Seasonal Watering Plan 2020-21

VICTORIAN ENVIRONMENTAL WATER HOLDER

VICTORIA State Government

Acknowledgement of Traditional Owners

The VEWH proudly acknowledges Victoria's Aboriginal communities and their rich culture and pays respect to their Elders past and present.

We acknowledge Aboriginal people as Australia's first peoples and as Traditional Owners and custodians of the land and water on which we rely. We recognise the intrinsic connection of Traditional Owners to Country, and we value their ongoing contribution to managing Victoria's landscapes. We also recognise and value the contribution of Aboriginal people and communities to Victorian life and how this enriches us.

The VEWH recognises the intersection between environmental flow objectives and outcomes for Traditional Owners and Aboriginal Victorians. We acknowledge the ongoing contribution that Aboriginal people are making to planning and managing water for the environment and the benefits that have resulted from these partnerships. The contribution of Traditional Owners to this year's seasonal watering plan is detailed in the regional introductions.

For tens of thousands of years, Aboriginal people have occupied Australia. There have been very different clan and Nation boundaries to those that exist today, often embodying deep cultural relationships with the land and waterways. In this seasonal watering plan, the VEWH has endeavoured, using the best-available information, to name the Traditional Owner groups and their Nations that lived in the area we now call Victoria, and who continue to maintain and enhance longstanding culture and tradition. We have also sought and, in some regions, have provided some background on local Aboriginal names for waterways.

We acknowledge that the Traditional Owner groups and their associations with particular areas are not definitive, and there may be multiple names for the waterways covered by the seasonal watering plan. The VEWH does not claim this information to be exact. We provide such information in the spirit of acknowledgement of Traditional Owners past and present and their long-standing connection to Country.

The VEWH embraces the spirit of reconciliation, working towards equity and an equal voice for Traditional Owners.

Above: Scar tree drawing by Marcus Lee Design, a certified supplier with Supply Nation.

Acknowledgement of program partners

The Victorian Environmental Water Holder acknowledges that the Seasonal Watering Plan is based on the significant contributions and hard work of Victoria's catchment management authorities and Melbourne Water, in consultation with their communities.

Foreword

It gives me great pleasure to introduce the Victorian Environmental Water Holder's (VEWH's) *Seasonal Watering Plan 2020-21*, which outlines the scope of where and when water for the environment may be delivered over the next 12 months.

Last year was a year of change at the VEWH as we welcomed a refreshed Commission to the helm and saw my appointment to the position of Chairperson. Our Commissioners have diverse backgrounds and bring a balance of experience and knowledge in environmental management, sustainable water management, economics and public administration to the environmental watering program.

The past year also saw changes to the *Water Act 1989* which, for the first time in Victoria, enshrined recreational and Aboriginal water values into law. By tapping into local knowledge, the seasonal watering plan aims to optimise the delivery of water to produce shared benefits for all Victorians.

At the VEWH, supporting the involvement of Traditional Owners in the planning, management and delivery of environmental water has been an ongoing focus and we are beginning to see results, most recently at Ranch Billabong and the Moorabool River, where water for the environment has provided both cultural and environmental benefits.

The effects of climate change on our environment are becoming more apparent – there is no more extreme example than the devastating summer bushfires following drier than average conditions over the past few years. Pleasingly, the climate outlook for winter 2020 provides some hope for an average or wet beginning to the 2020–21 watering year. However, the uncertainty of seasonal conditions means it is important for our planning to be adaptable.

This year's seasonal watering plan provides a clear guide to how the VEWH and program partners plan to use the water available to achieve the best possible environmental watering outcomes for Victorians in a range of climate scenarios. It represents a consolidation of proposed watering actions from catchment management authorities and Melbourne Water developed from an ever-building bank of local knowledge from our regions and scientific monitoring programs.

I thank everyone who has provided input to the plan and those who will be involved in its delivery over the coming year.

Chris Chesterfield
Chairperson, Victorian Environmental Water Holder

Round Lake waterbirds, by North Central CMA

Section 1

Introduction

1.1 The Victorian environmental watering program

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

This seasonal watering plan previews all the potential watering actions that may be delivered across Victoria in 2020–21.

In this section ...

1.1.1 Why do we need an environmental watering program?

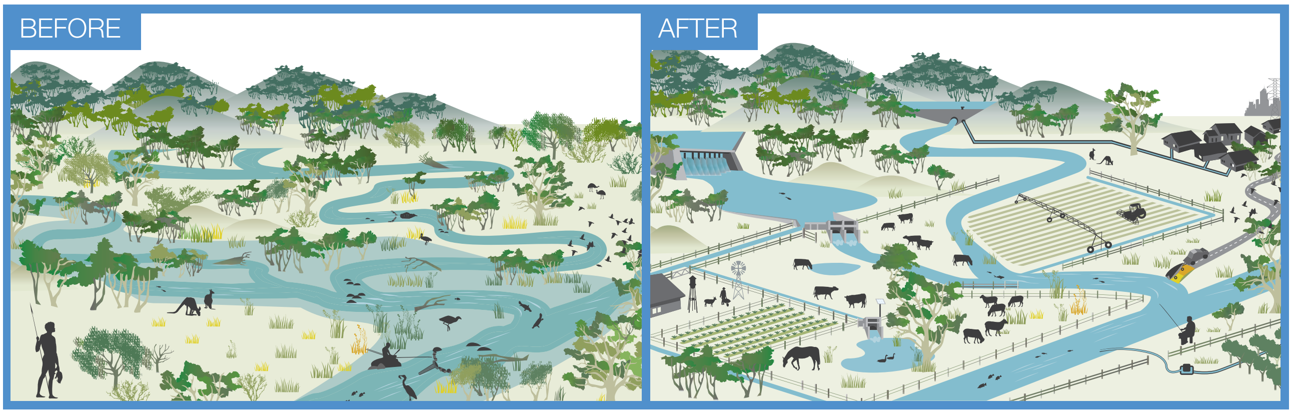
Many of Victoria's rivers and wetlands have been significantly modified, compared to how they were during the tens of thousands of years that Traditional Owners managed them. Water now flows differently through the landscape: it is captured in dams and weirs and diverted by infrastructure — pipelines, pumps, drains, levees and constructed channels — to support homes, farms, irrigators, industries, towns and cities.

