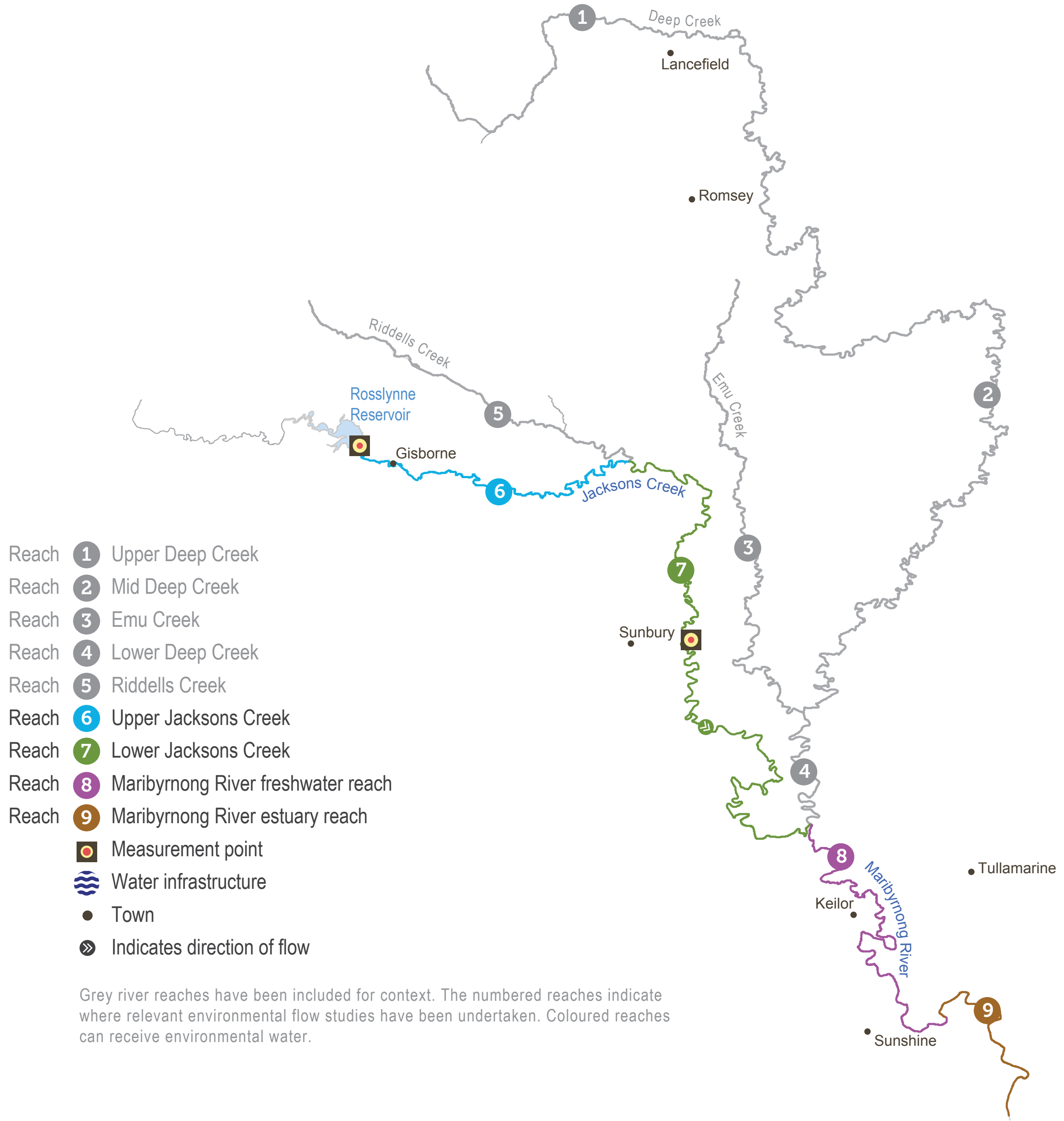
The VEWH does not hold an environmental entitlement in the Maribyrnong system and depends on temporary trade to meet demands. Over the past four years, Melbourne Water and the VEWH have worked with local diversion licence holders to purchase unused water that can then be delivered specifically for environmental outcomes in the system. This arrangement is negotiated each year and will only occur with the agreement of all parties involved.

Recent conditions

Between 2012 and 2015, rainfall and run-off into the waterways of the Maribyrnong system decreased with the drier conditions. Spring 2016 saw a return of wetter conditions with multiple high-flow events, particularly in reach 7. Flows in reach 6 were lower because Rosslynne Reservoir captures a high proportion of upstream flows and there are few tributaries to deliver unregulated flows immediately downstream of the storage. Despite the wet conditions, most winter/spring flow targets were either not met or only partially met.

Conditions dried over summer and into autumn, and environmental water was delivered to provide freshes to the waterway. These events were timed for March and May to improve water quality — particularly oxygen levels, which are essential for waterbugs, fish and platypus. The events also refreshed pools, improved fish passage and supported aquatic plants.

Figure 3.4.1 The Maribyrnong system



Scope of environmental watering

Table 3.4.1 shows potential environmental watering actions and their environmental objectives.

Table 3.4.1 Potential environmental watering actions and objectives for the Maribyrnong River

Potential environmental watering[1]	Environmental objectives
Summer/autumn freshes (up to 3 events of 20–40 ML/day for up to 7 days) in December–May	• Maintain water quality by flushing pools • Support the in-stream vegetation • Provide passage for small-bodied native fish
Summer/autumn low flows (4–6 ML/day) in December–May	• Maintain waterbug habitat by providing suitable depth over riffles
Winter/spring low flows (20–40 ML/day) in June–November	• Maintain or rehabilitate in-stream vegetation and disturb invasive terrestrial vegetation populations • Allow for the passage of small-bodied fish through the system

1 *The range in flow requirements represent the target flow requirements for reaches 6 and 7.*

Scenario planning

Table 3.4.2 outlines the potential environmental watering actions and expected water use under a range of planning scenarios.

Under drought or dry climate scenarios, any available environmental water would be used to protect or maintain aquatic habitat in Jacksons Creek by delivering low-flow freshes and, under drought conditions, delivering low flows. These deliveries aim to ensure in-stream plants and animals have refuge to survive.

Under average and wet conditions, the VEWH expects unregulated flows would meet most of the environmental flow objectives. It could still use environmental water to fill gaps between unregulated events or to extend the duration of small, unregulated events.

Jacksons Creek at Sunbury, by Melbourne Water

Table 3.4.2 Potential environmental watering for the Maribyrnong system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Minimal unregulated flows • Passing flows cease	• Low volumes of unregulated flows • Passing flows partially to fully meet low flows	• Unregulated flows partially meet most objectives • Passing flows partially to fully meet low flows	• Unregulated flows meet most objectives • Passing flows partially to fully meet low flows
Potential environmental watering	• Summer/autumn low flows • Summer/autumn freshes	• Summer/autumn freshes	• Summer/autumn freshes • Winter/spring low flows	• Summer/autumn freshes • Winter/spring low flows
Volume of environmental water required to achieve objectives	• 300 ML	• 300 ML	• 600 ML	• 600 ML

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 3.4.3 shows the partners, stakeholder organisations and individuals with which Melbourne Water engaged when preparing the Maribyrnong system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Port Phillip and Western Port Regional Catchment Strategy and Melbourne Water's Healthy Waterways Strategy.

Table 3.4.3 Partners and stakeholders engaged in developing the Maribyrnong system seasonal watering proposal

Partner and stakeholder engagement
• DELWP • Environment groups (Landcare and friends groups including Jacksons Creek EcoNetwork and Friends of the Maribyrnong Valley) • Keilor irrigators • Melbourne Water (Diversions Group) • Southern Rural Water • VEWH • Western Water

3.5 Werribee system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

The Werribee River flows south-east from the Wombat State Forest near Ballan before dropping through the Werribee Gorge to Bacchus Marsh and then flowing into Port Phillip Bay at Werribee. The Lerderderg River is a major tributary that joins the river at Bacchus Marsh. The main storages in the Werribee system are Pykes Creek Reservoir, Melton Reservoir and Merrimu Reservoir.

Environmental values

The Werribee system supports a range of native fish including river blackfish, flathead gudgeon, short-finned eel, tupong, Australian smelt, several species of galaxiids and a large population of black bream in the estuary. A highly diverse community of frogs and waterbugs inhabit the upper reaches and platypus are present in the lower reaches. The freshwater-saltwater interface of the Werribee River estuary is a regionally significant ecosystem due to the many aquatic plants and animals it supports, providing nursery habitat for juvenile freshwater fish species and estuarine species (such as black bream).

Social, cultural and economic values

The Werribee River is a much-needed resource for agriculture, industry, recreation and tourism. The system provides irrigation water for agricultural industries throughout the Bacchus Marsh and Werribee areas (including the market gardens at Werribee South) and domestic water for Melton and Bacchus Marsh.

The Werribee River and its tributary the Lerderderg River flow past popular camping and hiking spots in the Wombat State Forest and Lerderderg State Park. Along its length, the Werribee River provides opportunities for recreational activities including fishing, bird watching, passive boating (such as canoeing and kayaking) and bushwalking.

In the lower reaches, the river meanders through the Werribee River Park and Werribee Park Tourism Precinct. The precinct includes the Werribee Open Range Zoo, National Equestrian Centre, Mansion Hotel & Spa and Werribee Park Golf Club, and it contributes more than $116 million a year to the Wyndham local government area. The Werribee River Trail and Federation Trail bike paths are popular recreational cycling routes.

Werribee is an Aboriginal word meaning backbone or spine. Significant Aboriginal cultural heritage sites including fish traps, artefacts and burial sites have been found along the riverbanks and escarpments. The Werribee River continues to be a place of significance for the Wurundjeri, Wadawurrung and Boon Wurrung (Bunurong) people, who are the Traditional Owners in the region.

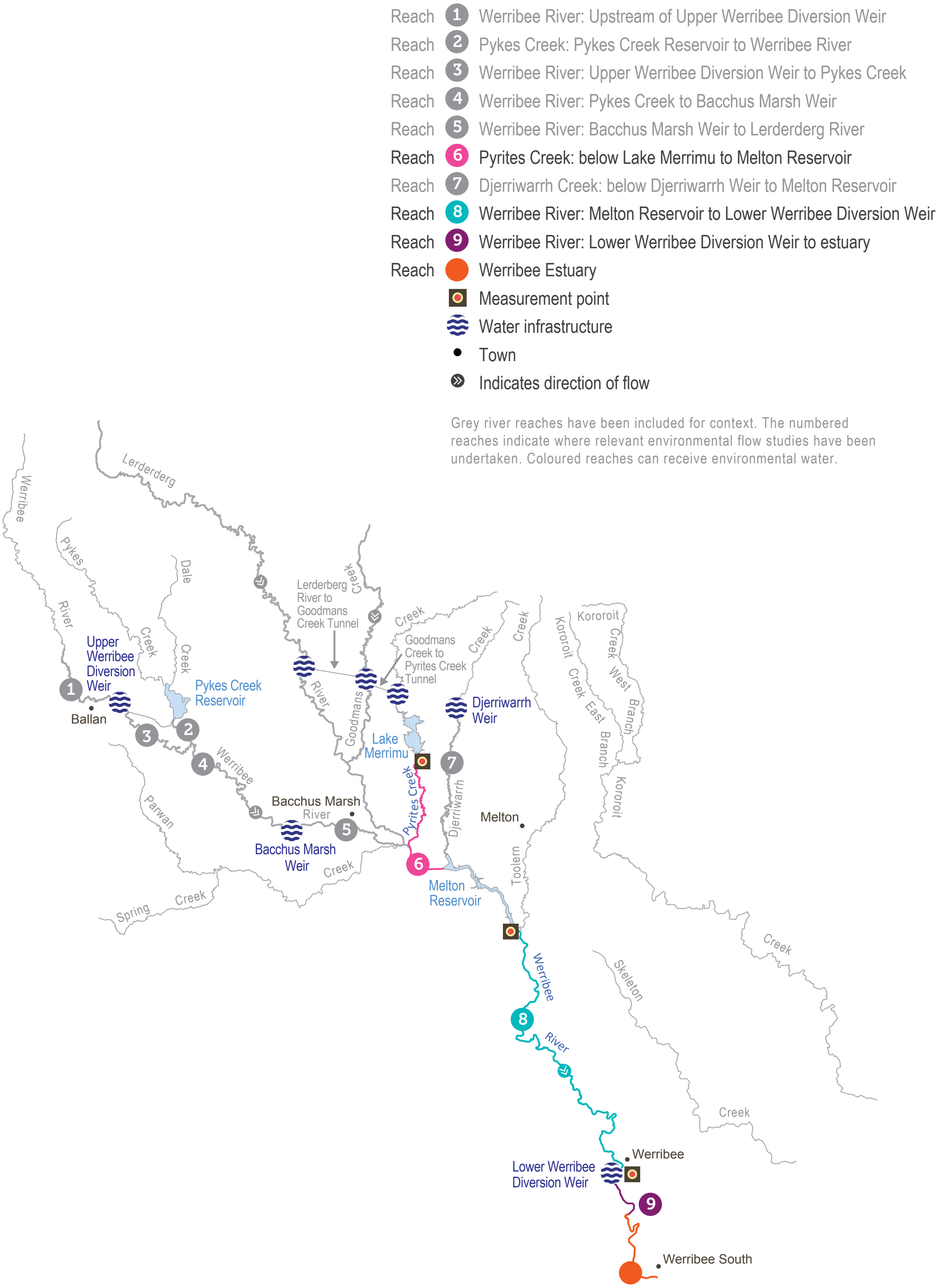
Environmental watering objectives in the Werribee system

Maintain diverse populations of macrophytes (large water plants) and shrubs to provide shade and food for organisms further up the food chain
Protect and increase native fish populations including black bream and galaxiids by providing pool habitat and flows for fish to move upstream and downstream and encouraging fish to spawn
Maintain habitat for frogs
Provide or improve habitat for waterbugs
Maintain pool water quality for fish and platypus and inundate estuary salt marshes with brackish water
Move built-up silt from riffles (in the shallower parts of the river)

System overview

The priority river reaches for environmental flow delivery in the Werribee system are the reach downstream of Lake Merrimu (reach 6), the reach within Werribee (reach 9) and the estuary. These support a diverse range of native fish species, waterbugs and platypus. Flows targeting the estuary are expected to provide some benefits to reach 8 and water may also be delivered for environmental objectives in this reach under suitable conditions. Environmental water released from Lake Merrimu can be re-harvested in Melton Reservoir, minus en route losses. It can then be held and re-released from Melton at a later date to achieve environmental objectives in the lower Werribee River. Flows are measured downstream of Lake Merrimu (reach 6), downstream of Melton Reservoir (reach 8) and at the Werribee Diversion Weir for reach 9 and the estuary.

Figure 3.5.1 The Werribee system



Recent conditions

Above-average rainfall in winter/spring 2016 ended a four-year dry spell in the Werribee River. Melton Reservoir spilled in September 2016, and unregulated flows passed through the system from September to November 2016. Environmental water helped extend flows in the lower Werribee River in November. Large spring flows are important for the ecology of the lower Werribee River and would have naturally occurred in most years. River regulation has significantly reduced the frequency of large spring-flow events and they now occur only in wet years when the reservoirs spill.

The current environmental entitlement in the Werribee system is not sufficient to deliver large-flow events. An additional 1,100 ML was made available to the environment in 2015–16 and it was carried over specifically to deliver a large, spring flow. The release in November 2016 was the largest single release of environmental water in the Werribee catchment to date. Environmental water was also used to deliver freshes to the lower Werribee River in autumn to maintain water quality and support native fish habitat and recruitment.

Environmental water was delivered to Pyrites Creek (reach 6) from Lake Merrimu in spring 2016. A high-flow event was delivered at the beginning of September, before the spring rains. A second high-flow event was delivered in November, after the wet conditions had ended. These flow events flushed organic matter from benches and supported the recruitment and growth of native vegetation along the creek. The first event passed through to the lower Werribee River as Melton Reservoir was spilling at the time. The second event was re-harvested in Melton Reservoir and reused in the large fresh delivered to the lower Werribee River in November. No environmental water was released from Lake Merrimu to Pyrites Creek in summer/autumn, as a wet winter/spring followed by a dry (cease-to-flow) summer/autumn is the natural cycle of this creek.

Scope of environmental watering

Table 3.5.1 shows potential environmental watering actions and their environmental objectives.

Werribee River after environmental watering, by Melbourne Water

Table 3.5.1 Potential environmental watering actions and objectives for the Werribee system

Potential environmental watering	Environmental objectives
Pyrites Creek (reach 6)	
Spring/summer freshes (up to 3 freshes of 30 ML/day for 2 days in September–December)	• Improve waterbug habitat by scouring silt and sand from riffles • Promote vegetation growth
Spring/summer high flows (up to 3 high flows of 130 ML/day for 2 days in September–December)	• Flush organic matter from benches • Increase the recruitment and growth of riparian vegetation
Winter/spring/summer low flows (2 ML/day [or natural] in June–December)	• Create riffle habitat for waterbugs • Provide frog habitat • Promote the growth of aquatic plants • Allow fish movement between pools
Lower Werribee River (reaches 8, 9 and the estuary)	
Spring/summer freshes (up to 2 freshes of 50–80 ML/day for 2 days in November–December)	• Promote juvenile black bream recruitment • Promote longer-distance movement of fish through reach 9
Winter/spring/summer low flows (10 ML/day in June–December)	• Maintain suitable conditions for black bream spawning and recruitment • Provide habitat for waterbugs and fish and support vegetation growth in reach 9
Autumn low flows 10 ML/day during March–May	• Allow downstream migration of diadromous fish — fish that move between freshwater and saltwater to complete their life cycle — to the estuary • Provide habitat for waterbugs and fish • Support vegetation growth in reach
Summer/autumn freshes (up to 3 freshes of 80 ML/day[1] for 2 days during January–April)	• Maintain pool water quality for fish and platypus in reach 9 • Increase the recruitment of juvenile black bream in the estuary • Scour silt and algae from riffles in reach 8
Winter/spring/summer freshes (up to 4 freshes of 350 ML/day for 3 days during June–December)	• Increase the diversity of riparian vegetation in reaches 8 and 9 • Provide fish movement cues (all) • Inundate saltmarsh vegetation with brackish water in the estuary

1 *The original recommendation from the flow study (Ecological Associates 2005, Jacobs 2014) is for 137 ML delivered in one day. The recommendation has been revised (due to operational constraints) to be 160 ML delivered over two days. Monitoring has shown this achieves the hydraulic and water quality objective.*

Scenario planning

Table 3.5.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The critical environmental flows to deliver under the drought and dry scenarios are deliveries to Pyrites Creek (reach 6) and freshes to maintain water quality in the lower Werribee River. The amount of water available may not be sufficient to meet all these demands, particularly under drought conditions, and therefore releases will need to be made according to the greatest need. When possible, winter releases from Lake Merrimu to Pyrites Creek (reach 6) will be captured in Melton Reservoir and used for environmental flow releases to the lower Werribee River later in the water year. This is an essential management option to enable the best use of limited environmental water under drought and dry conditions.

Under average or wet conditions, Melton Reservoir is likely to spill, meaning releases from upstream will spill through the reservoir and provide a small increase in unregulated flow to the lower Werribee River. More environmental water is needed under average or wet conditions due to the inability to re-harvest releases from Merrimu Reservoir in Melton Reservoir.

Carrying over some water into 2017–18 is essential to help protect the health of Pyrites Creek (reach 6) in the following year under dry conditions.

Table 3.5.2 Potential environmental watering for the Werribee system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Minimal consumptive releases out of storage into reach 8 in summer/ autumn	• No unregulated flows below Melton Reservoir, minimal passing flows to reach 6 • Consumptive releases out of storage into reach 8 in summer/ autumn	• Unregulated spills in winter/spring from Melton into reaches 8 and 9 and the estuary; most reach 6 low flows met by passing flows • Consumptive releases out of storage into reach 8 in summer/autumn	• Unregulated spills in winter/spring from Melton into reaches 8 and 9 and the estuary; all reach 6 low flows provided • Consumptive releases out of storage into reach 8 in summer/autumn
Expected availability of environmental water	• 2,000 ML carryover • 50 ML allocation • 0 ML inflows • 2,050 ML total	• 2,000 ML carryover • 500 ML allocation • 200 ML inflows • 2,700 ML total	• 2,000 ML carryover • 700 ML allocation • 400 ML inflows • 3,100 ML total	• 2,000 ML carryover • >800 ML allocation • >900 ML inflows • >3,700 ML total
Potential environmental watering – tier 1 (high priorities)	• Winter/spring/ summer low flows (reach 6) • 2 spring/ summer freshes (reach 6) • 2 summer/autumn freshes (lower reaches) • Autumn low flows (lower reaches)	• Winter/spring/ summer low flows (reach 6) • 3 spring/ summer freshes (reach 6) • 2 summer/autumn freshes (lower reaches) • Autumn low flows (lower reaches) • 1 spring/summer fresh (lower reaches)	• Winter/spring/ summer low flows (reach 6) • 3 spring/summer freshes (reach 6) • 2 summer/autumn freshes (lower reaches) • Autumn low flows (lower reaches) • 2 spring/summer freshes (lower reaches) • Winter/spring/ summer low flows (lower reaches)	• 3 spring/summer freshes (reach 6) • 3 spring/summer high flows (reach 6) • 2 summer/autumn freshes (lower reaches) • Autumn low flows (lower reaches) • 2 spring/summer freshes (lower reaches) • Winter/spring/ summer low flows (lower reaches)
Potential environmental watering –tier 2 (lower priorities)[1]	• Winter/spring/ summer freshes (lower reaches)	• Winter/spring/ • summer freshes (lower reaches)	• Winter/spring/ summer freshes (lower reaches)	• Winter/spring/ summer freshes (lower reaches)
Possible volume of environmental water required to achieve objectives[2]	• 350 ML (tier 1) • 1,300 ML (tier 2)	• 700 ML (tier 1) • 1,300 ML (tier 2)	• 900 ML (tier 1) • 1,300 ML (tier 2)	• 1,200 ML (tier 1) • 1,300 ML (tier 2)
Priority carryover requirements	• 200 ML			

[1] *Tier 2 actions are lower-priority actions to be considered if water is available.*

[2] *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, Melbourne Water considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 3.5.3 shows the partners, stakeholder organisations and individuals with which Melbourne Water engaged when preparing the Werribee system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Port Phillip and Western Port Regional Catchment Strategy and Melbourne Water's Healthy Waterways Strategy.

Werribee River, by Erin Round

Table 3.5.3 Partners and stakeholders engaged in developing the Werribee system seasonal watering proposal

Partner and stakeholder engagement
• Southern Rural Water and licensed diverters • VEWH • Werribee River Community Advisory Group including representatives of Melton, Wyndham and Moorabool councils, Waterwatch, Werribee Riverkeeper, NatureWest, Friends of Werribee Gorge and Long Forest Mallee, Pinkerton Landcare & Environment Group, Friends of Toolern Creek, Werribee South Fishing Club, Werribee & District Anglers Club, Western Water and Port Phillip and Westernport CMA

3.6 Moorabool system

Waterway manager – Corangamite Catchment Management Authority

Storage operator – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder

The Moorabool River is a tributary of the Barwon River. It flows south from the Central Highlands between Ballarat and Ballan to join the Barwon River at Fyansford just north of Geelong. The Moorabool River is a highly regulated catchment with major storages that include Lal Lal, Moorabool and Bostock reservoirs, which supply potable water to communities in and around Ballarat and Geelong. Lal Lal Reservoir is used to supply water to the Ballarat area. Water from Lal Lal is also delivered via the Moorabool River to She Oaks Weir to supply towns in the Geelong area.

The surrounding catchment is heavily farmed, with about three-quarters of the catchment area used for agriculture. Despite substantial extraction and many years of drought, the river still retains significant environmental values.

Environmental values

The Moorabool River is home to native fish species including the Australian grayling, river blackfish, Australian smelt, flat-headed gudgeon, southern pygmy perch, short-finned eel, spotted galaxias and tupong. The system contains extensive areas of endangered remnant vegetation including streambanks shrubland and riparian woodland ecological vegetation communities. Platypus, water rats and a range of waterbugs are also present. The Moorabool River flows into the Barwon River, connecting it to the Ramsar-listed lower Barwon wetlands.

Social, cultural and economic values

The Moorabool River has important social, cultural, recreational and economic values. Its confined valley provides spectacular scenery and its reaches include parks, picnic sites, lookouts, swimming holes, fishing and camping spots and historic bridges. Many local people in the region have a connection to and long history with the river. They have actively helped protect and restore the river, and strongly advocated the establishment of the *Moorabool River Environmental Entitlement 2010*.

Local Aboriginal Victorians and their Nations also have a strong connection with the waterway and place a high cultural value on it, including those represented by the Wathaurung Aboriginal Corporation (Wadawurrung).

Environmental watering objectives in the Moorabool system

	Maintain remnant vegetation communities including a range of macrophytes (large water plants) within the river channel; these communities provide shade and food for organisms further up the food chain
	Protect and increase native fish populations including Australian grayling, southern pygmy perch, spotted galaxias, tupong and short-finned eel by providing flows for fish to move upstream and downstream and suitable conditions for fish to spawn
	Reshape the riverbank and riverbed and ensure fish and other water animals have a range of habitat pools and places to shelter
	Improve water quality during the year, particularly during summer
	Maintain a wide range and high biomass of waterbugs to provide energy, break down dead organic matter and support the river's food chain

System overview

There are several large water storages including Lal Lal Reservoir in the upper reaches of the river. In the lower reach (between She Oaks and Batesford), there are nine private diversion weirs that are a significant barrier to fish. These barriers have increased the extent of slow-flowing habitat and reduced habitat diversity in the lower reach of the Moorabool, reducing the diversity and abundance of migratory fish in this part of the river.

The Moorabool is a water supply catchment for Barwon Water and Central Highlands Water. Releases are made for urban water supply by Barwon Water from Lal Lal Reservoir to She Oaks Weir. These releases contribute to environmental outcomes in reach 3a and 3b and allow more-efficient delivery of environmental water to reach 4. Barwon Water and Corangamite CMA work together to optimise these benefits.

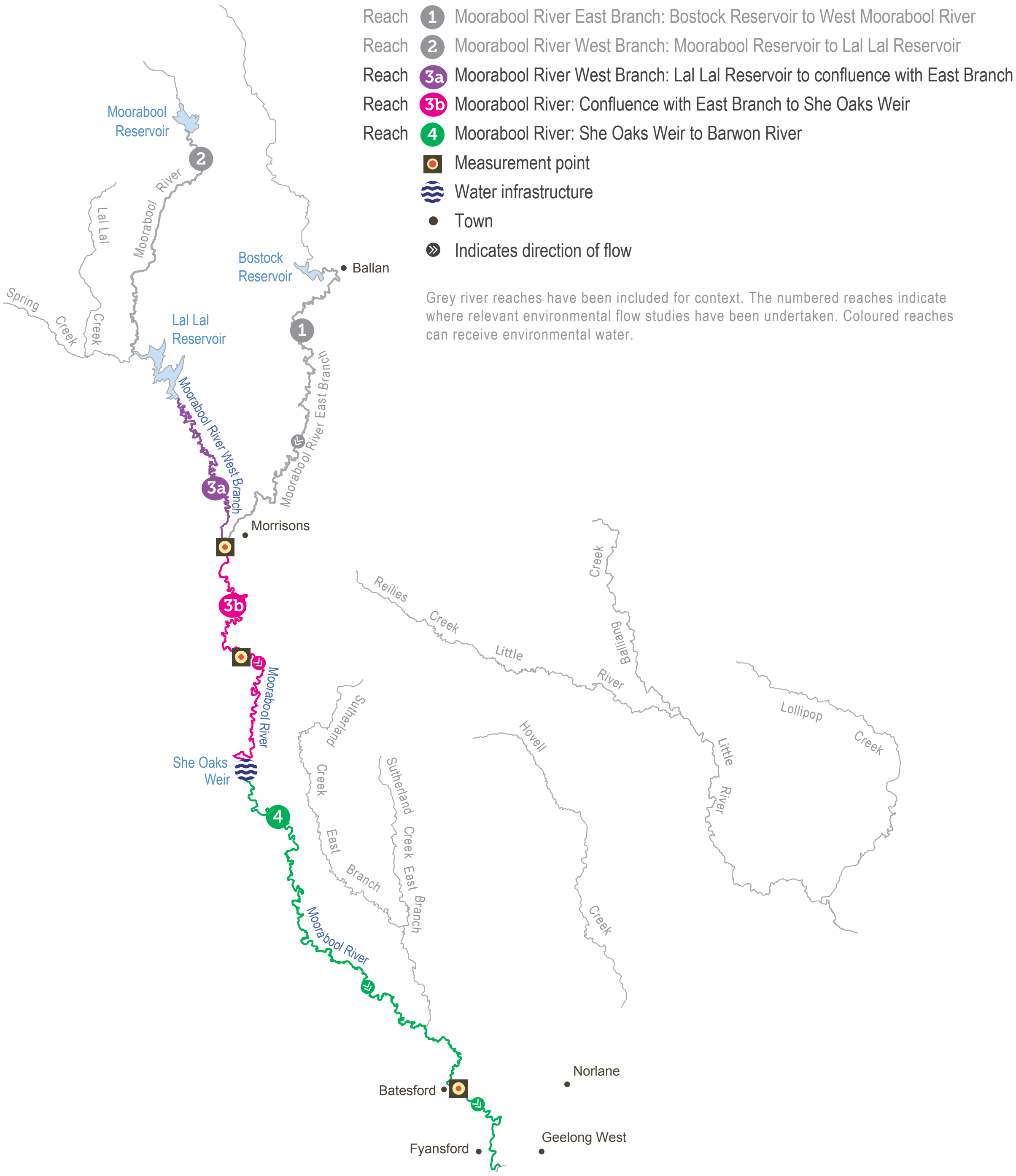
Water allocated to the Moorabool River environmental entitlement is stored in Lal Lal Reservoir and includes passing flows that help maintain flows in the river. Passing flows are a significant component of annual streamflow and are important in maintaining baseflows through winter. The priority reaches for environmental water delivery are the reaches between Lal Lal Reservoir and She Oaks Weir (reaches 3a and 3b), as these are where the small amount of available environmental water can have the most beneficial impact. Environmental water delivered also provides benefits to significant flow-dependant values in reach 4 (which flows from She Oaks Weir down to the confluence with the Barwon River in Geelong).

Changing seasons in the lower Moorabool River: the river under flow-stress in summer 2015 with a flow rate of 10 ML/day (top), and in spring 2016 with a flow rate of 4,000 ML/day (bottom), by Saul Vermeeren

Recent conditions

High rainfall in September and October 2016 filled Lal Lal Reservoir and increased the volume of environmental water available under the entitlement from 10 percent to 100 percent full capacity. Passing flows from Lal Lal Reservoir were delivered for most of 2016. In late 2016, the reservoir was 100 percent full and spilling for a short period, which also contributed to river flows. Winter high-flow and bankfull events were achieved naturally in 2016, which allowed the Corangamite CMA to focus environmental water delivery on summer low flows and summer fresh targets in 2017.

Figure 3.6.1 The Moorabool system



Scope of environmental watering

Table 3.6.1 shows potential environmental watering actions and their environmental objectives.

Table 3.6.1 Potential environmental watering actions and objectives for the Moorabool system

Potential environmental watering[1]	Environmental objectives
Summer/autumn low flows (5–20 ML/day in December–May)	• Maintain pool and riffle habitat for fish, waterbugs, platypus and submerged aquatic vegetation • Maintain water quality
Summer/autumn freshes (1–2 freshes targeting 30–60 ML/day for 3–5 days in December–May)	• Allow fish and platypus movement and maintain access to habitat • Flush silt and scour biofilms and algae from the streambed • Maintain the vegetation on the riverbank • Trigger downstream spawning migration of adult short-finned eel and grayling • Maintain water quality, top up habitat refuge pools and avoid critical loss of biota
Winter/spring low flows (10–86 ML/day in June–November)	• Allow fish movement • Restrict the spread of land-based vegetation into the river channel
Winter/spring freshes (2–3 freshes targeting 80–162 ML/day for 10 days in May–November)	• Allow fish and platypus movement and maintain access to habitat • Trigger downstream spawning migration of adult tupong and upstream migration of juvenile galaxias, tupong, short-finned eel and grayling • Flush silt and scour biofilms and algae from the streambed and transport organic matter • Increase the growth and recruitment of native riparian vegetation including woody shrubs and maintain vegetation zonation on the banks

[1] *The target reaches for environmental watering are reaches 3a, 3b and 4 of the Moorabool system unless otherwise stated.*

Scenario planning

Table 3.6.2 outlines the potential environmental watering and expected water use under a range of planning scenarios, based on the flow recommendations for reach 3b of the Moorabool River.

Under all climate scenarios, the main priorities for environmental water use in the Moorabool River in 2017–18 will be to provide recommended low flows and freshes throughout summer and autumn to maintain water quality and habitat for fish, and to deliver a winter fresh to allow fish and platypus to move up and down the river and promote vegetation growth. Water quality is monitored throughout summer to identify when freshes need to be released to avoid dangerously low levels of dissolved oxygen or dangerously high levels of salinity. If more environmental water becomes available under any climate scenario, it may be used to increase the number of freshes or the magnitude of summer low flows; or it may be used to deliver managed low flows through winter. The VEWH expects most of the recommended flow components will be partly met under dry climate scenarios and will be mostly met under a wet climate scenario.

Although environmental watering in the Moorabool River is primarily to achieve outcomes in reaches 3a and 3b, where possible deliveries will be planned to also provide benefits in reach 4. For example, increasing the magnitude of summer freshes (when water availability allows) will provide some increased flow through reach 4. The CMA prioritises carryover of 750 ML each year (if possible) to allow delivery of trigger-based freshes in the following year if there is a low allocation.

Table 3.6.2 Potential environmental watering for the Moorabool system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Minimal catchment inflows • Limited passing flows	• Low catchment inflows • Passing flows	• Moderate catchment inflows • Unregulated and passing flows	• High catchment inflows • Unregulated and passing flows
Expected availability of environmental water	• 5,500 ML carryover • 200 ML inflows • 5,700 ML total	• 5,500 ML carryover • 1,000 ML inflows • 6,500 ML total	• 5,500 ML carryover • 2,000 ML inflows • 7,086 ML total[1]	• 5,500 ML carryover • 4,000 ML inflows • 7,086 ML total[1]
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes (trigger-based) • Summer/autumn low flows • Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes (trigger-based) • Summer/autumn low flows • Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes (trigger-based) • Summer/autumn low flows • Summer/autumn freshes • Winter/spring freshes	• Summer/autumn freshes (trigger-based) • Summer/autumn low flows • Summer/autumn freshes • Winter/spring freshes
Potential environmental watering – tier 2 (lower priorities)[2]	• Summer/autumn low flows – remainder • Winter/spring low flows • Winter/spring fresh – remainder	• Summer/autumn low flows – remainder • Winter/spring low flows • Winter/spring fresh – remainder	• Summer/autumn low flows – remainder • Summer/autumn freshes – remainder • Winter/spring low flows • Winter/spring freshes – remainder	• Summer/autumn low flows – remainder • Summer/autumn freshes – remainder • Winter/spring low flows • Winter/spring freshes – remainder
Possible volume required to achieve objectives[3]	• 2,500 ML (tier 1)[4] • 2,583 ML (tier 2)	• 2,500 ML (tier 1)[4] • 2,583 ML (tier 2)	• 2,500 ML (tier 1)[4] • 4,927 ML (tier 2)	• 2,500 ML (tier 1)[4] • 4,927 ML (tier 2)
Priority carryover requirements	• 750 ML	• 750 ML	• 750 ML	• 750 ML

1 *The environmental entitlement includes a maximum share of storage of 11.9 percent, or 7,086 ML.*
2 *Tier 2 actions are lower-priority actions to be considered if water is available.*
3 *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*
4 *Under the environmental entitlement, a maximum of 7,500 ML may be used in any three-year period, effectively limiting the use of environmental water to 2,500 ML in any one year.*

Risk management

In preparing its seasonal watering proposal, Corangamite CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 3.6.3 shows the partners and stakeholder organisations with which Corangamite CMA engaged when preparing the Moorabool system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Corangamite Regional Catchment Strategy and Corangamite Waterway Strategy.

Table 3.6.3 Partners and stakeholders engaged in developing the Moorabool system seasonal watering proposal

Partner and stakeholder engagement
• Barwon Water • Central Highlands Water • DELWP • Moorabool Stakeholder Advisory Committee, with representatives of People for a Living Moorabool, Geelong Landcare Network, Southern Rural Water, Central Highlands Water, Parks Victoria, Barwon Water, the VEWH and the local community • Parks Victoria • People for a Living Moorabool and other local community groups • Southern Rural Water • VEWH

3.7 Barwon system

The Barwon River flows east from the Otway Ranges towards Geelong and discharges into Bass Strait at Barwon Heads. The Barwon estuary contains a system of wetlands and lakes collectively called the lower Barwon wetlands. Environmental water can be used to manage levels at Reedy Lake and Hospital Swamps, which connect to the Barwon River when water levels in the river are high. The main storages in the Barwon River catchments are the West Barwon and Wurdee Boluc reservoirs. A new entitlement is being developed in the Barwon system, which would allow environmental water to be delivered from the West Barwon Reservoir to the upper Barwon River.

3.7.1 Upper Barwon River

DELWP is currently drafting the *Upper Barwon River Environmental Entitlement* to fulfil priority action 4.17b in the *Central Region Sustainable Waterway Strategy* to transfer part of Barwon Water's water entitlement in the West Barwon Reservoir to the environment.

The draft of the new entitlement is expected to be released soon for community and stakeholder input before the Minister for Water considers it for approval. Once the *Upper Barwon River Environmental Entitlement* is approved, the Corangamite CMA will implement a further planning and consultation process to determine priority watering actions and prepare a seasonal watering proposal. If the CMA finalises a proposal during 2017–18, the VEWH will review it and update the *Seasonal Watering Plan 2017–18* to incorporate the agreed priority watering actions.

3.7.2 Lower Barwon wetlands

Waterway manager – Corangamite Catchment Management Authority

Environmental water holder – Victorian Environmental Water Holder

The estuarine reach of the Barwon River contains a system of wetlands and lakes including Lake Connewarre, Reedy Lake, Hospital Swamps, Salt Swamp and Murtnaghurt Lagoon.

Environmental values

Reedy Lake and Hospital Swamps form part of the internationally recognised Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site, which provide a home for many thousands of migratory birds from around the world.

The wetlands support about 47 threatened animal and plant species and communities. These include some of Victoria's rarest species (such as the brolga, orange-bellied parrot, Australasian bittern, growling grass frog, Australian grayling and dwarf galaxias) and subtropical and temperate coastal saltmarsh communities.

Reedy Lake supports a range of vegetation communities including coastal saltmarsh, herbfields and reed beds. River regulation has changed Reedy Lake from a partly ephemeral system into a permanently wet lake that has largely remained in a constantly wet state since the 1970s. Permanent inundation has favoured the reed bed community in the lake and over time it has increased its extent and replaced much of the coastal saltmarsh and herbfield communities and open-water habitat. While reed beds form an important part of the lake's ecosystem, their continued expansion is reducing habitat diversity. In turn, this is reducing the number and diversity of internationally important migratory waterbirds the wetland supports. Unfortunately, the carp population had also steadily increased, diminishing the health of the lake. Carp prey on native fish and compete with them for habitat and food. They also damage aquatic vegetation.

In summer/autumn 2016–17, the Corangamite CMA implemented the first year of a three-year partial drying regime at Reedy Lake. This helped control carp numbers and improve conditions for communities of coastal saltmarsh and herbfields. Achieving a more-natural wetting and drying regime is the single most important management action to protect the long-term ecology of the lower Barwon wetlands.

Hospital Swamps is made up of five unique wetland basins that support a high diversity of ecological values and processes. Large areas of threatened coastal saltmarsh and diverse waterbird populations are present at the site. Vegetation communities in Hospital Swamps have remained largely unchanged over time due to the maintenance of natural wetting and drying cycles.

Social, cultural and economic values

The lower Barwon wetlands are located close to Geelong, the second-biggest city in Victoria. They form a very important part of the region's social fabric. The wetlands are valued by many people for their intrinsic beauty, ecological significance and recreational uses. In particular, the wetlands are used heavily by Geelong Field and Game and Geelong Field Naturalists for conservation activities and events, birdwatching, game hunting and passive recreation. It is a culturally significant area for Aboriginal Victorians including those represented by the Wathaurung Aboriginal Corporation (Wadawurrung). The system also supports a commercial eel fishery.

Environmental watering objectives in the lower Barwon wetlands

Provide suitable foraging habitat including mud flats and shallow water for wading birds, and refuge for waterbirds and shorebirds
Provide habitat for fish breeding and growth and improved conditions for migration and dispersal when wetlands are connected to the Barwon River
Provide varying water levels and conditions to promote soil salinisation to support the persistence and growth of threatened saline-dependant ecological vegetation communities
Maintain the high diversity of ecological vegetation communities in the wetlands Increase the growth and extent of coastal saltmarsh, herbfields and lignum shrubland ecological vegetation communities

System overview

Environmental water can be actively managed at Reedy Lake and Hospital Swamps using regulating structures at the wetlands.

Unlike many other systems, the environmental entitlement does not provide access to water held in storage. Instead, it allows water to be diverted via regulators from the Barwon River into Reedy Lake and Hospital Swamps when river levels are above 0.7 m AHD (Australian Height Datum). High water levels in the Barwon River can also result in natural inundation of the wetlands.

Recent conditions

Above-average rainfall in winter/spring 2016–17 delivered three overbank flows in the Barwon River, which resulted in higher-than-average water levels in the wetlands in spring. Water levels over summer dropped, due to reduced seasonal rainfall. Suitable summer conditions allowed for the implementation of a partial drying regime at Reedy Lake. Operational limitations at Hospital Swamps restricted full achievement of the regime, although the lowered water levels did achieve some ecological outcomes.

Despite the wet conditions at the start of the water year, the Corangamite CMA lowered water levels and partially dried Reedy Lake to 0.1 m AHD for the first time in more than a decade, starting a long-term process to restore the site's threatened ecological values. Achieving a more-natural wetting and drying regime is the single most important management activity to protect the ecology of the lower Barwon wetlands. The lower water level in summer 2016–17, in combination with the planned watering regime in future years, is expected to reduce the carp population, limit the growth of invasive tall reeds and increase the growth and extent of coastal saltmarsh, herbfields and lignum shrubland ecological vegetation communities.

A natural pattern of wetting and drying was partially implemented in Hospital Swamps, which meant inflows from the Barwon River entered the wetland in winter/spring and were actively drawn down, reducing the water level over the drier summer months. While low water levels were achieved, a full drying cycle was not completed due to operational constraints. Low water levels helped to support important ecological processes. Future drying of the wetland is essential to maintain the balance between freshwater and saltwater processes, which is necessary to support the diverse mix of vegetation communities and provide feeding and breeding habitat for waterbirds and native fish.

Scope of environmental watering in 2017–18

Table 3.7.1 shows potential environmental watering actions and their environmental objectives.

The main objective for environmental watering in the lower Barwon wetlands is to implement natural wetting and drying cycles. The wetlands will be filled in winter and spring when water levels in the Barwon River are high and will be allowed to draw down over summer. These regimes will be managed by using existing regulators that can control flow in either direction between the Barwon River and the wetlands.

Hospital Swamps has had an appropriate wetting and drying regime for many years and there is no plan to change its management in 2017–18.

The plan for Reedy Lake will be to implement the second year of the partial drying regime. The lake will be allowed to fill in winter and spring and then draw down to a target level of 0.3 m AHD in summer to reduce the extent of reed beds and allow other vegetation communities to recolonise. Increasing the variety of vegetation communities and habitat structure over time is expected to improve conditions for internationally significant waterbird species.

Figure 3.7.1 The lower Barwon wetlands

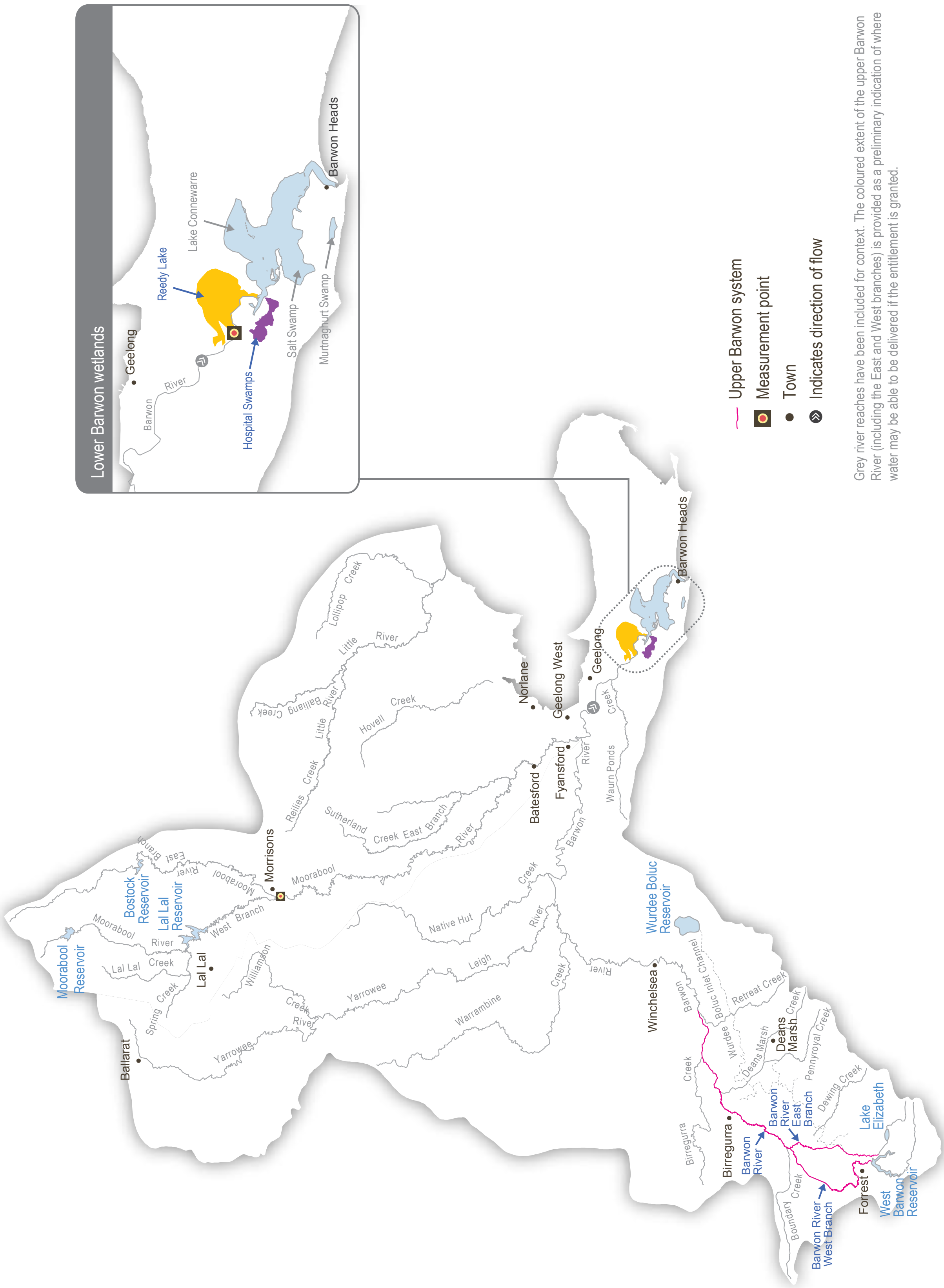


Table 3.7.1 Potential environmental watering actions and objectives for the lower Barwon wetlands

Potential environmental watering	Environmental objectives
Reedy Lake	
Autumn/winter/spring fill and top-ups (March/April–October)[1] *The inlet to Reedy Lake will be opened in autumn in response to a sustained increase in flows in the Barwon River*	• Maintain connectivity with the Barwon River • Provide feeding habitat for waterbirds in flooded vegetation and the wetland fringe • Stimulate fish breeding
Spring/early summer drawdown (October–January) and continued low water levels (around 0.3 m AHD) throughout summer/autumn (January–March/April) *The inlet to Reedy Lake will be closed to allow water levels to drop to about 0.3 m AHD through evaporation; during this period, the inlet and outlet may be manipulated if required to maximise the drawdown or to introduce saltwater to the lake*	• Reduce the extent of tall reeds in the system by increasing the salt content of the water and soil • Reduce the threat of carp and associated impacts on plants and animals • Promote suitable conditions for threatened vegetation communities (such as coastal saltmarsh, herbfields and lignum shrubland) • Provide increased habitat diversity (including salt pans, mudflats and shallow water) • Provide wading bird habitat in summer • Provide summer waterbird refuge and foraging habitat • Improve lake shore salinity and increase soil salinisation • Initiate decomposition of organic matter on the wetland bed, to increase lake productivity when it is refilled • Improve soil health and allow weathering of heavy metals in lake fringe soils • Allow seasonal recruitment of aquatic macrophytes at wetland fringes
Hospital Swamps	
Autumn/winter/spring fill and top-ups (March/April–December) [1] *Hospital Swamps will be connected to the Barwon River for at least 6 weeks by keeping the inlet and outlet open*	• Create habitat and support waterbug populations • Stimulate fish and waterbird breeding • Allow fish to colonise the wetland from the river • Allow soil and surface water salts to be diluted over winter • Promote and sustain the growth of important wetland vegetation communities
Summer/autumn drawdown (December–March/April) *The inlet to Hospital Swamps will be closed to allow water levels to drop through evaporation; during this period, the outlet will be opened for short periods if a summer storm increases water levels above 0.85 m AHD*	• Reduce the threat of carp and associated impacts on plants and animals • Prevent the expansion of tall reeds in the system by increasing the salt content of the water and soil • Provide increased habitat diversity including salt pans, mudflats and shallow water • Provide wading bird habitat in early summer • Provide early summer waterbird refuge and foraging habitat • Improve lake shore salinity and increase soil salinisation • Initiate the decomposition of organic matter on the wetland bed, to increase lake productivity when it is refilled • Improve soil health and allow weathering of heavy metals in lake fringe soils • Promote suitable conditions for threatened vegetation communities (such as coastal saltmarsh, herbfields and lignum shrubland) • Allow seasonal recruitment of aquatic macrophytes at wetland fringes

1 *Water can only be diverted into the lower Barwon wetlands when water levels in the Barwon River are above 0.7 m AHD at the lower Barrage gauging station, in line with provisions for accessing water under the environmental entitlement.*

Scenario planning

Table 3.7.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Inundation of the wetlands over the winter period and drawdown in summer are priority actions under all scenarios, but the extent of the wetting and drying will vary in response to natural conditions. Under a wet scenario, the Barwon River is likely to experience more sustained high flows and therefore the extent of inundation may be higher and the amount of drawdown lower compared to a dry climate scenario. Partial drying is expected at all wetlands under all climate scenarios and is important to maintain or increase vegetation diversity and soil salinisation and to provide a variety of feeding and breeding habitat for waterbirds. The wetlands will be managed adaptively throughout the year in response to climatic conditions, to optimise environmental outcomes.

Corangamite CMA will monitor water levels, water quality and environmental conditions throughout the drawdown period and adjust the water levels as needed.

Table 3.7.2 Potential environmental watering for the lower Barwon wetlands under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Some natural inflows from the Barwon River in winter/spring • Dry conditions over summer will assist in the drawdown of the wetlands	• Some natural inflows from the Barwon River in winter/spring • Mild conditions over summer may assist drawdown of the wetland water levels	• Overbank flows likely to inundate the wetlands as a result of higher river flows, stormwater inflows and local rain/run-off • Extensive drawdown of wetlands is unlikely
Reedy Lake			
Potential environmental watering	• Autumn/winter/spring filling flows (March/April–October) • Spring/early summer/autumn drawdown and low water levels (0.3 m AHD) (October–March/April)		
Hospital Swamps			
Potential environmental watering	• Autumn/winter/spring filling flows (March/April–December) • Summer/autumn drawdown (December–March/April)		

Risk management

In preparing its seasonal watering proposal, Corangamite CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 3.7.3 shows the partners, stakeholder organisations and individuals with which Corangamite CMA engaged when preparing the lower Barwon wetlands seasonal watering proposal.

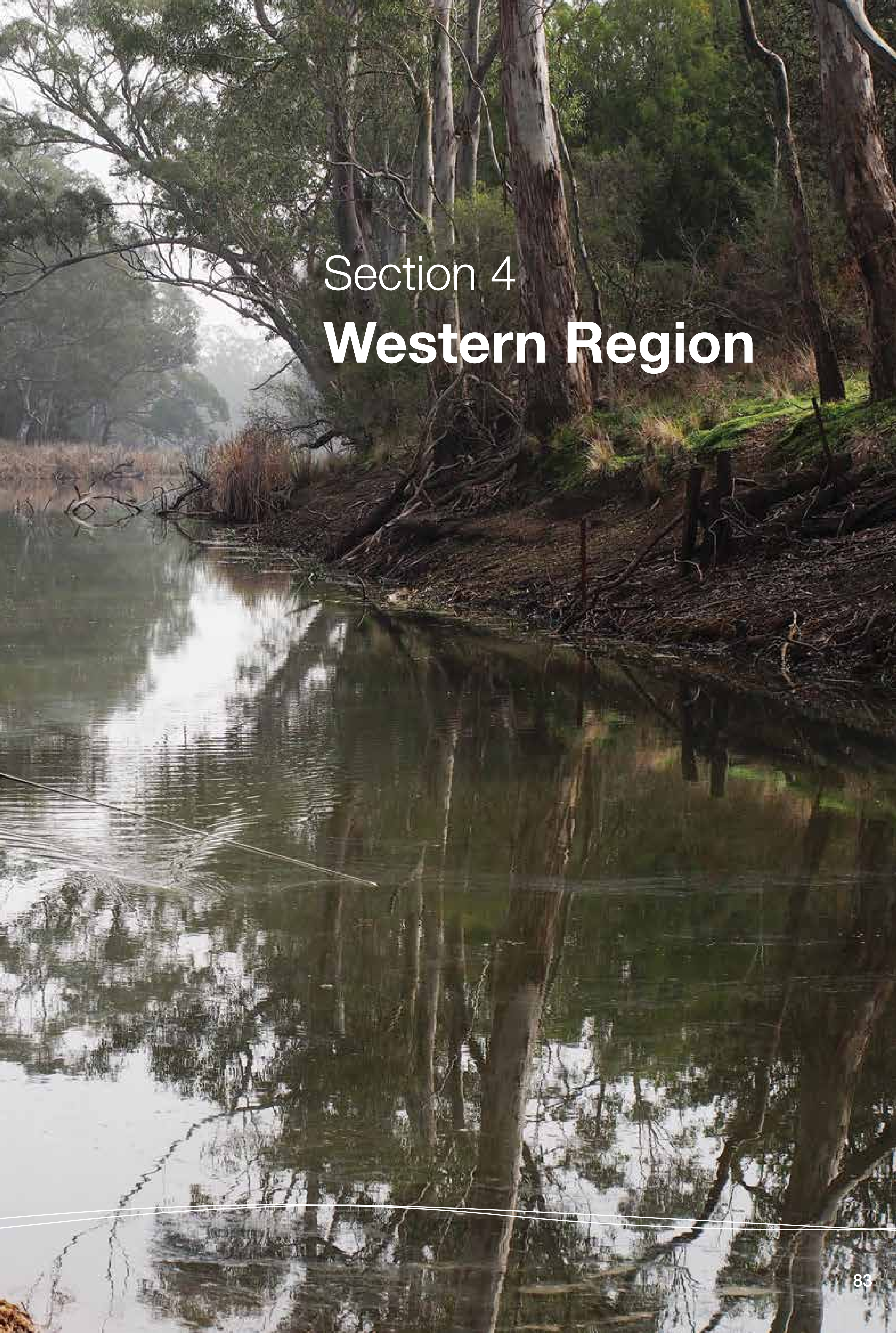
Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Corangamite Regional Catchment Strategy and Corangamite Waterway Strategy.

The Corangamite CMA has undertaken extensive consultation about the planned watering regimes for Reedy Lake and Hospital Swamps over the last six years with a broad range of stakeholders and interest groups representing over 1,500 people. These people were involved in developing the original environmental flow study and in subsequent scientific work exploring ecological risks, vegetation monitoring, alternative management approaches and infrastructure operations. The results of this comprehensive work show that lowering water levels at Reedy Lake is the only feasible management practice that will mitigate threats to the ecological health of the wetland and ensure all user groups can continue to use the system into the future.

Table 3.7.3 Stakeholders engaged in developing the lower Barwon wetlands seasonal watering proposal

Stakeholder engagement
• Lower Barwon Community Advisory Committee with representatives of Geelong Field and Game, Geelong Environment Council, Geelong Field Naturalists Club, Geelong Gun & Rod Association, Federation University Australia, RMIT University, DELWP, Environment Victoria, VRFish, Barwon Water, local landowners, community members, Parks Victoria, Southern Rural Water and the VEWH; with additional stakeholders invited on an as-needed basis including science and engineering consultants and the Department of Economic Development, Jobs, Transport and Resources • Commercial eel fishers • Fisheries Victoria

Section 4
Western Region



4.1 Western Region overview

The three systems in the Western Region that can receive environmental water are the Wimmera and Glenelg river systems and the Wimmera-Mallee wetlands.

The landscape

The Glenelg River rises in the Grampians and flows west through Harrow and then south to Casterton and Dartmoor for over 500 km, making it one of the longest rivers in Victoria. A short stretch of the estuary winds through SA before returning to Victoria to enter the sea at Nelson.

The Wimmera River rises in the Pyrenees Range near Elmhurst and flows through Horsham, Dimboola and Jeparit before terminating at Lake Hindmarsh, which is Victoria's largest natural freshwater lake. The Wimmera River receives flows from several regulated tributaries including the MacKenzie River and the Mount William, Burnt and Bungalally creeks.

The Wimmera-Mallee wetlands system includes 51 wetlands that were formerly supplied by the Wimmera-Mallee channel system. The wetlands are all within the footprint of the Wimmera-Mallee Pipeline project, which is bounded to the west and south by the Wimmera River and to the east by the Avoca River.

Environmental water is supplied from the Wimmera-Mallee headworks system, which also supplies towns, industries and farms across the Western Region. The complex network of channels and pipelines in the water supply and distribution systems managed by GWMWater enables water to be transferred between storages and delivered in different catchments, for example transferring from the Glenelg River to supply water in the Wimmera catchment.

Environmental values

The Glenelg River supports the endangered Glenelg freshwater mussel and Glenelg spiny crayfish, as well as platypus and native fish including river blackfish, estuary perch and pygmy perch. Its species diversity makes the river one of Australia's 15 national biodiversity hotspots. The endangered Wimmera bottlebrush also grows along the Glenelg River.

The Wimmera River supports diverse vegetation and animal communities and is home to one of Victoria's few self-sustaining populations of freshwater catfish as well as flat-headed gudgeon and Australian smelt. The MacKenzie River has the only stable population of platypus in the Wimmera and supports the Glenelg spiny crayfish and turtles. Tributaries such as Burnt and Mount William creeks also support populations of native fish and threatened species. The tributaries, along with the Bungalally Creek, provide important habitat corridors and have good streamside vegetation.

The Wimmera-Mallee wetlands provide a variety of different wetland types across a dry landscape. They are home to many types of water-dependent plants, birds, turtles and frogs and also provide drought refuge and drinking holes for other native animals.

Community considerations

Aboriginal Victorians and their Nations in the Western Region continue to have a deep and enduring connection to the region's rivers, wetlands and floodplains. The VEWH acknowledges the Traditional Owners of the Western Region and pays respect to their Elders past, present and future. It recognises that water has cultural importance and value for Traditional Owners and Aboriginal Victorians.

Traditional Owner groups in and around western Victoria (including areas where there is no environmental water management) include the Bindjali, Dja Dja Wurrung, Djagurd Wurrung, Gunditjmara, Jaadwa, Jadawadjali, Jupagulk, Wamba Wamba, Wadawurrung, Wergaia and Wotjobaluk people, among others.

The Glenelg Hopkins and Wimmera CMAs work with Gunditj Mirring Traditional Owner Corporation and Barengi Gadjin Land Council to understand how environmental water management in the Glenelg and Wimmera rivers can better support Aboriginal aspirations, particularly around caring for Country and protecting important story places and cultural resources.

Year by year and case by case, the VEWH and its program partners consider opportunities raised by communities to use environmental water to provide additional social, cultural and recreational benefits (for example, releasing environmental water increases the enjoyment of people camping by a waterway, or publicising an environmental water release in advance provides more opportunities for kayakers). Where possible, the VEWH and its program partners incorporate such opportunities into watering decisions, as long as they do not compromise environmental outcomes or increase demand on the water holdings.

When planning to use water for the environment, the potential social, economic, Aboriginal cultural and recreational benefits for communities which could arise from the water's use are considered.

The Glenelg River is highly valued by anglers across Australia. Several fishing competitions are held on the river each year. The Glenelg River also hosts other recreational activities (such as walking, swimming, sightseeing, boat cruises, canoeing, birdwatching and camping).

The Wimmera River is extremely important for recreation activities (such as walking, boating, rowing, waterskiing, fishing, swimming, canoeing and camping). Several large community events are held on the waterway including festivals, a triathlon, rowing regattas, dragon boating and fishing competitions. The wetlands in the region are used for canoeing, yabbying, duck hunting, swimming and birdwatching.

Some scoped opportunities for shared community benefits of environmental water in western Victoria for 2017–18 include:

- where possible, managing environmental water deliveries to support major recreational events along the Wimmera River (such as the Horsham, Dimboola and Jeparit fishing competitions, waterskiing at the Kanamaroo Festival, the Dimboola Regatta and Head of the Wimmera rowing event and the Horsham Triathlon)
- improving water quality in the Glenelg River resulting in better river conditions at popular camp grounds in the upper reaches, which improves amenity and provides more opportunities for swimming, fishing and canoeing
- increasing opportunities for yabbying and birdwatching at the Wimmera-Mallee wetlands
- improving habitat for recreational fish species resulting in increased recreational fishing opportunities along the Glenelg, Wimmera and MacKenzie rivers and Burnt and Mt William creeks
- increasing amenity at walking tracks in Horsham, Dimboola, Jeparit and Dadswells Bridge along the Wimmera River and Burnt and Mt William creeks, and along the Glenelg River including the Glenelg River Walk at Harrow and Casterton, and the Kelpie Trail.

The VEWH's ability to deliver these benefits depends on climate, water available and the way the system is being operated to deliver water for other purposes (such as to homes, farms or businesses).

For more information about scoped opportunities for shared community benefits in 2017–18, contact the VEWH or the relevant waterway manager.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental water planning and releases need to be part of an integrated approach to catchment management. Many of the environmental objectives in this seasonal watering plan will not be fully met without simultaneously addressing excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of streambank vegetation and invasive species, to name just a few issues.

Victorian and Australian government agencies, community groups and private landowners implement many programs to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments. Activities in the Western Region that are planned and implemented to coordinate with the management of environmental water include:

- erosion control in the upper Wimmera catchment, to improve water quality
- stock exclusion fencing along priority waterways throughout the catchments of the Wimmera and Glenelg rivers, to support the re-establishment of riparian and in-stream vegetation
- major works to improve fish passage at Sandford Weir and Dergholm Gauge, in combination with environmental water delivery to facilitate the movement of migratory fish from the estuary to the upstream reaches of the Glenelg and Wannon rivers
- carp management activities in both the Wimmera and Glenelg systems to reduce the number of carp and to better understand their behaviour in both rivers to improve environmental watering outcomes
- installation of snags in the Glenelg River reach 2 using red gum trunks and root balls to restore complex habitat in the reach
- control of invasive species within the Wimmera-Mallee wetlands.

For more information about integrated catchment management programs in the Western Region refer to the Glenelg Hopkins, Wimmera, North Central and Mallee regional catchment strategies and waterway strategies.

Seasonal outlook 2017–18

Conditions in 2016–17 were very wet, particularly in winter/spring, and naturally high flows and some flooding helped the rivers and wetlands recover from the very dry conditions in 2015–16. Allocations reached 100 percent for the first time since 2011–12. While the catchments dried over summer/autumn, delivery of accumulated passing flows and environmental water helped to optimise the benefits achieved from natural flows, while still reserving a significant volume to carry over into 2017–18.

If 2017–18 has low rainfall, environmental watering in the Western Region will focus on protecting water quality to maintain habitat and build the resilience of in-stream native plants and animals. The carryover available going into 2017–18 will be particularly important in this scenario. Under wetter conditions, priority will be given to reserving water for use in 2018–19 and delivering some of the flow components that have not been possible in the lead-up to last year's wet conditions (like some of the winter/spring flow components). The focus of environmental watering in the Wimmera-Mallee wetlands will continue to be providing refuge within the dry landscape to support local plants and animals.

The Murray–Darling Basin Plan

The Wimmera system forms part of the larger Murray–Darling Basin and water diversions and environmental water deliveries in this region are also subject to the requirements of the Murray–Darling Basin Plan.

The VEWH's environmental planning and delivery is consistent with the requirements of the Murray–Darling Basin Plan. The potential environmental watering outlined in section 4 of this seasonal watering plan fulfils Victoria's obligations under section 8.26 of the Murray–Darling Basin Plan to identify annual environmental watering priorities for Victoria's water resource areas.

Refer to section 5.1 for further information about the Murray–Darling Basin Plan.

4.2 Glenelg system

Waterway manager – Glenelg Hopkins Catchment Management Authority

Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder

The Glenelg River rises in the Grampians and flows west through Harrow and then south to Casterton and Dartmoor for over 500 km, making it one of the longest rivers in Victoria. A short stretch of the estuary winds through SA before returning to Victoria to enter the sea at Nelson.

Environmental values

The lower section of the Glenelg River is recognised as one of Australia's 15 national biodiversity hotspots due to the high-value aquatic life it supports including the endangered Glenelg freshwater mussel and Glenelg spiny crayfish. It is also home to platypus and important native fish populations including river blackfish, estuary perch, tupong and diverse pygmy perches. Some of these fish species migrate long distances upstream from the Glenelg River estuary to complete their lifecycles. Frasers Swamp is another important feature of the upper Glenelg system and is home to a healthy growling grass frog population.

The Glenelg River supports a variety of riparian vegetation communities including the endangered Wimmera bottlebrush. Riparian and floodplain vegetation is comprised of river red gum woodlands with paperbark, bottlebrush and tea tree understorey.

Social, cultural and economic values

The Glenelg system is highly valued by recreational anglers and several fishing competitions are held on the river throughout the year along with high-profile events such as an Australian Bream Tournament and Fisheries Victoria's The Great Perch Search broodfish collection event. Other recreational activities including walking, sightseeing, boat cruises, canoeing, birdwatching and camping are popular along parts of the river. Many landholders rely on the Glenelg River for stock water and use the productive floodplains for grazing. The river provides tourism opportunities and supports businesses in townships (such as Harrow, Casterton, Dartmoor and Nelson). Maintaining healthy Country is vitally important to Aboriginal Victorians in the Glenelg River area including those represented by the Gunditj Mirring Traditional Owners Aboriginal Corporation and the Barengi Gadjin Land Council, and Aboriginal Victorians have a continuing connection to the river system.

Environmental watering objectives in the Glenelg system

Assist in-stream and riverside plants to recover after disturbance from recent floods

Protect and increase populations of native fish

Cue fish movement and spawning to increase the recruitment of species such as the short-finned eel, black bream, estuary perch and tupong

Maintain a wide range and population of waterbugs to provide energy, break down organic matter and support the river's food chain

Move built-up sand on the river bed to provide healthy habitat pools for native fish, platypus, the critically endangered Glenelg freshwater mussel and the endangered Glenelg spiny crayfish

System overview

The Glenelg River is an integral part of the Wimmera-Mallee headworks system, which supplies towns and properties across the Western Region. Moora Moora Reservoir and Rocklands Reservoir in the upper Glenelg catchment and three weirs on the upper Wannon River are all used to divert water from the Glenelg system to the Wimmera catchment. Environmental water is actively managed in the main stem of the Glenelg River below Rocklands Reservoir, and passing flow rules are in place for the Glenelg River and upper Wannon River.

The priority environmental flow reaches of the Glenelg River are Rocklands Reservoir to 5-Mile Outlet (reach 1a), 5-Mile Outlet to the confluence with the Chetwynd River (reach 1b) and Chetwynd River to the Wannon River (reach 2). Environmental water in the Glenelg system is released from Rocklands Reservoir for reach 1a via the reservoir wall outlet and for reach 1b via the 5-Mile and 12-Mile outlets. Releases are made at these points to meet objectives in these reaches as well as in reach 2. The Glenelg River reach 3 and estuary benefit from environmental water releases to upstream reaches, but releases are not specifically targeted at these reaches.

The Glenelg River above Rocklands Reservoir (reach 0) runs mostly through the Grampians National Park and retains significant environmental values. Flows through this reach are affected by the operation of Moora Moora Reservoir and work is being undertaken to confirm its flow requirements. Work is also being undertaken to better understand the role environmental releases from Rocklands Reservoir play in the health of the Glenelg River estuary, which is listed as a heritage river reach and has been nominated for international listing under the Ramsar Convention.

Figure 4.2.1 The Glenelg system

Grey river reaches have been included for context.
The numbered reaches indicate where relevant
environmental flow studies have been undertaken.
Coloured reaches can receive environmental water.

Recent conditions

Heavy rainfall in winter/spring 2016 ended a very dry 18 month period and led to widespread flooding throughout the Glenelg catchment. The floods connected the river and floodplain, provided a significant influx of carbon into the system, scoured woody debris and boosted food resources for aquatic species. The high flows also allowed migratory fish species to disperse throughout the system and recolonise areas that were unsuitable during the preceding dry period. Although not specifically measured, the natural high flows and floods probably provided cues and conditions for some fish species to breed. These natural flow events met many of the environmental flow objectives for winter and spring and so managed environmental flow releases were not needed. Passing flows were also suspended for much of winter/spring to reduce the flood risk to communities downstream of Rocklands Reservoir.

Environmental water allocations reached 100 percent in October 2016 for the first time since 2011–12. Water that was accumulated as a result of the suspended passing flows in winter was released from late November 2016 to help meet the recommended low flows and freshes through summer and autumn. Regulated environmental water releases began in April and will continue until the start of the next passing flow season in June 2017.

Electrofishing demonstration on the Glenelg River at Harrow, by Chloe Wiesenfeld

Scope of environmental watering

Table 4.2.1 shows potential environmental watering actions and their environmental objectives.

Table 4.2.1 Potential environmental watering actions and objectives for the Glenelg system

Potential environmental watering	Environmental objectives
Summer/autumn freshes targeting reach 1a (2 freshes of 60 ML/day for 2–3 days each in December–May)	• Maintain or increase the abundance and variety of waterbugs • Scour sand from pools to increase the quality and quantity of fish habitat • Maintain the condition of emergent vegetation on the lower banks • Flush pools to improve water quality
Summer/autumn freshes targeting reaches 1b (2 freshes of 100 ML/day for 2–3 days each in December–May)	
Summer/autumn freshes targeting reach 2 (2 freshes of 150 ML/day for 2–3 days each in December–May)	
Summer/autumn low flows targeting reach 1a (10 ML/day or natural in December–May)[1]	• Protect against rapid water quality decline over the low-flow period • Maintain edge habitats, pools and shallow water habitat for fish, waterbugs and platypus • Maintain a near-permanent inundated stream channel to prevent excessive in-stream terrestrial species growth and to promote in-stream vegetation
Summer/autumn low flows targeting reach 1b (15 ML/day or natural in December–May)[1]	
Summer/autumn low flows targeting reach 2 (25 ML/day or natural in December–May)[1]	
Winter/spring freshes targeting reach 1b (1–5 freshes of 250 ML/day for 1–5 days in June–November)[2]	• Wet benches to improve the condition of emergent vegetation and to maintain habitat diversity • Provide adequate depth for fish passage and cue fish movement • Scour sand from pools to improve the quality of fish habitat • Maintain or increase vegetation diversity in the river and on channel benches
Winter/spring freshes targeting reach 2 (1–5 freshes of 300 ML/day for 1–5 days in June–November)	
Winter/spring low flows targeting reach 1a (60 ML/day or natural in June–November)[1,3]	• Maintain water quality for fish, waterbugs and aquatic vegetation • Maintain shallow water habitat for fish and waterbugs and facilitate the annual dispersal of juvenile platypus
Winter/spring low flows targeting reach 1b (100 ML or natural per day in June–November)[1,3]	
Winter/spring low flows targeting reach 2 (160 ML/day or natural in June–November)[1,3]	
Trial release to reach 0 (up to 50 ML/day over a 4–5 day period)	• Develop an operational understanding of our ability to deliver environmental flows to support values in this reach including the capacity of infrastructure, metering and safety considerations

[1] *Cease-to-flow events occur naturally in the Glenelg system and may be actively managed. In the most recent flows study, the recommendation is that cease-to-flow events should occur as infrequently as possible and not exceed the duration of events that might have occurred naturally, to reduce stress on environmental values. Cease-to-flow events should be followed with a fresh.*

[2] *Winter/spring freshes in reach 1a are important for the health of the Glenelg River, but due to operational constraints and potential flooding risks they can only be achieved through natural events.*

[3] *Passing flows provided under the environmental entitlement generally provide winter/spring low flows. However, if passing flows are reduced, managed environmental water releases may be required to supplement them or to ensure appropriate rates of rise and fall and provide appropriate conditions in fresh events.*

Scenario planning

Table 4.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. While the actions are similar in each climatic scenario, the magnitude, duration and/or frequency differ between scenarios: therefore, the volume required under each scenario also differs.

Under most scenarios, there will probably be periods of cease-to-flow in summer. Where possible, the duration of these cease-to-flow periods will be carefully managed and monitored to minimise adverse impacts. The priority is to protect water quality and refuge pools to ensure habitat is available for native fish and other animals (such as platypus) in the warmer months, when the risks are highest. Under a drought or dry climate scenario, low flows will be provided for some periods in reaches 1b and 2, but they are unlikely to be delivered to reach 1a. Freshes will be used to maintain some pool habitats in reach 1a.

Under a wet climate scenario, the priority will be to increase the magnitude, frequency and duration of planned watering actions through summer and autumn and to deliver more of the recommended winter/spring flows. Some low flows will also be delivered to reach 1a. Natural river flows and passing flows are also likely to help meet many of the environmental flow objectives in a wet year. Reserving water for carrying over into the 2018–19 water year will be a priority under all scenarios.

Table 4.2.2 Potential environmental watering for the Glenelg system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Some passing, compensation and low unregulated flows, particularly in winter/spring	• Some passing, compensation and low unregulated flows, particularly in winter/spring	• Some passing, compensation and unregulated flows, particularly in winter/spring	• Passing flows and unregulated flows meet watering requirements in winter/spring
Expected availability of environmental water[1]	• 32,210 ML carryover • 23,119 ML VEWH • 0 ML CEWH[2] • 55,329 ML total[3]	• 32,210 ML carryover • 25,147 ML VEWH • 0 ML CEWH[2] • 57,357 ML total[3]	• 32,210 ML carryover • 32,854 ML VEWH • 0 ML CEWH[2] • 65,064 ML total[3]	• 32,210 ML carryover • 40,560 ML VEWH • 0 ML CEWH[2] • 72,770 ML total[3]
Potential environmental watering – tier 1 (high priorities)[4]	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn low flows reach 1b • Summer/autumn low flows reach 2 • Winter/spring freshes reach 1b • Winter/spring freshes reach 2 • Summer/autumn freshes reach 1a	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn low flows reach 1b • Summer/autumn low flows reach 2 • Winter/spring freshes reach 1b • Winter/spring freshes reach 2 • Summer/autumn freshes reach 1a	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn low flows reach 1a • Summer/autumn low flows reach 1b • Summer/autumn low flows reach 2 • Winter/spring freshes reach 1b • Winter/spring freshes reach 2 • Winter/spring low flows reach 1a • Trial release reach 0	• Summer/autumn low flows reach 1a • Summer/autumn low flows reach 2 • Summer/autumn freshes reach 1b • Summer/autumn low flows reach 1b • Summer/autumn freshes reach 2 • Summer/autumn freshes reach 1a • Winter/spring freshes reach 1b • Winter/spring low flows reach 1a • Trial release reach 0
Potential environmental watering – tier 2 (lower priorities)[5]	• Summer/autumn low flows reach 1a • Winter/spring low flows reach 1a • Winter/spring low flows reach 1b • Winter/spring low flows reach 2	• Summer/autumn low flows reach 1a • Winter/spring low flows reach 1a • Winter/spring low flows reach 1b • Winter/spring low flows reach 2	• Summer/autumn freshes reach 1a • Winter/spring low flows reach 1b • Winter/spring low flows reach 2	• Winter/spring low flows reach 1b • Winter/spring freshes reach 2 • Winter/spring low flows reach 2
Possible volume of environmental water required to achieve objectives[6]	• 9,880 ML (tier 1) • 11,760 ML (tier 2)	• 12,280 ML (tier 1) • 11,480 ML (tier 2)	• 27,760 ML (tier 1) • 25,480 ML (tier 2)	• 27,110 ML (tier 1) • 20,780 ML (tier 2)

1 *Environmental water in the Wimmera–Glenelg system is shared between the Glenelg and Wimmera systems. The volumes specified show the likely availability across the shared systems.*

2 *Commonwealth environmental water is only available for use in the Wimmera system.*

3 *This volume is a forecast of the total water likely to be available under the VEWH entitlement in 2017–18 including carryover water and the forecast allocation for the complete water year.*

4 *As the entitlement is shared between the Wimmera and Glenelg catchments, a prioritisation process will be undertaken in consultation with the Wimmera and Glenelg Hopkins CMAs to determine the potential watering actions that will be undertaken in each system in the 2017–18 year.*

5 *Tier 2 actions are lower-priority actions to be considered if water is available.*

6 *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Frasers Swamp, by Emma Coates

Risk management

In preparing its seasonal watering proposal, Glenelg Hopkins CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 4.2.3 shows the partners, stakeholder organisations and individuals with which Glenelg Hopkins CMA engaged when preparing the Glenelg system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Glenelg Hopkins Regional Catchment Management Strategy and Glenelg Hopkins Waterway Strategy.

Table 4.2.3 Partners and stakeholders engaged in developing the Glenelg system seasonal watering proposal

Partner and stakeholder engagement
• Aboriginal groups (Gunditj Mirring Traditional Owner Corporation and Barengi Gadjin Land Council) • Community members and landholders • DELWP • Environment groups: Baghalla/Killara, Chetwynd, Culla-Pigeon Ponds, Dunrobin, Red Cap and Wando River Landcare groups, Balmoral Land Management and Tree Group, Glenelg River User Group and Friends of the Glenelg River • Fisheries Victoria • Glenelg Hopkins CMA Advisory Group (including representatives of stakeholder groups and landholders in the region) • GWMWater • Local tourism and sand extraction businesses and community service organisations based in Balmoral, Coleraine, Winnap, Nelson and the western Grampians • Parks Victoria • Recreational groups: Balmoral District Angling Club, Casterton Angling Society, Dartmoor Angling Club, VRFish, Fishcare Victoria, South West Fishing Report, individual anglers • Southern Grampians Shire • VEWH • Wimmera CMA

4.3 Wimmera system

Waterway manager – Wimmera Catchment Management Authority

Storage manager – GWMWater

Environmental water holders – Victorian Environmental Water Holder and Commonwealth Environmental Water Holder

The Wimmera River starts in the Pyrenees Range near Elmhurst and flows through Horsham, Dimboola and Jeparit before terminating at Lake Hindmarsh, which is Victoria's largest freshwater lake. The Wimmera receives flows from several regulated tributaries including the MacKenzie River and the Mount William and Burnt creeks. All these tributaries, Bungalally Creek and the Wimmera River downstream of Mount William Creek can receive environmental water. In exceptionally wet periods, Lake Hindmarsh may overflow into Outlet Creek and on to Lake Albacutya, an internationally recognised Ramsar-listed wetland.

Environmental values

The Wimmera system is home to many significant plant and animal species including populations of freshwater catfish, flat-headed gudgeon, carp gudgeon, river blackfish, southern pygmy perch, Australian smelt and Wimmera bottlebrush.

The Wimmera River itself supports abundant native fish, waterbird, turtle, frog and native water rat populations and one of Victoria's few self-sustaining populations of freshwater catfish.

The MacKenzie River contains the only stable population of platypus in the Wimmera and supports good populations of native fish including river blackfish, waterbugs, threatened Glenelg spiny crayfish and turtles. During dry periods, the middle and upper reaches of the MacKenzie River maintain regular flow and provide refuge for these populations.

The vegetation along Burnt and Bungalally creeks provide habitat corridors and upper Burnt Creek contains an important native fish community and a population of threatened western swamp crayfish. Mount William Creek supports regionally important populations of river blackfish, southern pygmy perch and threatened western swamp crayfish.

Social, cultural and economic values

The Wimmera system offers many popular recreational activities including walking, boating, rowing, waterskiing, fishing and camping, and it provides important amenity for Wimmera residents. Events held on the waterways include waterskiing at the annual Kanamaroo Festival, the Horsham Triathlon, the Dimboola Regatta and Head of the Wimmera rowing event and fishing competitions in Horsham, Jeparit and Dimboola. The waterways in the Wimmera system continue to hold significance for Traditional Owners and their Nations in the region including those represented by the Barengi Gadjin Land Council.

Environmental watering objectives in the Wimmera system

	Rehabilitate and protect populations of native fish including one of Victoria's few self-sustaining populations of freshwater catfish
	Maintain water quality to provide suitable conditions for fish and other water-dependent plants and animals
	Increase platypus populations by increasing the quality and quantity of habitat and food and providing suitable conditions for breeding and dispersal
	Improve the condition, abundance and diversity of aquatic, emergent and riparian vegetation
	Increase the abundance and diversity of waterbugs which provide energy, break down dead organic matter and support the waterway's food chain

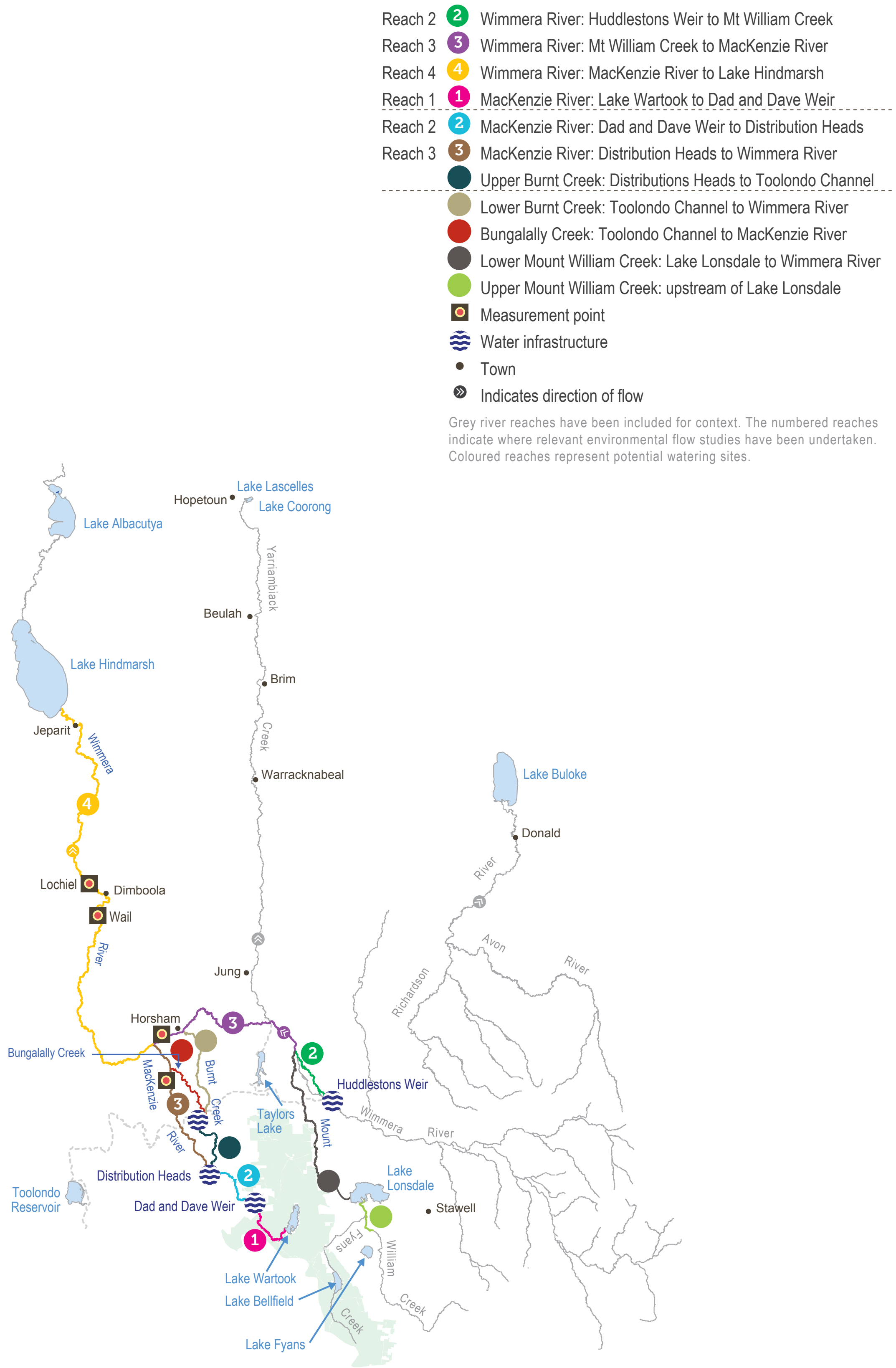
System overview

Water in the Wimmera system is stored in three on-stream reservoirs — Lake Wartook on the MacKenzie River, Lake Lonsdale on Mount William Creek and Lake Bellfield on Fyans Creek — and in several off-stream storages — Taylors Lake, Lake Fyans and Toolondo Reservoir. A channel system enables water to be transferred between several storages. Water can also be transferred from the Glenelg system to the Wimmera system from Rocklands Reservoir via the Rocklands–Toolondo Channel and from Moora Moora Reservoir via the Moora Channel. The connected storages and channels are collectively called the Wimmera–Glenelg Headworks System and harvested water is also used for towns and stock and domestic supply throughout the Wimmera catchment and parts of the Avoca, Hopkins, Loddon, Glenelg and Mallee catchments. Passing flows are provided to the Wimmera River and to lower Mount William and Fyans creeks.