In some rivers, up to half of the water that would have naturally flowed in them is removed each year to provide water for homes, farms and industry. While this allows communities to grow and thrive, it also means these waterways cannot function as they would naturally.

Reduced river flows and less frequent wetland inundation have disrupted the breeding cycles of native fish, frogs, waterbirds, platypus and other animals. They have restricted the growth and recruitment of native plants and reduced the productivity of waterways. Our waterways still support many native species, but the total abundance of native plants and animals has substantially declined, and the aesthetic value and ecosystem services those waterways provide have diminished.

Healthy waterways are essential for the plants and animals that live in them and for the people and industries that rely on clean water and the ecosystem services they provide. Many rivers and wetlands cannot survive altered water regimes without help. We must actively manage how water flows through these rivers, to protect their health and to support the plants that grow in them and the native animals that need them to live, feed and breed.

Figure 1.1.1 A typical Victorian river catchment before and after the development of dams, weirs and channels.



1.1.2 What do we mean by 'water for the environment'?

Water for the environment is water that is overseen by environmental water holders and released at a time and rate intended to improve the health of river and wetland systems including their biodiversity, ecological function, water quality and other uses that depend on environmental condition. It's not the only water that contributes to environmental condition, but it is water that governments reserve specifically to be actively managed to help mitigate the environmental impacts resulting from the modification of rivers and wetlands to supply water for consumptive uses. 'Environmental flows' and 'environmental water' are other terms to describe water for the environment.

The amount of water for the environment available to be released each year is described in environmental water entitlements, which are legal rights to water that is available in a reservoir or river system or another specified location. Environmental water entitlements have rules and conditions similar to those in other water entitlements used to reserve water for towns, irrigators and industry.

Environmental water holders must make decisions about the best use of this water each year, and the seasonal watering plan is the public preview of the types of decisions that might be made about environmental water entitlements in Victoria under a range of different circumstances throughout the year.

For more information about water for the environment, including how other water sources are considered in the planning and management of this water, see section 1.4.

1.1.3 What do we aim to achieve with water for the environment?

Water for the environment aims to support the habitat, feeding and breeding needs of native aquatic plants and animals. This includes maintaining flows or permanent pools in rivers that would otherwise dry out; maintaining water quality within tolerable limits; providing triggers for fish to migrate; watering wetlands to support carbon and nutrient cycles and to stimulate the growth of plankton, waterbugs or small fish to provide food for larger fish and waterbirds; and watering vegetation to keep it alive or to trigger new growth. To do these things, water for the environment is released into rivers to mimic some of the flows that would have occurred naturally, before the construction of dams, weirs and channels. This helps maintain the physical, chemical and biological health of rivers.

Environmental water managers set the timing, duration and volume of water releases to return some of the small- and medium-sized river flows that are essential in the life cycles of native plants and animals. For example, Australian grayling are signalled by an increased river flow in autumn to migrate downstream for spawning: to release their eggs. Breeding waterbirds need wetlands to retain water for long enough for their chicks to grow and fledge, and floodplain forests need to be inundated every few years to ensure the iconic tree species (such as river red gums and black box) survive and reproduce. Water for the environment also moves sediment and nutrients through river systems, connect habitats and improves water quality.

Many wetlands are now either disconnected from the rivers that used to naturally fill them, or they are permanently connected to rivers or channels. This means that some wetlands don't get enough water, and others get too much.

In wetlands, environmental water managers aim to provide the wetting and drying cycles that plants and animals depend on for survival, reproduction and long-term resilience. For example, where wetlands and floodplains have been cut off from natural river flows, environmental watering can reconnect these areas, sometimes using irrigation infrastructure (such as pumps, channels and regulators).

By improving the health of rivers, wetlands and floodplains, environmental watering also supports vibrant and healthy communities. Healthy waterways make cities and towns more liveable, which supports the physical and mental wellbeing of communities. They supply water for towns and diverse industries: agriculture, fishing, real estate, recreation and tourism, among others. Most of Victoria's towns are located near a river or lake with which the community identifies, and many people travel to their favourite waterway for holidays and to relax, play and connect with nature; and healthy waterways sustain Country for Aboriginal communities.

1.1.4 What is the Victorian environmental watering program, and who is involved?

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

The program involves a range of groups and organisations. Relationships between local communities, waterway managers, storage managers, land managers, environmental water holders and scientists are the foundation of the program. The program is overseen by the Victorian Minister for Water through the Department of Environment, Land, Water and Planning (DELWP).

Many public authorities collaborate to deliver the program: they 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 environmental watering proposals for the rivers and wetlands in their region. Waterway managers also order water for the environment from storage managers, and they monitor the outcomes of releases.

Storage managers — designated water corporations — deliver water for all water users including waterway managers and environmental water holders.

The VEWH decides where water for the environment will be used, carried over or traded, to get maximum benefit for the state's waterways. In northern Victoria, the VEWH also works with the Commonwealth Environmental Water Office, the Murray-Darling Basin Authority (MDBA) and at the New South Wales and South Australian governments to prioritise how and where water is used and to ensure the use of water for the environment is coordinated to optimise the health of the connected waterways of the Murray-Darling Basin.

Public land managers (such as Parks Victoria, DELWP and Traditional Owner land management boards) are closely involved in planning and delivering water for the environment on 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 water for the environment, it is essential to understand the environmental values of Victoria's rivers and wetlands. This understanding draws on the knowledge of local communities and scientists.

Local communities including Traditional Owners help identify environmental values in each region and help monitor the success of environmental watering. Local communities make great use of their local rivers and wetlands, and they bring a wealth of cultural, economic, recreational, social and Traditional Owner perspectives to the program.