Priority reaches for environmental watering in the Wimmera system are the Wimmera River reach 4, MacKenzie River reaches 2 and 3, upper and lower Mount William Creek, upper and lower Burnt Creek and Bungalally Creek.

Yarriambiack Creek is a distributary of the upper Wimmera River that naturally would have received some flows during high-flow events. However, the creek now receives more flows due to modifications to the offtake. This affects environmental water deliveries to the high-priority reaches of the Wimmera River. In line with past practice during dry years, flows entering the creek may be blocked to ensure watering objectives in the Wimmera River are not compromised.

Figure 4.3.1 The Wimmera system



Recent conditions

Heavy rainfall in winter/spring 2016 ended a prolonged dry period in the Wimmera catchment. Unregulated natural flows and passing flows met a high proportion of planned winter and spring watering actions. Passing flows from Lake Lonsdale were suspended for much of winter/spring to reduce the flood risk associated with the natural high flows through the system and to help storage management operations. Managed environmental water releases in 2016–17 were mainly used to provide low flows and freshes during summer and autumn. With the high rainfall, allocations reached 100 percent in October 2016 for the first time since 2011–12. In April 2017, the CEWH received its first allocation of 15 percent.

The wet conditions in 2016 and environmental water deliveries have improved the condition of the rivers and creeks in the Wimmera system. Monitoring from 2016–17 shows that native fish numbers are increasing and the MacKenzie River platypus populations are continuing to breed.

Scope of environmental watering

Table 4.3.1 shows potential environmental watering actions and their environmental objectives.

Table 4.3.1 Potential environmental watering actions and objectives for the Wimmera system

Potential environmental watering	Environmental objectives
Wimmera River (reach 4)	
Summer/autumn low flows (15 ML/day or natural in December–May)[1]	• Maintain in-stream habitat to support native fish populations and waterbugs • Maintain near-permanent inundation of the stream channel for riparian vegetation and to prevent the growth of terrestrial plants in the streambed
Winter/spring low flows (30 ML/day in June–November)	• Provide variability in flows to maintain various types of habitat
Summer/autumn freshes (1–3 freshes of 70 ML/day for 2–7 days in December–May)	• Flush pools to improve water quality and maintain habitat for fish and waterbugs • Provide fish passage to allow fish to move through the reach
Winter/spring freshes (1–5 freshes of 70 ML/day for 1–4 days in June–November)	• Provide fish passage to allow fish to move through the reach and increase the flow to stimulate their movement • Maintain water quality to support fish populations
Winter/spring freshes (1–3 freshes of 200 ML/day for 1–3 days in June–November[2])	• Wet lower benches, moving organic debris and promoting habitat diversity
Winter/spring freshes (1–2 freshes of up to 1,300 ML/day for 2–3 days in June–November)	• Flush surface sediments from hard substrates to improve habitat quality and support waterbugs • Wet higher benches, moving organic debris and promoting diverse habitat • Maintain the quality, diversity and extent of submerged and emergent aquatic vegetation for fish habitat
MacKenzie River (reach 2 and 3)	
Year-round low flows (of 2–27 ML/day or natural, year-round)[1]	• Maintain edge habitats and deeper pools and runs for waterbugs • Maintain near-permanent inundation of the stream channel for riparian vegetation and to prevent the growth of terrestrial plants including the Wimmera bottlebrush in the streambed and aquatic vegetation for fish habitat • Maintain a sufficient area of pool habitat for native fish populations • Facilitate the annual dispersal of juvenile platypus into the Wimmera River
Summer/autumn freshes (3–4 freshes of 5–50 ML/day for 2–7 days each in December–May)	• Provide variable flows during the low-flow season for waterbugs, fish movement and maintenance of water quality and habitat diversity
Winter/spring freshes (5 freshes of 35–55 ML/day for 2–7 days in June–November)	• Stimulate fish movement and maintain water quality and habitat diversity
Winter/spring freshes (1–5 freshes of up to 130–190 ML/day for 1–4 days in June–November)	• Maintain edge habitats and shallow water habitat for waterbugs • Maintain inundation of the stream channel to protect riparian vegetation and prevent excessive streambed colonisation by terrestrial vegetation species • Maintain a sufficient area of pool habitat for native fish populations

Table 4.3.1 Potential environmental watering actions and objectives for the Wimmera system *continued*

Potential environmental watering	Environmental objectives
Burnt Creek	
Year-round low flows targeting upper Burnt Creek (1 ML/day or natural, year-round)[1]	• Maintain edge habitats and shallow water habitat for waterbugs • Maintain inundation of the stream channel to protect riparian vegetation and prevent excessive streambed colonisation by terrestrial vegetation species • Maintain a sufficient area of pool habitat for native fish populations
Summer/autumn freshes targeting upper Burnt Creek (3 freshes of 30 ML/day for 2–7 days each in December–May)	• Prevent the decline in water quality by flushing pools during low flows
Winter/spring freshes targeting upper Burnt Creek (1–5 freshes of 55 ML/day for 3–7 days in June–November)	• Allow fish to move throughout the reach • Flush sediments from hard substrates to increase biofilm production and food for waterbugs
Winter/spring freshes targeting upper Burnt Creek (1–3 freshes of up to 160 ML/day for 1–3 days in June–November)	• Disturb biofilms present on rocks or woody debris to stimulate new growth and provide food for waterbugs
Year-round fresh targeting lower Burnt Creek (1 fresh of 45 ML/day or natural for 2 days at any time)	• Inundate riparian vegetation to maintain its condition and facilitate recruitment • Move organic debris in the channel to support waterbugs • Maintain the structural integrity of channels
Mount William Creek	
Top-up of upper Mount William Creek pools	• Maintain habitat for native fish and waterbugs
Year-round low flows targeting lower Mount William Creek (5 ML/day or natural, year-round)[1]	• Maintain edge habitats and shallow water habitat for waterbugs and endemic fish • Maintain near-permanent inundation of the stream channel for riparian vegetation and to prevent the growth of terrestrial plants in the streambed
Summer/autumn freshes targeting lower Mount William Creek (3 freshes of 20–30 ML/day for 2–7 days in December–May)	• Prevent a decline in water quality by flushing pools during low flows • Provide variable flows during the low-flow season for waterbugs, for fish movement and to maintain water quality and diversity of habitat
Winter/spring freshes targeting lower Mount William Creek (1–5 freshes of up to 100 ML/day for 1–7 days in June–November)	• Wet benches, move organic debris and promote habitat diversity • Flush surface sediments from hard substrates to support waterbugs
Mount William Creek	
Winter/spring freshes targeting lower Mount William Creek (1–3 freshes of up to 500 ML/day for 1–3 days in June–November)	• Wet the highest benches, move organic debris and promote habitat diversity
Bungalally Creek	
Year-round fresh (1 fresh of 60 ML/day for 2 days at any time)	• Inundate the riparian zone to maintain its condition and facilitate recruitment for riparian vegetation communities • Maintain the structural integrity of the channel and prevent loss of channel capacity

1 *Cease-to-flow events occur naturally in the Wimmera system and may be actively managed. In the most recent flow study, the recommendation is that cease-to-flow events should occur as infrequently as possible and not exceed the duration of events that might have occurred naturally, to reduce stress on environmental values. Cease-to-flow events should be followed with a fresh lasting at least seven days.*

2 *Dependent on catchment conditions, the timing of this fresh may vary, to optimise environmental outcomes.*

Scenario planning

Table 4.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. While the type of actions are similar in each climate scenario, the magnitude, duration and/or frequency of specific watering actions may differ, and so the volume required under each scenario also differs. For example, in Wimmera River reach 4, one summer/autumn fresh of 70 ML/day for two to seven days is recommended, but under a wet scenario the recommendation is for three of these freshes.

Under most scenarios, there will probably be periods of cease-to-flow in all reaches. The priority is to protect water quality and refuge pools in rivers and creeks to ensure habitat is available for native fish and other animals (such as platypus) during the warmer months, when risks are highest.

Natural unregulated flows and increased environmental water allocations will allow more environmental water objectives to be met under an average or wet climate scenario. The priority under these scenarios will be to increase the magnitude, frequency and duration of planned watering actions throughout summer and autumn and to deliver recommended flows in winter/spring. Natural river flows and passing flows are also likely to contribute to achieving these objectives. Reserving water to carry over into the 2018–19 water year will also be a priority under all scenarios.

Wimmera River, by Chloe Wiesenfeld

Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Some passing flows but no unregulated flows	• Some passing but no unregulated flows	• Passing and unregulated flows, particularly in winter/spring	• Passing flows and unregulated flows
Expected availability of environmental water[1]	• 32,210 ML carryover • 23,119 ML VEWH • 0 ML CEWH[2] • 55,329 ML total[3]	• 32,210 ML carryover • 25,147 ML VEWH • 0 ML CEWH[2] • 57,357 ML total[3]	• 32,210 ML carryover • 32,854 ML VEWH • 0 ML CEWH[2] • 65,064 ML total[3]	• 32,210 ML carryover • 40,560 ML VEWH • 0 ML CEWH[2] • 72,770 ML total[3]
Potential environmental watering – tier 1 (high priorities)[4]				
MacKenzie River reaches 2 & 3	• Partial summer/ autumn low flows and freshes • Partial winter/spring low flows • Winter/spring smaller freshes	• Partial summer/ autumn low flows and freshes • Partial winter/spring low flows • Winter/spring smaller freshes	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and smaller and larger freshes	• Summer/autumn low flows • Partial summer/ autumn freshes • Winter/spring low flows and smaller and larger freshes
Wimmera River reach 4	• Partial summer/ autumn low flows and freshes • Partial winter/spring low flows • Winter/spring smaller fresh	• Partial summer/ autumn low flows and freshes • Partial winter/spring low flows • Winter/spring smaller and larger freshes	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and smaller and larger freshes	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and smaller and larger freshes
Upper Burnt Creek	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and freshes	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and freshes	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and freshes	• Summer/autumn low flows • Partial summer/ autumn freshes • Winter/spring low flows and freshes
Upper Mt William Creek	• Top-ups	• Top-ups	• N/A	• N/A
Lower Mt William Creek	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and freshes	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and freshes	• Partial summer/ autumn low flows and freshes • Winter/spring low flows and freshes	• Summer/autumn low flows • Partial summer/ autumn freshes • Winter/spring low flows and freshes
Lower Burnt Creek	• N/A	• N/A	• Year-round fresh	• Year-round fresh
Bungalally Creek	• N/A	• N/A	• Year-round fresh	• Year-round fresh
Potential environmental watering – tier 2 (lower priorities)[5]				
MacKenzie River reaches 2 & 3	• Remainder summer/autumn low flows and freshes • Remainder of winter/spring low flows	• Remainder of summer/autumn low flows and freshes • Remainder of winter/spring low flows	• Remainder of summer/autumn low flows and freshes • Remainder of winter/spring low flows	• Remainder of summer/autumn freshes • Remainder of winter/spring low flows

Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios *continued*

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 2 (lower priorities)[5]				
Wimmera River reach 4	• Remainder of summer/autumn low flows and freshes • Remainder of winter/spring low flows and freshes • Reach 3 winter/spring low flows	• Remainder of summer/autumn low flows and freshes • Remainder of winter/spring low flows and freshes • Reach 3 winter/spring low flows	• Remainder of summer/autumn low flows and freshes • Reach 3 winter/spring low flows	• Remainder of summer/autumn freshes • Reach 3 winter/spring low flows
Upper Burnt Creek	• Remainder of summer/autumn low flows and freshes	• Remainder of summer/autumn low flows and freshes	• Remainder of summer/autumn low flows and freshes	• Remainder of summer/autumn freshes
Lower Mount William Creek	• Remainder of summer/autumn low flows and freshes	• Remainder of summer/autumn low flows and freshes	• Remainder of summer/autumn low flows and freshes	• Remainder of summer/autumn freshes
Possible volume of environmental water required to achieve objectives[6]	• 21,635 ML (tier 1) • 24,045 ML (tier 2	• 22,280 ML (tier 1) • 24,020 ML (tier 2	• 29,615 ML (tier 1) • 20,345 ML (tier 2	• 33,035 ML (tier 1) • 19,655 ML (tier 2

1 *Environmental water in the Wimmera–Glenelg system is shared between the Glenelg and Wimmera systems. The volumes specified show the likely availability across the shared systems.*

2 *Commonwealth environmental water is only available for use in the Wimmera system.*

3 *This volume is a forecast of the total water likely to be available under the VEWH entitlement in 2017–18 including carryover water and the forecast allocation for the complete water year.*

4 *As the entitlement is shared between the Wimmera and Glenelg catchments, a prioritisation process will be undertaken in consultation with the Wimmera and Glenelg Hopkins CMAs to determine the potential watering actions that will be undertaken in each system in the 2017–18 year.*

5 *Tier 2 actions are lower-priority actions to be considered if water is available.*

6 *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, Wimmera CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 4.3.3 shows the partners and stakeholder organisations with which Wimmera CMA engaged when preparing the Wimmera system seasonal watering proposal. Other stakeholders and individuals are consulted throughout the year to help Wimmera CMA implement the seasonal watering plan.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Wimmera Regional Catchment Strategy and Wimmera Waterway Strategy.

Wimmera CMA holds an annual Environmental Water Management Forum at which feedback is sought from community groups and agencies in the area with an interest in environmental water about the effectiveness of environmental watering, drought actions and related issues. Groups in this forum included the Barengi Gadjin Land Council, Yarriambiack Shire, Northern Grampians Shire, Hindmarsh Shire and Horsham Rural City councils, Parks Victoria, Fisheries Victoria, Dimboola and Jeparit town committees, Lake Lonsdale Action Group, Friends of Bungalally Creek and Friends of Burnt Creek, VRFish, Natimuk Lake Water Ski Club, Dimboola Water Ski Club, Dimboola Fishing Classic, Horsham Triathlon Committee, Wimmera Anglers Association, Dimboola Rowing Club, Jeparit Anglers' Club, Hindmarsh Ski Club, Native Fish Australia (Wimmera) and Horsham Fishing Competition Committee.

Table 4.3.3 Partners engaged in developing the Wimmera system seasonal watering proposal

Partner engagement
• CEWO • Glenelg Hopkins CMA • GWMWater • VEWH

4.4 Wimmera-Mallee wetlands

Waterway managers – Mallee, North Central and Wimmera catchment management authorities

Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder

The Wimmera-Mallee wetlands include 51 wetlands on public and private land spread across the dry north-west area of Victoria.

Environmental values

There are a wide range of wetland types in the Wimmera-Mallee wetlands system, including freshwater meadows, open freshwater lakes and freshwater marshes. This diversity is important to provide a range of different wetland habitats for the plants and animals in the western part of the state. They also vary in size, consist of many different vegetation communities and are home to native waterbird populations including brolgas, egrets, blue-billed ducks, freckled ducks, Australian painted snipes and glossy ibis. The wetlands provide a valuable source of water for other native animals including the vulnerable growling grass frog, turtles and many other species that rely on these wetlands as drought refuges and drinking holes. Rare and vulnerable vegetation species (such as spiny lignum, ridged water milfoil and cane grass) are also present in some wetlands.

Social, cultural and economic values

The Wimmera-Mallee wetlands are highly valued by the community and provide places for recreational activities including canoeing, yabbying, duck and quail hunting and bird watching. The Wimmera-Mallee wetlands have been and continue to be places of significance for the Aboriginal Victorians in the region including the Wamba Wamba people and those represented by the Barengi Gadjin Land Council and the Dja Dja Wurrung Clans Aboriginal Corporation. Some of the sites have artefacts and scar trees recorded in or adjacent to them.

Environmental watering objectives in the Wimmera-Mallee wetlands

	Provide watering holes for native animals across the landscape
	Strengthen and maintain plant life in and around the wetlands, including to provide shade, shelter and food for native animals
	Provide habitat and food to maintain regional populations of native frogs and turtles
	Create shallow and deep wetlands to provide foraging and breeding habitat for a wide range of waterbirds

System overview

Historically, the wetlands received water from the open channel system before the Wimmera-Mallee Pipeline was completed. As part of the pipeline project, all stock and domestic supply dams were replaced with tanks and the open channel distribution system was replaced by pipelines. The project achieved significant water savings for environmental watering of the area's flow-stressed rivers, creeks and waterways and created regional development opportunities; but it also reduced the amount of open-water habitat in areas that were formerly supplied by the open channel system. To mitigate the loss of open water in the landscape, a 1,000 ML environmental entitlement was created to supply water to wetlands (some with associated dams) that were previously supplied through the old channel system. The entitlement is supplied via the Wimmera-Mallee Pipeline. A project was completed in 2011 to identify priority wetlands to be connected to the pipeline system, and all 51 wetlands are now connected.

Environmental water delivery to the wetlands relies on capacity in the Wimmera-Mallee Pipeline. CMAs work closely with GWMWater and land managers (including Parks Victoria, DELWP and private landowners) to manage around these capacity constraints and deliver environmental water to these wetlands.

Crow Swamp, by Chloe Wiesenfeld

Recent conditions

The Wimmera-Mallee received well above-average rainfall in winter 2016–17 and many of the wetlands naturally filled. The environmental entitlement also received full allocations for the first time in four years.

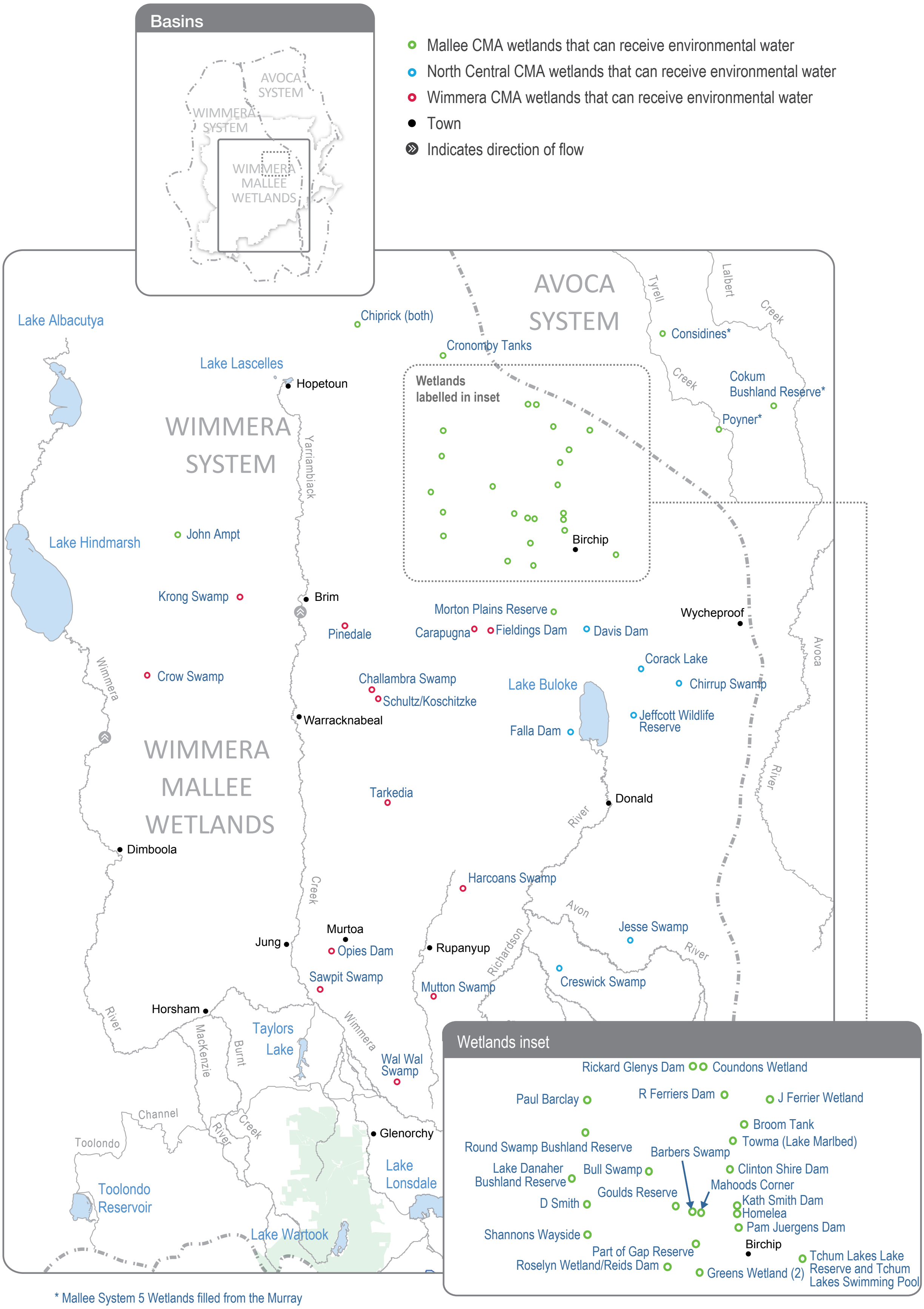
Environmental water was delivered to 31 Wimmera-Mallee wetlands in 2016–17: 21 wetlands in the Mallee area, three in the north-central area and seven in the Wimmera area. Deliveries were made in spring 2016 and autumn 2017, with some wetlands receiving water once and others receiving water twice.

Many different animals (such as lace monitors, kangaroos, wallabies, turtles, carpet pythons, ducks, grebes, stilts and other waterbirds, frogs, yabbies and eastern long-necked turtles) used the Wimmera-Mallee wetlands in 2016–17. Vegetation (both submerged in the wetlands and on the banks, including nardoo, water milfoil and water ribbons) has responded well at the wetlands that were watered or naturally filled and is contributing to the improved environmental conditions at these wetlands.

Scope of environmental watering

Table 4.4.1 shows potential environmental watering actions and their environmental objectives. Watering actions for the Wimmera-Mallee wetlands will typically be in spring or autumn, but may occur at any time of the year depending on environmental need, seasonal conditions and pipeline capacity.

Figure 4.4.1 The Wimmera-Mallee wetlands



* Mallee System 5 Wetlands filled from the Murray

Table 4.4.1 Potential environmental watering actions and objectives for the Wimmera-Mallee wetlands

Potential environmental watering	Environmental objectives
North Central wetlands	
Davis Dam	• Maintain black box and cane grass vegetation • Provide drought refuge and a watering point for terrestrial animals
Creswick Swamp	• Maintain the range of aquatic plants and re-establish marbled marshwort • Provide refuge, feeding and breeding opportunities for frog and turtles
Chirrup Dam	• Provide drought refuge and a watering point for animals (particularly frogs and turtles) to facilitate recolonisation of Chirrup Swamp when it is naturally inundated
Corack Lake	• Maintain aquatic plants • Provide refuge and nursery habitat for turtles and frogs • Provide variety of feeding conditions for waterbirds (such as drawdown zones and shallows)
Falla Dam	• Maintain as a drought refuge for turtles and frogs and a watering point for terrestrial species
Jeffcott Wildlife Reserve	• Maintain a range of aquatic plants • Provide refuge and breeding conditions for water-dependent species (such as frogs, waterbugs, turtles and waterbirds)
Jesse Swamp	• Maintain native aquatic plants and re-establish marbled marshwort • Provide shallow foraging habitat for waterbirds (including brolgas) and feeding opportunities for frogs
Wimmera wetlands	
Carapugna	• Maintain regional populations of native animals especially frogs and wetland and woodland birds • Maintain and where possible increase the abundance of wetland plants, especially threatened species
Challambra Swamp	
Crow Swamp	
Fieldings Dam	
Krong Swamp	
Mutton Swamp	
Pinedale	
Sawpit Swamp	
Schultz–Koschitzke	
Tarkedia	
Wal Wal Swamp	
Harcoans Swamp	
Opies Dam	
Mallee wetlands	
Barbers Swamp	• Maintain the health of fringing lignum and black box communities • Provide suitable feeding and breeding habitat for various waterbird guilds
Bull Swamp	
Cokum Bushland Reserve	
Morton Plains Reserve	
Tchum Lakes Lake Reserve (North Lake - Wetland)	
Tchum Lakes Swimming Pool (North Lake – Dam)	

Table 4.4.1 Potential environmental watering actions and objectives for the Wimmera-Mallee wetlands *continued*

Potential environmental watering	Environmental objectives
Mallee wetlands	
Broom Tank	• Maintain the health of fringing lignum and black box communities • Provide watering points for terrestrial animals and woodland birds
Poyner	
Clinton Shire Dam	
Pam Juergens Dam	
Greens Wetland	
Roselyn Wetland	
Considines	
Goulds Reserve	• Maintain the health of fringing lignum and black box communities
Part of Gap Reserve	
Newer Swamp	
Towma (Lake Marlbed)	
Coundons Wetland	• Maintain the health of fringing lignum and black box communities • Provide watering points for terrestrial animals and woodland birds • Provide foraging, refuge and breeding habitat for turtles and frogs
J Ferrier Wetland	
Mahoods Corner	• Provide suitable feeding and breeding habitat for various waterbird guilds
Shannons Wayside	
Chiprick	• Provide watering points for terrestrial animals and woodland birds
D Smith Wetland	
Homelea Wetland	
John Ampt	
Kath Smith Dam	
Paul Barclay	
R Ferriers Dam	
Rickard Glenys Dam	
Cronomby Tanks	• Maintain the health of fringing lignum and black box communities • Provide foraging, refuge and breeding habitat for turtles and frogs
Lake Danaher Bushland Reserve	

Scenario planning

Table 4.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The wetlands considered for potential environmental watering in 2017–18 have been determined after assessing their water requirements, recent watering history and considering climatic conditions, water availability and the expected capacity in the Wimmera-Mallee Pipeline.

Under drought conditions, small volumes of water will be delivered to selected wetlands to top up water levels from previous environmental or natural watering events. Under average and wet climate scenarios more water becomes available which allows more wetlands to be watered. The volume of water delivered to individual wetlands will also increase under average and wet climate scenarios and some wetlands may be overfilled to inundate surrounding patches of native vegetation.

Due to the low reliability of environmental water in the Wimmera-Mallee wetlands, it is important to carry over water during wet periods to help manage the system during dry periods. A critical carryover volume of 161–254 ML has been identified for 2017–18 depending on the scenario.

Table 4.4.2 Potential environmental watering for the Wimmera-Mallee wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No rainfall or catchment inflows are likely to contribute to water levels in the wetlands	• No rainfall or catchment inflows are likely to contribute to water levels in the wetlands	• Some localised catchment inflows may contribute to water levels in some wetlands	• Catchment inflows are likely to contribute to water levels in most of the wetlands
Expected availability of environmental water	• 1,253 ML carryover • 0 ML allocation • 1,253 ML available	• 1,253 ML carryover • 60 ML allocation • 1,313 ML available	• 1,253 ML carryover • 250 ML allocation • 1,503 ML available	• 1,253 ML carryover • 250 ML allocation • 1,503 ML available
Potential environmental watering	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Fieldings Dam • Greens Wetland • Harcoans • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Greens Wetland • Harcoans • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Krong Swamp • Lake Danaher Bushland Reserve	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Krong Swamp • Lake Danaher Bushland Reserve

Table 4.4.2 Potential environmental watering for the Wimmera-Mallee wetlands under a range of planning scenarios *continued*

Planning scenario	Drought	Dry	Average	Wet
	• Mutton Swamp • Opies dam • Pam Juergens Dam • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland–Reids Dam • Sawpit Swamp • Schultz–Koschitzke • Tarkedia Dam • Wal Wal	• Morton Plains Reserve • Mutton Swamp • Opies dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland–Reids Dam • Newer Swamp • Sawpit Swamp • Schultz–Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp	• Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland–Reids Dam • Newer Swamp • Sawpit Swamp • Schultz–Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp	• Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner[1] • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland–Reids Dam • Newer Swamp • Sawpit Swamp • Schultz–Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp
Possible volume of environmental water required to achieve objectives	• 261 ML	• 335 ML	• 519 ML	• 676 ML
Priority carryover requirements	• 161 ML	• 168 ML	• 168 ML	• 254 ML

[1] *Water supplied to these wetlands in supply system 5 is made available from GWMWater allocations.*

Risk management

In preparing its seasonal watering proposal, the Wimmera, Mallee and North Central CMAs considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

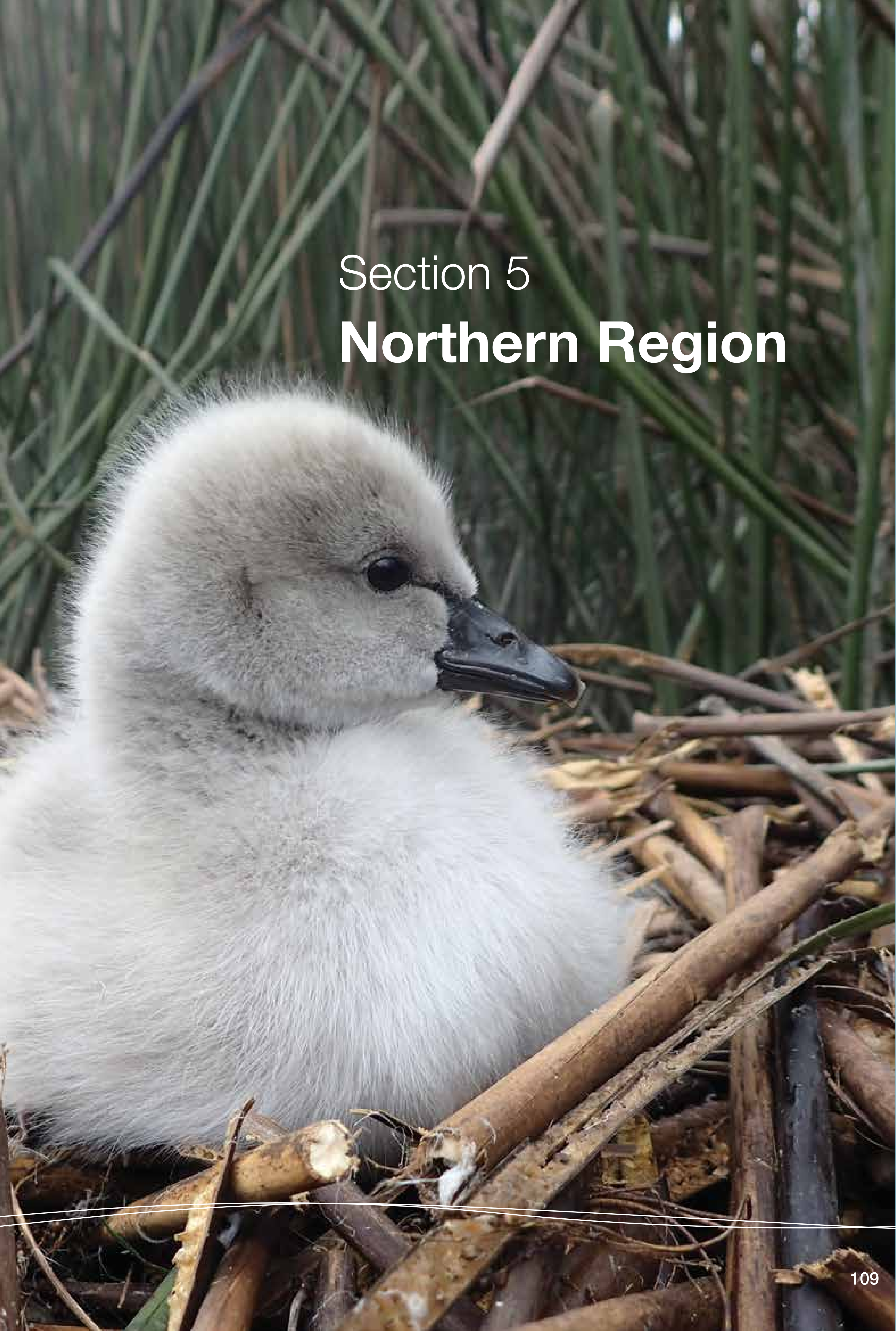
Engagement

Table 4.4.3 shows the partners, stakeholder organisations and individuals with which the Wimmera, Mallee and North Central CMAs engaged when preparing the Wimmera-Mallee wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the respective Wimmera, North Central and Mallee regional catchment strategies and waterway strategies as relevant.

Table 4.4.3 Partners and stakeholders engaged in developing the Wimmera-Mallee wetlands seasonal watering proposal

Partner and stakeholder engagement
All CMAs • GWMWater • Parks Victoria • VEWH
Mallee CMA • Landholders with wetlands on their properties in the Mallee area • Barenji Gadjin Land Council • Landcare groups • DELWP • North Central and Wimmera CMAs
North Central CMA • Wimmera-Mallee Wetlands Environmental Water Advisory Group comprising community members, interest groups, a North Central CMA Community Consultative Committee representative, a North Central CMA Board member, DELWP, Parks Victoria and the VEWH • North Central CMA Community Consultative Committee, a community advisory group to the North Central CMA Board • Landholders with wetlands on their properties in the North Central area • Landcare groups • Barenji Gadjin Land Council • Dja Dja Wurrung Traditional Owners • DELWP • Mallee and Wimmera CMAs
Wimmera CMA • Landholders with wetlands on their properties in the Wimmera area • Field & Game Australia representatives • North Central and Mallee CMAs



Section 5
Northern Region

5.1 Northern Region overview

The Northern Region has many rivers, wetlands and floodplains with priority sites including the Goulburn, Broken, Loddon, Campaspe and Ovens river systems and some of their associated floodplains and wetlands. On the Victorian Murray system, priority sites include Barmah Forest, Gunbower Forest, Hattah Lakes and Lindsay, Wallpolla and Mulcra islands.

The landscape

The major river systems of northern Victoria include the Ovens, Goulburn, Broken, Loddon and Campaspe rivers, which flow north from headwaters in Victoria's Great Dividing Range into the River Murray. Most environmental water used in northern Victoria is sourced from major storages in these systems including Lake Eildon (Goulburn system) Hume Reservoir (Murray system), Lake Eppalock (Campaspe system) and Cairn Curran Reservoir (Loddon system). These storages hold water for all entitlement holders including for irrigation, urban and environmental use.

Floodplains are an important feature along the River Murray corridor because they provide variable ecosystems as the river flows through areas with different climates, soils and topography. Noteworthy floodplain systems on the River Murray include Barmah Forest, Gunbower Forest, Hattah Lakes and Lindsay Island, which are all included in the VEWH's environmental watering program. There also are thousands of floodplain wetlands and billabongs along the River Murray and its tributaries.

The water systems of the Northern Region are often physically connected through infrastructure (such as Goulburn Weir and the Waranga Western Channel), which allows water to be transferred from the Goulburn River to the Loddon and Campaspe systems. They are also connected through a water market that allows trading of water between systems. Within the limitations of each mechanism, environmental water can be transferred between systems for delivery to environmental sites across northern Victoria, but most environmental water is usually used to provide benefits in the systems where the water is held.

Environmental values

Improving native fish populations is an important objective for environmental watering in northern Victoria. The endangered Murray hardyhead lives in wetlands in the Mallee and North Central CMA areas. Murray cod, silver perch and golden perch benefit from environmental flows in the Goulburn River, lower Broken Creek, Loddon River, Pyramid Creek, Gunbower Creek and Mullaroo Creek.

The vast network of wetlands across northern Victoria support many species of waterbirds that can benefit from environmental water deliveries. For example, magpie geese — endangered in Victoria — are now using Lake Cullen near Kerang to breed after releases of environmental water, and breeding pairs of brolga — considered vulnerable in Victoria — are now regularly found at Moodies Swamp near Shepparton.

The giant bullfrog — critically endangered in Victoria — and the growling grass frog — endangered in Victoria — can be found in floodplain wetlands in the lower River Murray and the Hattah Lakes. Frogs are a good food source for snakes and lizards at these wetlands.

Native vegetation has also benefited from environmental watering across northern Victoria including river swamp wallaby grass — nationally vulnerable — in Barmah Forest, the water nymph — rare in Victoria — in Black Swamp and the jerry-jerry — vulnerable in Victoria — at Lake Yando. River red gums and black box are found beside rivers and on floodplains across all of northern Victoria and these species provide habitat for birds, reptiles, mammals and insects.

Community considerations

Traditional Owners and their Nations in the Northern Region continue to have a deep connection to the region's rivers, wetlands and floodplains. This ancient connection is evidenced by the hundreds if not thousands of scar trees, middens, burial sites, artefacts and ovens along waterways. Aboriginal people maintain an enduring connection to Country including important ceremonial places and resources (such as food and medicine).

The VEWH acknowledges the Traditional Owners of northern Victoria and pays respect to their Elders past, present and future. It recognises that water has significant cultural importance and value for Traditional Owners and Aboriginal people.

The Traditional Owner groups in and around northern Victoria (including areas where there is no environmental water management) include the Barapa Barapa, Dhudhuroa, Dja Dja Wurrung, Latji Latji, Mutti Mutti, Nari Nari, Ngintait, Ngurai-illiam wurrung, Nyeri Nyeri, Tatti Tatti, Taungurung, Wadi Wadi, Wamba Wamba, Waywurru, Wegi Wegi, Yaithmathang, Yita Yita and Yorta Yorta peoples, among others.

Examples of engagement with Traditional Owner groups include:

- North Central CMA working with the Barapa Barapa and Dja Dja Wurrung peoples to understand how environmental water management can better support Aboriginal aspirations
- Mallee CMA engaging with Traditional Owners in the Mallee through its Aboriginal Reference Group.

Rivers and wetlands in northern Victoria are very popular fishing, camping and hunting spots. Hattah Lakes, Gunbower Forest and Barmah Forest are appreciated by locals, tourists and birdwatchers from all over the world. Importantly, these waterways also support business opportunities from tourism, forestry and irrigated agriculture, which contributes significantly to Australia's prosperity through food and fibre farming.

Year by year and case by case, the VEWH and its program partners consider opportunities raised by communities to use environmental water to provide additional social, cultural and recreational benefits (for example, releasing environmental water increases the enjoyment of people camping by a waterway, or publicising an environmental water release in advance provides more opportunities for kayakers). Where possible, the VEWH and its program partners incorporate such opportunities into watering decisions, as long as they do not compromise environmental outcomes or increase demand on the water holdings.

When planning to use water for the environment, the potential social, economic, cultural, and recreational benefits for communities which could arise from the water's use are considered. Some scoped opportunities for shared community benefits in northern Victoria for 2017–18 include:

- starting to fill Hattah Lakes in July to provide enough time to deliver 100 GL of water to inundate black box trees on the floodplain and then allow water drawdown by mid-late spring. It will take over 100 days to deliver 100 GL. Starting in July will provide the optimal timing for black box trees and is also preferred by Parks Victoria so it can prepare the national park for summer visitors
- improving amenity for campers at many reserves, crossings and towns along the Loddon and Campaspe rivers including the popular Aysons Reserve on the Campaspe near Elmore, which draws hundreds of campers during school holidays
- restoration of visitor access to the national park on the lower Ovens floodplain, a popular area for campers and other recreational pursuits
- potentially altering the timing of an environmental flow to ensure rising or stable river levels for the Murray cod opening (a recreational fishing event) on the Goulburn River
- improving the health of native plants (such as water ribbon) and sites in Gunbower Forest and along Gunbower Creek that are culturally significant to the Barapa Barapa people, to help them continue cultural practices
- improving the movement and dispersal of fish (such as golden perch, silver perch and Murray cod) in the Loddon River and Pyramid Creek, which increases fishing opportunities for anglers.

The VEWH's ability to deliver these benefits depends on climate, water available and the way the system is being operated to deliver water for other purposes (such as to homes, farms or businesses).

For more information about scoped opportunities for shared community benefits in 2017–18, contact the VEWH or the relevant waterway manager.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental water planning and releases need to be part of an integrated approach to catchment management. Many of the environmental objectives in this Seasonal Watering Plan will not be fully met without simultaneously addressing excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of streambank vegetation and invasive species, to name just a few issues.

Victorian and Australian government agencies, community groups and private landowners implement many programs to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments.

North Central CMA's implementation of its *Native Fish Recovery Plan* is an example of integrated catchment management in the region. Centred on the Torrumbarry Irrigation Area and encompassing Gunbower Creek, Pyramid Creek, the lower Loddon River and associated wetlands, the recovery plan aims to increase native fish populations by improving waterway connectivity, habitat and flows. So far, with delivery partners such as Goulburn-Murray Water, the Box Creek regulator fish lock, which allows fish to move into Kow Swamp from Pyramid Creek, has been built. A pilot project has begun to install an irrigation channel screen at Cohuna Weir, to stop native fish entering an irrigation channel off Cohuna Weir pool. Snags have been reinstated in Pyramid Creek to improve habitat for Murray cod, golden perch and silver perch and a combination of irrigation water and environmental water has been used to provide flows to support fish movement and spawning.