Scientists provide indispensable evidence about how water for the environment supports native plants and animals in the short and long terms, and they work with waterway managers to monitor, evaluate and report on environmental watering outcomes.

Citizen scientists are increasingly monitoring environmental watering outcomes. In some regions, Birdlife Australia volunteers help monitor outcomes at wetlands, and Waterwatch volunteers collect water-quality information to inform management decisions about some rivers.

How are Traditional Owners engaged in the environmental watering program?

Traditional Owners' connections to Country are central to their sense of identity and cultural continuity. Victoria's waterways are an important part of Country, and Traditional Owners have successfully managed them for thousands of years. Program partners increasingly look to incorporate Traditional Owners' knowledge about how to manage waterways. For instance, in the northern region, Barapa Barapa and Wamba Wemba Traditional Owners work closely with North Central CMA to plan for and monitor environmental watering outcomes in Gunbower and Guttrum forests. In the western region, Barengi Gadjin Land Council has partnered with Wimmera CMA to deliver water for the environment to Ranch Billabong, which is a place of strong cultural significance.

Traditional Owners and their Nations in Victoria have a deep and enduring connection to Victoria's rivers, wetlands and floodplains, spanning tens of thousands of years. The VEWH and its program partners recognise the intersection between environmental flow objectives and Aboriginal environmental outcomes and acknowledge the benefit of genuine, enduring partnerships with Aboriginal people in planning and managing water for the environment.

In many regions of Victoria, Traditional Owner Nations have strong relationships with the program partners, and they are working to better realise Aboriginal Victorians' aspirations and to incorporate Traditional Owners and their objectives and knowledge into the management of environmental flows. These initiatives and ongoing contributions to the program are highlighted in the regional overviews in this seasonal watering plan.

There are certainly more opportunities for the VEWH and its partners to develop enduring partnerships with Traditional Owners who want to participate in the management of water for the environment. The VEWH and its program partners will continue to look for these opportunities and endeavour to develop enduring partnerships with Traditional Owners. The VEWH is funding some projects to help waterway managers and Traditional Owners identify opportunities to better align environmental watering objectives and actions with Aboriginal objectives and to participate in managing water for the environment.

1.1.5 What is the role of the Victorian Environmental Water Holder?

The VEWH is a statutory authority established by the Victorian Government in 2011. It is responsible for managing Victoria's water for the environment. Set up under the *Water Act 1989*, the VEWH manages environmental entitlements — a legal right to access a share of water available at a location — to improve the environmental values and health of Victoria's rivers, wetlands and floodplains, and the plants and animals that rely on them.

The role of the VEWH is to:

- make decisions about the most effective use of the environmental entitlements including for use, carryover and trade (see subsection 1.4.2)
- commit water and authorise waterway managers to implement watering decisions (see subsection 1.3.2)
- work with storage managers, waterway managers and other environmental water holders to coordinate and optimise environmental outcomes from the delivery of all water (see section 1.4)
- commission targeted projects to demonstrate the ecological outcomes of environmental flows at key sites and to help improve the management of water for the environment
- publicly communicate environmental watering decisions and outcomes
- invest in complementary works and measures, knowledge, monitoring, research and other priority activities in collaboration with DELWP, where it improves the ability to manage water for the environment and the performance of the environmental watering program.

The VEWH has four part-time commissioners, who are supported by a small team. The commissioners at the time this seasonal watering plan was published were Chris Chesterfield (Chairperson), Peta Maddy (Deputy Chairperson), Rueben Berg (Commissioner) and Jennifer Fraser (Commissioner). Commissioners are appointed by the Governor in Council on the recommendation of the Minister for Water.

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

The environmental watering program fits within broader Victorian Government policies for integrated catchment management: it is a holistic way of managing land, water and biodiversity from the top to the bottom of our catchments.

Key policy documents influencing the VEWH from a Victorian context include *Water for Victoria*, the *Victorian Waterway Management Strategy* and regional sustainable water strategies. Regional waterway strategies also determine priority waterways, in consultation with local communities, and outline integrated waterway management actions.

Water for Victoria is a plan for a future with less water as Victoria responds to the impacts 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 sector including the VEWH. *Water for Victoria* recognises that protecting and improving waterway health is a long-term commitment that needs coordinated action. 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 environmental flows are planned for many of these waterways in this seasonal watering plan.

Complementary catchment management activities are often needed to achieve 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 through large, woody habitat). 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 1.1.2 shows examples of complementary waterway management activities in Victorian waterways that receive water for the environment.

In most systems, environmental flows are delivered using existing infrastructure (such as dam outlet gates and water supply channels) built for and still used for the supply of water for irrigators, industries and communities. Permanent and temporary pumps are sometimes also used to deliver water for the environment to wetlands. Capacity limits with these types of infrastructure and the need to avoid flooding private land restrict the size and timing of releases of water for the environment. In some systems, these restrictions mean only a fraction of the required environmental flows can be released into waterways, which significantly reduces the environmental outcomes that can be achieved.

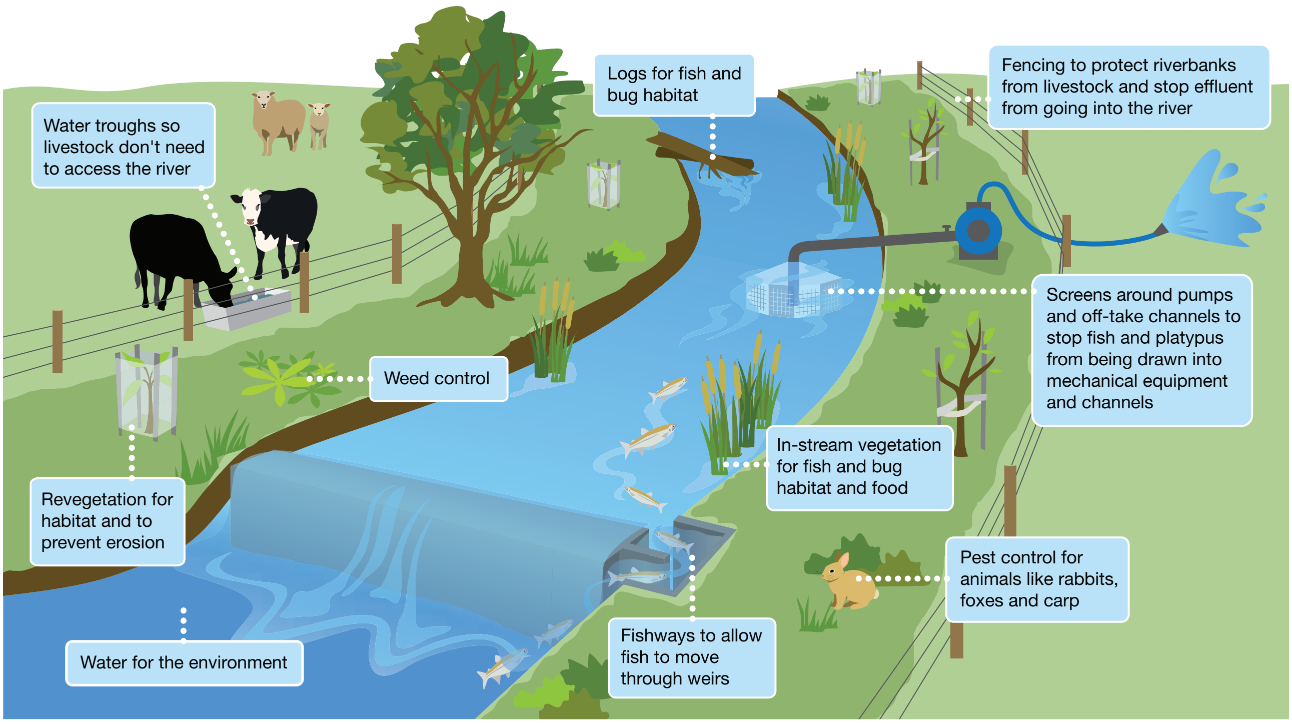
Victoria's environmental watering program is integral to the success of the following three strategies and plans.

Our Catchments, Our Communities 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. Under this strategy, CMAs will lead 10 new integrated catchment management projects across the state, in collaboration with catchment management partners. The Caring for Campaspe and Living Moorabool projects are two projects involving environmental watering actions.

Protecting Victoria's Environment – Biodiversity 2037 is the plan 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 is being 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 that form part of the basin. The VEWH continues to work closely with the Victorian Government and other agencies to implement the Basin Plan.

Figure 1.1.2 Examples of complementary management actions



1.1.7 How does the environmental watering program consider climate change?

Victoria's climate has seen a drying and warming trend over the last two decades, and it is predicted this trend will continue in the future. Climate modelling[1] indicates there will be more extreme events including droughts, floods and heatwaves, and there are expected to be more bushfires. Seasonal shifts in rainfall are expected to continue, with proportionally less rain in the cooler months. Average streamflow is predicted to decline across all parts of Victoria, with some of the greatest declines expected in the south-west and parts of the central and northern regions, as Figure 1.1.3 shows.

Some effects of climate change are already apparent. The *Long-term Water Resource Assessment for Southern Victoria*[2] shows that long-term water availability for the environment has declined by 4–28% in southern basins over the last 10–15 years, as Figure 1.1.4 shows. Reduced rainfall over this period has resulted in less frequent spills from reservoirs and lower rates of catchment run-off to waterways downstream of reservoirs. These changes mean that water for the environment needs to be a greater proportion of the water that is essential for environmental outcomes including waterway and wetland health.

Environmental water entitlements on their own are less than what is recommended for intended environmental outcomes; and if a greater proportion of entitlements is used to compensate for reduced spills and run-off, there will be fewer opportunities to release the managed flows needed to improve environmental outcomes. A long-term water resource assessment for northern Victoria is due to begin in 2025.

These observed and forecast changes to streamflows and extreme climatic events threaten not just to reduce the availability of water for the environment but also to decrease water quality and increase the incidence of algal blooms. Plants and animals that live in and around waterways and rely on well established flow patterns for successful feeding, breeding and movement through the landscape will also be affected.

Action 3.5 of *Water for Victoria* aims to improve the management of environmental flows in a changing climate. It states the Victorian Government's commitment to continue to invest in environmental works and measures for priority environmental watering sites, which will allow better use of the VEWH's existing water. In some instances, the VEWH may be able to opportunistically complement this investment using water trade revenue, where this optimises environmental outcomes.

1 Timbal, B. et al. (2016) *Climate change science and Victoria*. Victoria Climate Change Initiative (VicCI) report. Bureau of Meteorology, Australia. Bureau Research Report 14, pp 94.

2 Department of Environment Land Water and Planning 2020, *Long-Term Water Resource Assessment for Southern Victoria*, Victorian Government, Melbourne.

Action 3.5 also reaffirms commitments to recover water for the environment in the Thomson, Barwon, Moorabool, Werribee and Maribyrnong systems. Extra water was added to the Thomson environmental entitlement in 2017 and a new environmental entitlement was created for the upper Barwon River in 2019. Work continues to investigate water-recovery options in the other systems. All water recovered under these commitments will be managed by the VEWH and its partners to optimise future environmental outcomes in the face of climate change.

The VEWH and its program partners are addressing the challenges of climate change in the following ways.

Setting environmental watering objectives that describe the environmental outcomes that can be achieved under future climatic conditions

Environmental flow studies and environmental water management plans are revised periodically to update environmental watering objectives and their required water regimes. These reviews consider how climate change will affect current environmental values and the types of outcomes that can be achieved in the future. Waterway managers also alter environmental watering objectives for individual systems to include the latest scientific information, as it becomes available. The seasonal watering plan presents the most up-to-date environmental watering objectives and the watering actions required to achieve them.