Other examples of integrated catchment management in the Northern Region include:

- fox baiting in Barmah Forest by the Yorta Yorta Nation Aboriginal Corporation's works crew to protect turtle nests from predation
- removing willows from Birchs Creek
- putting artificial snags in Broken Creek and the Goulburn River in partnership with local fishing clubs.

Six natural resource management (NRM) agencies from Victoria, NSW and SA along the River Murray corridor are integrating programs under the Tri-State Murray NRM Regional Alliance. They formed the alliance in 2015 after recognising that by working together, NRM agencies can achieve better and more cost-effective social, economic and environmental outcomes.

For more information about integrated catchment management programs in the Northern Region refer to the Mallee, North Central, North East and Goulburn Broken regional catchment strategies and waterway strategies.

Seasonal outlook 2017–18

Each year on 15 May, the Northern Victoria Resource Manager releases a water availability outlook for northern Victoria for the coming year. These seasonal outlooks are updated monthly once the season begins and are available at www.nvrm.net.au.

The 2017–18 outlook at 15 May 2017 is that early-season water availability will be higher than in recent years. Opening high-reliability entitlement allocation is expected to be at least 30 percent in the Goulburn and Loddon systems, 50 percent in the Murray system and 100 percent in the Campaspe system, with all expected to reach 100 percent by the end of 2017–18 in all but an extreme dry inflow scenario. Under a wet climate scenario, all systems should reach their 100 percent allocations early in the year. Under an extreme dry scenario (for example, assuming inflows are similar to the lowest one percent of inflows on record), the Goulburn system is expected to reach 45 percent allocation and the Murray system is expected to reach around 70 percent allocation against high-reliability entitlements for the year. Allocation against low-reliability entitlements is also possible in 2017–18.

Environmental water demands in northern Victoria are usually high in winter and spring. As the outlook indicates, there is likely to be good water availability early in the season. High allocations combined with carryover from 2016–17 means that water is likely to be available for early-season demands. Because the storages were relatively full leading into winter, there is an increased chance of storage spills during 2017–18. Storage spills in winter/spring may meet or exceed many of the environmental water flow targets in downstream waterways. This can reduce the amount of environmental water that needs to be delivered, allowing additional watering actions to be undertaken during the year. However, storage spills may also result in some or all unused water carried over from the previous year being deducted from the environmental water account.

The VEWH coordinates its activities with other environmental water holders in northern Victoria, NSW and SA to achieve environmental outcomes at the Murray–Darling Basin scale. One example of coordination is the management of River Murray increased flows (RMIF), these flows being part of VEWH's entitlements in the Murray system. RMIF are co-owned by Victoria and NSW and can be used to achieve environmental outcomes in the Murray system in Victoria, NSW and SA. Recommendations for coordinated use of RMIF are made by the Southern Connected Basin Environmental Watering Committee.

The VEWH liaises with the MDBA and the Commonwealth Environmental Water Office to optimise the benefits of environmental water delivery in Victorian systems. Delivery of Living Murray and Commonwealth environmental water to meet Victorian environmental water objectives is covered for relevant systems in the following parts of this section.

Environmental water delivered through northern Victorian waterways can sometimes be reused to achieve further environmental benefits downstream (see section 1.4.2 about return flows). If return flows are not reused at Victorian environmental sites, the VEWH, Living Murray and CEWH return flows may continue to flow across the border to SA where they will be used to provide environmental benefits in the Coorong, Lower Lakes and Murray Mouth area.

The VEWH may also authorise waterway managers to order Living Murray and Commonwealth water for downstream sites, provided there are no adverse impacts on Victorian waterways.

What is the Murray–Darling Basin Plan?

Northern Victoria is part of the Murray–Darling Basin and environmental water deliveries in the Northern Region are subject to the requirements of the Murray–Darling Basin Plan. The MDBA developed the plan under the *Commonwealth Water Act 2007* and it became law in November 2012. The plan sets legal limits on the amount of water that can be taken from the Murray–Darling Basin's surface and groundwater resources. Chapter 8 of the plan also sets out a high-level environmental watering plan which defines environmental objectives to protect, restore and build the resilience of water-dependent ecosystems and their associated functions. The VEWH's environmental planning and delivery is consistent with the requirements of the plan. The potential environmental watering outlined in sections 4 and 5 of this Seasonal Watering Plan fulfil Victoria's obligations to identify annual environmental watering priorities for Victoria's water resource areas under section 8.26 of the Murray–Darling Basin Plan.

5.2 Victorian Murray system

Waterway managers – Goulburn Broken, North Central and Mallee catchment management authorities

Storage managers – Goulburn-Murray Water, Lower Murray Water, Murray–Darling Basin Authority (River Murray Operations)

Environmental water holders – Victorian Environmental Water Holder, Murray–Darling Basin Authority (the Living Murray program), Commonwealth Environmental Water Holder

Region overview

The Victorian Murray system contains many significant floodplains and wetland systems covering the Goulburn Broken, North Central and Mallee CMA areas. The Barmah Forest, Kerang wetlands and Hattah Lakes are internationally significant Ramsar-listed sites due to the abundance and range of waterbird species that use them. Other wetlands in the system are either nationally or regionally significant.

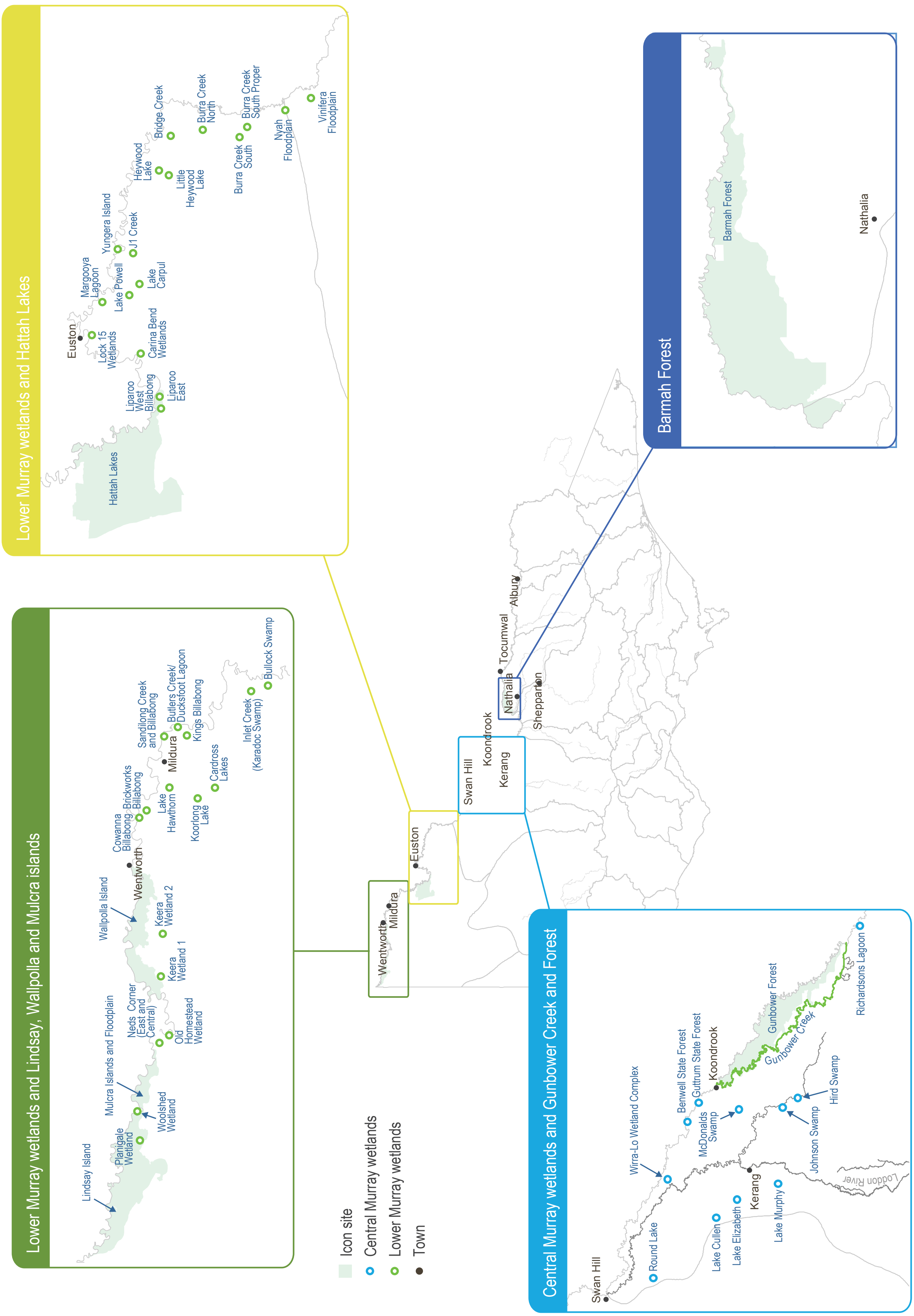
The Victorian Murray system provides a wide range of habitat types that support rare and threatened waterbird species including the painted snipe, brolga, royal spoonbill and white-bellied sea eagle. The system's floodplain wetlands also provide habitat for the nationally endangered Murray hardyhead fish, one of the most threatened vertebrate species in Australia.

The Victorian Murray system supports a variety of recreational activities (such as camping, fishing, water sports, birdwatching and recreational hunting) and Aboriginal cultural heritage values (such as scar trees, middens, burial sites, artefacts and ovens).

Environmental water can be supplied from a range of sources to meet demands in the Victorian Murray system. These include entitlements held by the VEWH, the Living Murray program and the CEWH; reuse of return flows; and in some instances use of consumptive water en route. The source of the water and the ability of the VEWH and its program partners to deliver all watering actions will depend on the availability of water, water commitments by other environmental water holders and operational conditions. As a result, expected environmental water availability is not specified for the Victorian Murray system.

Birdwatching at Lake Powell, by Mallee CMA

Figure 5.2.1 The Victorian Murray system



5.2.1 Barmah Forest

The Barmah–Millewa Forest covers 66,000 ha and straddles the Murray and Edwards rivers between the townships of Tocumwal, Deniliquin and Echuca. The Victorian component is the Barmah National Park and River Murray Reserve covering 28,500 ha of forest and wetlands.

Environmental values

The Barmah–Millewa Forest is the largest river red gum forest in Australia and the most intact freshwater floodplain system along the River Murray. The forest supports important floodplain vegetation communities including the threatened Moira grass plains and is a significant feeding and breeding site for waterbirds including bitterns, ibis, egrets, spoonbills and night herons. Significant populations of native fish, frogs and turtles also live in the forest's waterways.

Social, cultural and economic values

The Barmah Forest supports a variety of recreational and tourism activities (such as bushwalking, fishing, river cruises and bird watching). Camping is popular along much of the 112 km frontage to the River Murray: with its majestic river red gums, sandy beaches and a large variety of wildlife, the Murray provides the ideal backdrop for camping. Four canoe trails have been developed in the park, and the forest also provides excellent fishing opportunities, particularly for Murray cod, golden perch, freshwater catfish and yabbies.

The forest is valued for its part in Australia's heritage and for its natural and Aboriginal and post-European settlement cultural heritage values. Aboriginal sites of significance include scar trees, middens, burial sites, artefacts and ovens. The Barmah Forest is highly significant for Traditional Owners of the Yorta Yorta Nation who have a continuing connection to Country including important ceremonial places and resources (such as foods and medicines). The Barmah Forest is jointly managed by the Yorta Yorta Nation. Non-Aboriginal artefacts are largely associated with past forestry and grazing practices in the forest.

Ibis colony at Boals Deadwood wetland in Barmah Forest, by Goulburn Broken CMA

Environmental watering objectives in Barmah Forest

	Enhance the health of river red gum communities and aquatic vegetation in the wetlands and watercourses and on the floodplain Increase germination and growth of Moira grass
	Maintain or increase the habitat available for frogs
	Maintain or increase the number of waterbirds feeding in the forest Successfully recruit colonial nesting waterbirds
	Maintain or increase the habitat available for turtles
	Protect and increase populations of native fish by providing flows to encourage them to spawn Maintain or increase the availability of habitat for native fish, including suitable drought refuges
	Enable nutrient cycling (particularly carbon) between the floodplain and the river through connectivity

System overview

Water management in the Barmah–Millewa Forest depends on gravity distribution from the River Murray. When river flows are above 15,000 ML/day downstream of Yarrawonga Weir, both sides of the forest are managed as a whole. When flow is less than 15,000 ML/day, each side of the forest can be managed separately by operating the regulators individually. When flow downstream of Yarrawonga Weir is less than 10,500 ML/day, all regulators are usually closed to prevent unseasonal flooding of the forest in summer and autumn.

River regulation and water extraction from the River Murray has reduced the frequency, duration and magnitude of flood events in the Barmah–Millewa Forest. This has reduced the diversity, extent and condition of vegetation communities and the habitat and health of dependent animal species.

Environmental water releases aim to protect essential habitat under dry conditions and when possible to build on unregulated flows and consumptive water en route to optimise environmental outcomes. Environmental water delivered to the forest can often be used again at sites further downstream as part of multisite watering events.

Recent conditions

Spring 2016 saw the return of wet conditions and the largest flood event in Barmah–Millewa Forest since 1993. Environmental water deliveries maintained flows in November and December which improved the health of floodplain vegetation and provided water to wetlands through to February to help nesting waterbirds successfully fledge their young.

In most years, downstream demands from other water users result in the river being at capacity through the forest in summer and autumn (10,500 ML/day downstream of Yarrawonga). In 2016–17, flows were lower in these seasons because of reduced irrigation demand from Hume Reservoir. Environmental water was delivered from January to April to maintain a higher flow in the River Murray to support a trial delivery of water through a creek in Millewa Forest, to improve habitat for native fish.

Wetland plants and river red gums responded well to the large, prolonged flood event in Barmah Forest. Environmental water was used to maintain the flooding of Moira grass plains through November and December. Moira grass is a key species of the open plains and excellent growth was recorded across most watered areas. Moira grass flowered profusely at some watered sites, but it was patchy at sites where filamentous brown algae smothered its stems. The nationally endangered river swamp wallaby grass also grew well at sites that received natural flooding and environmental water in 2016.

Waterbirds had a fantastic year across the Barmah–Millewa Forest in 2016–17, with thousands of pairs of birds from a wide range of species nesting and successfully breeding. These included listed species such as egrets and likely breeding of the highly cryptic Australasian little bittern. Environmental water was delivered to particular wetlands to help ibis and spoonbill chicks survive and fledge. Without the delivery of environment water, adult birds would probably have abandoned their nests in response to dropping water levels before the young could look after themselves.

Preliminary results of native fish monitoring showed native species (such as Murray cod and silver and golden perch) spawned in spring. Larval Murray crayfish were found in the River Murray below Barmah Lake, a significant finding as crayfish were extremely uncommon in this area of the river after the 2010–11 hypoxic blackwater event, which caused widespread deaths of fish and crustaceans. Another unusual finding in 2016–17 was of a platypus in a Barmah Forest wetland, adjacent to the river.

Scope of environmental watering

Table 5.2.1 shows potential environmental watering actions and their environmental objectives.

Table 5.2.1 Potential environmental watering actions and objectives for Barmah Forest

Potential environmental watering	Environmental objectives
Spring/summer freshes in the River Murray channel (3 events of up to 1,000 ML/day for 8 days each in October–December)	• Provide flow variability within the main river channel to cue spawning of native fish species, primarily golden and silver perch
Winter/spring low flows to various waterways in Barmah Forest ('translucent regulator' operation providing variable flow rates in July to November)	• Maintain fish and turtle populations in permanent waterways • Maintain connectivity to the river • Remove accumulated organic matter by cycling carbon to the river system and minimising the risk of anoxic (low oxygen) blackwater • Maintain water quality • Provide increased flow variability within the forest
Spring/summer freshes to Gulf and Boals creeks (100 ML/day for 3–5 days as required in November–April)	• Maintain critical drought refuge areas in Barmah Forest • Protect fish and turtle populations in permanent waterways • Maintain water quality
Spring/summer low flows to Gulf and Boals creeks (100 ML/day for 30–60 days as required in November–April)	• Maintain refuge areas in Barmah Forest • Maintain fish and turtle populations in permanent waterways • Maintain connectivity to the river • Remove accumulated organic matter by cycling carbon to the river system and minimising the risk of anoxic (low oxygen) blackwater • Maintain water quality
Spring inundation of floodplain marshes (variable flow rates to extend the duration and inundation extent of natural flooding in September–December)[1]	• Provide flooding of sufficient duration to allow the growth of floodplain marsh vegetation in open plains • Create foraging ground for birds and increase the habitat available for turtles, frogs and small-bodied native fish
Targeted wetland watering to Boals Deadwood, Reedy Lagoon and Top Island wetlands (100–250 ML/day for 4 months in September–February)	• Initiate and/or maintain the breeding of colonial nesting and flow-dependent waterbirds

Table 5.2.1 Potential environmental watering actions and objectives for Barmah Forest *continued*

Potential environmental watering	Environmental objectives
Summer/autumn River Murray high flow (8,000 ML/ day downstream of Yarrawonga in January to April)	• Increase large-bodied native fish populations in the River Murray and anabranch creeks
Autumn/winter River Murray low flows (4,000 ML/ day downstream of Yarrawonga in May to June)	• Increase large-bodied native fish populations in the River Murray and anabranch creeks

[1] *Environmental water is delivered at flow rates outlined in the MDBA's Objectives and outcomes for river operations in the River Murray System (MDBA, 2016).*

Scenario planning

Table 5.2.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Environmental water requirements vary significantly for Barmah Forest in response to natural conditions. Under dry conditions, objectives focus on maintaining the condition of permanent creeks to sustain fish and turtle populations. Under average or wet conditions, the focus shifts to building resilience in the system by increasing responses to natural flood events. Specific actions may include extending the duration of natural flooding to increase the germination of wetland plants (such as Moira grass) in floodplain marshes or extending watering in river red gum forests to increase the recruitment and survival of young plants.

Targeted wetland watering may occur under a range of conditions to support the breeding of colonial nesting waterbirds and other flood-dependent birds.

Table 5.2.2 Potential environmental watering for Barmah Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flow periods unlikely • Flows in the River Murray will remain within channel all year	• Some small unregulated flows in late winter/spring • Low chance of overbank flows in late winter/spring	• Likely chance of small-to-medium unregulated flows in winter/spring • Likely chance of overbank flows in winter/spring	• High probability of moderate-to-large unregulated flows in winter/spring • Expected large overbank flows
Potential environmental watering	• Spring/summer freshes in the River Murray channel • Winter/spring low flows • Spring/summer freshes	• Spring/summer freshes in the River Murray channel • Winter/spring low flows • Spring/summer low flows • Targeted wetland watering • Autumn/winter low flows	• Spring/summer freshes in the River Murray channel • Winter/spring low flows • Spring/summer low flows • Spring inundation of floodplain marshes • Targeted wetland watering • Autumn/winter low flows	• Spring/summer freshes in the River Murray channel • Winter/spring low flows • Spring/summer low flows • Spring inundation of floodplain marshes • Targeted wetland watering • Summer/autumn high flows • Autumn/winter low flows
Possible volume of environmental water required to achieve objectives[1]	• 30,000 ML (no return flows)	• 172,000 ML (with 120,000 ML return flows)	• 596,000 ML (with 480,000 ML return flows)	• 716,000 ML (with 600,000 ML return flows)

[1] *The possible volumes of environmental water required in Barmah Forest are estimates; the actual volumes required are highly dependent on conditions. Unregulated or operational flows may meet some of the demand.*

Risk management

In preparing its seasonal watering proposal, the Goulburn Broken CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 5.2.3 shows the partners and stakeholder organisations with which Goulburn Broken CMA engaged when preparing the Barmah Forest seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Goulburn Broken Regional Catchment Strategy and Goulburn Broken Waterway Strategy.

Table 5.2.3 Partners and stakeholders engaged in developing the Barmah Forest seasonal watering proposal

Partner and stakeholder engagement
• CEWO
• DELWP
• MDBA (River Murray Operations and Living Murray program)
• NSW National Parks and Wildlife Service
• NSW Office of Environment and Heritage
• Parks Victoria
• VEWH
• Yorta Yorta Nation Aboriginal Corporation

5.2.2 Gunbower Creek and Forest

Gunbower Forest is a large, flood-dependent forest situated on the River Murray floodplain in northern Victoria between Torrumbarry and Koondrook. Covering 19,450 ha, it is bounded by the River Murray to the north and Gunbower Creek to the south.

Environmental values

Gunbower Forest contains a range of important environmental values including rare and widely diverse wetland habitats, vulnerable and endangered plants and animals and large areas of remnant vegetation communities (such as river red gum forest). The forest provides a range of habitats for birds and supports internationally recognised migratory waterbirds.

Gunbower Creek provides important habitat for native fish (such as Murray cod, golden perch and freshwater catfish). Due to the large variety of native fish in the creek, it is considered to be a valuable refuge and source of fish for the recolonisation of surrounding waterways.

Social, cultural and economic values

Gunbower Creek and Forest are both valuable sites from a cultural and socioeconomic perspective. The Barapa Barapa and Yorta Yorta communities have a strong connection to the Gunbower Creek and Forest area. The Barapa Water for Country project — a partnership between Barapa Barapa and North Central CMA — has provided an opportunity for Barapa people to spend time on and re-connect with Country in and around Gunbower Forest in recent years.

The forest provides economic values through timber production, apiculture (beekeeping), recreation and tourism. The forest and creek support numerous recreational activities including boating, kayaking, canoeing, camping, fishing and birdwatching. The Gunbower Heritage River Trail is a popular tourist attraction that highlights important Aboriginal and European cultural heritage sites. The River Red Gum Drive is one of Victoria's iconic four-wheel-drive routes and follows the River Murray track through the Gunbower National Park.

Gunbower Creek is the major carrier for the delivery of irrigation supply to the surrounding productive lands.

Environmental watering objectives in Gunbower Creek and Forest

	Maintain and improve the resilience of wetland plants and help river red gums recover from damage they sustained during the Millennium Drought
	Maintain healthy populations of native fish species in forest wetlands and rehabilitate large- and small-bodied native fish communities in Gunbower Creek Use flows to connect Gunbower Forest to Gunbower Creek enabling fish, insects, crustaceans, molluscs, worms and carbon to move between them, supporting the life cycle of Gunbower's native fish
	Provide feeding, breeding and refuge habitat for waterbirds including colonial nesting species
	Increase the number and type of frog species in the forest

System overview

Gunbower Forest is an internationally significant site under the Ramsar Convention and forms part of the Living Murray Gunbower–Koondrook–Perricoota icon site. River regulation and water extraction from the River Murray and Gunbower Creek has reduced the frequency, duration and magnitude of flood events in Gunbower Forest over the long term. This has affected the extent and condition of habitat and the health of dependent animal communities.

Gunbower Creek is managed primarily as an irrigation carrier and supplies the Torrumbarry Irrigation Area from the River Murray. The daily variation in water levels in the creek through spring, summer and autumn is much higher now than under natural conditions due to changing irrigation demand. This significantly affects native fish populations and ecological processes. Environmental water is used to smooth out the sudden and frequent changes in water level by filling the gaps in flows caused by irrigation demand within the creek. This action supports fish migration and breeding and promotes other ecological processes while maintaining water delivery for irrigation needs. Flows linking the creek to the Gunbower Forest floodplain and the River Murray can be restored through environmental watering and are vital to enhance ecosystem function (such as carbon exchange).

The Living Murray structural works program in the middle and lower forest was completed in 2013. The works allow up to 3,800 ha of the wetlands and floodplain to be watered with considerably less water than would be required under natural conditions. The works enable efficient watering through Gunbower Creek and the forest to maintain wetland and floodplain condition.

Recent conditions

Gunbower Forest has received six years of consecutive flooding as a result of natural and managed events. Dry conditions were expected for 2016–17 and watering objectives focused on maintaining the health of high-value wetlands — Black Swamp, Reedy Lagoon and Pig Swamp. A small volume of environmental water was pumped to Pig Swamp in upper Gunbower Forest in winter 2016 to support stressed river red gums and wetland vegetation that had not received any water since the 2011 floods.

High rainfall in winter and spring 2016 caused natural floods in Gunbower Forest. Overbank flows from the River Murray into Gunbower Forest commenced in July and continued through to early September. Flows at Torrumbarry Weir peaked at about 52,000 ML/day and inundated at least 10,000 ha of the forest. Environmental water was delivered through one of the lower landscape regulators to enable native fish movement and carbon and nutrient cycling between the creek and forest.

Field observations showed that river red gums responded with a flush of new growth and are in a better condition to withstand future dry conditions. Black box vegetation communities, located on the higher floodplains, were inundated for several weeks, which caused a range of aquatic understorey species including common nardoo to flourish. A high diversity of aquatic plants also germinated in some of the permanent and semipermanent wetlands. Unfortunately, there was little growth of aquatic vegetation in some wetlands (such as Greens Lagoon and Long Lagoon). The lack of response in these wetlands may be due to relatively deep water being held in them for extended periods during late spring and summer, and high turbidity caused by invasive fish species (such as carp). Although Reedy Lagoon had less wetland vegetation diversity after the flooding in spring 2016, surveys in March 2017 recorded some yellow bladderwort, a delicate carnivorous plant rarely found in Gunbower Forest.

Fewer waterbirds used the wetlands in the lower part of Gunbower Forest for feeding and breeding in 2016–17 than in previous years when environmental water was delivered (for example, in 2015–16). The main species to breed in the wetlands in 2016–17 were grey teal and pacific black ducks. Ten pairs of nankeen night herons were also observed in Little Reedy Lagoon, but is it not known whether they successfully bred. The relatively low rates of bird breeding observed in the forest's wetlands in 2016–17 may be linked to the widespread availability of breeding habitat caused by the floods in the River Murray and many of the nearby river systems.

Environmental water was provided through Gunbower Creek to support native fish outside the irrigation season. Traditionally, the creek has been drawn down to a series of disconnected deep pools at the end of the irrigation season: this is now recognised as a major factor threatening the survival of juvenile fish, particularly Murray cod. Providing environmental flows during this period maintains connections between habitats and food resources to support native fish species.

Strong recruitment of Murray cod in Gunbower Creek was observed through monitoring in 2014, corresponding to the delivery of environmental watering intended to trigger spawning of Murray cod in spring and early summer in 2013–14. Surveys in 2016–17 showed the Murray cod population in Gunbower Creek was well-represented by juvenile and subadult size classes, which is similar to populations in the River Murray considered to have sustainable levels of recruitment. These demographic patterns indicate that recently recruited juvenile and adult Murray cod are benefiting from the creek's management. Despite this, the Murray cod population in Gunbower Creek is still below the target size and requires ongoing environmental management to become self-sustaining in the long term.

Scope of environmental watering

Table 5.2.4 shows potential environmental watering actions and their environmental objectives.

Table 5.2.4 Potential environmental watering actions and objectives for Gunbower Creek and Forest

Potential environmental watering	Environmental objectives
Gunbower Forest	
Reedy Lagoon and Black Swamp (fill in autumn/winter if the wetlands have dried completely)	• Reduce the number of carp in permanent wetlands • Maintain/enhance the health and resilience of vegetation communities in permanent wetlands • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species
Reedy Lagoon and Black Swamp (fill in winter/spring and provide top-ups if significant bird breeding event occurs)	• Maintain the health and resilience of vegetation communities in permanent wetlands • Maintain suitable feeding and refuge habitat for waterbirds • Support a significant bird breeding event if one is triggered naturally
Reedy Lagoon and Black Swamp (top-ups in autumn/winter)	• Maintain the health and resilience of vegetation communities in permanent wetlands • Maintain suitable feeding and refuge habitat for waterbirds
Winter/spring fresh in Yarran Creek (variable flow rates and duration based on unregulated flows in the River Murray)	• Provide connectivity between Gunbower Creek and River Murray, through Yarran Creek and Shillinglaws regulators, to increase flowing habitat for the lateral movement of native fish, turtles and seed propagules • Provide migration and spawning opportunities for native fish
Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates to maintain appropriate inundation extent)	• Improve the health of river red gum communities • Maintain/enhance healthy populations of native fish in wetlands and increase opportunities for riverine fish to access floodplain resources • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species • Support a significant bird breeding event if one is triggered naturally
Gunbower Creek	
Winter low flows (up to 400 ML/day between July–August and May–June)	• Increase the survival rate and maintain the growth of native fish (such as Murray cod) by maintaining access to food and habitat resources
Spring/summer high flows (targeting a gradual increase in flows up to 700 ML/day including various periods of stable flows in August–January)	• Increase the recruitment, growth and survival of native fish (such as Murray cod) by maintaining access to breeding habitat and food resources
Summer/autumn low flows (above 300 ML/day, between January to May)	• Maintain the survival rate and growth of native fish by increasing access to food and habitat resources
Increased winter/spring low flows (up to 500 ML/day between July–August and May–June, if unregulated conditions occur in the River Murray)	• Increase native fish recruitment by providing cues for migration and spawning, in line with larger flows in the River Murray • Increase the survival rate and maintain the growth of native fish (such as Murray cod) by maintaining access to breeding habitat and food resources

Scenario planning

Table 5.2.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The scale of the floodplain watering in Gunbower Forest will be determined by climatic conditions, delivery capacity and environmental water availability.

The main objective for 2017–18 is to allow most of the permanent and semipermanent wetlands throughout Gunbower Forest to dry, in the absence of any natural flooding. Drying aims to reduce the number of carp across the forest. A drying phase will also promote the growth of wetland vegetation and allow newly recruited plants to establish and set seed before the next watering of the forest.

In drought conditions, permanent and semipermanent wetlands in Gunbower Forest will be allowed to draw down and dry. Environmental watering is planned to occur at only two very high-priority wetlands, Reedy Lagoon and Black Swamp, in autumn/winter 2018. Drying of these deep wetlands before the delivery of environmental water is crucial to reduce the large number of adult carp in the wetland and hindering the recovery of wetland vegetation.

It is planned that in all other conditions — dry, average and wet — Reedy Lagoon and Black Swamp will receive environmental water in winter/spring 2017. The wetlands will provide drought refuge for waterbirds and other water-dependent animals and maintain wetland vegetation. Environmental water may also be used to maintain water levels in the wetlands to ensure the wetland vegetation remains in good condition, or to increase the success of any significant colonial waterbird breeding event that may be triggered naturally in these wetlands or in others. Bird breeding top-ups will aim to maintain an appropriate inundation depth for the time it takes for juvenile birds to successfully fledge from their nests.

In dry to wet years, higher flows (above 15,000 ML/day for more than two weeks) in the River Murray may result in some natural flooding and could provide opportunities to support a winter/spring fresh in Yarran Creek. Flows through Yarran Creek and Shillinglaws Regulator will increase flowing habitat between Gunbower Creek and the River Murray and support the movement of native fish, turtles and seed propagules.

In winter, higher flows (above 25,000 ML/day) in the River Murray and high rainfall in the upper catchments may cause moderate levels of natural flooding in the forest. Environmental water may be used to extend the duration and extent of the flooding, to enhance the health of the floodplain that is still recovering from the Millennium Drought.

Gunbower Creek is a highly regulated system. As a result, natural conditions (such as flooding and rainfall) do not greatly influence environmental objectives or flow requirements in the system. Environmental water management will aim to support all aspects of native fish life cycles, ensuring there are sufficient habitat and food resources for native fish throughout the year.

The highest environmental water priority for Gunbower Creek is to maintain flowing habitat and access to feeding resources for native fish during winter, when flow rates would otherwise drop due to there being no irrigation demand and Goulburn-Murray Water needing to conduct system maintenance works. The second-highest priority is to smooth out flows during the irrigation season to provide opportunities for native fish (especially Murray cod) to breed and for their larvae to disperse. If there are high unregulated flows in the River Murray during winter/spring, environmental water may be used to increase the low-flow rate in Gunbower Creek to about 500 ML/day to provide cues for Murray cod to migrate and spawn at the same time as populations in the River Murray.

Gunbower Creek, by North Central CMA

Table 5.2.5 Potential environmental watering for Gunbower Creek and Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural inflows into Gunbower Forest	• Minor natural inflows into Gunbower Forest may occur in winter/spring	• Some natural inflows into Gunbower Forest are likely in winter/spring but unlikely to be significant	• Overbank flows are likely in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Reedy Lagoon and Black Swamp (autumn/winter fill) • Gunbower Creek winter low flows • Gunbower Creek spring/summer high flows • Gunbower Creek summer/autumn low flows	• Reedy Lagoon and Black Swamp (winter/spring) • Gunbower Creek winter low flows • Gunbower Creek spring/summer high flows • Gunbower Creek summer/autumn low flows	• Reedy Lagoon and Black Swamp (winter/spring) • Gunbower Creek winter low flows • Gunbower Creek spring/summer high flows • Gunbower Creek summer/autumn low flows • Yarran Creek winter/spring fresh	• Reedy Lagoon and Black Swamp (winter/spring) • Yarran Creek winter/spring fresh • Gunbower Creek winter low flows • Gunbower Creek spring/summer high flows • Gunbower Creek summer/autumn low flows
Potential environmental watering – tier 2 (lower priorities)[1]	• N/A	• Yarran Creek winter/spring fresh • Reedy Lagoon and Black Swamp (autumn/winter top-ups)	• Gunbower Creek winter/spring increased low flows • Reedy Lagoon and Black Swamp (autumn/winter top-ups)	• Extension of natural inundation of Gunbower Forest floodplain, floodrunners and wetlands • Gunbower Creek winter/spring increased low flows
Possible volume of environmental water required to meet objectives[2,3]	• 28,000 ML (tier 1) • N/A	• 28,400 ML (tier 1) • 3,500 ML (tier 2)	• 31,000 ML (tier 1) • 5,500 ML (tier 2)	• 33,500 ML (tier 1) • 17,000 ML (tier 2)
Priority carryover requirements	• 11,000 ML	• 12,000 ML	• 10,000 ML	• 8,000 ML

1 *Tier 2 actions are lower-priority actions to be considered if water is available.*

2 *Represents the estimated volume of water required to underwrite the losses associated with the delivery of consumptive water en route (except for discrete wetland watering actions).*

3 *Environmental water requirements for tier 2 are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 5.2.6 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing the Gunbower Creek and Forest seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the North Central Regional Catchment Strategy and North Central Waterway Strategy.

Table 5.2.6 Partners and stakeholders engaged in developing the Gunbower Creek and Forest seasonal watering proposal

Partner and stakeholder engagement
• CEWO • Gannawarra Shire Council, Campaspe Shire Council, Cohuna Progress Association and Murray Regional Tourism Board • Gunbower Island Community Reference Group (with representatives of the Cohuna Progress Association, bird observers, Field & Game Australia, BirdLife Australia, Gunbower Landcare Group, irrigators and general community members) • Gunbower Operations Advisory Group (with representatives of Goulburn-Murray Water, Parks Victoria, DELWP, Vic Forests, Forestry Corporation NSW, North Central CMA, MDBA, CEWH and the VEWH) • Gunbower Technical Working Group (with DELWP [Threatened Flora and Fauna] representatives and fish, vegetation and bird consultants and ecologists) • North Central CMA Community Consultative Committee, an advisory group to the North Central CMA Board comprising regional community members • VEWH • Yorta Yorta and Barapa Barapa Traditional Owners

5.2.3 Central Murray wetlands

The central Murray wetland system consists of 11 wetlands on the lower Loddon River and River Murray floodplains.

Environmental values

The wetlands in the central Murray system support vulnerable or endangered species including the Australasian bittern, Murray hardyhead, Australian painted snipe and growling grass frog. The wetlands provide habitat for many threatened bird species (including the great egret and white-bellied sea eagle) listed under several Acts and international agreements. Internationally recognised, Ramsar-listed wetlands in the system include Lake Cullen, Hird Swamp and Johnson Swamp, while others are of bioregional significance.

Social, cultural and economic values

The Barapa Barapa, Yorta Yorta and Wamba Wamba Nations are the Traditional Owner groups of the central Murray wetlands. The area is considered one of the most archaeologically important areas of Victoria with numerous middens, mounds, artefacts, scar trees and surface scatters documented. These Nations continue to have a connection to the central Murray wetlands.

The wetlands are used for various recreational activities including birdwatching and bushwalking, and some wetlands are also used for duck hunting. Tourism is an important contributor to the local economy. Groundwater recharge and carbon storage are other indirect benefits of the wetlands.

Environmental watering objectives in the central Murray wetlands

	Maintain and rehabilitate river red gum, black box, lignum woodland and wetland plant communities Provide appropriate wetting and drying conditions to support seed germination, seedling survival and recruitment including of semi-aquatic plant species in damp areas of wetlands Manage the extent and density of invasive plant species including Tall Marsh vegetation Support a mosaic of wetland plant communities to provide feeding and breeding habitat for a diversity of native animals
	Maintain habitat for the critically endangered Murray hardyhead
	Provide habitat for waterbird resting, feeding and breeding including threatened species (such as Australasian bittern, little bittern and brolga)
	Provide habitat for the endangered growling grass frog

System overview

The central Murray wetlands are almost wholly contained within the Torrumbarry Irrigation Area and are all wetlands of regional or international significance. The area has experienced dramatic changes since European settlement with the construction of levees, roads and channels. Most of the wetlands are now cut off from natural flooding and rely on environmental water to maintain their ecological character and health.

Nine of the wetlands can receive environmental water using permanent infrastructure: Lake Cullen, Hird Swamp, Johnson Swamp, Round Lake, McDonalds Swamp, Lake Elizabeth, Lake Murphy, Richardson's Lagoon and the Wirra–Lo wetland complex. To date, neither Guttrum or Benwell forests, which both border the River Murray, have permanent infrastructure to deliver environmental water. Some of the semipermanent wetlands in these forests can receive environmental water via temporary pumping from the River Murray.

Recent conditions

High rainfall during winter/spring caused widespread flooding in the area, including of the Loddon and Avoca River floodplains. The wet conditions in 2016 followed more than three years of below-average rainfall, which shifted management of the wetlands from a planned dry scenario early in the season to a wet scenario by early-to-mid-spring. Environmental watering focused on sites that remained isolated from natural flooding — via channels, roads and levees — as well as the delivery of large wetland watering actions that could not be achieved without assistance from natural floods.

Environmental watering in 2016–17 included top-up flows to Round Lake and Lake Elizabeth to maintain and establish suitable conditions for Murray hardyhead, and to Richardson's Lagoon, McDonalds Swamp, Hird Swamp and Wirra–Lo wetland complex to support the diverse waterbirds, plants and other animals typical of temporary freshwater marshes.

Before 2016–17, Lake Cullen had remained dry since 2012. Under the optimum watering regime, the wetland was due for a fill in the 2016–17 season, but due to the potential for groundwater interaction watering was only proposed if the neighbouring Avoca Marshes and Lake Bael Bael filled first. Heavy rainfall in September and October 2016 saw flooding in the Avoca River and subsequently of Lake Bael Bael. First and Second Marsh filled naturally. Environmental water was used to partially fill Lake Cullen in spring 2016 and supply top-ups in summer and autumn, which provided waterbird feeding and breeding habitats throughout the watering year. The nationally endangered Australasian bittern, Australian little bittern, brolga, magpie geese, whiskered tern and Australian shoveller were also recorded using the tall marsh habitat at the wetland.

Two of the wetlands in the central Murray system — Johnson Swamp and Lake Murphy — did not receive any floodwater or environmental water during 2016–17. Lake Murphy dried in January 2016 and remained dry for the entire year, helping to promote the germination and establishment of vegetation (such as river red gums) in and around the wetland. Johnson Swamp was allowed to draw down and dry following managed deliveries in the previous year, providing habitat for a large number of frogs and waterbirds including breeding brolga and black swan recorded in November 2016. The drawdown phase promoted highly productive mudflat habitat, important for the establishment of amphibious plant species.

Round Lake remained permanently inundated during the season to support the resident Murray hardyhead population. While fish surveys in autumn 2016 detected the presence of the fish, environmental DNA sampling in winter 2016, which detects species by analysing the DNA released by organisms into the environment, did not detect any Murray hardyhead DNA. A negative result from the new technology reflects the difficulties sampling for this species, especially in cooler months when populations are naturally lower. A recommendation was made to repeat surveys in spring and summer when populations are typically higher, if funding allows. Waterbird surveys in spring and summer recorded at least 21 species, with large numbers of Eurasian coot and black swans.

Lake Elizabeth continued to show a high coverage of aquatic plant species favoured by Murray hardyhead since the first environmental watering in 2014. The plants provide ideal habitat for the fish that were translocated into the wetland during spring and autumn in 2015.Waterbird surveys at Lake Elizabeth show that the variety of species and number of waterbirds are at their highest since monitoring began in 2012. The survey in January 2017 recorded up to 7,500 Eurasian coot, large populations of grey teal and threatened species such as freckled duck, blue-billed duck, hard head and Australasian shoveler present at the wetland.

Richardson's Lagoon spring and summer surveys recorded a lower number of waterbirds in comparison to other wet years, although there was still a variety of species and evidence of black swan, pacific black duck, grey teal and dusky moorhen breeding.

The Wirra–Lo wetland complex supported a high diversity of waterbird and woodland bird species in its five wetlands and the creeks adjoining them including the plumed whistling duck, hardhead, Australian wood duck, royal spoonbill, straw-necked ibis and the vulnerable grey-crowned babbler. The previously planted wetland plant species had flourished and spread naturally through the wetland: they include water ribbon, water milfoil, wavy marshwort, swamp buttercup and floating swamp wallaby-grass.

McDonalds Swamp waterbird surveys recorded a large variety and number of waterbirds. This included significant species listed in the Victorian *Flora and Fauna Guarantee Act 1988*: the intermediate egret, Australasian bittern, magpie geese, blue-billed duck, royal spoonbill, grey-crowned babbler, migratory glossy ibis and Latham's snipe. Successful breeding of black swan, pink-eared duck, Australian wood duck, Eurasian coot, black-winged Stilt, red-kneed dotterel, Australian shelduck, pacific black duck, grey teal and purple swamphen was also recorded.

The environmental water delivered to Hird Swamp in late autumn 2017 has provided habitat for a large number of feeding waterbirds. It is expected that the upcoming bird surveys at the wetland will establish that large numbers and species of waterbirds will use the wetland in 2017–18.

Guttrum and Benwell forests received natural inflows during winter and spring 2016 from the high flows in the River Murray. The natural flooding allowed wetland and aquatic plants to germinate and flower in some parts of the forest, although in most parts of the forest the understorey is still in poor condition. Reed Bed Swamp (in Guttrum Forest) had little-to-no wetland vegetation recorded despite the recent flooding. Much of the forest is still recovering from the Millennium Drought and requires a more-natural watering regime and the reduction of grazing pressure to support recovery.

Scope of environmental watering

Table 5.2.7 shows potential environmental watering actions (including wetland drying) and their environmental objectives.

Table 5.2.7 Potential environmental watering actions and objectives for the central Murray wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Round Lake (top-ups as required to maintain water-quality targets)	• Maintain habitat for Murray hardyhead • Maintain suitable waterbird habitat
Lake Elizabeth (top-ups as required to maintain water-quality targets)	• Maintain habitat for translocated Murray hardyhead • Support submerged salt-tolerant aquatic plant assemblage and a high diversity of waterbirds
Wirra–Lo wetland complex (top-ups as required to maintain depth)	• Rehabilitate river red gum and a variety of aquatic vegetation communities, providing suitable habitat for the growling grass frog and a high diversity of waterbirds including brolga
Hird Swamp West and East (fill in winter/spring and provide top-ups if required to support bird breeding)	• Optimise the benefits of autumn/winter partial fill and trigger an early waterbird breeding event • Maintain a variety of vegetation communities (including open-water habitat) to support waterbird feeding and breeding habitats
Richardson's Lagoon (fill in winter/spring and provide top-ups if required to support bird breeding)	• Promote germination, growth and recruitment of a variety of floodplain plant species • Maintain a variety of water-dependent species including fish, waterbirds, frogs and turtles
Guttrum and Benwell forests (fill Reed Bed Swamp in winter/spring and provide top-ups if required to support bird breeding)[1]	• Rehabilitate a variety of aquatic vegetation, semi-aquatic vegetation and river red gum communities in semipermanent wetlands that received natural flooding in 2016–17 • Provide refuge habitat for waterbirds and water-dependant animals • Support colonial waterbird breeding, if it occurs
McDonalds Swamp (partial fill in autumn/winter)	• Promote a variety of vegetation communities by supporting juvenile river red gums and reduce the spread of tall marsh • Facilitate early plant germination and provide suitable conditions for winter frog breeding
Lake Murphy (partial fill in autumn/winter)	• Promote the growth of a variety of vegetation communities including recently planted juvenile river red gums to support waterbird and frog feeding and breeding habitats
Wetland drying	
Johnson Swamp (drying) and Lake Cullen (drawdown)	• Not to be actively watered in 2017–18 • The drying phase of Johnson Swamp will help maintain a variety of habitats (such as herbland meadows) to support a range of waterbirds and animals; drying may also assist with the management of large reed encroachment • Lake Cullen will be allowed to draw down to maintain the salt-tolerant wetland plant communities and provide a variety of habitat types to support a diversity of waterbirds

[1] *Guttrum and Benwell forests may receive environmental water in 2017–18 pending further investigation by North Central CMA. Infrastructure projects for Guttrum and Benwell forests are being assessed as part of the Sustainable Diversion Limit Offset mechanism of the Murray–Darling Basin Plan. Until works are approved and completed, environmental watering will only consider semipermanent wetlands that can receive water pumped from the River Murray.*

Scenario planning

Table 5.2.8 outlines the potential environmental watering and expected water use under a range of planning scenarios.

North Central CMA has done landscape-scale planning for these wetlands to optimise wetland watering regimes over multiple years. An important consideration in this planning is to ensure there is a large variety of habitat types across the area to support waterbirds and other water-dependent animals at all times.

The wetlands of highest priority (tier 1) for environmental water management in the central Murray wetlands in 2017–18 under all planning scenarios are Round Lake, Lake Elizabeth and the Wirra–Lo wetland complex. Round Lake supports what is thought to be the only stable population of the critically endangered Murray hardyhead in the Kerang area. Murray hardyhead were also translocated to Lake Elizabeth in autumn 2016. These wetlands need to be maintained for future stocking and translocation programs to prevent the regional loss of the species. The Wirra–Lo wetland complex is a permanent drought refuge for waterbirds and other threatened species, and an aim is for it to provide habitat to enable the return of the nationally listed growling grass frog.

If water availability increases under all planning scenarios, additional wetlands (under tier 2) may receive environmental water to help meet native plant, animal and waterbird objectives. Under drought and dry conditions, environmental water may be used to fill some wetlands that did not receive environmental water or natural inflows in 2016–17, or to maintain water depth in wetlands that received environmental water in the previous year. This will address the needs of wetland vegetation, native fish and bird species in the area.

Under very wet conditions, natural floods may partially or completely fill some of the central Murray wetlands, but environmental water may be required to maintain water depth to support waterbird breeding and the condition of the vegetation.

Lake Murphy may receive a partial fill in autumn/winter 2017–18 if the recently planted river red gums are large enough to withstand the watering. If the trees are assessed as too small, the fill will be postponed until spring 2018–19.

No environmental water is planned to be delivered to Johnson Swamp and Lake Cullen in 2017–18. Johnson Swamp is in the second year of a drying phase to promote a greater diversity of habitats for waterbirds and to support juvenile river red gums that established after recent environmental watering. Lake Cullen received a fill (from empty) in 2016–17 and will be allowed to draw down naturally in 2017–18. As the wetland draws down, it will allow wetland plants that have germinated to grow and set seed, and it will also provide a range of types of habitat for waterbirds including deep water habitat, tall marsh and mudflats.

Australian little bittern at Johnson Swamp, by Simon Starr

Table 5.2.8 Potential environmental watering for central Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands are unlikely	• Some catchment run-off and unregulated flows into the wetlands is possible, particularly in winter/spring	• Low-to-moderate catchment run-off and unregulated flows into the wetlands are likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Round Lake • Lake Elizabeth • Wirra–Lo wetland complex	• Round Lake • Lake Elizabeth • Wirra–Lo wetland complex • Hird Swamp • Richardson's Lagoon • Guttrum and Benwell forests	• Round Lake • Lake Elizabeth • Wirra–Lo wetland complex • Hird Swamp • Richardson's Lagoon • Guttrum and Benwell forests • McDonalds Swamp	• Round Lake • Lake Elizabeth • Wirra–Lo wetland complex • Hird Swamp • Richardsons Lagoon • Guttrum and Benwell forests • McDonalds Swamp
Potential environmental watering – tier 2 (lower priorities)[1]	• Hird Swamp • Richardsons Lagoon • Guttrum and Benwell forests • McDonalds Swamp	• McDonalds Swamp • Lake Murphy	• Lake Murphy	• Lake Murphy
Possible volume of environmental water required to meet objectives[2]	• 4,000 ML (tier 1) • 4,500 ML (tier 2)	• 7,900 ML (tier 1) • 1,300 ML (tier 2)	• 8,500 ML (tier 1) • 700 ML (tier 2)	• 8,500 ML (tier 1) • 700 ML (tier 2)
Priority carryover requirements	• 3,700 ML	• 3,700 ML	• 4,500 ML	• 7,100 ML

[1] *Tier 2 actions are lower-priority actions to be considered if water is available.*

[2] *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 5.2.9 shows the partners, stakeholder organisations and individuals with which North Central CMA engaged when preparing the central Murray wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the North Central Regional Catchment Strategy and North Central Waterway Strategy.

Table 5.2.9 Partners and stakeholders engaged in developing the central Murray wetlands seasonal watering proposal

Partner and stakeholder engagement
• Birdlife Australia • Central Murray Wetlands Environmental Water Advisory Group (comprising community members, private landholders, a representative of Game Management Authority and North Central CMA project staff and Board and Community Consultative Committee representatives) • CEWH • Community members • DELWP • Field & Game Australia • Gannawarra Shire Council • Goulburn-Murray Water • Guttrum and Benwell Community Reference Group • Landholders owning a wetland that receives environmental water • Loddon Shire Council • North Central CMA Board • North Central CMA Community Consultative Committee, an advisory group to the North Central CMA Board comprising regional community members • Parks Victoria • Swan Hill Rural City Council • VEWH

5.2.4 Hattah Lakes

Hattah Lakes is a complex of more than 20 semipermanent freshwater lakes over an area of 48,000 ha. The complex forms part of the Hattah-Kulkyne National Park. The complex is adjacent to the River Murray in north-west Victoria, and the ecology of the lakes and floodplain is strongly influenced by flooding regimes.

Environmental values

Hattah Lakes provides important waterbird breeding habitat, particularly for colonial nesting waterbirds (such as cormorants). Being located in a remote and arid landscape, Hattah Lakes also provides large-scale drought refuge for waterbirds, fish and terrestrial animals. Eleven native and five non-native fish species have been reported in the lakes and five of these have conservation significance in Victoria including the freshwater catfish and fly-specked hardyhead.

Flood-dependent vegetation at Hattah Lakes ranges from wetland communities that require frequent flooding to lignum and black box communities that require inundation two or three times a decade. The reduced frequency and duration of floods in the River Murray has degraded the water-dependent vegetation communities across the Hattah Lakes, which has in turn reduced the diversity and abundance of animals that rely on healthy vegetation for habitat.

Social, cultural and economic values

Hattah-Kulkyne National Park is a popular location for camping, canoeing, birdwatching and photography.

The Hattah Lakes hold significance for Traditional Owners. They contain important ceremonial places and for thousands of years provided resources such as food and materials for the Latji Latji people.

Environmental watering objectives in the Hattah Lakes

Rehabilitate a healthy and diverse mix of wetland and floodplain plant life to maintain the ecological character of this internationally protected site
Maintain high-quality habitat for native fish in wetlands Use flows to connect the lakes to the river so large-bodied fish (including Murray cod and golden perch) can move, feed and breed
Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial species (such as the spoonbill and egret)

System overview

The Hattah Lakes system is naturally filled when there are high flows in the River Murray and some lakes hold water for several years after floods recede. Regulation of the River Murray has significantly reduced the frequency and magnitude of natural floods through the Hattah Lakes system.

Large-scale engineering works were completed under the Living Murray program to improve water regimes at Hattah Lakes under low-flow conditions. Pumps and regulators are used to deliver water to parts of the floodplain and then retain and/or discharge it to provide the water regimes that support the environmental values of the system.

Recent conditions

At the beginning of 2016–17 the delivery of environmental water to Hattah Lakes was not a high priority as environmental water had been provided to Hattah Lakes three times since 2013, a dry year was expected and water allocations were low. Wetland drying was considered appropriate to allow vegetation to establish. As winter and spring progressed, conditions turned wet and it was decided to deliver water to Hattah Lakes to align with the natural conditions that were occurring throughout the region. Almost 35,000 ML of environmental water was pumped into Hattah Lakes in September and October.

In October and November 2016, there was a major flood in the lower River Murray and the Hattah Lakes and floodplain were inundated for 16 weeks above the retention level of the lakes. Floods in major contributing systems, the Edward-Wakool and Murrumbidgee, were the largest in over two decades. Those systems washed huge amounts organic material into the River Murray, causing widespread deoxygenated blackwater and fish deaths. The water that was pumped into the lakes was not impacted by deoxygenated blackwater that arrived later during the flood, and so Hattah Lakes provided a refuge for fish and other animals from the deoxygenated blackwater present in the River Murray.

The combination of pumping water to Hattah Lakes and two flood peaks inundated the floodplain to 44.6 m AHD. This is the second time this water level been reached since 2005, and the condition of black box trees improved in response to the flooding. However, the water did not reach trees at slightly higher elevations, up to 45.0 m AHD, which have not been inundated by floodwater since the 1970s.

Scope of environmental watering

Table 5.2.10 shows potential environmental watering actions and their environmental objectives.

Table 5.2.10 Potential environmental watering actions and objectives for the Hattah Lakes

Potential environmental watering[1]	Environmental objectives
Winter/spring fill of semipermanent wetlands	• Maintain water in semipermanent wetlands to provide habitat for fish and waterbirds
Winter/spring fill of semipermanent and temporary wetlands	• Improve the condition of red gum forests and woodland
Winter/spring floodplain inundation up to 45.0 m AHD	• Improve the condition of black box woodlands

[1] *The Hattah Lakes pump station may also be operated at any time of year to meet annual maintenance requirements.*

Scenario planning

Table 5.2.11 outlines potential environmental watering and expected water use under a range of planning scenarios.

Even with the flooding that occurred in 2016, and the managed environmental watering at Hattah Lakes since 2013, the condition of black box woodland in the highest floodplain terraces remains poor. The trees are unhealthy because the managed flows have not exceeded 45.0 m AHD, where large stands of black box are growing. The last flood of woodland at this height was in 1975. The highest water level in 2016 was 44.6 m AHD, and providing water to 45.0 m AHD in 2017 will help increase survival of black box trees that recruited in 2016, trigger additional recruitment and improve the condition of other established trees.

The lakes have retained water from the 2016 flood and therefore the volume of environmental water needed to meet the target level of 45.0 m AHD is much less than if current water levels were low. About 100,000 ML is needed to fill Hattah Lakes to 45.0 m AHD in 2017. This is a rare opportunity to achieve floodplain inundation not seen since 1975.

It will take at least 100 days to deliver 100,000 ML, therefore it is important to commence filling at the start of the water year so the lakes fill by mid-late spring and then start to draw down into the summer. This is the preferred timing from an environmental perspective. It is also preferred by Parks Victoria, managers of the Hattah-Kulkyne National Park, so that the park can be prepared for visitors in summer.

The rainfall predictions for the Murray–Darling Basin in early winter 2017 are for drier than average conditions, however streamflows will likely be average because major upstream storages remain full and are likely to spill. Based on these streamflow predictions it will be appropriate to commence filling in July, targeting 45.0 m AHD. If conditions are not suitable or environmental water is not available, there is scope to instead focus on environmental objectives for the permanent and semipermanent wetlands at lower elevations with a partial fill later in winter/spring.

Table 5.2.11 Potential environmental watering for the Hattah Lakes under a range of planning scenarios

Planning scenario	Very dry	Dry	Average	Wet	Very wet
Expected conditions	• Low flows year-round in the River Murray and no natural inflows to Hattah Lakes. Substantial wetland drying will occur	• Rare high-flow events in the River Murray and no natural inflows to Hattah Lakes. Substantial wetland drying will occur	• Short periods of high flows, most likely in late winter and spring, providing minor inflows to Hattah Lakes	• Sustained periods of high flows with spills from storages resulting in widespread inundation of Hattah Lakes	• Lengthy periods of high flows with major spills from storages resulting in widespread inundation of Hattah Lakes and floodplain
Potential environmental watering	• Winter/spring fill of semipermanent wetlands	• Winter/spring fill of semipermanent and temporary wetlands	• Winter/spring fill of lakes and floodplain inundation to 45.0 m AHD		
Possible volume	• 10,000 ML	• 15,000 ML	• 100,000 ML		

Risk management

In preparing its seasonal watering proposal, Mallee CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 5.2.12 shows the partners and stakeholder organisation with which Mallee CMA engaged when preparing the Hattah Lakes seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Mallee Regional Catchment Strategy and Mallee Waterway Strategy.

Table 5.2.12 Partners and stakeholders engaged in developing the Hattah Lakes seasonal watering proposal

Partner and stakeholder engagement
• Birdlife Australia (Mildura) • CEWO • DELWP • Goulburn-Murray Water • Landcare Groups (Kulkyne Way Landcare, Red Cliffs and District Landcare, Annuello [Robinvale and District] Landcare, Robinvale Indigenous Landcare, Sea Lake Landcare and Manangatang Landcare) • Mallee Aboriginal Reference Group • Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members) • Mid-Murray Field Naturalists • Mildura 4WD Inc • MDBA • Parks Victoria • Sunraysia bushwalkers • Sustainable Living Mildura • VEWH • Wildside Outdoors

5.2.5 Lower Murray wetlands

The lower Murray wetlands are found across the floodplain of the River Murray between Swan Hill and the SA border. The system includes creeks, wetlands and floodplains that are ecologically important and reflect the natural character and attributes of the River Murray floodplain.

Environmental values

The lower Murray wetlands are comprised of multiple wetlands, creek and billabongs on the floodplain of the River Murray. Depending on their location in the landscape, interactions with groundwater and their management history, the wetlands may be permanent, temporary, freshwater or saline. The differences in water regime and water quality among the wetlands provide a range of habitats for plants and animals. For example, permanent, saline wetlands (such as Brickworks Billabong) provide vital habitat for the endangered Murray hardyhead fish. Unlike permanent wetlands, temporary freshwater wetlands fill and dry intermittently. During the wet phase, they provide short-term boom periods when river red gums and wetland plants grow, spread and provide habitat for aquatic animals. During the dry phase, sediments aerate and oxygen is replaced, and terrestrial plants grow and complete life cycles.

Social, cultural and economic values

There are several irrigation districts in the Sunraysia area that are supplied by the River Murray and contribute significant wealth to the local economy. Camping, fishing and other water-based recreational activities are popular along the River Murray including at some wetlands in the lower Murray system. Waterbirds provide opportunities for bird watching and hunting.

The wetlands of the lower Murray wetlands system hold significance for Traditional Owners. For thousands of years they provided resources such as food and materials to the Latji Latji, Wadi Wadi, Dadi Dadi and Wamba Wamba peoples.

Environmental watering objectives in the lower Murray wetlands

	Increase the diversity, extent and abundance of wetland plant life
	Improve the condition of river red gums, black box and lignum to provide habitat for large terrestrial animals (such as lace monitors and bats)
	Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial species (such as the egret)
	Improve water quality and increase habitat for fish

System overview

Regulation and diversion of River Murray flows has substantially reduced the frequency and duration of the high river flows that are needed to provide water to the lower Murray wetlands. This change to the water regime has caused a decline in the environmental values associated with billabongs and other floodplain habitats.

Environmental water can be delivered to some wetlands in the region through a combination of direct pumping from the River Murray and through use of irrigation supply infrastructure. All the wetlands can be managed independently of each other.

Recent conditions

Major floods in spring 2016 provided natural inflows to most of the floodplain wetlands that are on lower elevations of the River Murray floodplain. Broad, landscape-scale watering last occurred in summer 2010–11. Before the peak of the flood arrived, several small earthen levees that were built by Mallee CMA to contain environmental water that was pumped into wetlands in previous years were cut to allow floodwater to pass between wetlands. The natural flood met the environmental water objectives for the lower Murray wetlands, and there was no need to deliver environmental water to the system in the first half of 2016–17.

The floods prompted a boom in productivity and growth for most wetlands and provided welcome relief for sites that are heavily affected by salinity. Despite the size of the flood, not all wetlands received flows. Some wetlands at higher elevations and wetlands that are disconnected from the floodplain by levees or road infrastructure remained dry. In March 2017, environmental water was delivered to Lake Heywood to augment natural inflows and enable watering of Little Heywood Lake, which did not received natural inflows in spring.

Scope of environmental watering

Table 5.2.13 shows potential environmental watering actions and their environmental objectives.

Environmental watering will focus on maintaining and improving vegetation condition, habitat quality and availability throughout the wetlands, floodplains and waterways in the lower Murray area. Environmental water may also be used to rehabilitate some salt-affected wetlands.

Table 5.2.13 Potential environmental watering actions and objectives for the lower Murray wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Brickworks Billabong (fill in spring or partial fill in autumn, as needed to maintain water-quality targets and minimum water level)	• Maintain and improve the condition of aquatic vegetation and water quality to increase the population of Murray hardyhead
Cardross Lakes (partial fill as needed to maintain water-quality targets and minimum water level)	
Koorlong Lake (partial fill as needed to maintain water-quality targets and minimum water level)	
Lock 15 wetlands (fill or partial fill year-round)	• Improve the productivity of connected riparian zones and wetlands • Rehabilitate floodplain productivity to maintain resident populations of terrestrial animals including carpet python and insectivorous bats • Contribute to the carbon requirements of the River Murray channel ecosystem
Lake Hawthorn (partial fill in spring or as required to maintain water at the minimum level)	• Reintroduce saline marsh habitat, particularly *Ruppia* • Provide habitat for shorebirds
Nyah Floodplain (fill in spring/summer)	• Improve condition and structure of wetland vegetation • Provide seasonal feeding and reproductive opportunities for native fish • Provide breeding habitat for waterbirds including colonial nesting species • Rehabilitate floodplain productivity to maintain resident populations of terrestrial animals including carpet pythons, sugar gliders and grey-crowned babblers
Vinifera Floodplain (fill in spring/summer)	
Burra Creek North (fill in winter/spring)	• Rehabilitate seasonal connectivity along Burra Creek • Improve the health and structure of vegetation • Stimulate the growth of emergent and semi-emergent aquatic vegetation
Burra Creek South (fill in winter/spring)	
Burra Creek South Proper (fill in winter/spring)	
Little Heywood Lake (fill in winter/spring)	• Maintain black box woodland • Provide shallow water habitat for waterbirds
Neds Corner East and Central (fill in spring)	• Provide breeding and roosting habitat for colonial waterbirds
J1 Creek (fill in winter/spring)	• Maintain and improve the health of river red gum, black box and lignum
Yungera Wetland (fill in winter/spring)	
Carina Bend Wetlands (fill in winter/spring)	• Improve the condition of mature river red gum • Provide aquatic habitat to support fish and frogs • Provide habitat for waterfowl
Planigale Wetland (fill in winter/spring)	• Promote the growth of vegetation that aligns with the intermittent swampy woodland, lignum swampy woodland and riverine chenopod ecological vegetation classes • Improve habitat for mammals and reptiles • Support growling grass frogs
Old Homestead Wetland (fill in winter/spring)	• Promote growth of vegetation that aligns with the intermittent swampy woodland, lignum swampy woodland and riverine chenopod ecological vegetation classes
Woolshed Creek (fill in winter/spring)	• Improve the condition of woodland vegetation • Improve habitat for mammals and reptiles • Support growling grass frogs

Table 5.2.13 Potential environmental watering actions and objectives for the lower Murray wetlands *continued*

Potential environmental watering	Environmental objectives
Inlet Creek (Karadoc Swamp) (fill in winter)	• Improve the condition of mature black box trees • Provide habitat to support frogs and fish • Provide habitat for waterbirds
Bullock Swamp (fill in winter/spring)	• Provide freshwater inflows and flushing flows to reduce salinity levels and improve the condition and diversity of wetland vegetation • Improve ecological function
Butlers Creek/Ducksfoot Lagoon (fill in spring/ summer)	• Provide feeding habitat for waterbirds • Control noogoora burr
Cowanna Billabong (fill in winter/spring)	• Increase wetland productivity • Provide opportunities for fish to move between wetlands and the River Murray
Margooya Lagoon (fill in winter/spring)	• Improve the condition of river red gums • Improve the native fish assemblage of the lagoon • Rehabilitate submerged aquatic vegetation in the open-water areas of the wetland
Liparoo East (fill in winter/spring)	• Improve the condition of the lignum swampy woodland vegetation community and provide habitat for waterbird breeding
Liparoo West (fill in winter)	
Sandilong Creek (fill in spring/summer)	• Support catfish recruitment • Maintain terrestrial vegetation
Keera Wetland 1 (fill in spring)	• Promote the growth of vegetation that aligns with the intermittent swampy woodland, lignum shrubland and lignum swampy woodland ecological vegetation classes
Keera Wetland 2 (fill in spring)	
Wetland drying	
Kings Billabong, Bridge Creek, Heywood Lake, Lakes Powell and Carpul, Sandilong Billabong	• These wetlands will not be actively watered in 2017–18 • Drying will support a wide range of wetland-dependent birds and animals and to promote the growth and establishment of vegetation in and surrounding the wetland

Scenario planning

Table 5.2.14 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The highest-priority wetlands for environmental watering in 2017–18 under all climate scenarios and particularly in a drought scenario are Cardross Lakes, Lake Koorlong and Brickworks Billabong, as these sites support the critically endangered Murray hardyhead.

Depending on seasonal conditions and water availability under dry, average and wet scenarios, remaining wetlands are prioritised considering their optimal water regimes and the condition of the environmental values at each site. Additional wetlands will be watered to mimic conditions that would naturally occur. In this way the environmental responses are optimised as plants and animals respond to natural environmental cues.

Some wetlands will not be actively watered in 2017–18 and will be allowed time to dry. This will allow time for vegetation to germinate and establish, and to increase the diversity of habitats available for aquatic plants and animals during the next wet phase. At the same time, the dry phase will provide opportunities for terrestrial animals to access resources within a temporarily dry wetland.

Table 5.2.14 Potential environmental watering for lower Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No unregulated flows in the River Murray year-round and wetlands rely on environmental water delivery (a very low rainfall year-round and extremely hot and dry conditions in summer/autumn causes substantial wetland drying)	• Short periods of high flows in the River Murray are possible however overbank flows to wetlands do not occur; low rainfall and very warm summer/autumn	• Sustained periods of high flows in the River Murray in late winter and early spring will provide some opportunity for low-lying wetlands to be naturally inundated but most wetlands will still rely on environmental water delivery • Local rainfall may be high and provide catchment flows to some wetlands	• Lengthy periods of high flows and floods with major spills from storages, resulting in widespread inundation of the floodplain and most wetlands • Some reliance on environmental water to achieve target water levels • Local rainfall may be high and will provide catchment flows to most wetlands
Potential environmental watering – tier 1 (high priorities)	• Brickworks Billabong • Cardross Lakes • Koorlong Lake	• Brickworks Billabong • Cardross Lakes • Koorlong Lake • Lock 15 wetlands • Lake Hawthorn • Nyah Floodplain • Vinifera Floodplain • Burra Creek North • Little Heywood Lake • Neds Corner East and Central	• Brickworks Billabong • Cardross Lakes • Koorlong Lake • Lock 15 wetlands • Lake Hawthorn • Nyah Floodplain • Vinifera Floodplain • Burra Creek North • Little Heywood Lake • Neds Corner East and Central • Burra Creek South • Burra Creek South Proper • J1 Creek • Yungera Wetland • Liparoo West Billabong • Carina Bend Wetlands • Planigale Wetland • Old Homestead Wetland • Woolshed Wetland	• Brickworks Billabong • Cardross Lakes • Koorlong Lake • Lock 15 wetlands • Lake Hawthorn • Nyah Floodplain • Vinifera Floodplain • Burra Creek North • Little Heywood Lake • Neds Corner East and Central • Burra Creek South • Burra Creek South Proper • J1 Creek • Yungera Wetland • Liparoo West Billabong • Carina Bend Wetlands • Planigale Wetland • Old Homestead Wetland • Woolshed Wetland • Keera Wetland 2 • Inlet Creek (Karadoc Swamp) • Bullock Swamp • Liparoo East Billabong • Butlers Creek/ Ducksfoot Lagoon • Cowanna Billabong • Margooya Lagoon • Sandilong Creek • Keera Wetland 1

Table 5.2.14 Potential environmental watering for lower Murray wetlands under a range of planning scenarios *continued*

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 2 (lower priorities)[1]		• Burra Creek South • Burra Creek South Proper	• Inlet Creek (Karadoc Swamp) • Bullock Swamp • Liparoo East Billabong • Butlers Creek/ Ducksfoot Lagoon • Cowanna Billabong • Margooya Lagoon • Sandilong Creek • Keera Wetland 1	
Possible volume of environmental water required to meet objectives[2]	• 1,150 ML (tier 1) • 0 ML (tier 2)	• 6,000 ML (tier 1) • 1,050 ML (tier 2)	• 11,000 ML (tier 1) • 3,150 ML (tier 2)	• 13,100 ML (tier 1)

[1] *Tier 2 actions are lower-priority actions to be considered if water is available.*

[2] *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, Mallee CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 5.2.15 shows the partners and stakeholder organisations with which Mallee CMA engaged when preparing the lower Murray wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Mallee Regional Catchment Strategy and Mallee Waterway Strategy.

Table 5.2.15 Partners and stakeholders engaged in developing the lower Murray wetlands seasonal watering proposal

Partner and stakeholder engagement
• 25 Landcare Groups • 4 Friends groups • CEWO • DELWP • Environmental groups (Trust for Nature, Nyah and Districts Action Group, Nyah and Districts Weed Warriors, Sustainable Living in the Mallee, Mallee Fowl Recovery Group, Mid-Murray Field Naturalists) • Goulburn-Murray Water • Lake Lascelles Committee • Lake Tchum Committee • Lower Murray Water • Mallee Aboriginal Reference Group • Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members) • Mallee District Aboriginal Services • Meringur Historical Society • Mildura Birdlife, Wildside outdoors – canoeing, Mildura 4WD Inc • Mildura Rural City and Swan Hill Rural City councils • MDBA • Parks Victoria • Recreational Groups (Sunraysia Apiarists Association, Riverside Golf Course, Sunraysia Bushwalkers) • VEWH

5.2.6 Lindsay, Mulcra and Wallpolla islands

Lindsay, Mulcra and Wallpolla islands cover over 26,100 ha of River Murray floodplain, forming part of the Chowilla floodplain and Lindsay–Wallpolla Island Living Murray icon site that straddles the Victoria and SA border.

Environmental values

The Mullaroo and Potterwalkagee creeks are renowned for holding large Murray cod. These creeks provide fast flowing fish habitat compared to the nearby weir pools in the River Murray, and large breeding fish in the creeks are an important source of juveniles to the Murray system. The waterways and wetlands throughout the icon site also support several other threatened fish species such as the freshwater catfish, silver perch, Murray–Darling rainbowfish and unspeckled hardyhead.

The vast scale of the Lindsay, Mulcra and Wallpolla Islands Icon Site is noteworthy because it provides very large expanses of habitat to support wetland-dependent and terrestrial species. When flooded, waterways and wetlands within this system provide excellent habitat for waterbirds, 40 species of which are threatened in Victoria including the great egret and red-necked stint. These formed important criteria in placing Lindsay Island, Lake Wallawalla and Mulcra Island on the Directory of Important Wetlands in Australia. Terrestrial animals also benefit from the improved productivity and food resources when flooding occurs.

The reduced frequency and duration of floods in the River Murray has degraded the water-dependent vegetation communities, which has in turn caused declines in the diversity and abundance of animals that rely on healthy vegetation for habitat.

Social, cultural and economic values

Lindsay, Mulcra and Wallpolla islands offer recreation opportunities in a remote location with camping, boating and fishing popular for residents of nearby communities and long-distance travellers.

The wetlands and waterways in the Lindsay, Mulcra and Wallpolla islands system hold significance for Traditional Owners. They are important ceremonial places and for thousands of years have provided resources such as food and materials to the Latji Latji, Wadi Wadi, Dadi Dadi and Wamba Wamba peoples.

Environmental watering objectives in the Lindsay, Wallpolla and Mulcra islands

Increase the diversity, extent and abundance of wetland plant life
Increase abundance, diversity and distribution of native fish Provide flows for large-bodied fish (including Murray cod and perch) to swim, feed and breed
Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial species (such as the egret)

System overview

The Lindsay, Mulcra and Wallpolla islands floodplain is characterised by a network of permanent waterways small creeks and wetlands. The larger, permanent waterways–Lindsay River, Potterwalkagee Creek and Wallpolla Creek–form the southern boundaries of the site and create large floodplain islands with the River Murray to the north.

Naturally, these waterways and wetlands would flow and fill in response to high water levels in the River Murray. However, the regulation of the River Murray has reduced its influence on the Lindsay, Mulcra and Wallpolla system.

Although large floods can still occur, flows through the system are mostly regulated by the River Murray locks 6 to 9. Regulators and containment structures have been built throughout the Lindsay, Mulcra and Wallpolla floodplain and are used to help protect the environmental values at the site.

Recent conditions

In spring 2016 a major flood in the lower River Murray inundated most of the floodplain across Lindsay, Mulcra and Wallpolla Islands. Floods in the major contributing systems, such as the Edward-Wakool and Murrumbidgee, were the largest in over two decades and washed huge amounts of organic material into the River Murray, causing widespread deoxygenated blackwater and fish deaths. Monitoring has found that although many large fish died, many others found refuge or tolerated the low oxygen and returned to the Lindsay River and Mullaroo Creek when the water quality improved.

The large overbank flows also improved the condition of important floodplain vegetation. The main observations are increased density of river red gum and black box canopies and improved lignum health.

Scope of environmental watering

Table 5.2.16 shows potential environmental watering actions and their environmental objectives.

Table 5.2.16 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands

Potential environmental watering	Environmental objectives
Lindsay Island – Mullaroo Creek	
Year-round low flows (up to 600 ML/day)	• Maintain flowing water habitat for native fish species (such as Murray cod, silver perch and golden perch)
Spring/summer high flow (up to 1,300 ML day for up to 4 months between September and January)[1]	• Initiate fish movement and improve spawning and recruitment opportunities for native fish
Lindsay Island – Lindsay River	
Year-round low flows (40 ML/day via the northern regulator)	• Maintain flowing water habitat for native fish species (such as Murray cod, silver perch and golden perch)
Spring/summer high flow (up to 450 ML/day for up to 4 months between September and January via the northern and southern regulator)[1]	• Initiate fish movement and improve spawning and recruitment opportunities for native fish
Lindsay Island wetlands	
Lake Wallawalla (partial or complete fill in winter/spring)	• Improve the diversity and condition of littoral zone herbland plants • Provide opportunities for waterbird breeding and fledging
Websters Lagoon (partial or complete fill in winter/spring)	• Maintain wetland habitat for fish and waterbirds
Mulcra Island – Potterwalkagee Creek	
Year-round low flows in lower Potterwalkagee Creek (40 ML/day via the Stony Crossing regulator)	• Maintain flowing water habitat for native fish species (such as Murray cod, silver perch and golden perch)
Winter/spring/summer low flows in upper Potterwalkagee Creek (up to 100 ML/day between June and February via the upper Potterwalkagee Creek regulator)	• Maintain seasonal flowing water habitat for native fish species (such as Murray cod, silver perch and golden perch)
Spring/summer high flows in lower Potterwalkagee Creek (up to 400 ML/day for 3 months between September and January via the Stony Crossing regulator and upper Potterwalkagee Regulator)[1]	• Initiate fish movement and improve spawning and recruitment opportunities for native fish
Spring/summer high flow in upper Potterwalkagee Creek (up to 150 ML/day for 3 months between September and January)[1]	
Mulcra Island wetlands	
Snake Lagoon (partial or complete fill in winter/spring)	• Improve wetland productivity and habitat for wetland birds and fish
Mulcra Horseshoe (complete fill in winter/spring)	
Wallpolla Island	
Wallpolla Horseshoe (partial or complete fill in winter/spring)	• Maintain variable water levels in the littoral zone to improve wetland productivity
Wallpolla East (partial or complete fill in spring)	• Improve the condition of the riverine grassy woodland and floodway pond herbland ecological vegetation classes
Sandy Creek (partial or complete fill in spring)	• Improve the condition of the grassy riverine forest – floodway pond herbland complex ecological vegetation classes

Scenario planning

Table 5.2.17 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Watering at Lindsay, Mulcra and Wallpolla islands in 2017–18 will focus on providing minimum low flows and variable high flows in the major waterways and anabranches of the system: the Lindsay River and Mullaroo and Potterwalkagee creeks. Minimum low flows are required under all climatic scenarios to provide permanent habitat for fish. High flows are required to initiate movement of native fish, and the magnitude and duration of high flows will vary depending on seasonal conditions. Most high flows will commence in spring and may extend into early summer. Flows will be coordinated with weir pool operations of lock 7 (Lindsay River and Mullaroo Creek) and Lock 8 (Potterwalkagee Creek).

Sandy Creek and Wallpolla Horseshoe wetlands on Wallpolla Island require water under all climatic scenarios. More water will be delivered to these wetlands if the climatic conditions are average-to-wet, rather than dry.

Table 5.2.17 Potential environmental watering for the Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios

Planning scenario	Very dry	Dry	Average	Wet	Very wet
Expected conditions	• Low flows year-round in the River Murray and no natural floodplain inundation; substantial wetland drying will occur	• Rare high-flow events in the River Murray and no natural floodplain inundation; substantial wetland drying will occur	• Short periods of high flows, most likely in late winter and spring, providing minor inundation of the floodplain	• Sustained periods of high flows with spills from storages resulting in widespread inundation of the floodplain	• Long periods of high flows with major spills from storages resulting in widespread inundation of the floodplain and inundation of most wetlands
Lindsay Island					
Mullaroo Creek and Lindsay River	• Year-round low flow	• Year-round low flow	• Year-round low flow • 1 winter/ spring/summer high flow	• Year-round low flow • 1 winter/spring/ summer high flow	• Year-round low flow • 1 winter/ spring/summer high flow
Wetlands			• Lake Wallawalla (partial fill) • Websters Lagoon • (Complete fill)	• Lake Wallawalla (complete fill) • Websters Lagoon • (Complete fill)	• Lake Wallawalla (complete fill) • Websters Lagoon • (Complete fill)
Water demand[1]	• <2,000 ML	• <2,000 ML	• 8,000–10,600 ML	• 16,000–18,600 ML	• 16,000–18,600 ML
Mulcra island					
Lower Potterwalkagee Creek	• Year-round low flow	• Year-round low flow	• Year-round low flow • Spring/ summer high flow	• Year-round low flow • Spring/summer high flow	• Year-round low flow • Spring/ summer high flow
Upper Potterwalkagee Creek			• Winter/spring/ summer low flows	• Winter/spring/ summer low flows • Spring/summer high flow	• Winter/spring/ summer low flows • Spring/ summer high flow
Wetlands and floodplain				• Snake Lagoon (partial or complete fill)	• Snake Lagoon and Mulcra Horseshoe (complete fill)
Water demand[1]	• <2,000 ML	• <2,000 ML	• 8,000–10,600 ML	• 16,000–18,600 ML	• 16,000–18,600 ML
Mulcra island					
Lower Potterwalkagee Creek	• Year-round low flow	• Year-round low flow	• Year-round low flow • Spring/ summer high flow	• Year-round low flow • Spring/summer high flow	• Year-round low flow • Spring/ summer high flow

Table 5.2.17 Potential environmental watering for the Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios *continued*

Planning scenario	Very dry	Dry	Average	Wet	Very wet
Mulcra island					
Upper Potterwalkagee Creek			• Winter/spring/summer low flows	• Winter/spring/summer low flows • Spring/summer high flow	• Winter/spring/summer low flows • Spring/summer high flow
Wetlands and floodplain				• Snake Lagoon (partial or complete fill)	• Snake Lagoon and Mulcra Horseshoe (complete fill)
Water demand[1]	• <2,000 ML	• <2,000 ML	• <2,000 ML	• 500–2,500 ML	• 5,000–7,000 ML
Wallpolla island					
	• Wallpolla Horseshoe (partial fill) • Sandy Creek (partial fill)	• Wallpolla Horseshoe (partial fill) • Sandy Creek (partial fill)	• Wallpolla Horseshoe (partial fill) • Sandy Creek (partial fill) • Wallpolla East (partial fill)	• Wallpolla Horseshoe (complete fill) • Sandy Creek (partial fill) • Wallpolla East (partial fill)	• Wallpolla Horseshoe (complete fill) • Sandy Creek (complete fill) • Wallpolla East (complete fill)
	• 300 ML	• 700 ML	• 1,600 ML	• 2,200 ML	• 2,800 ML

[1] *Volume includes the estimated volume of environmental water required to underwrite the losses associated with the delivery of consumptive water en route (for flows within Mullaroo Creek, Lindsay River and Potterwalkagee Creek).*

Risk management

In preparing its seasonal watering proposal, Mallee CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 5.2.18 shows the partners and stakeholder organisation with which Mallee CMA engaged when preparing the Lindsay, Mulcra and Wallpolla islands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Mallee Regional Catchment Strategy and Mallee Waterway Strategy.

Table 5.2.18 Partners and stakeholders engaged in developing the Lindsay, Mulcra and Wallpolla islands seasonal watering proposal

Partner and stakeholder engagement
• 24 Landcare groups • 4 friends groups • CEWO • DELWP • First People of the Millewa-Mallee Aboriginal Corporation • Goulburn-Murray Water • Lake Lascelles Committee • Mallee Aboriginal Reference Group • Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members) • Victorian Malleefowl Recovery Group • Mid-Murray Field Naturalists • Mildura Rural City Council • MDBA • Parks Victoria • Recreational users (Sunraysia bushwalkers, Birdlife Australia (Mildura), Mildura 4WD Inc) • Sustainable Living in the Mallee • VEWH

5.3 Ovens system

Waterway manager – North East Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holder – Commonwealth Environmental Water Holder

The Ovens system rises in the Great Dividing Range near Mount Hotham and flows about 150 km to join the River Murray in the backwaters of Lake Mulwala. Two small water storages have been constructed in the system: Lake Buffalo on the Buffalo River and Lake William Hovell on the King River. The regulated reaches of the Ovens system include the Buffalo River downstream of Lake Buffalo, the King River downstream of Lake William Hovell and the Ovens River from its confluence with the Buffalo River to the River Murray.

Environmental values

The Ovens system supports many native fish species including the Murray cod, trout cod, golden perch and fly-specked hardyhead. The Buffalo River is important for large fish species during part of their breeding cycle, while trout cod are found as far up the King River as Whitfield. The Ovens system has seen a successful recovery project for trout cod, and efforts to reintroduce Macquarie perch are underway.

Frogs (such as the giant bullfrog and growling grass frog) are abundant in the lower Ovens River and associated wetlands and in the King River upstream of Cheshunt. The lower Ovens wetlands support egrets, herons, cormorants, bitterns and treecreepers while the vegetation along the rivers is mostly river red gums, which are among the healthiest examples in north-east Victoria.

Social, cultural and economic values

Recreational activities include fishing, boating, kayaking, waterskiing, swimming and bushwalking. Irrigation supports the food and wine industries that attract tourists to the system. The lower Ovens–River Murray weir pool associated with Lake Mulwala is another tourist drawcard. There are also significant Aboriginal cultural heritage values with scar trees and artefact scatters as the physical evidence of Aboriginal people living along the river. The Ovens River continues to be a place of significance for Traditional Owners and their Nations in the system including the Yorta Yorta, Bangarang, Taungurung and Dhudhuroa peoples.

Environmental watering objectives in the Ovens system

	Provide flows for native fish to move between pools and over rocky or shallow parts of the river
	Maintain the form of the riverbank and channel plus a range of different river bed surfaces to support all stream life Scour silt build-up and clean cobbles in river bed pools to maintain habitat for native plants and animals
	Maintain water quality for all river life
	Provide habitat for a wide range of waterbugs which provide energy, break down dead organic matter and support the river's food chain

System overview

The Ovens system maintains a larger proportion of its natural flow regime (particularly in winter/spring) than do other regulated rivers. This is a result of relatively small storages that spill regularly and allow unregulated flows to the rivers.