Strengthening decisions about where and how water for the environment is used

During prolonged dry periods (which are more likely in the future), there is not enough water available to meet the needs of all waterways. Rigorous decisions must be made about where and how to use the available water, to optimise environmental outcomes for enduring benefit. Most high-priority environmental watering objectives rely on ecosystem processes that operate beyond individual rivers or wetlands. Therefore, in prioritising sites for environmental watering, decision-makers are increasingly considering the combination of waterways that need to be watered to optimise outcomes. Portfolios of waterways are being managed in a coordinated way to support high-value species, as well as critical ecosystem services.

For example, coordinated releases from Hume Reservoir, the Goulburn River and Campaspe River have been used to trigger the movement of young golden perch and silver perch throughout northern Victorian waterways. The VEWH and its program partners are also working together to identify the most important refuge habitats to water during critically dry periods.

Optimising environmental outcomes of operational water releases

The VEWH is working closely with storage managers and river operators to identify how operational releases — water releases made from storages to enable the water distribution system to operate or make water available for consumptive uses — can be delivered in ways that meet customer needs and contribute to environmental outcomes. This also helps river operators meet their environmental obligations.

Planning for a range of climatic scenarios each year

Watering requirements can vary considerably between wet and dry years. In drought and dry conditions, the aim is to prevent catastrophic losses and maintain critical refuge habitats to prevent significant declines of native populations. In wet conditions, the aim shifts to boosting ecological productivity and environmental condition and to increasing populations of native plants and animals. Climatic conditions can change quickly within a year, and the VEWH and its program partners need to be able to respond accordingly. The seasonal watering plan identifies potential watering actions that may be delivered to each system under different climatic scenarios: this is explained in more detail in subsection 1.3.4.

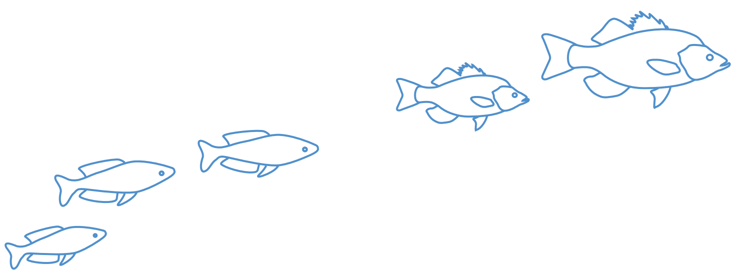
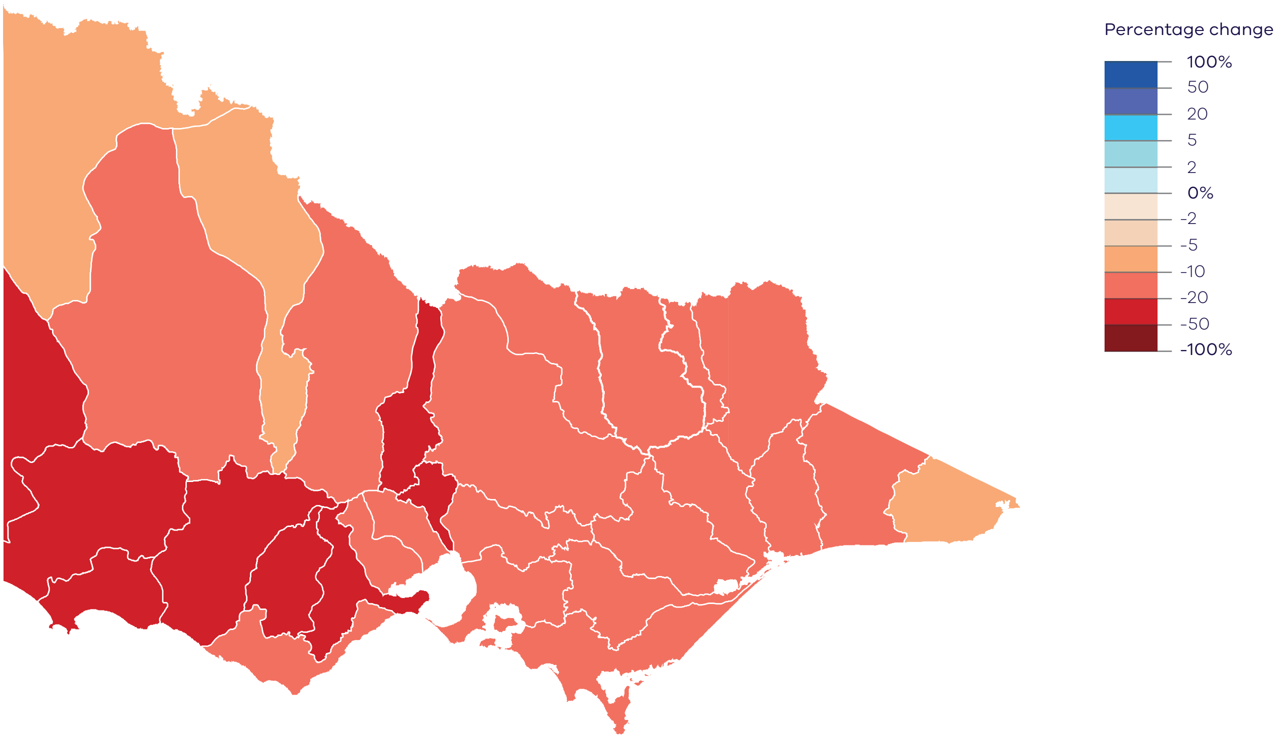
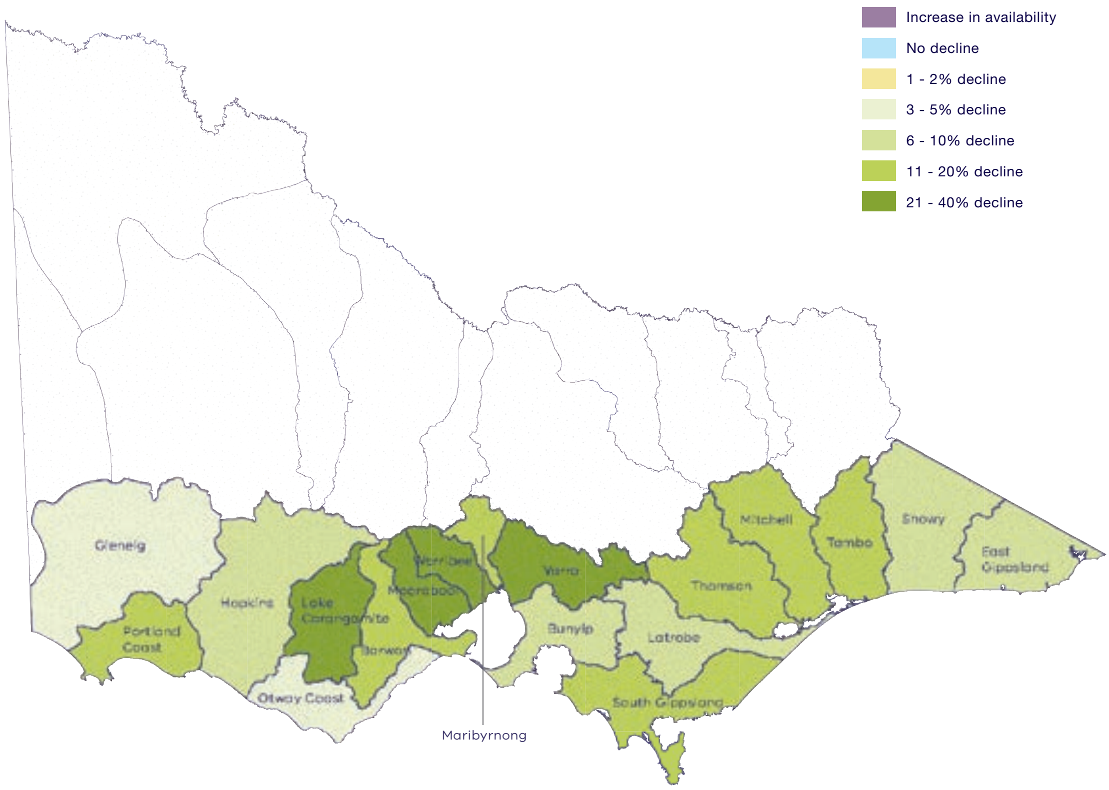