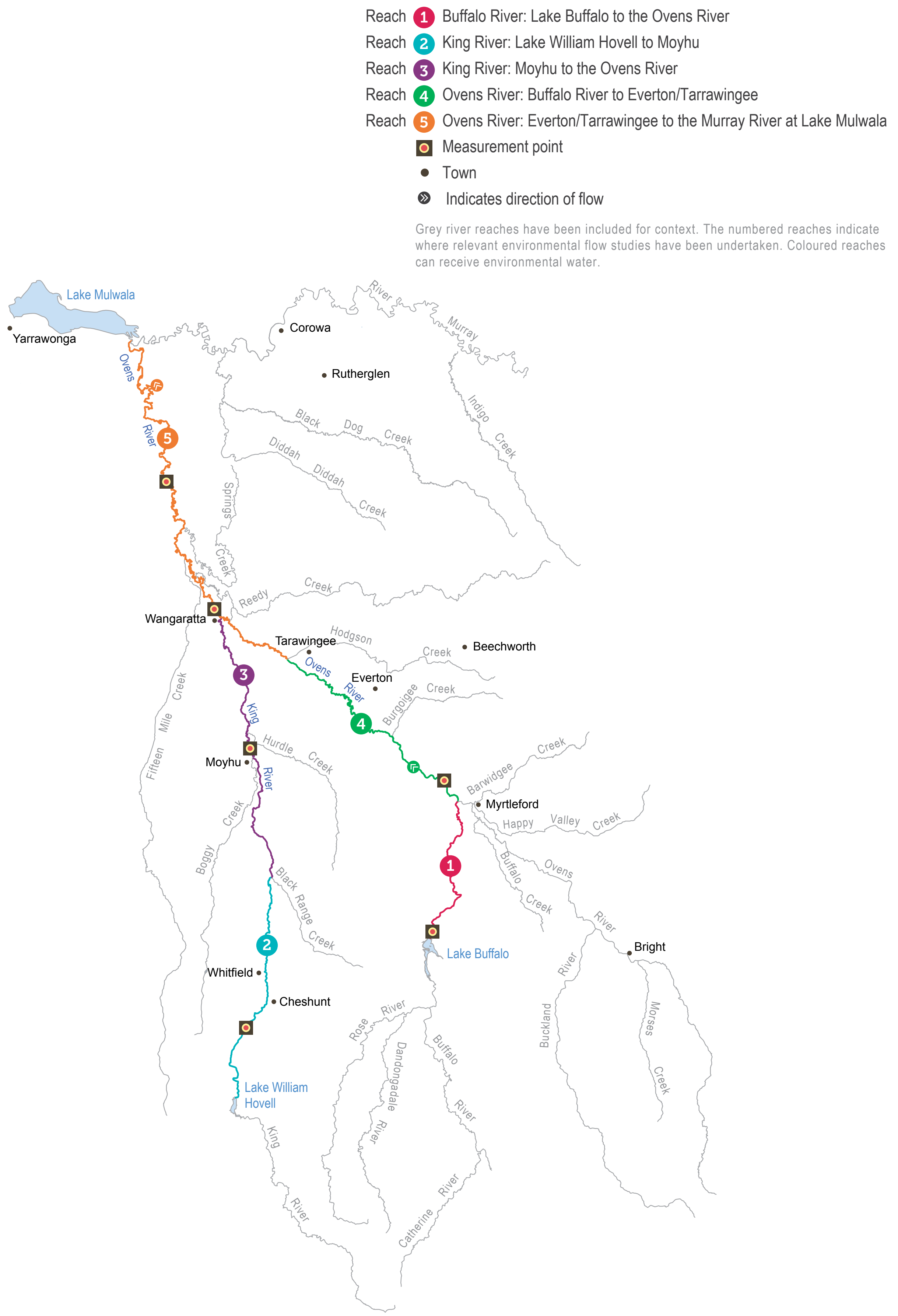
The water that flows out of the Ovens River is regulated by the largest weir pool (Lake Mulwala) on the Murray regulated system. Ovens River flows contribute to the reliability and variability of the flow regime for the River Murray and support many downstream uses including irrigation, urban supply and watering of iconic sites (such as Barmah Forest).

Environmental water is held in Lake Buffalo and in Lake William Hovell and can be released under regulated conditions when the storages are not spilling. Five reaches in the Ovens system can benefit from environmental water releases. While all are important, there are relatively small environmental holdings available in the system to meet the needs of all reaches. The volume available is well short of the volume required to meet the flow objectives, but it is still delivered in the most beneficial way possible. When water is only available from the holdings, outcomes in the reaches immediately downstream of the storages are targeted. When paired with consumptive water on its way to the Murray system, additional environmental benefits are likely to be achieved in the lower Ovens River.

Recent conditions

Wet conditions in winter/spring 2016 resulted in significant unregulated flows and the largest spring events in the Ovens catchment since 2010–11. Summer and autumn were mostly dry. A bulk drawdown of Lake Buffalo occurred in February 2017, with environmental water piggybacking to deliver a fresh event down the system. The drawdown occurred earlier than past drawdown events due to infrastructure maintenance works. 50 ML of environmental water was released from Lake William Hovell over two days in mid-March to temporarily vary the flow downstream of the storage in reach 2.

Figure 5.3.1 The Ovens system



Scope of environmental watering

Table 5.3.1 shows potential environmental watering actions and their environmental objectives.

Table 5.3.1 Potential environmental watering actions and objectives for the Ovens system

Potential environmental watering	Environmental objectives
Summer/autumn fresh in reach 5 (1 fresh of 130–260 ML/day for at least 3 days in December–May)	• Maintain flow cues to stimulate movement of native fish • Maintain short-term fluctuations in discharge to move sediment and maintain waterbug habitat • Maintain connectivity between pools and riffles • Scour biofilm from the river bed
Supporting variability[1] of summer/autumn low flows targeting reaches 1, 2 and 3	• Maintain natural connectivity between pools and riffles • Maintain short-term fluctuations in discharge to move sediment and maintain waterbug habitat

[1] *Operational releases from storage can vary, with environmental water used to provide some variability over one or two days.*

Scenario planning

Table 5.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The climatic conditions and inflows into storages have a large effect on how environmental water is likely to be used. Under dry conditions, environmental water aims to provide low-flow variability below the storages. As conditions become wetter, there are more opportunities to piggyback environmental releases on the bulk drawdown of water from Lake Buffalo and achieve environmental outcomes for the length of the regulated river. Environmental water cannot be released if the storages are spilling. Under wet conditions, the storages are very likely to be spilling due to their small capacity. The desired flows through the Ovens system are likely to be achieved naturally under wet conditions. The environmental water holdings in the Ovens system have a high level of security and are expected to be available under all scenarios.

Buffalo River downstream Lake Buffalo, by North East CMA

Table 5.3.2 Potential environmental watering for the Ovens system under a range of planning scenarios

Planning scenario	Dry	Average	Wet[1]
Expected river conditions	• Possible winter/early spring unregulated flows • Highly likely low summer/autumn flows • Bulk water release unlikely	• High winter/spring unregulated flows • Possible summer/autumn low flows • Bulk water release likely	• High unregulated flows throughout most of the year • Bulk water release likely • All flow objectives achieved naturally
Expected availability of environmental water	• 50 ML Lake William Hovell • 20 ML Lake Buffalo • 70 ML total		
Potential environmental watering	• Summer/autumn low flows	• Summer/autumn fresh • Summer/autumn low flows	
Possible volume of environmental water required to meet objectives	• 70 ML	• 70 ML	• 0 ML

[1] *Spill conditions likely to mean environmental water cannot be released under wet conditions.*

Risk management

In preparing its seasonal watering proposal, North East CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Engagement

Table 5.3.3 shows the partners with which North East CMA engaged when preparing the Ovens system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the North East Regional Catchment Strategy and North East Waterway Strategy.

Table 5.3.3 Partners engaged in developing the Ovens system seasonal watering proposal

Partner engagement
• CEWO • Goulburn-Murray Water • VEWH

5.4 Goulburn system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Commonwealth Environmental Water Holder, Victorian Environmental Water Holder, Murray–Darling Basin Authority (the Living Murray program)

The Goulburn is Victoria's largest river basin, covering over 1.6 million ha or 7.1 percent of the state. The Goulburn River flows for 570 km from the Great Dividing Range upstream of Woods Point to the River Murray east of Echuca. It is an iconic heritage river because of its environmental, recreational and Aboriginal cultural heritage values. It supports large areas of intact river red gum forest and provides habitat for threatened and endangered bird and fish species. It also contains important cultural heritage sites, provides water for Victoria's largest irrigation district and supports recreational activities (such as fishing and canoeing). Several wetlands in the Goulburn Broken catchment are formally recognised for their conservation significance.

Engagement

Table 5.4.1 shows the partners and stakeholder organisations with which Goulburn Broken CMA engaged when preparing the Goulburn system seasonal watering proposal.

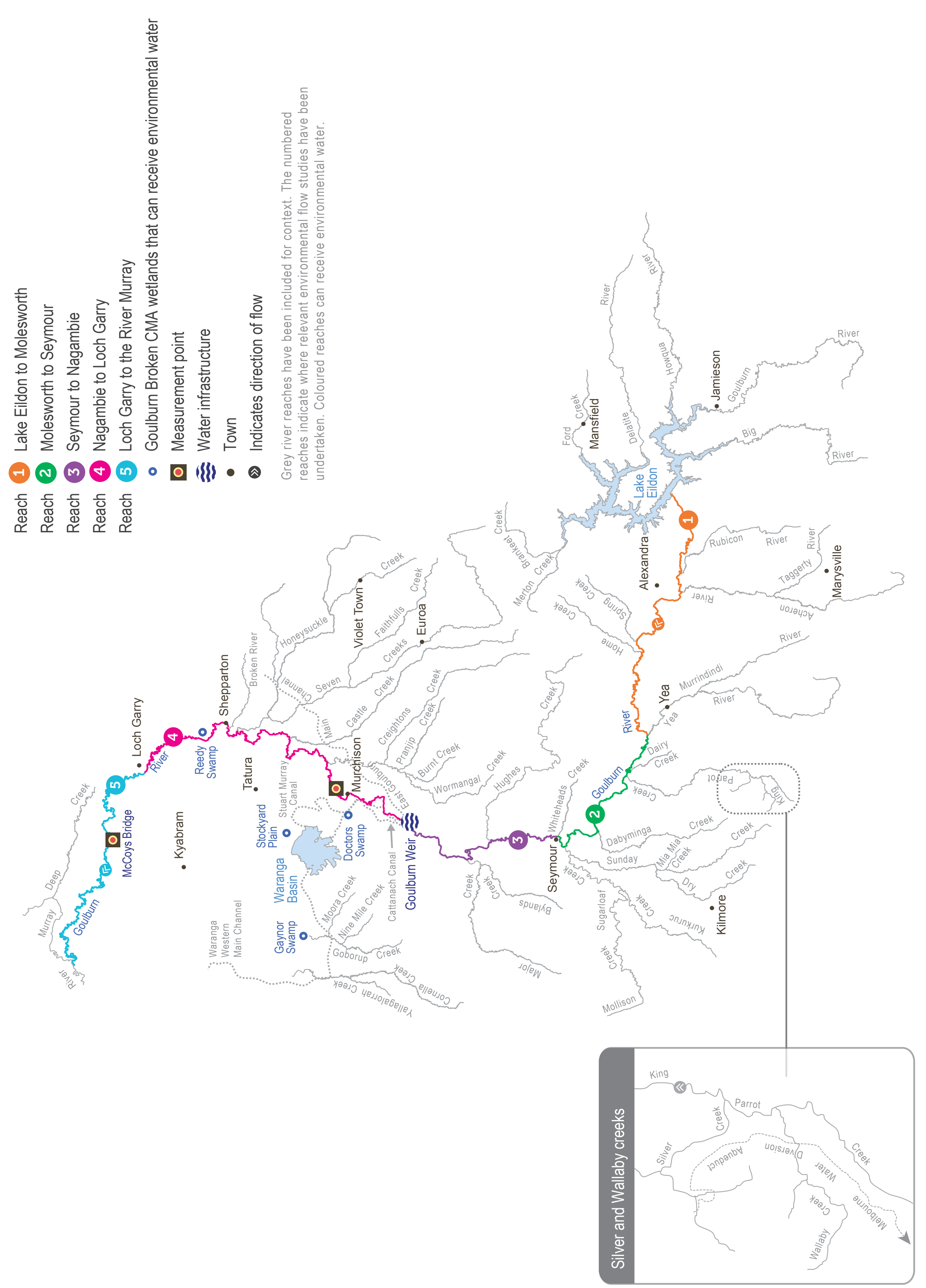
Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Goulburn Broken Regional Catchment Strategy and Goulburn Broken Waterway Strategy.

Table 5.4.1 Partners and stakeholders engaged in developing the Goulburn system seasonal watering proposal

Partner and stakeholder engagement
• CEWO • Goulburn Environmental Water Advisory Group, which includes recreational users, local environment groups and landholders • Goulburn-Murray Water • Parks Victoria • VEWH

Having fun at the Goulburn River at Murchison, by Tony Kubeil

Figure 5.4.1 The Goulburn system



5.4.1 Goulburn River

The Goulburn River flows for 570 km from the Great Dividing Range upstream of Woods Point to the River Murray east of Echuca.

Environmental values

The Goulburn River supports a range of native fish species including golden perch, silver perch, Murray cod, trout cod, Macquarie perch and freshwater catfish. Its aquatic vegetation, scour holes and submerged logs provide a high diversity of habitat for adult and juvenile fish. The bank vegetation is dominated by river red gums, which provide habitat for many species including the squirrel glider. Birds (such as egrets, herons and cormorants) use trees along the river to roost and feed, while frogs benefit from vegetation shallowly inundated along and adjacent to the river.

Mid Goulburn River tributaries between Lake Eildon and Goulburn Weir are important Macquarie perch habitat, while freshwater catfish can be found in lagoons connected to the Goulburn River in reach 3. Monitoring in the lower Goulburn River below the Goulburn Weir shows successful spawning in response to environmental flows.

Social, cultural and economic values

The Goulburn Broken catchment covers two percent of the area of the Murray–Darling Basin and contributes 11 percent of the water for use in the basin, with the majority contributed from the Goulburn River. Most of this water is used by irrigated agriculture, with the rest providing water for towns and stock and domestic users. The Goulburn River is popular for recreation, fishing and boating. Fishing in particular provides substantial economic and social benefits to the area. The Goulburn River floodplain has many important Aboriginal cultural heritage sites such as scar trees, mounds, stone artefact scatters and middens. The Goulburn River continues to be a place of importance for Traditional Owners and their Nations in the region, including the Yorta Yorta and Taungurung peoples.

Environmental watering objectives in the Goulburn River

Increase aquatic and flood-tolerant plants in the river channel and on the lower banks to provide shelter and food for animals and to stabilise the riverbank
Protect and boost populations of native fish (including golden perch) by increasing the availability of habitat and encouraging fish to migrate and spawn
Maintain the form of the riverbank and channel — including a high diversity of riverbed surfaces — to support all stream life
Provide habitat and food for macroinvertebrates, which provide energy, break down organic matter and support the river's food chain

System overview

The construction and operation of Lake Eildon and Goulburn Weir have significantly altered the Goulburn River's natural flow pattern. Water harvesting during naturally wet periods and regulated releases to meet irrigation and other consumptive demand during dry periods mean flow downstream of these structures is typically low in winter and spring and high in summer and autumn. This effectively reverses the natural seasonal flow pattern. Land-use changes and the construction of small dams and drainage schemes have further modified the Goulburn River's flow regime. Levees and other structures prevent water inundating the floodplain.

The regulated flow regime in the Goulburn River is partly ameliorated by inflows from tributaries (such as Seven Creek and the Broken River) that provide some natural flows downstream of Lake Eildon and Goulburn Weir. Large floods that cause these to fill and spill are also important for the flow regime.

Environmental water in the Goulburn system is held by the VEWH, CEWH and MDBA as part of the Living Murray program. The CEWH is the largest holder of environmental water in the Goulburn system. The availability and use of Commonwealth environmental water is essential to achieve environmental outcomes in the Goulburn River. Environmental water held on behalf of the Living Murray program may also help meet environmental objectives in the Goulburn system en route to icon sites in the Murray system (see Table 1.4.2).

Environmental water may need to be delivered through the Goulburn system to meet a downstream environmental objective. Where possible, these releases are managed to achieve outcomes in the Goulburn system before being reused downstream.

Environmental targets can also be met by water delivered from Lake Eildon to meet downstream consumptive demands in the River Murray (known as inter-valley transfers). Goulburn inter-valley transfers occur at times during the irrigation season, from spring to autumn. These flows may help achieve the desired environmental objectives without the need to release environmental water.

The priority environmental flow reaches in the Goulburn River are downstream of Goulburn Weir (reaches 4 and 5) as they are the most flow-stressed sections of the river and support more-abundant and diverse native fish communities. These two reaches are collectively referred to as the lower Goulburn River. Delivering environmental water to the lower Goulburn River also provides benefits to the mid Goulburn River between Lake Eildon and Goulburn Weir (reaches 1 to 3). Environmental water releases from Lake Eildon that target the mid Goulburn River (reach 1 in particular) are most beneficial between late autumn and early spring, when low river flows can occur. For most of the year (early spring to late autumn), transfers of consumptive water from Lake Eildon that are diverted out of the river at Goulburn Weir result in the flow exceeding the environmental flow targets for reaches 1 to 3.

Recent conditions

A series of dry years in the Goulburn catchment from 2013–14 to 2015–16 — with 2015–16 being one of the driest years on record — was broken in 2016–17 with the return of wet conditions. Winter/spring rainfall resulted in significant unregulated flows that provided the second large overbank event in the lower Goulburn River in the past 20 years. Several storm events occurred over summer. A particularly large storm in the last few days of December 2016 washed low-oxygen water from parts of the floodplain into the river channel, which led to an anoxic blackwater event that killed large numbers of fish. Autumn was dry across the catchment. Peak demand in the Goulburn River for environmental water is in spring, but the unregulated flows in spring 2016 met the flow objectives and were well-above what can be delivered with environmental water. The unregulated flows provided ideal conditions for the recovery of vegetation on the mid and upper levels of the bank along the lower Goulburn River. Since the floods, an increase in understory plants, especially native, water tolerant species suited to conditions on a riverbank, have been observed. The vegetation on the lower part of the bank that showed significant recovery in 2015–16 as a result of environmental water deliveries was disturbed by the high river flows, but it is expected to recover.

Environmental water combined with inter-valley transfers (Goulburn water being delivered to the Murray, mostly to meet Murray irrigation demand) to deliver summer low flows and a fresh in late summer/early autumn aimed to provide cues for fish movement into the Goulburn River from the River Murray. Preliminary monitoring results show that some golden and silver perch moved into the Goulburn River during the fresh. A winter fresh commencing in June 2017 is also planned to move sediment, inundate snags and replenish slackwaters, benefiting waterbugs, fish and native vegetation.

The vast majority of environmental water delivered in the Goulburn River is reused at downstream sites along the River Murray. In 2016–17, Goulburn water was reused to meet native fish objectives in Gunbower Creek, along the River Murray and in the Lower Lakes, Coorong and Murray Mouth in SA.

Scope of environmental watering

Table 5.4.2 shows potential environmental watering actions and their environmental objectives.

Checking bank conditions on the Goulburn River near McCoys Bridge, by Goulburn Broken CMA

Table 5.4.2 Potential environmental watering actions and objectives for the Goulburn River

#[1]	Potential environmental watering[2]	Environmental objectives
1	Year-round low flows (500 ML/day in reach 4 and/or 540 ML/day in reach 5)	• Optimise habitat and movement opportunities for large- and small-bodied native fish • Provide conditions that support habitat and food for waterbugs including by maintaining suitable water quality, encouraging the establishment of aquatic vegetation, submerging snags and encouraging plankton production
2	Autumn/winter/spring low flows (400 ML/day in reach 1 in April–September)	• Maintain and improve habitat for small-bodied native fish, waterbugs and aquatic vegetation
3	Winter/spring fresh (1 fresh of up to 10,000 ML/day with flows above 5,600 ML/day for 14 days in reach 4 and reach 5 in June–November)	• Support the establishment of flood-tolerant bank vegetation • Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat • Initiate spawning and pre-spawning migration and support the recruitment of golden perch
4a	Winter/spring freshes (up to 2 events of up to 5,000 ML/day for 2 days in reach 4 and reach 5 in July to September)	• Initiate pre-spawning migration of golden perch • Increase available feeding habitat for golden perch
4b	Spring/summer fresh (1 fresh of up to 15,000 ML/day for 2 days in reach 4 and reach 5 in November–December)	• Initiate spawning and pre-spawning migrations and the recruitment of golden perch • Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
5	Increased year-round low flows (830 ML/day in reach 4 and/or 940 ML/day in reach 5)	• Optimise habitat and movement opportunities for large- and small-bodied native fish • Provide conditions that support habitat and food for waterbugs including by maintaining suitable water quality, encouraging the establishment of aquatic vegetation, submerging snags and encouraging plankton production • Submerge additional snags to provide food and habitat for waterbugs • Maintain pool depths and distribute sediment • Provide slackwater habitat in spring/summer to support spring-spawned larvae and juvenile fish
6	Winter fresh (1 fresh of up to 15,000 ML/day with flows above 6,600 ML/day for 14 days in reach 4 and reach 5 in June–August)	• Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
7	Summer/autumn fresh (1 fresh of up to 5,600 ML/day for up to 10 days in reach 4 and reach 5 in February–April)	• Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat • Support the establishment of flood-tolerant bank vegetation • Stimulate the migration of native fish from the River Murray into the Goulburn River

[1] *The numbers in this column refer to the numbered potential environmental watering actions in Table 5.4.3.*

[2] *Environmental water may be used to slow the recession of unregulated flows or operational releases to reduce damage to banks and vegetation from rapid drops in water levels. This also helps prevent waterbugs and fish from being stranded in small pools on riverbanks or benches following higher flows.*

Scenario planning

Table 5.4.3 outlines the potential environmental watering actions and expected water use under a range of planning scenarios.

Various triggers for action are applied as part of the adaptive management of environmental water in the Goulburn system. For example, the second of the two proposed spring freshes that target golden perch spawning may not be delivered if monitoring shows spawning was achieved during the first, longer-duration spring fresh.

The highest priorities for environmental watering in 2017–18 will be providing year-round low flows below Goulburn Weir (reaches 4 and 5) and below Eildon (reach 1). These low flows improve habitat for animals in the river channel and support aquatic vegetation. Under drought conditions, there is less environmental water available and less actions can be delivered. Under dry to wet conditions, almost all actions can be delivered, with good water availability in 2017–18 following on from a wet 2016–17 that increased the volume of water in storage. Delivering more watering actions will have the biggest benefit to the health of the river. Tier 2 actions may be implemented if more water becomes available. Recession flow management is a higher priority under below-average to wet conditions, where the likelihood of large, unregulated flow events in winter and spring increases. Under these conditions, slowing the recession of unregulated peaks can help protect banks from erosion and slumping.

In determining potential watering actions for 2017–18, critical carryover into 2018–19 was considered. Carryover is a priority under the drought scenario, to ensure baseflows can be provided from July to September 2018. Under all other scenarios, there is expected to be sufficient opening allocation on 1 July 2018 to meet this demand in 2018–19.

Goulburn River, by Goulburn Broken CMA

Table 5.4.3 Potential environmental watering for the Goulburn River under a range of planning scenarios

Planning scenario	Drought	Dry	Below-Average	Average-Wet
Expected river conditions	• No unregulated flows	• Unregulated flows expected to provide some low flows between winter to mid-spring and likely small winter/spring freshes	• Unregulated flows expected to provide low flows in winter to mid-spring and likely medium winter/ spring freshes	• Unregulated flows expected to provide low flows and multiple overbank flow events in winter/ spring
	• Normal minimum passing flows at reach 5 of 400 ML/day from July–October and 350 ML/day from November–June			
Expected availability of environmental water	• 189,000 ML carryover • 10,000 ML VEWH • 130,000 ML CEWH • 18,000 ML Living Murray • 347,000 ML total	• 189,000 ML carryover • 10,000 ML VEWH • 276,000 ML CEWH • 39,000 ML Living Murray • 514,000 ML total	• 189,000 ML carryover • 10,000 ML VEWH • 276,000 ML CEWH • 39,000 ML Living Murray • 514,000 ML total	• 189,000 ML carryover • 10,000 ML VEWH • 276,000 ML CEWH • 39,000 ML Living Murray • 514,000 ML total
Potential environmental watering – tier 1 (high priorities)[1]	• Year-round low flows (1) • Autumn/winter/ spring low flows (reach 1) (2) • Spring fresh (3) • Spring/summer fresh (4) • Increased year-round low flows (partial) (5)	• Year-round low flows (1) • Autumn/winter/ spring low flows (reach 1) (2) • Spring fresh (3) • Spring/summer fresh (4) • Increased year-round low flows (5) • Winter fresh (6)	• Year-round low flows (1) • Autumn/winter/ spring low flows (reach 1) (2) • Spring fresh (3) • Spring/summer fresh (4) • Increased year-round low flows (5) • Winter fresh (6) • Recession flow management	• Year-round low flows (1) • Autumn/winter/ spring low flows (reach 1) (2) • Spring fresh (3) • Spring/summer fresh (4) • Increased year-round low flows (5) • Winter fresh (6) • Summer/autumn fresh (7) • Recession flow management
Potential environmental watering – tier 2 (lower priorities)[1,2]	• Increased year-round low flows (full) (5) • Winter fresh (6) • Summer/autumn fresh (7) • Recession flow management	• Summer/autumn fresh (7) • Recession flow management	• Summer/autumn fresh (7)	
Possible volume of environmental water required to achieve objectives[3]	• 314,000 ML (tier 1) • 295,000 ML (tier 2)	• 486,000 ML (tier 1) • 103,000 ML (tier 2)	• 504,000 ML (tier 1) • 73,000 ML (tier 2)	• 514,000 ML (tier 1) • 0 ML (tier 2)
Critical carryover into 2018–19	• 23,000 ML	• 0 ML	• 0 ML	• 0 ML

[1] The number in brackets after the potential environmental watering action aligns to the numbering in Table 5.4.2 above.
[2] Tier 2 actions are lower-priority actions to be considered if water is available.
[3] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.4.2 Goulburn wetlands

Of some 2,000 natural wetlands in the Goulburn Broken area, only four in the Goulburn catchment (Reedy Swamp, Gaynor Swamp, Stockyard Plain and Doctors Swamp) can currently receive environmental water.

Environmental values

There are a large number of natural wetlands across the Goulburn catchment including Reedy Swamp and Doctors Swamp, which have formally recognised conservation significance. The Goulburn wetlands support a variety of plant communities ranging from swamps dominated by river red gums to cane grass wetlands.

Reedy Swamp contains a mosaic of vegetation types including tall marsh, floodway pond herbland and rushy riverine swamp. It is an important drought refuge and nesting site for colonial waterbirds and an important stopover feeding site for migratory birds (such as sharp-tailed and marsh sandpipers).

Doctors Swamp is considered one of the most intact red gum swamps in Victoria, supporting over 80 wetland plants.

Gaynor Swamp is a cane grass wetland situated on paleo-saline soils and can sometime receive saline water from nearby saline wetlands during times of flood. When wet, Gaynor Swamp supports thousands of waterbirds including brolga and intermediate egrets. Because Gaynor Swamp has a higher salt concentration than other wetlands in the region, it attracts a different type of feeding waterbird as it draws down. One of the most significant species that feed on exposed mudflats at Gaynor Swamp is the red-necked avocet.

Stockyard Plain is a bioregionally significant wetland that spans private and public land and is valued for its waterbird habitat. The wetland provides breeding habitat for threatened brolga and has the nationally threatened ridged water milfoil.

Social, cultural and economic values

Visitor activities enjoyed at the Goulburn wetlands include birdwatching, picnicking, camping and walking. Doctors Swamp and Gaynor Swamp are state game reserves.

The Goulburn wetlands are identified as culturally sensitive areas under the Victorian *Aboriginal Heritage Act 2006*. The Goulburn wetlands have been and continue to be places of significance for Traditional Owners of the Yorta Yorta Nation. The area traditionally supported a rich and diverse supply of plant and animal resources for food, medicines, shelter, clothing and tools.

Environmental watering objectives in the Goulburn wetlands

Maintain and improve the range of native plant life including river red gum and grassy wetland species

Provide feeding and breeding habitat for waterbirds including migratory and colonial nesting waterbirds

Provide habitat for frog breeding

System overview

All the Goulburn wetlands can receive environmental water via irrigation supply infrastructure in the Shepparton and Central Goulburn irrigation districts. The volume delivered at any one time depends on the available capacity in the irrigation supply network and may also be negotiated with adjacent landholders.

Reedy Swamp is naturally inundated when flow in the Goulburn River exceeds about 20,000 ML/day. Doctors Swamp can only receive environmental water if the Cattanach Canal is running at 2,500 ML/day and there is available capacity after irrigation demand and operational requirements are met. The opportunity to deliver environmental water to Reedy Swamp is greater in autumn and winter.

Environmental water has not been delivered to Gaynor Swamp or Stockyard Plain. Infrastructure to allow environmental water to be delivered to Gaynor Swamp is due to be completed by autumn 2018, whereas the delivery of environmental water to Stockyard Plain is subject to an agreement with private landholders.

Recent conditions

Natural inflows from regional flooding and high rainfall in the Goulburn catchment filled all Goulburn wetlands in late winter and early spring 2016–17. The inflows triggered plant growth and germination and supported large numbers of waterbirds and frogs. For the first time, Sloane's froglet was recorded at Doctors Swamp along with large numbers of breeding Australasian shelducks and a brown tree creeper that nested in the middle of the swamp. The floods also caused a large field of billy buttons to grow on the fringe of Doctors Swamp.

Summer rainfall topped up the wetlands and some remained wet into autumn 2017. No environmental water was delivered to the Goulburn wetlands in 2016–17.

Reedy Swamp and Doctors Swamp have started to draw down, whereas Gaynor Swamp and Stockyard Plain completely dried over summer 2016–17. All wetlands reached their maximum inundation phase in 2016–17 and require a drying phase to promote vegetation growth and support recently germinated wetland plants.

Scope of environmental watering

Table 5.4.4 shows potential environmental watering actions and their environmental objectives.

Table 5.4.4 Potential environmental watering actions and objectives for the Goulburn wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Gaynor Swamp (fill in autumn/winter)	• Maintain the diversity of wetland vegetation including cane grass • Provide waterbird breeding and feeding habitat
Stockyard Plain (fill in autumn/winter)	• Maintain the diversity of wetland vegetation including cane grass • Provide waterbird breeding and feeding habitat
Doctors Swamp (partial fill in autumn/winter)	• Maintain the diversity of wetland vegetation including river red gum • Provide waterbird breeding and feeding habitat
Wetland drying	
Reedy Swamp	• Reedy Swamp will not be actively watered in 2017–18 • The drying will help maintain habitats to support a wide range of wetland-dependent birds and animals and to promote the growth and establishment of vegetation in and around the wetland

Scenario planning

Table 5.4.5 outlines potential environmental watering and expected water use under a range of planning scenarios.

Goulburn Broken CMA has planned wetland watering to maintain a range of habitat types to support waterbirds and other water-dependant animals in the region at any point in time.

Due to the natural flooding of all the Goulburn wetlands in 2016–17 and the high summer rainfall, all wetlands have exceeded their maximum inundation extents and now require six to nine months of complete drying. Drying the wetlands will allow the vegetation to establish and set seed before the next wet period and build on the objectives of promoting a range of wetland vegetation types to support waterbirds and frogs.

If there are no natural inflows, the Goulburn wetlands will be allowed to dry for the first half of 2017–18. Environmental water may then be used to fill or partially fill Gaynor Swamp, Stockyard Plain and Doctors Swamp in autumn/winter 2018. The wetlands should ideally be allowed to completely dry for at least six months and therefore the specific timing of environmental water deliveries will depend on when each wetland dries. Reedy Swamp will not receive environmental water in 2017–18.

Environmental water deliveries to Gaynor Swamp and Stockyard Plain cannot be guaranteed in 2017–18. Gaynor Swamp can only receive environmental water if new infrastructure is completed and operational by autumn 2018. Deliveries to Stockyard Plain will depend on the agreement of all landholders.

Environmental water is likely to be delivered to Doctors Swamp in autumn/winter 2017–18 if the wetland has been completely dry for at least six months or if vegetation in the wetland is showing signs of significant stress. If neither of these conditions are met, environmental water deliveries may be delayed until 2018–19.

Table 5.4.5 Potential environmental watering for the Goulburn wetlands under a range of planning scenarios

Planning scenario[1]	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands are highly unlikely	• Catchment run-off and unregulated flows into the wetlands are unlikely	• Some catchment run-off and unregulated flows into some of the wetlands are likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Gaynor Swamp • Stockyard Plain • Doctors Swamp	• Gaynor Swamp • Stockyard Plain • Doctors Swamp	• Gaynor Swamp • Stockyard Plain • Doctors Swamp	• N/A
Potential environmental watering – tier 2 (lower priorities)[2]	• N/A	• N/A	• N/A	• N/A
Possible volume of environmental water required to achieve objectives[3]	• 2,500 ML (tier 1)	• 2,500 ML (tier 1)	• 1,600 ML (tier 1)	• N/A
Priority carryover requirements	• 2,500 ML	• 2,500 ML	• 1,600 ML	• 0 ML

1 *If any of the wetlands support significant waterbird breeding events in spring/summer, environmental water deliveries may be considered to support bird habitat until fledging.*
2 *Tier 2 actions are lower-priority actions to be considered if water is available.*
3 *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.5 Broken system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

The Broken system (including the Broken River, lower Broken Creek, upper Broken Creek and wetlands) supports threatened plant and animal species. These include six native fish species of Victorian and national conservation significance. The system also supports a range of habitats for fish and waterbirds, especially in cane grass wetlands that provide important brolga breeding habitat. The lower Broken Creek forms an important part of the irrigation distribution system, delivering water from the Murray and Goulburn systems into the Murray Valley and Shepparton irrigation districts. It contains important Aboriginal cultural heritage sites and is also popular for recreation.

Engagement

Table 5.5.1 shows the partners and stakeholder organisations with which Goulburn Broken CMA engaged when preparing the Broken system seasonal watering proposal.

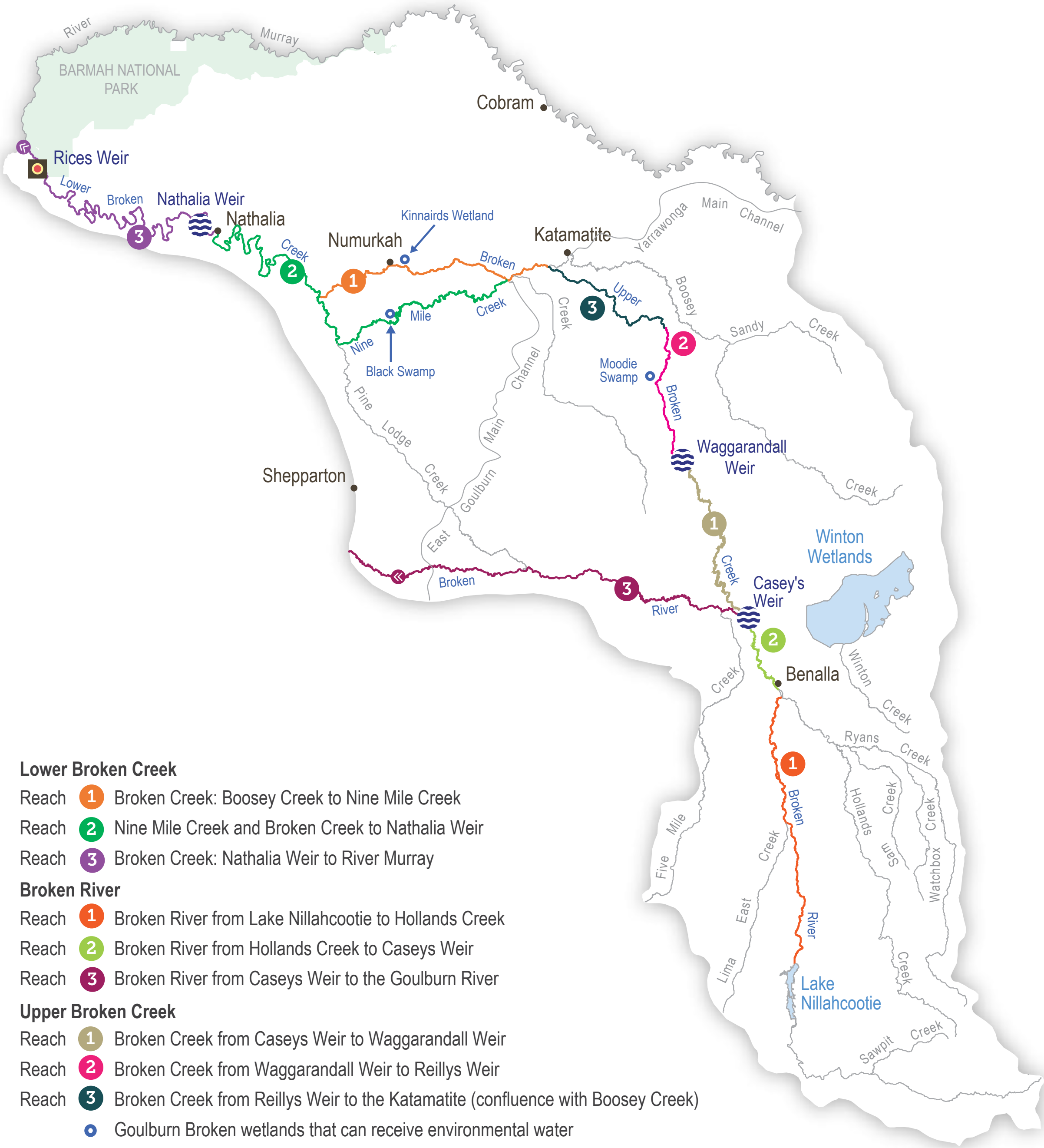
Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the Goulburn Broken Regional Catchment Strategy and Goulburn Broken Waterway Strategy.

Table 5.5.1 Partners and stakeholders engaged in developing the Broken system seasonal watering proposal

Partner and stakeholder engagement
• Broken Environmental Water Advisory Group, comprising community members • CEWO • Goulburn Broken Catchment Wetland Advisory Group (with representation from Goulburn Valley Landcare, Field & Game Australia, Goulburn-Murray Water, Moira Shire, Council of Greater Shepparton, Turtles Australia, Parks Victoria, Trellys Fishing and Hunting and Kinnairds Wetland Advisory Committee) • MDBA (River Murray Water) • VEWH

Brolga at Moodie Swamp, by Jo Wood

Figure 5.5.1 The Broken system



Lower Broken Creek

Reach 1 Broken Creek: Boosey Creek to Nine Mile Creek

Reach 2 Nine Mile Creek and Broken Creek to Nathalia Weir

Reach 3 Broken Creek: Nathalia Weir to River Murray

Broken River

Reach 1 Broken River from Lake Nillahcootie to Hollands Creek

Reach 2 Broken River from Hollands Creek to Caseys Weir

Reach 3 Broken River from Caseys Weir to the Goulburn River

Upper Broken Creek

Reach 1 Broken Creek from Caseys Weir to Waggarandall Weir

Reach 2 Broken Creek from Waggarandall Weir to Reillys Weir

Reach 3 Broken Creek from Reillys Weir to the Katamatite (confluence with Boosey Creek)

Goulburn Broken wetlands that can receive environmental water

Measurement point

Water infrastructure

Town

Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.

5.5.1 Broken River and upper Broken Creek

The Broken River rises in the Wellington–Tolmie highlands in central Victoria and flows in a westerly direction to Lake Nillahcootie. The river then flows north to Benalla, then west before it discharges to the Goulburn River near Shepparton.

The Broken Creek diverges from the Broken River downstream of Benalla and flows to the River Murray near Barmah Forest. The creek is located on a flat riverine plain and has naturally low run-off from its local catchment. It receives flood flows from the Broken River although these are much less frequent than occurred naturally, due to earthworks and road construction.

Environmental values

The Broken River supports healthy and diverse aquatic vegetation. A range of native submerged and emergent plant species populate the bed and margins of the river including eelgrass, common reed and water ribbons. The Broken River retains one of the best examples of healthy in-stream vegetation in a lowland river in the region. These plants provide habitat for a range of animals including small- and large-bodied native fish species.

The upper Broken Creek area is dominated by unique box riparian vegetation and supports remnant plains grassy woodland. Much of this area also lies in a natural features reserve, which contains high-quality native vegetation. The creek supports a variety of threatened animals including fish species (such as the carp gudgeon, Murray cod, golden perch and Murray–Darling rainbowfish).

Social, cultural and economic values

The Broken River and upper Broken Creek floodplain contains a range of Aboriginal cultural heritage values including scar trees and sites of significance for Traditional Owner groups including the Yorta Yorta and Taungurung peoples. The Broken River and Broken Creek systems continue to hold significance for Traditional Owners. The systems also support a range of recreational and tourism values, providing opportunities for bushwalking, fishing and bird watching. The waterways are an important source of water and a delivery mechanism for stock and domestic and irrigation customers.

Environmental watering objectives in Broken River and upper Broken Creek

	Move built-up sand and clay material to restore deep pools and provide habitat for water animals
	Improve and maintain plants on the riverbank and in the river channel
	Protect and increase populations of native fish (including threatened Murray cod and golden perch) by improving pool habitat and stimulating fish to migrate and spawn
	Maintain water quality
	Support a wide range and high biomass of waterbugs to provide energy, break down dead organic matter and support the river's food chain

System overview

The Broken River has the characteristics of a foothills stream with relatively steep, confined sections immediately below Lake Nillahcootie. The river then takes on the characteristics of a lowland river with a more-extensive floodplain between Swanpool and its confluence with the Goulburn River at Shepparton. The main tributaries of the Broken River include Hollands Creek, Ryans Creek and Lima East Creek (formerly Moonee's Creek). Much of the area has been cleared for agriculture including dryland agriculture (such as livestock grazing and cereal cropping) and irrigated agriculture (such as dairy, fruit and livestock).

Upper Broken Creek extends for about 65 km from Caseys Weir to Katamatite. The creek has been used to divert consumptive water supplies from the Broken River for more than 100 years, although irrigation entitlements have been significantly reduced as part of water savings projects in the last ten years. There are now low flows all year round at the top of the creek (Caseys Weir to Waggarandal Weir) as water can only be supplied from the Broken River based on orders from customers in the creek. In the lower reaches (Waggarandal Weir to Reillys Weir and Reillys Weir to Katamatite), the system is most influenced by rainfall and catchment run-off which provide infrequent flow. Diverting water from the Broken River to the top reach may achieve some environmental objectives.