Figure 1.1.3 Projected changes in run-off in 2065, medium climate change scenario



Source: Water for Victoria, 2016

Figure 1.1.4 Changes in long-term surface water availability for the environment since 2005, by basin, southern Victoria



Source: Long-term Water Resource Assessment for Southern Victoria

1.1.8 How do we know the environmental watering program is successful?

Effective monitoring is essential for the continued improvement of the environmental watering program. It provides information that can be shared with all stakeholders to demonstrate the outcomes of watering actions, and it identifies what is needed to improve the effectiveness of future watering actions.

The effect of water for the environment in Victoria is directly assessed through large-scale monitoring programs, which measure multiple indicators at multiple sites over multiple years. There are also discrete investigations that examine responses at a single wetland or river reach.

DELWP funds two programs that monitor environmental watering outcomes at a statewide scale. The Victorian Environmental Flows Monitoring Assessment Program (VEFMAP) investigates the effect that environmental flows in Victorian rivers have on native fish and aquatic and riparian vegetation. The Wetland Monitoring Assessment Program (WetMAP) examines the effect that water for the environment has on native vegetation, waterbirds, fish and frogs in wetlands.

Selected Victorian waterways are monitored as part of three Murray-Darling Basin environmental water monitoring programs. The MDBA funds environmental condition and intervention monitoring activities at Barmah Forest, Gunbower Forest, Hattah Lakes and the Lindsay, Mulcra and Wallpolla islands as part of The Living Murray program. Annual condition report cards that are produced for each site demonstrate the effect of more than a decade of environmental watering at these important icon sites (see Figure 1.1.5). The Commonwealth Environmental Water Holder (CEWH) funds fish, vegetation, stream metabolism and bank erosion monitoring in the lower Goulburn River as part of its basinwide Long-term Intervention Monitoring program. The Australian Government, along with key research organisations and jurisdictional agencies, funds the Environmental Water Knowledge and Research program, which investigates four themes — vegetation, fish, waterbirds and food webs — to improve the science that supports the management of water for the environment in the Murray-Darling Basin.

The VEWH funds waterway managers to conduct discrete, short-term investigations at river reaches and wetlands. These investigations focus on learning and adaptive management.

A secondary focus of the VEWH's monitoring investment is communications, engagement and reporting to the community. To achieve these, the VEWH helps community groups, citizen scientists and Traditional Owners observe and report on the outcomes of the environmental watering program.

The VEWH and its program partners regularly liaise with scientists who are monitoring responses on the ground and with organisations responsible for overseeing the larger-scale monitoring programs, to ensure the most up-to-date information is used to inform environmental watering decisions. The VEWH also reports some of the available monitoring results in its annual *Reflections* report, to increase awareness about environmental watering outcomes among all stakeholders and the community.

Figure 1.1.5 shows scores by the MDBA of the overall achievement of ecological objectives for Living Murray icon sites between 2006–07 and 2017–18. Sites with scores higher in the alphabet have consistently received a large proportion of their water regime for five or more years. See www.mdba.gov.au for details.