Environmental targets can also be met by water delivered from Lake Nillahcootie to meet downstream consumptive demands in the River Murray (known as inter-valley transfers). Broken system inter-valley transfers occur usually during summer and autumn. These flows may help achieve the desired environmental objectives without the need to release environmental water.

Common spadefoot toad at Moodie Swamp, by Jo Wood

Recent conditions

The return of wet conditions in winter/spring 2016 resulted in bankfull and overbank flows along both the Broken River and upper Broken Creek. Flows of such magnitude had not occurred at all in the upper Broken Creek since 2010–11 and were more than double the highest flow rate recorded in the Broken River over the same period.

Tributary inflows over summer/autumn 2016–17 helped maintain a higher average flow in the lower reaches of the Broken River compared to the past few years, but the influence of Lake Nillahcootie reduced flows in reach 1. Over summer/autumn, reaches 2 and 3 experienced low flows typical for this time of year.

Scope of environmental watering

Table 5.5.2 shows potential environmental watering actions and their environmental objectives.

Table 5.5.2 Potential environmental watering actions and objectives for the Broken River and upper Broken Creek

Potential environmental watering	Environmental objectives
Summer/autumn fresh in upper Broken Creek (1 fresh of up to 100 ML/day for 2 days in December–May)	• Maintain water quality, particularly in refuge pools
Summer/autumn low flows in the Broken River (up to 15 ML/day in December–May)	• Maintain habitat for native fish, aquatic plants and waterbugs
Summer/autumn fresh in the Broken River (1 fresh of up to 500 ML/ day for 2 to 8 days in December–May)	• Move sediment and scour biofilms to increase productivity for waterbugs • Maintain habitat for aquatic plants • Provide passage for native fish and stimulate breeding and movement

Scenario planning

Table 5.5.3 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The demands for the upper Broken Creek and Broken River are greater than the volume of environmental water expected to be available in the Broken system. Environmental water will be available for use, but it may be used preferentially in Moodie Swamp (see section 5.5.3). Transfers of consumptive water in summer/autumn from Lake Nillahcootie to the Goulburn River are made via the Broken River, which can help meet some or all of the summer/autumn demand. Trade is also a mechanism that environmental water holders can use to increase the amount of environmental water available in the Broken system, subject to trade restrictions.

Table 5.5.3 Potential environmental watering for the Broken River and upper Broken Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Minimal volume transferred to the Goulburn	• Minimal unregulated flows • Up to 1,500 ML of consumptive water delivered via the Broken River in summer/autumn	• Some contribution of unregulated flows in upper Broken Creek, particularly in winter/spring • Up to 1,500 ML of consumptive water delivered via the Broken River in summer/autumn	
Expected availability of environmental water	• 127 ML	• 253 ML		
Potential environmental watering	• Summer/autumn fresh in upper Broken Creek • Summer/autumn low flows in Broken River	• Summer/autumn fresh in upper Broken Creek • Summer/autumn low flows in Broken River • Summer/autumn fresh in Broken River	• Summer/autumn fresh in upper Broken Creek • Summer/autumn fresh in Broken River	• Summer/autumn fresh in upper Broken Creek
Possible volume of environmental water required to achieve objectives	• Up to 1,900 ML	• Up to 4,200 ML	• Up to 3,300 ML	• Up to 1,000 ML

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.5.2 Lower Broken Creek

The lower Broken Creek and Nine Mile Creek (referred to collectively as the lower Broken Creek) begins near Katamatite, downstream of where Boosey Creek enters Broken Creek, and then flows west to join the River Murray.

Environmental values

The lower Broken Creek and Nine Mile Creek support a diverse and abundant native fish community including the threatened Murray cod, golden perch, silver perch, unspecked hardyhead and Murray–Darling rainbowfish. The associated floodplain and wetland habitats support box-dominated grassy woodland communities and numerous threatened species of state and national conservation significance including river swamp wallaby grass and the Australasian bittern.

Social, cultural and economic values

The lower Broken and Nine Mile creeks and associated floodplain and wetland habitats contain many important Aboriginal cultural heritage sites of significance for Traditional Owner groups including the Yorta Yorta Nation, provide water for agriculture and urban centres and support a variety of recreational activities (such as fishing and bushwalking).

Environmental watering objectives in the lower Broken Creek

- Control excessive build-up of azolla, which is a native aquatic plant that can lower water quality in the creek when significant blooms occur
- Protect and increase populations of native fish including the threatened Murray cod, golden perch and silver perch by maintaining habitat (water level and quality) and stimulating fish to migrate and spawn
- Maintain healthy water oxygen levels

System overview

The lower Broken and Nine Mile creeks have been regulated for over 100 years, significantly altering their flow regimes. Pre-regulation, the creeks would have mainly flowed in winter and spring and the adjacent floodplain would have received more-regular flooding from overbank flows. In summer and autumn, the creeks would have had much less flow, often contracting to isolated pools or drying out completely. The creeks now have numerous weirs and flow at a relatively constant level from mid-August until mid-May to support adjacent irrigated farming. These modifications have changed the way native animals use the creek. Previously, native fish would have moved into the creek when it was flowing and returned to the River Murray when it dried. Both creeks now provide year-round habitat for native fish, and fish passage structures allow fish to move between weir pools. Environmental water is used to support these permanent fish habitats by providing flows to support fish passage and by providing higher flows to trigger fish movement, control water quality or flush azolla as necessary.

The lower Broken Creek is operated separately to the upper Broken Creek and Broken River because regulated water is delivered to the lower Broken Creek from the Goulburn and Murray systems via the irrigation channel network, rather than from the Broken River.

Environmental water provided to the lower Broken Creek can be sourced from both the Goulburn and Murray systems. Environmental water is sourced from the Goulburn system through the East Goulburn Main Channel and from the Murray system through the Yarrawonga Main Channel. Water is then released into lower Broken Creek from irrigation area regulators along the length of lower Broken Creek. The priority river reach for environmental watering is reach 3 (from Nathalia Weir Pool to the River Murray). Environmental flows that target reach 3 are expected to also deliver the desired flows in reaches 1 and 2. The measurement point for target flows in the lower Broken Creek is at Rices Weir.

Environmental targets can also be met by water delivered from Lake Eildon (known as inter-valley transfers) or Hume Reservoir (known as choke bypass flows) to meet downstream consumptive demands in the River Murray. These consumptive deliveries occur usually during peak irrigation demand: from spring to autumn. These flows may help achieve the desired environmental objectives without the need to release environmental water.

Recent conditions

The wet winter/spring in 2016 resulted in significant unregulated flows in the lower Broken Creek, which met or exceeded the environmental flow targets. The large flood event in the River Murray in September 2016 completely submerged Rices Weir, and high unregulated flows through the whole system successfully flushed all reaches of lower Broken Creek and significantly reduced the risk of azolla build-up in spring and summer.

Environmental water was delivered to the lower Broken Creek from late October to maintain the target 250 ML/day flow rate. The flow release primarily aimed to freshen up the water quality around Rices Weir and reduce the effect of low-dissolved-oxygen water that backed up into the creek from the River Murray in October. The intervention provided a local refuge for native fish that were able to move into the creek via fishways and therefore escape the low oxygen levels in the River Murray.

Flows at Rices Weir were maintained at 250 ML/day for most of summer and autumn to provide habitat for native fish and maintain water quality. The flow rate was reduced to 120 ML/day in April, once cooler conditions arrived and there was less risk of poor water quality. Planning is underway to maintain flows of 40 ML/day from mid-May to mid-August 2017 to allow native fish to move throughout the creek and between the creek and the River Murray during the irrigation shut-down period.

Scope of environmental watering

Table 5.5.4 shows potential environmental watering actions and their environmental objectives.

Table 5.5.4 Potential environmental watering actions and objectives for the lower Broken Creek

Potential environmental watering	Environmental objectives
Year-round low flows (40 ML/day)[1]	• Provide native fish passage
Winter/spring low flows (120 ML/day in August–November)	• Minimise azolla growth
Spring/summer/autumn low flows (150–300 ML/day in October–May)	• Maintain water quality including keeping dissolved-oxygen levels above 5 mg/L
Winter/spring freshes (120–250 ML/day for up to 14 days in August–November)	• Remove large azolla blooms
Spring/summer low flows (250 ML/day in September–December)	• Increase the availability of native fish habitat during the migration and breeding seasons

1 *Primarily during the irrigation season between mid-August and mid-May, but it may be delivered year-round subject to supply constraints.*

Scenario planning

Table 5.5.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Due to regulation of the lower Broken and Nine Mile creeks, their environmental water needs are relatively fixed from year to year and independent of annual climatic conditions.

During 2017–18, environmental flows in the lower Broken Creek will be adjusted as needed to optimise the quantity of habitat and movement opportunities for native fish, maintain water quality and flush azolla through the system. The environmental flow objectives may be partly or wholly met by regulated flows to meet irrigation demand and by natural unregulated flows throughout the year and therefore environmental water will only be used to make up shortfalls. During dry conditions, environmental water will be mainly used to provide higher flows because irrigation demand and the associated consumptive water flows are likely to meet many of the environmental low-flow requirements. During wet conditions, there will be less demand for consumptive water and therefore more environmental water may be needed to meet the low-flow requirements.

Table 5.5.5 Potential environmental watering for the lower Broken Creek under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Some unregulated flows in winter • No unregulated flows throughout the irrigation season (mid-August–May) • No diversion of unregulated River Murray flows available	• Unregulated flows in winter/spring • No unregulated flows from October–May • Diversion of unregulated River Murray flows available mid-August–October	• Unregulated flows in winter/spring • No unregulated flows from November–May • Diversion of unregulated River Murray flows available mid-August–November
Potential environmental watering	• Year-round low flows • Winter/spring low flows • Spring/summer/autumn low flows • Winter/spring freshes • Spring/summer low flows		
Possible volume of environmental water required to achieve objectives	• 56,000 ML	• 55,000 ML	• 58,000 ML

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.5.3 Broken wetlands

Of some 2,000 natural wetlands in the Goulburn Broken area, only three in the Broken catchment (Black Swamp, Kinnairds Wetland and Moodie Swamp) can receive environmental water.

Environmental values

The Broken wetlands (which include Moodie Swamp, Kinnairds Wetland and Black Swamp) support a high diversity of vegetation communities ranging from swamps dominated by river red gums to cane grass wetlands. The wetlands contain state and nationally threatened vegetation communities and species including ridged water milfoil and river swamp wallaby grass. The wetlands also provide food resources and breeding habitat for bird species listed in international agreements and conventions (such as the eastern great egret, Latham's snipe, white-bellied sea eagle and glossy ibis).

Social and economic values

The Broken wetlands have been and continue to be places of significance for the Traditional Owners of the Yorta Yorta Nation. The wetlands traditionally provided a rich and diverse supply of plant and animal resources for food, medicines, shelter, clothing and tools. Some of the sites have artefacts and scar trees recorded in or adjacent to them.

The wetlands support a range of recreational activities including birdwatching, bike riding, bush walking and camping. Moodie Swamp and Black Swamp are state game reserves.

Environmental watering objectives in the Broken wetlands

Maintain or improve the diversity of wetland vegetation Maintain populations of nationally threatened plant species (such as ridged water milfoil, slender water milfoil and river swamp wallaby grass)
Maintain feeding and breeding habitat for waterbirds, particularly for brolga, royal spoonbill and Australasian shoveler

System overview

The water regimes of these wetlands have been greatly influenced by their position in the surrounding Shepparton, Central Goulburn and Murray Valley irrigation districts, which have changed the timing, frequency, volume and duration of inundation. Environmental water, which is delivered via irrigation system infrastructure, aims to restore some of the natural wetting and drying patterns of the wetlands.

Recent conditions

High rainfall and associated inflows filled Black Swamp, Kinnairds Wetland and Moodie Swamp in winter and spring 2016–17. Summer rainfall topped up the wetlands and prolonged their inundation.

Moodie Swamp was still holding water into autumn 2017. The wetland supported a large number of waterbirds including nankeen night herons, brolga, whisked terns and buff-banded rails. Plumed whistling ducks, black swans, Eurasian coots, dusky moorhens and Australian wood ducks bred at the wetland in 2016–17. For the first time, both musk duck and the greater crested grebe were recorded at the wetland. The wetland vegetation responded well to the natural flooding with ridged water milfoil and a new species of water milfoil found at the wetland.

Black Swamp received significant natural inflows in 2016 and remained wet until January 2017. Many young plants at Black Swamp were drowned in 2015–16 after someone deliberately tampered with a regulator, but the natural floods in 2016 have triggered new plant growth and a state-listed rare water nymph was found for the first time at Black Swamp in 2016. Bird surveys in December 2016 recorded the rare freckled duck using the wetland for the first time as well as large numbers of wading birds (such as herons, egrets and spoonbills).

Natural inflows into Kinnairds Wetland attracted a variety of waterbirds. Royal spoonbills and pied cormorants bred at the wetland and the endangered blue-billed duck was observed.

Scope of environmental watering

Table 5.5.6 shows potential environmental watering actions and their environmental objectives.

Table 5.5.6 Potential environmental watering actions and objectives for the Broken wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Moodie Swamp (fill in autumn/winter)	• Maintain the diversity of wetland vegetation • Maintain populations of the nationally threatened ridged water milfoil and slender water milfoil • Provide waterbird feeding and breeding habitat, particularly for brolga
Wetland drying	
Black Swamp and Kinnairds Wetland	• These wetlands will not be actively watered in 2017–18 • Drying of these wetlands will allow newly germinated and planted wetland plants to grow and set seed following extended wet phases

Scenario planning

Table 5.5.7 outlines potential environmental watering and expected water use under a range of planning scenarios.

Landscape-scale planning for these wetlands has been undertaken by the Goulburn Broken CMA to maintain a high diversity of habitat types in the area to support waterbirds and other water-dependant animals.

Moodie Swamp has been identified as very high priority in all planning scenarios as it supports cane grass habitat for brolga and Australasian bittern. It also supports highly diverse communities of water-dependent plants and animals. Under drought, dry and average scenarios, Moodie Swamp will be allowed to dry for at least six months before a fill in autumn/winter 2018. Watering may be delayed until spring 2018 if natural inflows prevent the wetland from drying for the desired period.

Both Kinnairds Wetland and Black Swamp provide important habitat for waterbirds and wetland vegetation communities including ridged water milfoil, water nymph and river swamp wallaby grass. They have both remained wet for an extended period and require at least a year of drying to allow for the vegetation to recover and set seed. Allowing the wetlands to dry will promote feeding and breeding habitat for waterbirds when they next fill.

In a wet scenario, the ecological objectives at these wetlands are typically met by natural inflows, and only small volumes of environmental water may be required to extend the duration or extent of natural flooding to support a significant waterbird breeding event if it occurs.

The decision to deliver environmental water to Broken wetlands will be based on their hydrological condition and waterbird breeding activity and on the potential impact of environmental watering on wetland vegetation communities.

Table 5.5.7 Potential environmental watering for the Broken wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands are highly unlikely	• Catchment run-off and unregulated flows into the wetlands are unlikely	• Some catchment run-off and unregulated flows into some of the wetlands are likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in the wetlands, particularly in winter/spring
Potential environmental watering	• Moodie Swamp	• Moodie Swamp	• Moodie Swamp	• Moodie Swamp
Possible volume of environmental water required to achieve objectives	• 500 ML (tier 1)	• 500 ML (tier 1)	• 500 ML (tier 1)	• 500 ML (tier 1)

Risk management

In preparing its seasonal watering proposal, Goulburn Broken CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.6 Campaspe system

Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water, Coliban Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder, the Murray–Darling Basin Authority (the Living Murray program)

The Campaspe River catchment extends from the Great Dividing Range in the south to the River Murray in the north, a total distance of about 150 km. The major waterways of the catchment are the upper Campaspe River and the Coliban River (both upstream of Lake Eppalock) and the lower Campaspe River (downstream of Lake Eppalock). Major tributaries are McIvor and Pipers creeks upstream of Lake Eppalock and Mount Pleasant, Forest and Axe creeks downstream of Lake Eppalock.

Malmsbury Reservoir on the Coliban River provides water for towns, irrigation and stock and domestic consumption. Lake Eppalock was constructed in 1965 on the Campaspe River below its confluence with the Coliban River. The storage is an important source of water for downstream irrigated agriculture; town water for Bendigo, other local towns and more recently Ballarat (via the Goldfields Superpipe); and the environment.

Engagement

Table 5.6.1 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing the Campaspe system seasonal watering proposal.

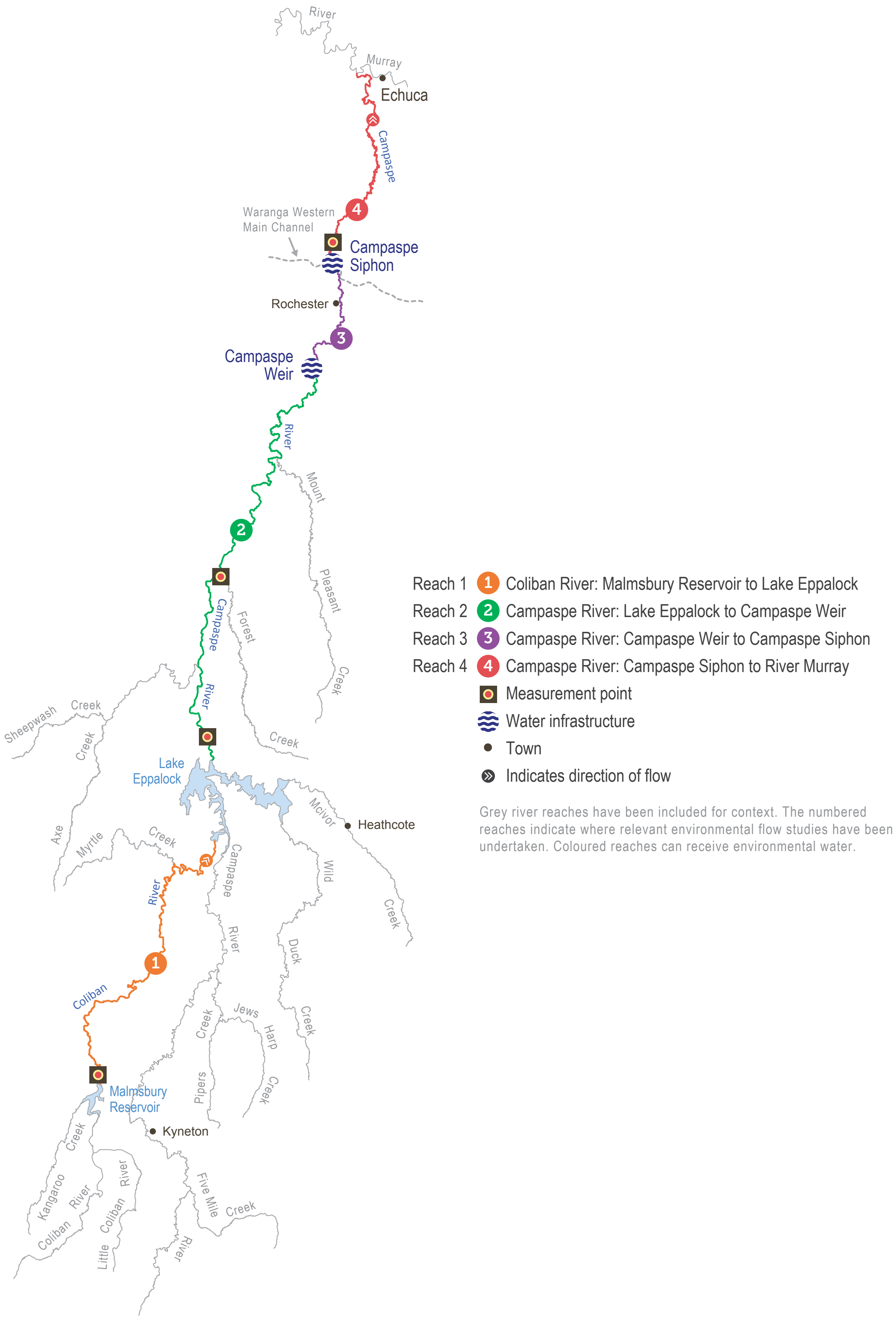
Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the North Central Regional Catchment Strategy and North Central Waterway Strategy.

Table 5.6.1 Partners and stakeholders engaged in developing the Campaspe system seasonal watering proposal

Partner and stakeholder engagement
• Campaspe Environmental Water Advisory Group comprising community members, DELWP, Goulburn-Murray Water, North Central CMA, the VEWH and the CEWH • Coliban Water • CEWO • Community Consultation Committee which provides the North Central CMA with community and local perspectives on projects and functions that have direct public benefits • Dja Dja Wurrung Clans Aboriginal Corporation • Dja Dja Wurrung Traditional Owners • Goulburn-Murray Water • VEWH

Campers Ron and Andrea Disher at Aysons Reserve, by North Central CMA

Figure 5.6.1 The Campaspe system



5.6.1 Campaspe River

Environmental values

The Campaspe River below Lake Eppalock provides important habitat for several fish species including Murray cod, silver perch, golden perch, Murray–Darling rainbowfish and flat-headed gudgeon. Maintaining flows is important for migration opportunities and dispersal of these native fish species and juvenile platypus. Turtles and frogs are also present and the intact river red gum canopy along the riverbanks supports terrestrial species (such as the squirrel glider).

Social, cultural and economic values

The Campaspe River is an important source of water and a delivery mechanism for irrigation and town water. Popular recreational activities along the Campaspe River include camping, boating, kayaking, fishing, swimming, bushwalking, picnicking and birdwatching. These activities draw locals and tourists alike, providing economic benefits to towns along the river. The Campaspe River is culturally significant with many Aboriginal cultural heritage sites including shell deposits, scar trees, mounds and artefacts recorded along the banks. The Campaspe River continues to be a place of significance for Traditional Owner groups and Nations in the region including the Dja Dja Wurrung, Taungurung and Yorta Yorta people.

Environmental watering objectives in the Campaspe River

Sustain adult river red gums and increase the growth of new plants Maintain and increase the cover of in-stream and riverside plants
Provide habitat to help protect and increase populations of native fish Help native fish species (such as the trout cod, river blackfish and Macquarie perch) recolonise the river
Maintain the resident platypus population by providing places to rest, breed and feed, as well as opportunities for juveniles to disperse to the River Murray
Provide connection along the length of the Campaspe River and into the River Murray
Increase the diversity and biomass of waterbugs to provide energy, break down dead organic matter and support the river's food chain
Prevent high salinity and maintain healthy levels of oxygen in deep pools

System overview

The construction and operation of Lake Eppalock has significantly altered downstream river flows and reversed seasonal flows. Lake Eppalock captures rainfall run-off and reduces natural winter and spring flows downstream. The stored water is then released at a higher-than-natural rate over summer and autumn to meet downstream irrigation demand in the reaches between Lake Eppalock and the Campaspe Siphon. Environmental water is held and released from Lake Eppalock, with some limited ability to regulate flows further downstream at the Campaspe Weir.

Higher-than-natural flows throughout summer may reduce the amount of suitable habitat for juvenile fish, which rely on protected shallow areas of water near the edge of the river channel. Delivering water to users downstream in the River Murray when they need it over summer is essential, and storage managers and the CMA have been working together to limit any negative effects these transfers may have on native plants and animals.

Providing the target flows in all reaches below Lake Eppalock is important. Environmental water is usually released from Lake Eppalock to meet specific flow targets in reach 4 (that is, downstream of Rochester). These flows also achieve the desired flow objectives in reaches 2 and 3 between Lake Eppalock and Rochester. Primary flow measurement points are at Barnadown (reach 2) and downstream of the Campaspe siphon (reach 4). In specific circumstances, water can be delivered to reach 4 from the Goulburn system via the Waranga western main channel.

Recent conditions

The Campaspe River has suffered from extreme climatic events over the last 15 years including the Millennium Drought and record floods in January 2011. Most of the recommended environmental flows could not be delivered between 2005 and 2010 because of very low rainfall and inflows to Lake Eppalock, and the ecological condition of the river declined. The 2011 flood scoured most of the established in-stream vegetation and riparian vegetation from the banks of the river. Conditions have been relatively normal since, but 2015–16 was quite dry and there was low water availability at the beginning 2016–17, with allocations starting at zero.

A small volume of water carried over from 2015–16 was used to provide winter low flows at the beginning of 2016–17 before conditions became very wet, causing high inflows to Lake Eppalock, which began to spill on 3 October 2016. Unregulated flows from tributaries downstream of Lake Eppalock and storage spills provided high flows to all reaches during winter and spring, meaning there was no need to release additional environmental water for much of this period. During the spill from Lake Eppalock, an overbank flow event occurred that helped to maintain the river form by scouring sediment from pools and riffles and by improving riparian vegetation. Rainfall throughout the rest of 2016–17 was variable, with a return to drier conditions again toward the end of the year.

Environmental water was delivered in accordance with a wet scenario. This aimed to optimise the benefit of high river flows to maintain and improve environmental values including native fish and bank vegetation and to increase the resilience of the river to cope with stress in future. Monitoring showed an improvement in the native fish community with increasing numbers and range of golden and silver perch throughout the river and high numbers of Murray–Darling rainbowfish. Fewer carp were recorded in reaches that had increased numbers of golden perch. To support native fish, environmental water was used to provide summer low flows targeting the lower reaches of the river to prevent high salinity and low-dissolved-oxygen concentrations and consequent impacts on native fish. Deliveries of water to downstream users in the River Murray in summer and autumn were managed by the storage operator and the CMA to achieve a series of summer and autumn freshes. Low flows in winter were also provided with a combination of environmental water and unregulated flows to allow fish to move between habitats, increase the abundance of waterbug habitat and improve water quality.

Scope of environmental watering

Table 5.6.2 shows potential environmental watering actions and their environmental objectives.

Kids by the Campaspe River, by Victoria Penko

Table 5.6.2 Potential environmental watering actions and objectives for the Campaspe River

Potential environmental watering	Environmental objectives
Summer/autumn low flows (10–50 ML/day in December–May)	• Maintain the aquatic vegetation • Maintain fish habitat and reinstate slack waters (areas with minimal water movement) • Limit the effect of cold water pollution from Lake Eppalock on fish • Maintain access to riffle habitat and water quality for waterbugs • Maintain permanent connectivity for water quality • Maintain permanent connectivity for platypus movement
Winter/spring freshes (up to 2 events at 1,000–1,800 ML/day for up to 7 days each in June–November)	• Reduce encroachment by exotic and terrestrial vegetation • Enhance river red gum recruitment • Stimulate fish movement, allow movement to downstream reaches and provide spawning triggers • Flush and mix river pools for water quality • Flush organics from the bank and benches to reduce the risk of blackwater events in summer • Mix and flush river pools for waterbugs • Inundate additional snags and flush sediment off biofilms (groups of microorganisms) for waterbugs • Support platypus habitat and breeding including triggers for burrow selection
Winter/spring low flows (50–200 ML/day [or natural[1]], in June–November)	• Provide longitudinal connectivity for fish • Maintain access to riffle habitat and water quality for waterbugs • Maintain the permanent longitudinal connectivity of the river for improved water quality • Facilitate platypus habitat and breeding opportunities
Summer/autumn freshes (up to 3 freshes of 50–200 ML/day for up to 3 days each in December–May)	• Maintain riparian vegetation • Increase the recruitment of in-channel vegetation • Increase the extent of/maintain in-stream aquatic vegetation • Provide longitudinal connectivity for fish in periods of low flows • Maintain waterbug habitat and wash organic matter into the river to drive aquatic food webs • Respond to blackwater events as required

[1] *'Or natural' means that flow rates may be above or below the specified target rates depending on inflows and climatic conditions.*

Scenario planning

Table 5.6.3 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Potential watering actions in 2017–18 range from maintaining critical habitat under drought conditions to improving the ecological health of the river under wet conditions. The potential watering actions are similar across scenarios but the number, target magnitude and duration of the flows increase under wetter conditions. The volume of environmental water required is therefore greater under wet than under dry conditions.

Water levels in Lake Eppalock will be very high at the beginning of the 2017–18 year. If there are significant inflows, it is highly likely the storage will spill early in the year, leading to a loss of carryover. Under all scenarios, allocations will start at 100 percent, meaning the Campaspe River is in a good position to achieve most of the potential watering actions for the year. If 2017–18 is a wet year, environmental water will be used to increase the number of freshes and increase the magnitude of low flows.

No critical carryover requirements have been identified for the Campaspe system into 2018–19: allocations available on 1 July 2017 from a very high-reliability component of the environmental entitlement will meet the highest-priority summer low flows in 2018–19. The best environmental outcomes will be achieved by meeting 2017–18 demand rather than by reserving water for the following year.

Table 5.6.3 Potential environmental watering for the Campaspe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average – wet
Expected river conditions	• Few or no unregulated flows • High consumptive water deliveries • No passing flows in winter • No spills from storage	• Some unregulated flows • Some consumptive water deliveries • Increased passing flows • Some unregulated flows from storage spill	• Frequent unregulated flows • Moderate summer consumptive water deliveries in reach 2 and low deliveries in reaches 3 and 4 in summer • Increased passing flows • Significant spills from storage
Expected availability of environmental water	• 20,600 ML VEWH • 6,600 ML CEWH • 100 ML Living Murray • 5,000 ML carryover • 32,300 ML total	• 20,600 ML VEWH • 6,600 ML CEWH • 100 ML Living Murray • 5,000 ML carryover • 32,300 ML total	• 20,600 ML VEWH • 6,600 ML CEWH • 100 ML Living Murray • 5,000 ML carryover • 32,300 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn low flow • Winter/spring low flow • Winter/spring fresh (1 event) • Summer/autumn freshes (3 events) • Additional freshes may be required to avoid critical loss of species/habitat if a low-dissolved-oxygen event occurs	• Summer/autumn low flow • Winter/spring low flow • Winter/spring freshes (2 events) • Summer/autumn freshes (3 events) • Additional freshes may be required to avoid critical loss of species/habitat if a low-dissolved-oxygen event occurs	• Summer/autumn low flow • Winter/spring low flow • Winter/spring freshes (2 events) • Summer/autumn freshes (3 events) • Additional freshes may be required to avoid critical loss of species/habitat if a low-dissolved-oxygen event occurs
Potential environmental watering – tier 2 (lower priorities)[1]	• Increased magnitude of winter/spring low flow • Winter/spring fresh (1 additional event) • Increased magnitude of summer/autumn freshes	• Increased magnitude of winter/spring low flow • Increased magnitude of winter/spring and summer/autumn freshes	• Increased magnitude of winter/spring low flow
Possible volume of environmental water required to achieve objectives[2]	• 26,900 ML (tier 1) • 16,200 ML (tier 2)	• 30,600 ML (tier 1) • 18,800 ML (tier 2)	• 32,400 ML (tier 1) • 15,300 ML (tier 2)

[1] *Tier 2 actions are lower-priority actions to be considered if water is available.*

[2] *Environmental water requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.6.2 Coliban River

Environmental values

The Coliban River provides important habitat for platypus, native water rats and small-bodied native fish (such as flat-headed gudgeon and mountain galaxias). The Coliban River also contains a diverse range of waterbugs supported by stands of emergent and submergent aquatic vegetation. It is bordered by remnant patches of streambank shrubland vegetation providing habitat for terrestrial animals. Historical records show that several native freshwater fish species including the Murray cod, river blackfish, Macquarie perch and Australian smelt once inhabited the river.

Social, cultural and economic values

Communities in Malmsbury, Taradale, Metcalfe and the surrounding area value the Coliban River for its aesthetic and recreational features including Ellis Falls and the Cascades. Popular recreational activities in the area include camping, fishing and birdwatching. The upper Coliban storages — Malmsbury and Lauriston Reservoir — supply urban, irrigation, stock and domestic demands in the surrounding area. The river and its adjacent lands are rich in cultural heritage with numerous scar trees, burial sites and artefacts recorded with Aboriginal Victoria. The Coliban River continues to be a place of significance for Traditional Owners who are now represented by the Dja Dja Wurrung Clans Aboriginal Corporation.

Environmental watering objectives in the Coliban system

	Maintain fringing vegetation and in-stream plants
	Protect and increase populations of native fish by providing flows that allow movement and trigger spawning
	Maintain adequate diversity and biomass of waterbugs to provide energy, break down dead organic matter and support the river's food chain
	Improve water quality and maintain healthy levels of dissolved oxygen in pools

System overview

Reach 1 of the Coliban River below Malmsbury Reservoir to Lake Eppalock can benefit from environmental watering. An important distinction between the Coliban River and other regulated Victorian systems is the lack of irrigation demand in the river. Therefore, the river below Malmsbury has lower-than-natural flows year-round and environmental water is needed to provide adequate flow during summer and autumn.

The VEWH does not have any environmental entitlements in the Coliban system, but passing flows can be managed to help mitigate some risks associated with critically low summer flow including low levels of dissolved oxygen. A small volume of Commonwealth environmental water is held in the system, but the high cost of delivery means there is no plan to use it in 2017–18.

Recent conditions

The start of the 2016–17 water year was dry and followed several years of mostly below-average streamflow. Therefore, a portion of passing flows was withheld at the beginning of the season to provide critical flows to the river over summer and autumn if dry conditions persisted. Conditions changed early in the year, and there was high rainfall and inflows to storages. The upper Coliban storages quickly filled and spills occurred between September and November providing several important flow events including winter freshes, winter bankfull flows and some small overbank flows. Overbank flows cannot be delivered with planned environmental releases because of infrastructure constraints and only occur when the storages spill.

After the spill event, passing flows were reduced to reserve water for use over summer and autumn. This meant flow in the lower reaches of the Coliban River quickly reduced and eventually ceased, turning lower reaches of the river into a series of disconnected pools. The flows delivered in 2016–17 were well below the environmental flow recommendations of the system except for the unregulated flow period of September to November and an unregulated flow event which reached the objectives of a summer/autumn fresh in April.

Scope of environmental watering

Table 5.6.4 shows potential environmental watering actions and their environmental objectives.

Table 5.6.4 Potential environmental watering actions and objectives for the Coliban system

Potential environmental watering	Environmental objectives
Summer/autumn freshes (5–15 ML/day for up to 2 weeks in December–May as required)[1]	• Maintain water quality (including dissolved-oxygen levels) and habitat for aquatic animals
Summer/autumn low flow (2–5 ML/day in December–May)	• Maintain the aquatic vegetation • Maintain fish habitat • Maintain the permanent connectivity of the river for improved water quality • Maintain aquatic habitat for waterbugs • Maintain habitat for platypus
Summer/autumn freshes (of 50–160 ML/day for 3 days each in December–May)	• Maintain/increase riparian and in-channel vegetation • Provide native fish habitat, movement and spawning • Improve water quality • Maintain habitat for waterbugs • Maintain habitat for platypus

1 *The actual volume and duration freshes will depend on available water resources, climatic conditions and conditions within the river.*

Scenario planning

Table 5.6.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Water availability in the Coliban system relies on withheld passing flows in winter/spring for use in the high-risk summer period, when poor water quality is more likely and providing constant low flows and/or short freshes can maintain habitat below the reservoir.

The volume of water available will vary depending on inflows, storage spills and the volume of passing flows accumulated, with a lower volume likely to be available under a drought/dry scenario. Water is not likely to be available to provide summer/autumn freshes except under average or wet conditions. The target flows and durations of freshes to manage a potentially catastrophic water-quality incident will vary depending on water availability, the severity of the incident and the amount of flow and water in the river at the time. There is insufficient water available to meet all the environmental water requirements of the Coliban system.

Table 5.6.5 Potential environmental watering for the Coliban system under a range of planning scenarios

Planning scenario	Drought–dry	Average – wet
Expected river conditions	• Little to no unregulated flows	• Some unregulated river flows from tributary inflows
Expected availability of environmental water	• Minimal passing flows and low volume to withhold for use at other times in the season	• Moderate-to-high passing flows with good volumes available but reduced ability to reserve flows due to possible storage spills • Withheld flows for use at other times in the season
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes • Summer/autumn low flows	• Summer/autumn freshes • Year-round low flows
Potential environmental watering – tier 2 (lower priorities)[1,2]	• Increased magnitude of summer/autumn low flows	• N/A
Possible volume of environmental water required to achieve objectives[3]	• 900 ML (tier 1) • 250 ML (tier 2)	• 1,200 ML (tier 1)
Priority carryover requirements	• Reserve passing flows for 2018–19	

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.7 Loddon system

Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

The Loddon system includes the Loddon River, Serpentine Creek, Tullaroop Creek, Birchs Creek, Pyramid Creek and the Boort wetlands. The system supports a wide range of environmental values as well as tourism and irrigation industries.

River blackfish are found in the upper reaches of the Loddon River and in parts of Serpentine Creek. There is a regionally important population of blackfish in Birchs Creek. The middle and lower reaches of the Loddon River support bony herring, Murray–Darling rainbowfish, golden perch, silver perch and Murray cod. Pyramid Creek is a tributary of the lower Loddon River that enters the Loddon River near Kerang and provides an important corridor for fish to move from the Loddon system into Kow Swamp, Gunbower Creek and the River Murray. Platypus may also disperse through Pyramid Creek and the lower Loddon River.

The Boort wetlands on the floodplain west of the Loddon River are regionally important for waterbird habitat and provide breeding opportunities for birds and turtles when there is water. During wet phases the aquatic plants provide habitat for frogs, which in turn provide food for herons, egrets and other birds. During temporary dry phases, the floors of these wetlands support a wide range of lakebed plants including some rare and threatened species.

Engagement

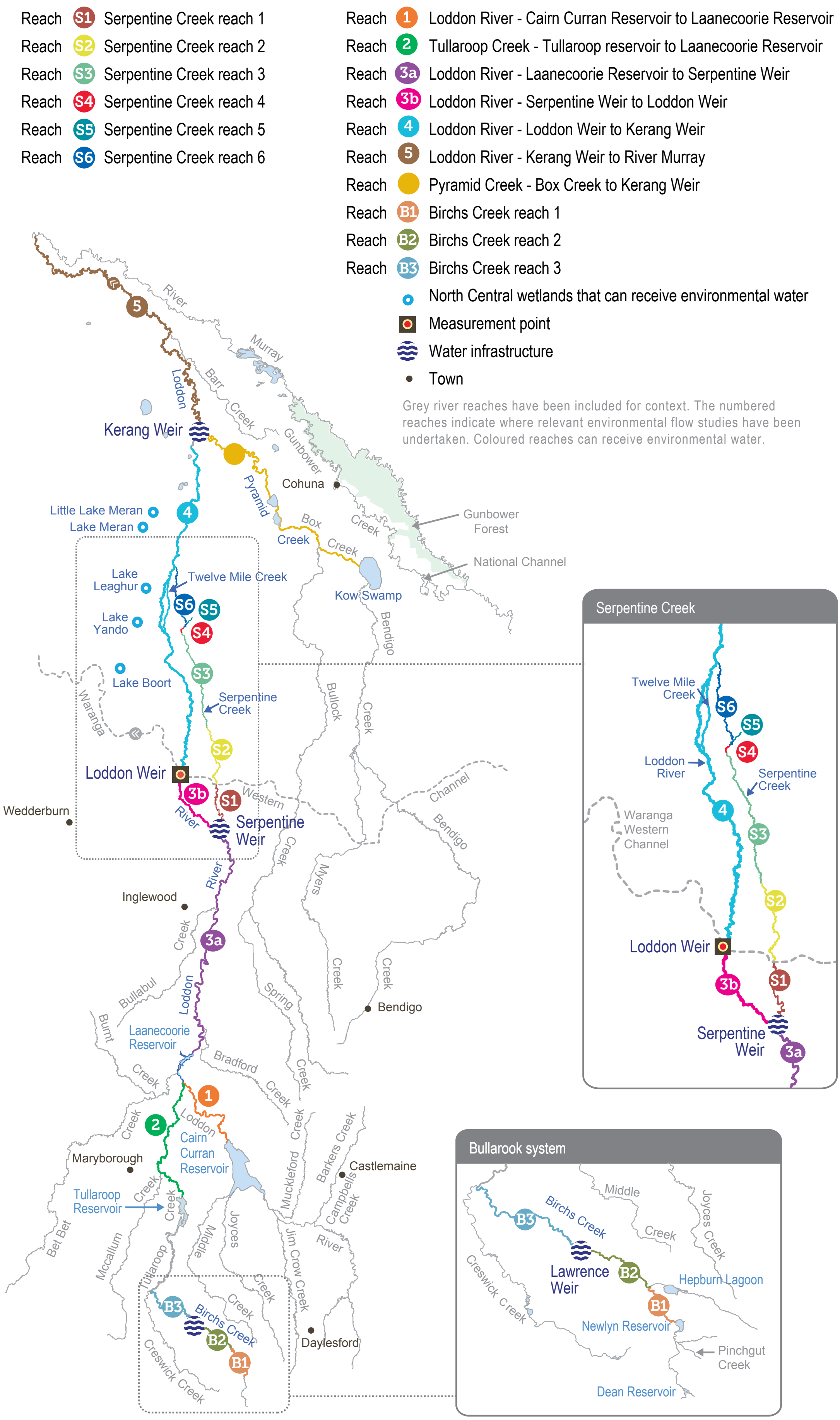
Table 5.7.1 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing the Loddon system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies and regional waterway strategies and by environmental flow studies, water management plans and other studies. The strategies incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the North Central Regional Catchment Strategy and North Central Waterway Strategy.

Table 5.7.1 Partners and stakeholders engaged in developing the Loddon system seasonal watering proposal

Partner and stakeholder engagement
• Birchs Creek Environmental Water Advisory Group and Loddon River Environmental Water Advisory Group (comprising community members and representatives of Goulburn-Murray Water, Central Highlands Water, DELWP and the VEWH) • Birdlife Australia • CEWO • Dja Dja Wurrung Clans Aboriginal Corporation • Field & Game Australia • Game Management Authority • Goulburn-Murray Water • Loddon Shire Rural Council, Campaspe Shire Rural Council • North Central CMA Community Consultative Committee, an advisory group to North Central CMA Board comprising community members • Parks Victoria • The Wetlands Environmental Water Advisory Group • VEWH • VRFish

Figure 5.7.1 The Loddon system



5.7.1 Loddon River system (including Tullaroop, Serpentine and Pyramid creeks)

The Loddon River flows north from its headwaters near Daylesford towards the River Murray. Tullaroop Creek is the main tributary in the upper Loddon River system. The middle section of the Loddon River includes Serpentine Creek and is characterised by many distributary streams and anabranches flowing north across a broad floodplain. The lower Loddon River is joined by Pyramid Creek at Kerang and at this point the Loddon becomes part of the River Murray floodplain.