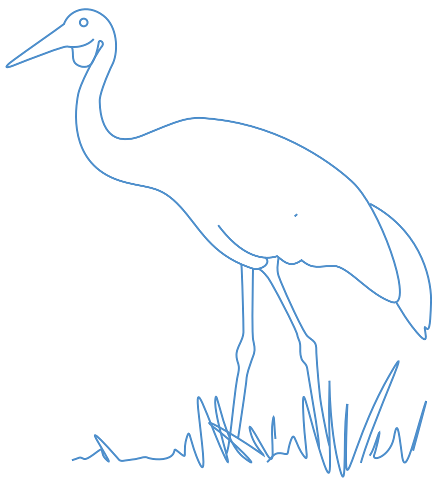


Figure 1.1.5 Environmental condition report card scores, Living Murray icon sites, 2006–07 to 2017–18

Overall achievement of objectives scores

	Barmah-Millewa Forest	Gunbower Forest	Koondrook-Perricoota Forest	Hattah Lakes	Lindsay, Mulcra and Wallpolla islands	Chowilla floodplain	Lower Lakes, Coorong and Murray Mouth
2018–19	B	A	D	B	B	B	C
2017–18	A	B	D	A	B	B	C
2016–17	A	B	C	A	B	B	B
2015–16	B	B	D	A	B	C	C
2014–15	B	B	D	A	-	C	B
2013–14	C	B	D	B	C	C	B
2012–13	C	B	D	C	C	C	B
2011–12	C	C	D	B	B	C	B
2010–11	B	B	D	C	C	B	D
2009–10	C	C	D	D	D	C	D
2008–09	D	C	D	D	D	C	D
2007–08	D	D	D	D	D	-	D
2006–07	D	-	-	-	-	-	C

Grades	A	B	C	D	-
	Most (75–100%) of ecological objectives have been met	More than half (50–74%) of ecological objectives have been met	Fewer than half (25–49%) of ecological objectives have been met	Few (0–24%) of ecological objectives have been met	Data not available

1.1.9 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 from the VEWH on (03) 9637 8951 or by email to general.enquiries@vewh.vic.gov.au.

You can get more detailed information about water for the environment in your region by contacting your local waterway manager: the contact details are in section 6.3.

Water for the environment fact sheets

The VEWH's fact sheets answer questions about water for the environment. 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 ...

1.2.1 What does 'seasonal' mean?

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

1.2.3 Who contributes to the seasonal watering plan?

1.2.4 Can the seasonal watering plan be changed?

1.2.5 When isn't a formal variation required to the seasonal watering plan?

The seasonal watering plan is a publicly available, transparent preview of all the potential watering actions 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 for use in Victoria (see subsection 1.4.1).

The seasonal watering plan for the upcoming water year is released by 30 June each year. The 2020–21 plan and any variations are valid for this water year — 1 July 2020 to 30 June 2021 — 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. It includes normal differences between summer, autumn, winter and spring, as well as an assessment of whether a year is drier or wetter than average. Environmental watering objectives and water availability may differ depending on seasonal conditions, so it is important that planning for water for the environment considers the range of potential seasonal conditions or water availability scenarios that may unfold, ranging from drought to very wet. This scenario planning provides a guide for the VEWH and waterway managers throughout the year when it comes to deciding what environmental flows to go ahead with. There is more information about how seasonal conditions influence environmental flows planning in subsection 1.3.4.

For each river and wetland system, the potential environmental flows under each seasonal condition or water availability scenario is explained under 'Scenario planning' in the relevant section.

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

Each year, waterway managers scope the potential environmental watering actions for their regions for the coming year in their 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). Environmental flow studies and environmental water management plans for Victorian waterways are available on the VEWH's website at vewh.vic.gov.au. Waterway strategies and regional catchment strategies are published on the relevant waterway manager's website. The seasonal watering proposals incorporate information and advice from local communities including Traditional Owners.

The VEWH reviews the proposed watering actions in each seasonal watering proposal and works with waterway managers to identify the potential watering actions for each region and across the state. This seasonal watering plan is a collated summary of the agreed actions from all the seasonal watering proposals.

The different stages of environmental flows planning including the different strategies and plans are shown in Figure 1.2.1. There is more information about each of these strategies and plans at vewh.vic.gov.au.

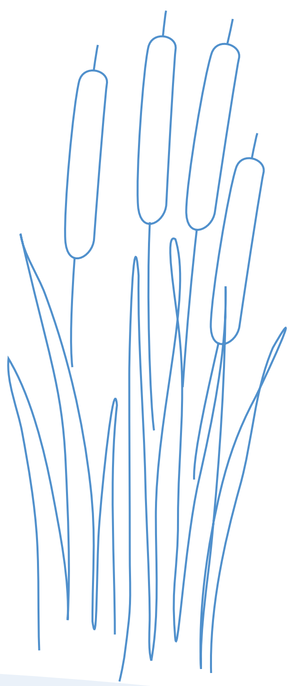


Figure 1.2.1 Victorian environmental watering program planning framework

Key - who is responsible for what
- Waterway managers
- VEWH
- Expert advisors

Regional waterway strategy
- Identifies priority river reaches/wetlands and values in each region
- Developed every eight years in consultation with local communities

Guides priorities for ↓

Environmental water management plan
- Outlines long-term environmental objectives, desired flow regimes and management arrangements
- Will be developed progressively for each system/site identified as a long-term priority for environmental watering
- Updated as required with new information
- Assumes current water recovery commitments/ targets

← Informs

Expert advice
- Environmental flow study: expert analysis of flow components required to support key environmental values and objectives
- Monitoring results: outcomes from monitoring programs such as the Victorian Environmental Flows Monitoring and Evaluation Program
- Traditional ecological knowledge, academic/ consultant expertise

Forms basis of ↓

Seasonal watering proposal
- Describes regional priorities for environmental water use in the coming year under a range of planning scenarios
- Developed annually

← Informs

Community engagement
- For example, Environmental Water Advisory Groups, Traditional Owners, local community groups, recreational users, irrigators, environment groups.

↓

Seasonal watering plan
- Describes statewide potential environmental watering in the coming year under a range of planning scenarios
- Developed annually
- Consolidates the seasonal watering proposals accepted by the VEWH
- Can be varied at any time (with same consultative requirements as initial development)

→ Decisions communicated through

Seasonal watering statement
- Communicates decisions on watering activities to be undertaken as water becomes available during the season
- Authorises waterway managers to undertake watering
- Can be released at any time during the season
- May be one or multiple statements for a system

↓

Water for the environment is delivered

1.2.3 Who contributes to the seasonal watering plan?

Stakeholder engagement about potential environmental watering actions occurs during the development of seasonal watering proposals. The level and method of engagement vary across the state, reflecting the differing systems, watering actions and stakeholders. In some regions, formal environmental watering advisory groups provide the opportunity for waterway managers and interested community members to discuss potential environmental flows 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, people living close to or with an interest in a specific waterway, members of recreational groups and members of local environmental groups.