Environmental values

The Loddon River system supports platypus, river blackfish and small native fish (such as flat-headed gudgeon, Australian smelt and mountain galaxias). While fish are most abundant and diverse in the upper reaches of the Loddon River and in Tullaroop Creek, river blackfish are also found in Serpentine Creek and rare Murray–Darling rainbow fish are found in the middle sections of the Loddon River. Pyramid Creek supports large-bodied fish (such as golden perch, Murray cod and silver perch) and is an important corridor for fish migration to and from the Loddon and Murray systems.

A major threat to fish in the Loddon system is the many barriers caused by weirs and reservoirs. In recent years the North Central CMA and Goulburn-Murray Water have upgraded infrastructure to improve fish passage at the chute, Box Creek regulator and Kerang Weir.

The condition of streamside vegetation throughout the Loddon system varies from bad to good depending on the recent water regime and the extent of clearing, grazing and weed invasions. The intact stands of streamside vegetation in good condition support a variety of woodland birds and other native animals.

Social, cultural and economic values

The Loddon River supplies the Boort irrigation district and is essential for prosperity in the region. Murray cod and golden perch are stocked in the Loddon River and are important recreational fishing species. Bridgewater on Loddon attracts visitors to waterskiing and triathlon competitions.

The Loddon River holds significance for Traditional Owners. The river contains important ceremonial places and for thousands of years provided resources such as food, materials and medicines to Traditional Owners now represented by the Dja Dja Wurrung Clans Aboriginal Corporation.

Environmental watering objectives in the Loddon River system

Maintain river red gum, tea tree and lignum and provide opportunities for new plants to germinate and grow
Protect and increase populations of native fish by providing flows for them to move upstream and downstream, and encourage spawning
Create opportunities for young platypus to disperse to new, high-quality habitat so they are not competing for space and food and become more resilient to threats (such as predation from foxes)

System overview

The major storages in the Loddon River system are Cairn Curran, Tullaroop and Laanecoorie reservoirs. Downstream of Laanecoorie Reservoir the river is further divided into sections due to the Bridgewater, Serpentine, Loddon and Kerang weirs.

Environmental water can be delivered to the Loddon River from Cairn Curran or Tullaroop reservoirs or from the Goulburn system via the Waranga Western Channel (which intersects the Loddon River at Loddon Weir). Water is provided to Pyramid Creek from the Murray system via the National Channel. Water is diverted from the Loddon River to Serpentine Creek and to the Boort Irrigation District to supply agriculture.

The water distribution system in the Loddon is very complicated due to modifications to the natural waterways for irrigation supply. The modifications to waterways and irrigation infrastructure provide challenges and opportunities for effective environmental water management. The highly regulated system makes it possible to manipulate the timing of releases at multiple locations, providing opportunities to accomplish environmental outcomes at discrete locations. However there are also many barriers that limit continuity and constraints that affect the volume and timing of environmental water releases.

The highest-priority reach for environmental watering is from Loddon Weir to Kerang Weir, because there is good potential to rehabilitate environmental values and because the reach doesn't carry irrigation water. Environmental water releases to this reach aim to improve the condition of riparian vegetation and increase the abundance of native fish. Environmental water is also delivered to the upper Loddon River, Tullaroop Creek and Serpentine Creek to maintain or increase populations of river blackfish and platypus.

Recent conditions

In July 2016, water resources in the Loddon system were critically low. There was a high risk that allocations would start at zero, and because Goulburn-Murray Water did not have enough reserve to operate the system for the whole water year, water entitlement holders (including the environment) would not be able to access their full carryover volume from previous years, and passing flows would be reduced. Planning at that time focussed on protecting refuge habitat and optimising the availability of water in the system for all users. High rainfall in July, August and September averted the problem and delivered one of the biggest floods recorded in the Loddon system.

The floods significantly improved the condition of aquatic and floodplain vegetation, and reed beds that had grown in the parts of the channel during the preceding dry years were scoured clear, which increased the quality and quantity of habitat for fish and other aquatic biota. The low dissolved oxygen blackwater events that killed fish in other river systems did not occur in the Loddon River after the floods.

As a result of increased water availability, more environmental water releases were provided in 2016–17 than originally expected. In December 2016, environmental water was released to Serpentine Creek for the first time. Environmental water was also released over summer to reduce the risk of a blackwater event. In April 2017, a coordinated release of water from the Loddon River and Pyramid Creek provided a high flow to stimulate fish migration through fishways at Kerang Weir on the Loddon River and the newly completed fish lock at Kow Swamp.

Scope of environmental watering

Table 5.7.2 shows potential environmental watering actions and their environmental objectives.

Murray River turtle, by North Central CMA

Table 5.7.2 Potential environmental watering actions and objectives for the Loddon River system

Potential environmental watering	Environmental objectives
Loddon River (reach 1)	
Year-round low flows (10– 80 ML/day year-round)	• Allow fish movement through the reach and maintain depth in pool habitat for native fish • Facilitate the long-distance movement of male platypus in the August–October breeding season • Maintain suitable water quality in pools in summer
Summer/autumn freshes (up to 4 freshes of 35–80 ML/day for 1–3 days in December–May)	• Promote the movement of fish so they access alternate habitats • Wash organic matter into the stream to drive the aquatic food webs • Mix and re-oxygenate pools and dilute concentrated salt • Inundate lower banks to wet the soil and promote the establishment, growth and survival of sedges and reeds
Winter/spring freshes (1–2 freshes of 400 to 700 ML/day for 1–5 days in July–October)	• Promote recruitment of riparian vegetation • Stimulate the movement of native fish and increase the breeding success of Murray cod • Flush accumulated leaf litter from banks and low benches into the channel to drive aquatic food webs
Tullaroop Creek (reach 2)	
Year-round low flows (5–40 ML/day year-round)	• Allow fish movement through the reach and maintain the depth of pool habitat for river blackfish • Facilitate the long-distance movement of male platypus in the August–October breeding season • Maintain suitable water quality in pools in summer
Summer/autumn freshes (up to 4 freshes of 30–40 ML/day for 1–3 days in December–May)	• Promote the movement of fish so they access alternate habitats • Wash organic matter into the stream to drive aquatic food webs • Mix and re-oxygenate pools and dilute concentrated salt • Inundate lower banks to wet the soil and promote the establishment, growth and survival of sedges and reeds
Winter/spring freshes (1–2 freshes of 200 to 400 ML/day for 1–5 days in July–October)	• Promote the recruitment of riparian vegetation • Stimulate the movement of native fish and increase the breeding success of Murray cod • Flush accumulated leaf litter from banks and low benches into the channel to drive aquatic food webs and increase ecological productivity
Loddon River (reach 4)	
Summer/autumn low flows (25–50 ML/day in December–May)	• Maintain water quality in pools • Maintain pool habitat for large-bodied fish (such as Murray cod, golden perch and bony herring) • Maintain shallow water habitats for small-bodied fish (such as flat-headed gudgeon) • Maintain connecting flows for aquatic plant propagules to disperse and establish
Summer/autumn freshes (up to 3 freshes 50–100 ML/day for 3–4 days in December–May)	• Facilitate the upstream movement of juvenile golden perch to increase the size of local populations • Wet submerged wood and flush silt and biofilms from hard surfaces to promote the growth of new biofilm and increase waterbug populations • Facilitate the downstream dispersal of juvenile platypus in April–May

Table 5.7.2 Potential environmental watering actions and objectives for the Loddon River system *continued*

Potential environmental watering	Environmental objectives
Loddon River (reach 4)	
Spring high flow (1 high flow of 450–750 ML/day with a 7-day peak in September–October)[1]	• Inundate banks, floodrunners and low-lying parts of the floodplain to increase the growth and recruitment of riparian vegetation • Provide a cue for golden perch and Murray cod to migrate and breed • Flush leaf litter and organic material from the bank to drive aquatic food webs
Autumn high flow (1 high flow of 400 ML/day with a 6-day peak in April–May)	• Provide a cue for native fish from the River Murray to swim upstream and colonise the Loddon River • Help juvenile platypus disperse from the upper Loddon River to the lower Loddon River and the River Murray
Winter/spring low flows (50–100 ML/day in June–November)	• Prevent terrestrial plants from encroaching into the channel • Increase the growth of fringing vegetation (such as sedges and reeds) • Maintain platypus populations by providing foraging and resting habitat
Serpentine Creek (reach 1)[2]	
Summer/autumn low flows (10–20 ML/day in December–May)	• Maintain connectivity between pools to maintain habitat for fish, turtles, platypus and waterbirds • Maintain water quality • Maintain aquatic vegetation
Winter/spring low flows (20–30 ML/day in June–November)	• Maintain spawning habitat and water levels for river blackfish • Provide flow variability to maintain vegetation fringing the bank • Inundate snags to maintain biofilms and foodweb productivity
Summer/autumn freshes (up to 4 freshes of 40 ML/day for 1–3 days in December–May)	• Flush accumulated sediment and scour biofilms to replenish the food chain • Maintain vegetation fringing the bank
Winter/spring fresh (1 fresh of 40–150 ML/day for 2 days in June–November)	• Improve habitat to increase the abundance of native fish and biomass of waterbugs • Maintain habitat for turtles • Scour organic matter that has accumulated in-channel
Serpentine Creek (reach 3)[2]	
Summer/autumn low flows (5–30 ML/day in December–May)	• Maintain connectivity between pools and habitat for fish, turtles, platypus and waterbirds • Maintain water quality • Maintain aquatic vegetation
Winter/spring low flows (30–40 ML/day in June–November)	• Maintain spawning habitat and water levels for river blackfish • Provide flow variability to maintain vegetation fringing the bank • Provide depth to inundate snags and maintain biofilms
Serpentine Creek (reach 3)[2]	
Summer/autumn freshes (up to 4 freshes of 40 ML/day for 3 days in December–May)	• Flush accumulated sediment and scour biofilms to replenish the food chain • Maintain vegetation fringing the bank
Winter/spring fresh (1 fresh of 100–200 ML/day for 2 days in September-November)	• Improve habitat to increase the abundance of native fish and biomass of waterbugs • Maintain habitat for turtles • Scour organic matter that has accumulated in-channel

Table 5.7.2 Potential environmental watering actions and objectives for the Loddon River system *continued*

Potential environmental watering	Environmental objectives
Pyramid Creek and Loddon River (reach 5)	
Winter low flow (90–200 ML/day May–August)	• Maintain system connectivity and water quality • Maintain fringing vegetation on the lower banks of the channel
Spring high flow (1 high flow of 700–900 ML/day for 10 days in September to November)	• Trigger and facilitate fish movement and breeding, particularly golden perch and silver perch, to increase local populations • Recruit and maintain riparian vegetation • Flush accumulated leaf litter from banks to provide carbon for aquatic foodwebs
Autumn high flow (1 high flow of 700–900 ML/day for 10 days in March–May)	• Trigger and facilitate the movement of juvenile fish

1 *Due to potential inundation of private land, environmental flows above 450 ML/day in reach 4 will not be provided without the agreement of potentially affected landholders.*

2 *Flows in Serpentine Creek will be shepherded through the system and allowed to run down in Pennyroyal Creek and Nine Mile Creek with the agreement of landholders.*

Scenario planning

Table 5.7.3 outlines the potential environmental watering and expected water use under a range of planning scenarios.

In 2017–18 water availability is expected to be high regardless of climatic conditions. It is therefore a good opportunity to enhance the environmental gains associated with the 2016–17 floods.

In the Loddon River, the magnitude of low flows will be adjusted throughout the year to match seasonal conditions. Under a dry climate scenario, low flows will be released at variable rates close to the low end of the ranges specified for potential watering actions. If it is a wet year, the magnitude of low-flow releases will increase to the upper end of the recommended range. In the Loddon River and Serpentine Creek, three to four summer/autumn freshes are planned for release under all climatic scenarios. During a dry and hot summer, the freshes will be timed to prevent water quality deteriorating.

Table 5.7.3 Potential environmental watering for the Loddon River system under a range of planning scenarios

<table>
<tr><th>Planning scenario</th><th>Drought</th><th>Dry</th><th>Average</th><th>Wet</th></tr>
<tr><td>Expected river conditions</td><td>• Negligible contributions from unregulated reaches and tributaries of the Loddon River leading to lengthy cease-to-flow periods in the absence of environmental or consumptive water deliveries</td><td>• Small contributions from unregulated reaches and tributaries of the Loddon River contributing to low flows, but still a moderate chance of some cease-to-flow periods in some reaches</td><td colspan="2">• Unregulated flows will provide low flows and multiple freshes, most likely in winter and spring
• Spills from Loddon system storages will provide extended-duration high flows and overbank flows at any time of the year</td></tr>
<tr><td>Expected availability of environmental water[1]</td><td>• Up to 18,500 ML</td><td colspan="3">• 18,500–24,000 ML</td></tr>
<tr><td colspan="5">Loddon River (reach 1) and Tullaroop Creek (reach 2)</td></tr>
<tr><td>Potential environmental watering</td><td colspan="4">• Year-round low flows
• 3 summer/autumn freshes
• winter/spring fresh</td></tr>
<tr><td colspan="5">Loddon River (reach 4)</td></tr>
<tr><td>Potential environmental watering</td><td colspan="2">• Year-round low flows
• 3 summer/autumn freshes
• 1 winter/spring high flow</td><td colspan="2">• Year-round low flows
• 3 summer/autumn freshes
• 1 winter/spring high flow
• 1 autumn high flow</td></tr>
<tr><td colspan="5">Serpentine Creek (reaches 1 and 3)</td></tr>
<tr><td>Potential environmental watering</td><td colspan="4">• Winter/spring low flows
• Summer/autumn low flows
• Up to 4 summer freshes
• 1 winter/spring fresh</td></tr>
<tr><td colspan="5">Loddon River, Tullaroop Creek and Serpentine Creek</td></tr>
<tr><td>Possible volume of environmental water required to achieve objectives</td><td>• Up to 18,400 ML</td><td>• Up to 20,700 ML</td><td colspan="2">• 9,000–17,300 ML</td></tr>
<tr><td colspan="5">Pyramid Creek and Loddon River (reach 5)</td></tr>
<tr><td>Potential environmental watering</td><td colspan="4">• 1 spring high flow
• 1 autumn high flow
• Winter low flows</td></tr>
<tr><td>Possible volume of environmental water required to achieve objectives</td><td colspan="4">• 8,500–17,000 ML</td></tr>
</table>

[1] *Does not include water available in the Goulburn and Murray systems that could be made available to support the achievement of environmental objectives in the Loddon system, subject to trading rules.*

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.7.2 Boort wetlands

The Boort wetlands are on the floodplain to the west of the Loddon River, downstream of Loddon Weir. They consist of Lake Boort, Lake Leaghur, Lake Yando and the Meran Lakes complex of wetlands. Several other wetlands occur in the district but are currently not managed with environmental water.

Environmental values

The Boort wetlands provide habitat for a range of plant and animal species, many of which are rare and threatened. At Lake Yando, 12 rare plant species have been recorded including the jerry-jerry and water nymph. Bird species recorded at Lake Boort, Lake Leaghur and Lake Meran include the white-bellied sea eagle, Latham's snipe and eastern great egret. Little Lake Meran is a swampy woodland with black box trees on the highest wet margins and river red gums fringing the waterline. Dense mats of water milfoil grow in the shallow margins and on exposed mudflats as the lake recedes. These shallow areas also provide feeding habitat for waterbirds and shorebirds (such as musk duck and common greenshank).

Social, cultural and recreational values

The Boort wetlands provide numerous recreation opportunities. Lake Meran and Lake Boort are state game reserves and hunting is also allowed at Lake Yando and Lake Leaghur. The large expanse of open water at Lake Meran is very popular for boating, fishing and waterskiing, attracting many visitors during holiday seasons. Lakes Yando, Boort and Leaghur contain excellent environmental values and birdwatchers and field naturalists regularly visit the lakes when they are wet or dry.

The Boort wetlands hold significance for Traditional Owners. The wetlands are important ceremonial places and for thousands of years have provided resources (such as food and materials) to the Traditional Owners now represented by the Dja Dja Wurrung Clans Aboriginal Corporation.

Environmental watering objectives in the Boort wetlands

Maintain or increase the growth of river red gums and aquatic and amphibious vegetation

Rehabilitate habitat and provide breeding opportunities to maintain local and regional populations of birds, fish, frogs and turtles

System overview

The natural water regimes of wetlands in the Loddon system have been substantially modified by the construction of levees and channels across the floodplain and by the construction and operation of reservoirs and weirs along the Loddon River. Environmental watering in the Boort wetlands aims to manage wet and dry phases to improve environmental condition and habitat value.

Recent conditions

Major flooding in September and October 2016 filled all of the Boort wetlands apart from Little Lake Meran, which is disconnected from the natural floodplain. The floods met or exceeded all of the environmental watering objectives for the year and therefore no environmental water was delivered to Boort wetlands in 2016–17.

The natural floods at Lake Boort and Lake Meran were well-timed and provided good outcomes for birds and vegetation. Substantial growth and flowering of river red gums was observed at both lakes, and bird breeding occurred. At Lake Yando, the floods drowned some juvenile river red gums that had recruited over the last couple of years, but the trees that survived have benefited from the watering and will likely be resilient to future floods. In January, a bloom of blue-green algae occurred at Lake Leaghur and there were fish deaths at Lake Meran. These events are an unfortunate consequence of the flood, which transported a large load of organic matter and nutrients into the lakes.

Natural floods are essential for the health of the Boort wetlands. They provide a big input of carbon and nutrients that drive ecosystem productivity, but they need to be interspersed with drawdown and dry periods to maintain the full range of wetland ecosystems processes. Lakes Meran, Boort, Leaghur and Yando will all be allowed to draw down naturally over the next couple of years. Because the wetlands vary in size, some will dry before others and so collectively provide a range of habitat types across the landscape of which mobile animals can take advantage.

Scope of environmental watering

Table 5.7.4 shows potential environmental watering actions and their environmental objectives.

Table 5.7.4 Potential environmental watering actions and objectives for the Boort wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Little Lake Meran (partial fill in autumn)	• Provide feeding and breeding opportunities for waterbirds • Provide open-water and mudflat habitats to support aquatic food webs and provide habitat for waterbirds • Increase the growth of river red gums
Wetland drying	
Lake Leaghur, Lake Boort, Lake Meran and Lake Yando (promote natural drawdown and drying)	• These wetlands will be in a drying phase in 2017–18 • The drying will help maintain a high diversity of habitats across the landscape that can support a wide range of wetland-dependent birds and animals • Gradual drawdown at each wetland will help rehabilitate vegetation zones in and around the wetland

Scenario planning

Table 5.7.5 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Apart from Little Lake Meran which is isolated from the Loddon River floodplain, all Boort district wetlands were filled by floods in 2016–17 and will be allowed to draw down naturally in 2017–18. At Little Lake Meran, up to 500 ML will provide a partial fill of the lake in autumn to increase the growth of river red gums, pending a health assessment of juvenile trees at the lake. If there is a risk that trees are too small to withstand several months' inundation, the watering may be postponed until spring 2018. If it is decided that the trees are mature enough to withstand inundation, environmental watering will go ahead under all climatic scenarios because the seasonal conditions are not expected to interfere with the vegetation outcomes.

Table 5.7.5 Potential environmental watering for the Boort wetlands under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected catchment conditions	• No natural inflows to wetlands	• Periods of high flows combined with localised catchment contributions expected to provide inflows to wetlands	• Multiple spills from Loddon system storages will provide extended durations of high flows and overbank flows which fill all wetlands
Potential environmental watering	• Little Lake Meran	• Little Lake Meran	• Little Lake Meran
Possible volume of environmental water required to achieve objectives	• 500 ML	• 500 ML	• 500 ML

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

5.7.3 Birchs Creek

Birchs Creek rises in the ranges north-east of Ballarat and flows north-west through Newlyn and Smeaton before joining Tullaroop Creek near Clunes. The target reach for environmental water is reach 3 because it contains the vulnerable river blackfish population, and most irrigation supply is diverted before the reach.

Environmental values

Birchs Creek supports native fish including a regionally significant population of river blackfish as well as mountain galaxias, flat-headed gudgeon and Australian smelt. Platypus are present in the creek in low numbers.

Social, cultural and economic values

Birchs Creek is popular among the nearby community for its aesthetic appeal and the intrinsic value of having water in the landscape. Water in the Birchs Creek system supports irrigated agriculture, particularly of potatoes.

Birchs Creek holds significance for Traditional Owners. The creek is an important ceremonial place and for thousands of years has provided resources (such as food and materials) to the Traditional Owners now represented by the Dja Dja Wurrung Clans Aboriginal Corporation.

Environmental watering objectives in Birchs Creek

Maintain suitable water quality to support river blackfish and other native fish

System overview

Birchs Creek is part of the Bullarook system which has two small storages — Newlyn Reservoir and Hepburn Lagoon — that fill and spill during winter or spring in most years with average or above-average rainfall.

Environmental water is held in and delivered from Newlyn Reservoir. The VEWH is allocated 100 ML of water on 1 December each year unless seasonal determinations of high-reliability water shares in the Bullarook system are less than 20 percent. Any unused environmental allocation from 1 December can be carried over into the first five months of the following water year (that is, from 1 July to 30 November), but if Newlyn Reservoir spills during these months the volume held in carryover is lost. Any water remaining on 30 November is forfeited. When seasonal determinations are less than 20 percent, the VEWH is not allocated water and the system's resources are shared equitably to protect critical human and environmental needs.

Recent conditions

In July 2016, the Birchs Creek catchment was very dry following extremely low rainfall over the preceding two to three years. Consistent rainfall in winter and spring 2016 recharged groundwater aquifers and caused Newlyn Reservoir to fill and spill: Newlyn spilled from July through to mid-December. Heavy rain in September and October caused two large floods in Birchs Creek.

Summer and autumn 2016–17 had below-average rainfall, but groundwater discharge provided consistent baseflows in reach 3. The baseflows maintained adequate water quality for aquatic animals and no environmental water releases were made during 2016–17.

Loddon River near Fernihurst, by Phil Slessar

Scope of environmental watering

Table 5.7.6 shows potential environmental watering actions and their environmental objectives.

Table 5.7.6 Potential environmental watering actions and objectives for Birchs Creek

Potential environmental watering	Environmental objectives
Winter/spring fresh (1 fresh of 30 ML/day for 3 days in September-November)	• Maintain aquatic vegetation along the edges of the river • Scour organic matter that has accumulated in the channel under very low-flow conditions
Summer/autumn freshes (up to 3 freshes of 10 ML/day for 3 days in December–May)	• Maintain water quality to minimise risks to aquatic animals associated with low dissolved oxygen and high water temperature • Maintain connectivity between refuge pools • Maintain aquatic vegetation

Scenario planning

In a drought scenario, 100 ML of environmental water that was carried over from 2016–17 will be available until 30 November 2017 and may be used to deliver a winter/spring fresh to improve vegetation condition before summer. Under a drought scenario, the VEWH will probably not be allocated water in December and water resources in the Bullarook system will be shared equitably, to maintain critical human and environmental needs.

Under a dry scenario, there may be an opportunity to use the water carried over from 2016–17 before 30 November 2017 or before Newlyn Reservoir spills. The VEWH will likely receive its allocation for the 2017–18 water year on 1 December 2017. That water will then be available throughout summer and autumn and may be used to deliver small freshes to improve water quality if flows are low in reach 3. Unused water will be carried over to 30 November 2018.

Under an average or wet scenario, Newlyn Reservoir is expected to spill early in the 2017–18 water year and the carryover from 2016–17 will be unavailable. The VEWH will receive an allocation of 100 ML on 1 December 2017, but it is unlikely that it will be used in summer or autumn because reach 3 of Birchs Creek will receive sufficient baseflows from groundwater discharge.

Table 5.7.7 Potential environmental watering for Birchs Creek under a range of planning scenarios

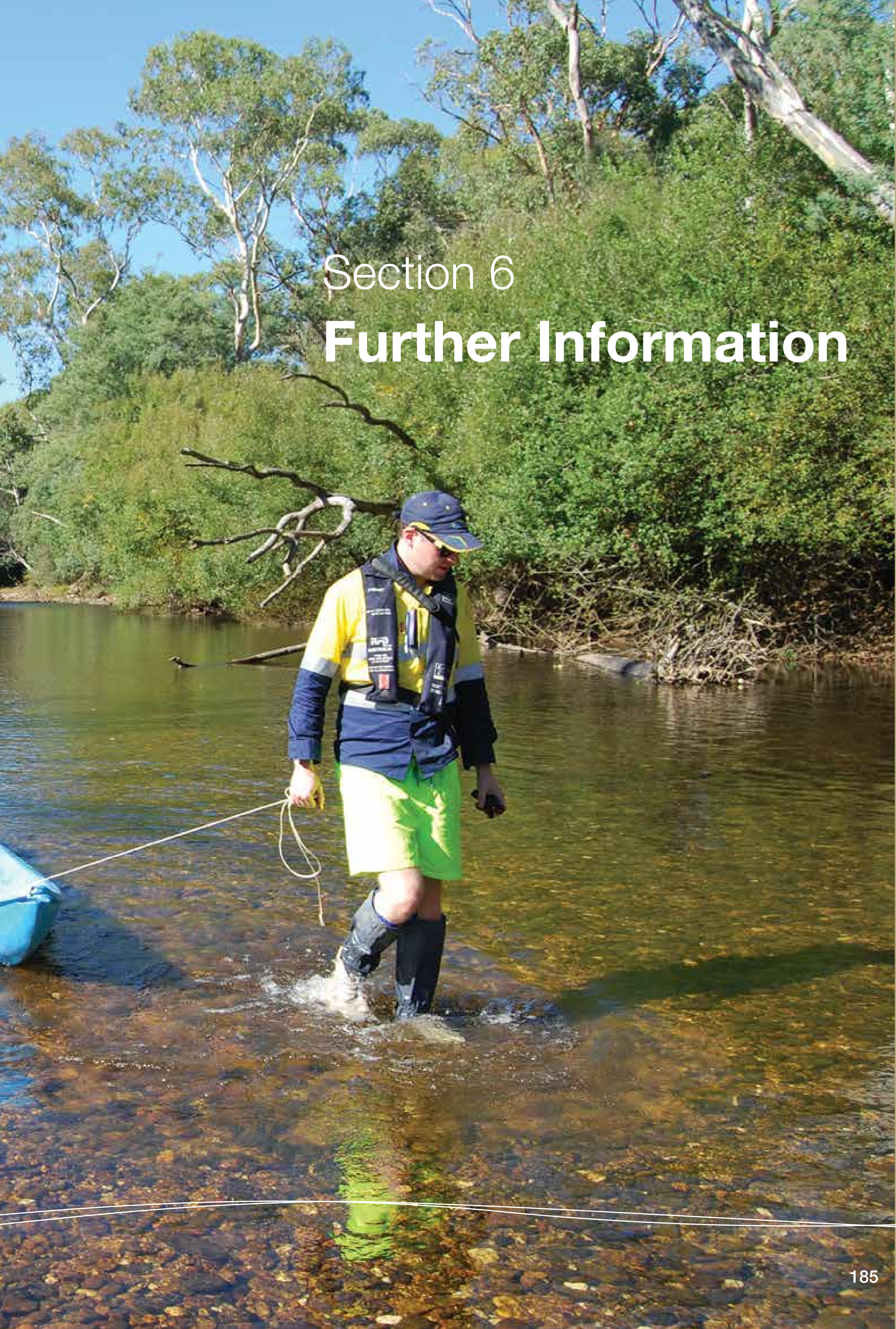
Planning scenario	Drought	Dry	Average-Wet
Potential environmental watering	• 1 winter/spring fresh	• 1 winter/spring fresh • 1–3 summer/autumn freshes	• 1–3 summer/autumn freshes
Possible volume of environmental water required to achieve objectives	• 100 ML	• 100–200 ML	• 100 ML

Risk management

In preparing its seasonal watering proposal, North Central CMA considered and assessed the risks of environmental watering and identified mitigation strategies. Program partners continually reassess risks and mitigation actions throughout the water year (see section 1.3.6).

Section 6

Further Information



6.1 Acronyms

AHD – Australian Height Datum (also see Glossary entry)

CEWH – Commonwealth Environmental Water Holder

CEWO – Commonwealth Environmental Water Office

CMA – Catchment management authority

DELWP – Department of Environment, Land, Water and Planning

MDBA – Murray–Darling Basin Authority

MDWWG – Murray Darling Wetlands Working Group

ML – Megalitre (also see glossary entry)

NRM – natural resource management

NVIRP – Northern Victoria Irrigation Renewal Project

RMIF — River Murray increased flows

VEWH – Victorian Environmental Water Holder

6.2 Glossary

Acid sulphate soils – Naturally occurring soils containing high quantities of iron sulphates. When these soils remain underwater they are stable, but if they are exposed to air, sulphuric acid is generated and can result in severe environmental impacts.

Adaptive management – An iterative decision-making process based on continuous learning that aims to reduce uncertainty over time.

Allocation (of water) – The specific volume of water allocated to water entitlements in a given water year or allocated as specified within a water resource plan.

Australian Height Datum (AHD) – Height above sea level.

Azolla – A native aquatic fern which grows in waterways in dense patches. Its presence usually indicates high levels of nutrients.

Bank erosion – The wearing-away of the banks of a stream or river (as distinct from erosion of the bed) that can occur in extensively dry conditions.

Bank slumping – A form of mass wasting in a river or stream that occurs when a coherent mass of loosely consolidated materials or rock layers moves a short distance down a slope.

Bankfull flows – Flows of sufficient size to reach the top of the riverbank, with little flow spilling onto the floodplain.

Baseflows – A relatively stable, sustained and low flow in a river, generally being its minimum natural level.

Biodiversity – The variety or abundance of plant and animal species in a particular habitat or environment.

Biofilms – Slimy films of bacteria, other microbes and organic materials that cover underwater surfaces including rocks and snags.

Biota – The animal or plant life of a particular area, habitat or geological period.

Blackwater – A natural occurrence caused by the breakdown of plant matter causing the water to discolour. The water turns black and can have very low dissolved-oxygen levels, which can stress or kill fish and other animals that breathe underwater.

Brackish water – Water that is moderately salty but not as salty as sea water. It may result from the mixing of seawater with freshwater, as in estuaries.

Carryover – Unused water of which entitlement holders are allowed to retain ownership into the following season, according to specified rules.

Catchment management authority – A statutory authority established to manage river health and regional and catchment planning and to manage waterways, floodplains, salinity and water quality.

Cease-to-flow – The period in which there is no discernible flow in a river and partial or total drying of the river channel.

Cold water pollution – A phenomena caused by cold water being released into rivers, primarily from large dams, in warmer months.

Commonwealth Environmental Water Office – An office that manages water entitlements recovered by the Australian Government through a combination of investments in water-saving infrastructure, water purchases and other water recovery programs. The entitlements are held by the CEWH.

Confluence – The point where a tributary joins a larger river (called the main stem) or where two streams meet to become the source of a river of a new name.

Consumptive water – Water owned by water corporations or private entitlement holders held in storages and actively released to meet domestic, stock, town and irrigation needs.

Diadromous fish – Fish that migrate between freshwater and saltwater.

Drawdown – Water released from a body of water (such as a reservoir) at the end of the irrigation season for dam operation and maintenance purposes.

Ecological vegetation communities – Components of a vegetation classification system, these are groups of vegetation communities based on floristic, structural and ecological features.

En route – Water that is on its way to being delivered to urban, rural and irrigation water users.

Environmental flow study – A scientific study of the flow requirements of a particular basin's river and wetland systems used to inform decisions about the management and allocation of water resources.

Environmental water - Water available for environmental purposes including entitlements held by the VEWH, passing flows and unregulated flows.

Environmental water entitlement – An entitlement to water to achieve environmental objectives in waterways. It covers an environmental entitlement, environmental bulk entitlement, water share, section 51 licence or supply agreement.

Environmental water management plan – A plan developed by a waterway manager outlining long-term environmental objectives and based on consultation with key stakeholders, local community and advisory groups to inform the seasonal watering proposal for the particular system.

Estuary – A partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with saltwater from the sea.

Fishway – A series of pools built like steps to enable fish to travel through a waterway, dam or waterfall.

Fledging – The care of a young bird until it can fly.

Flow components – Components of a river system's flow regime that can be described by magnitude, timing, frequency and duration (for example, cease-to-flow and overbank flows).

Freshes – Small or short-duration, peak-flow events which exceed the baseflow and last for a few days.

Geomorphology – The scientific study of landforms and the processes that shape them.

Groundwater – Water held underground in the soil or in pores and crevices in rock.

Headwater – A tributary stream of a river close to or forming part of its source.

Headworks system – A system including various storage infrastructure (such as reservoirs and diversion weirs) to enable connection of multiple waterways.

Heritage rivers – Rivers listed under the *Heritage Rivers Act 1992* and parts of rivers and river catchment areas in Victoria which have significant nature conservation, recreation, scenic or cultural heritage attributes.

High-reliability entitlement – A legally recognised, secure entitlement to a defined share of water. Full allocation of a high-reliability entitlement is expected in most years.

Hydrology – The study of the properties of the water and its movement in relation to land.

Inter-valley transfers – The transfer of water between river systems to meet demands as a result of water trade between river systems.

Irrigation releases – The release of water for irrigation purposes.

Juvenile – A stage of life at which an animal or plant is not yet fully mature.

Land manager – An agency or authority responsible for conserving natural and cultural heritage on public land including parks and reserves (such as Parks Victoria and DELWP).

Low-reliability entitlement – A legally recognised, secure entitlement to a defined share of water. Full allocation of a low-reliability entitlement is expected only in some years.

Macroinvertebrates – Animals without a backbone and which can be seen with the naked eye including worms, snails, mites, bugs, beetles, dragonflies and freshwater crayfish. They are also referred to as waterbugs.

Macrophytes – Aquatic plants that are either emergent (growing out of the water, for example phragmites), submergent (growing under the water, for example ribbonweed) or floating (for example floating pond weed).

Managed release – A release of environmental water which is stored in major reservoirs and used for priority watering actions to achieve environmental outcomes.

Megalitre – One million (1,000,000) litres.

Midden – A site of cultural significance where Aboriginal people left the remains of their meals and other domestic waste.

Millennium Drought – One of the worst droughts recorded since settlement, it went from about 1995 to 2012.

Operational releases – Releases made from major storages to enable the water distribution system to operate or to make water available to consumptive water users.

Overbank flows – The portion of a flood flow that flows outside the main river channel at relatively small depths over part of or the full width of the waterway and in a direction essentially parallel with the direction of the main channel.

Passing flows – Water released from storages to operate river and distribution systems (often to help deliver water for environmental or consumptive uses) and maintain environmental values and other community benefits. The volume of passing flows is generally determined by inflows to those storages.

Permanent trade – The transfer of ownership of a water share or licence.

Potential environmental watering – Environmental flow components that have been identified for a particular system in a particular year.

Pulse – A gradual build in the flow of water, typically to replicate optimal conditions for water species (such as fish to travel and spawn).

Ramsar-listed wetland – A wetland listed as internationally significant under the Convention on Wetlands signed in Ramsar, Iran in 1971.

Reach – A stretch or section of a river, generally defined in an environmental flow study.

Recruitment – The increase in plants or animals when they survive to the settlement or maturity stage.

Regional waterway strategy – An eight-year action plan prepared by a CMA for the rivers, wetlands and estuaries in its area. It provides a single regional planning document for waterways in the area.

Remnant vegetation – Patches of native trees, shrubs and grasses still remaining following disturbance.

Return flows – Any flows delivered for environmental purposes and then returned to the downstream system to be reused for other purposes. Returned flows may be captured and stored downstream for later reuse, although most commonly they remain within the waterway for in-stream reuse.

Riffle – A relatively shallow section of stream where water flows at a higher velocity with increased turbulence, causing many ripples to be formed in the water surface.

Riparian vegetation – Vegetation located in the area of land that adjoins, regularly influences or is influenced by a river.

Salt wedge – The transition zone of saltwater and freshwater environments which occurs when a freshwater river flows directly into saltwater.

Seasonal watering plan – The VEWH's annual operational document which outlines potential environmental watering across the state in the forthcoming water year.

Seasonal watering proposal – An annual proposal outlining the regional priorities for environmental water use in each water year and submitted by waterway managers to the VEWH for consideration in its seasonal watering plan.

Seasonal watering statement – A statement by the VEWH authorising a CMA to apply or use water from its environmental water entitlements consistently with the seasonal watering plan.

Shared benefits – The many recreational, Aboriginal cultural, social and economic benefits of environmental watering.

Slackwater habitat – Habitat in a body of water that has little or no flow, typically formed in areas where the current is restricted by obstructions.

Spawning – The process of species releasing eggs and sperm to reproduce.

Storage manager – Appointed by the Minister for Water to operate major water storages in a particular river basin, to deliver water to entitlement holders.

System operating water – Water managed by storage managers, held in storages and actively released to ensure the system can deliver consumptive water and water to meet other needs.

Temporary trade – Transfer of a seasonal allocation.

Terrestrial vegetation – Land-based plants.

The Living Murray program – An intergovernmental program which holds an average of 500,000 ML of environmental water a year for use at six iconic sites along the River Murray.

Trade – Water shares, allocations and take-and-use licences that can be traded in Victoria under rules the Minister for Water sets.

Translocation – The movement of living organisms from one area to another area where they are given free release.

Tributary – A smaller river or creek that flows into a larger river.

Unregulated (entitlement) – An entitlement to water declared in periods of unregulated flow in a river system (that is, flows that cannot be captured in storages).

Unregulated flows – Natural streamflows that cannot be captured in major reservoirs or storages.

Victorian Environmental Water Holder (VEWH) – An independent statutory body responsible for holding and managing Victorian environmental water entitlements and allocations.

Victorian environmental watering program – The overarching program by which all environmental watering actions are planned and delivered and in which all environmental watering partners are involved.

Water Act 1989 – The legislation that governs water entitlements and establishes the mechanisms for managing Victoria's water resources.

Water entitlement – The right to a volume of water that can (usually) be stored in reservoirs and taken and used under specific conditions.

Water trade – The process of buying, selling or exchanging water allocation or entitlements.

Water allocation – See Allocation (of water).

Water year – The same as a financial year: from 1 July to 30 June the next year.

Waterway manager – The agency or authority (such as a CMA or Melbourne Water) responsible for the environmental management of a catchment or waterway.

Waterways – Rivers, wetlands, creeks, floodplains, estuaries and other bodies of water.

6.3 Contact details

For further information about the *Seasonal Watering Plan 2017–18*, please contact the Victorian Environmental Water Holder.

Victorian Environmental Water Holder
Ground floor, 8 Nicholson St, East Melbourne, Victoria 3002
PO Box 500, East Melbourne, Victoria 3002
(03) 9637 8951
general.enquiries@vewh.vic.gov.au
www.vewh.vic.gov.au

For specific information about each system and details about specific seasonal watering proposals, please contact the relevant waterway manager.

Corangamite Catchment Management Authority
64 Dennis Street, Colac, Victoria 3250
PO Box 159, Colac, Victoria 3250
(03) 5232 9100
info@ccma.vic.gov.au
www.ccma.vic.gov.au

East Gippsland Catchment Management Authority
574 Main Street, Bairnsdale, Victoria 3875
PO Box 1012, Bairnsdale, Victoria 3875
(03) 5152 0600
egcma@egcma.com.au
www.egcma.com.au

Glenelg Hopkins Catchment Management Authority
79 French Street, Hamilton, Victoria 3300
PO Box 502, Hamilton, Victoria 3300
(03) 5571 2526
ghcma@ghcma.vic.gov.au
www.ghcma.vic.gov.au

Goulburn Broken Catchment Management Authority
168 Welsford Street, Shepparton, Victoria 3630
PO Box 1752, Shepparton, Victoria 3630
(03) 5822 7700
reception@gbcma.vic.gov.au
www.gbcma.vic.gov.au

Mallee Catchment Management Authority
DPI Complex, Corner Koorlong Avenue and Eleventh Street, Irymple, Victoria 3498
PO Box 5017, Mildura, Victoria 3502
(03) 5051 4377
reception@malleecma.com.au
www.malleecma.vic.gov.au

Melbourne Water
990 La Trobe Street, Docklands, Victoria 3008
PO Box 4342, Melbourne, Victoria 3001
131 722
enquiry@melbournewater.com.au
www.melbournewater.com.au

North Central CMA
628–634 Midland Highway, Huntly, Victoria 3551
PO Box 18, Huntly, Victoria 3551
(03) 5448 7124
info@nccma.vic.gov.au
www.nccma.vic.gov.au

North East CMA
Level 1, 104 Hovell Street, Wodonga, Victoria 3690
PO Box 616, Wodonga Victoria 3689
1300 216 513
necma@necma.vic.gov.au
www.necma.vic.gov.au

West Gippsland CMA
16 Hotham Street, Traralgon, Victoria 3844
PO Box 1374, Traralgon, Victoria 3844
1300 094 262
westgippy@wgcma.vic.gov.au
www.wgcma.vic.gov.au

Wimmera CMA
24 Darlot Street, Horsham, Victoria 3400
PO Box 479, Horsham, Victoria 3402
(03) 5382 1544
wcma@wcma.vic.gov.au
www.wcma.vic.gov.au

For specific information about the other environmental water holders in Victoria, please contact one of the following organisations.

Murray–Darling Basin Authority
Level 4, 51 Allara Street, Canberra City, ACT 2601
GPO Box 1801, Canberra City, ACT 2061
(02) 6279 0100
inquiries@mdba.gov.au
www.mdba.gov.au

Commonwealth Environmental Water Office
John Gorton Building, King Edward Terrace, Parkes, ACT 2600
GPO Box 787, Canberra, ACT 2061
1800 218 478
ewater@environment.gov.au
www.environment.gov.au/water/cewo

Front cover:
Top left: Coastal saltmarsh, Hospital Swamps, by Saul Vermeeren
Top right: Australasian bittern, by Andrew Silcocks
Centre: Neds Corner watering, by Mallee CMA
Bottom left: Canoeing at Lake Carpul, by Mallee CMA
Bottom right: Growling grass frog, by East Gippsland CMA

Inside front cover:
White-faced heron, by Andrew Silcocks

Back cover:
Top left: Magpie geese at Black Swamp, by Goulburn Broken CMA
Centre: Early stages of environmental water delivery at Nyah Floodplain, by Mallee CMA
Bottom left: Dragonfly at Moodie Swamp, by Fiona Lloyd
Bottom right: Birdwatching at Hattah Lakes, by Mallee CMA

Inside back cover:
Brolga, Johnson Swamp, by Damien Cook