Land managers and storage managers also consider and endorse, or provide their written support for, the seasonal watering proposals. This ensures releases of water for the environment align with land and storage management objectives and can feasibly be delivered through planned system operations, and that risks can be adequately managed.

For each region, there is a summary of the engagement activities waterway managers undertook when developing seasonal watering proposals: these are in the regional overviews in sections 2 to 5.

1.2.4 Can the seasonal watering plan be changed?

Under the *Water Act 1989*, the VEWH can only authorise the use of water for the environment if it is consistent with the seasonal watering plan. This is to ensure transparency about what environmental flows are planned and how they are managed.

To ensure flexibility to adapt to changing conditions, the Act allows the VEWH to vary any section of the seasonal watering plan. Variations may be needed to incorporate new knowledge or to address circumstances that were 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 current seasonal watering plan. You can email general.enquiries@vewh.vic.gov.au for a hard copy of any attachments.

1.2.5 When isn't a formal variation required to the seasonal watering plan?

In some instances, there may be unforeseen circumstances that will call for use of water for the environment that does not require a variation to the seasonal watering plan.

These include:

- minor operational adjustments to specific environmental watering actions
- water for the environment being used for environmental emergency management purposes
- small volumes of water for the environment being used for technical investigations or infrastructure maintenance
- facilitating the delivery of water for the environment held by other water holders for downstream, non-Victorian objectives.

As the VEWH cannot anticipate the specifics of these circumstances, it cannot include details about them in this plan. Waterway managers are required to consult the VEWH in all instances where releases of water for the environment do not align with the seasonal watering plan.

Minor operational adjustments

Minor operational adjustments to environmental watering actions may occur from time to time. For example, the targeted river reaches, flow rates, timings, magnitudes and durations detailed in sections 2 to 5 may need to be adjusted slightly, due to changes in predicted rainfall or other water orders, delivery infrastructure constraints, emerging ecological knowledge or the timing of specific ecological triggers (such as a bird-breeding event). In all cases, environmental watering actions will still aim to optimise environmental outcomes, in line with the objectives set out in the seasonal watering plan.

Environmental emergency management situations

Water for the environment may be needed for an environmental emergency management situation, for example to mitigate a toxic water quality event. Section 1.3.7 describes how environmental watering emergencies are managed and authorised.

Small technical investigations and maintenance

There may be instances where a small volume of water for the environment may be used for research and development purposes, or for small-scale infrastructure-testing or maintenance. Such instances are considered on a case-by-case basis and must aim to enhance knowledge and improve the management of water for the environment. They 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 South Australia). 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 harms to Victoria's rivers, wetlands and floodplains (and other risks) are appropriately managed.

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 water for the environment is committed and delivered.

In this section ...

Some factors that influence decisions about committing and delivering water for the environment 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 the flexibility to respond to these different factors, as they can significantly influence the environmental outcomes and shared benefits that can be achieved.

1.3.1 How are watering decisions made throughout the year?

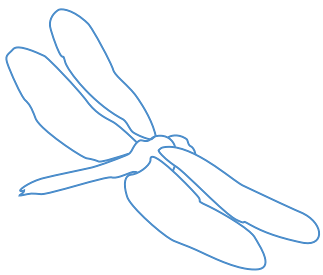
As the season unfolds, many of the uncertainties associated with seasonal conditions, water availability and operational context become clearer, and this clarity informs decisions about what environmental flows should proceed. Many on-ground factors do not become clear until very close to the anticipated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

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

Waterway managers, storage managers and land managers provide advice about which watering actions are needed and can be delivered in each region during the year. Environmental water holders use that information to decide which watering actions to authorise. All program partners have a role in identifying potential watering actions and enabling the release of water for the environment (as explained in subsection 1.3.3).

If planned watering actions need to be significantly changed during the season to respond to unforeseen circumstances, 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 Victorian Environmental Water Holder commit and authorise the use of water for the environment?

The VEWH aims to commit as much water as is sensibly possible, as early as possible, to provide waterway managers with certainty 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 release water for the environment. 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 system during the water year. 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 across different systems require access to the same environmental or bulk entitlement, decisions to commit water may require more thorough consideration. This may require prioritisation of one river or wetland over another or prioritisation of one flow component over another. Subsection 1.3.3 has further information about how these decisions are made.

In some instances, the VEWH may commit water very close to the anticipated date of release. This may be necessary because demand for the water arises at short notice, due to environmental, operational or weather conditions. For example, a colonial waterbird nesting event in Barmah Forest may trigger a need for water for the environment to maintain shallow flooding long enough for the birds to fledge.

There may also be instances where planned environmental flows are not delivered to a site. For example, an ecological trigger or seasonal conditions could nullify the potential benefit of the planned delivery, or a lack of catchment inflows may mean there is not enough water for the planned watering action.

The CEWH and the Southern Connected Basin Environmental Watering Committee (for The Living Murray program) commit water for use in Victoria with similar logic to that explained above. The VEWH then formally authorises the use of that water through seasonal watering statements.

Can environmental water holders and waterway managers 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 be due to environmental triggers indicating the water was no longer required, resourcing constraints or new information that the potential environmental or public risk of watering is too high.

1.3.3 How does the Victorian Environmental Water Holder prioritise different watering actions when there is not enough water for the environment available?

The VEWH works with its program partners to make decisions about where its available water the environment (and funding) are used, carried over or traded, to get maximum benefit for the state's waterways — our rivers, wetlands, estuaries and floodplains — and the wildlife that depend on them.

In implementing this program, it is important to recognise the dynamic nature of the environmental watering program. Seasonal conditions can vary considerably between years, which affects both the requirements of particular sites for water for the environment (the demand) and the availability of water for the environment (the supply).

A shortfall in supply might arise because of:

- significant, high-value demands for water for the environment
- drought or low water availability.

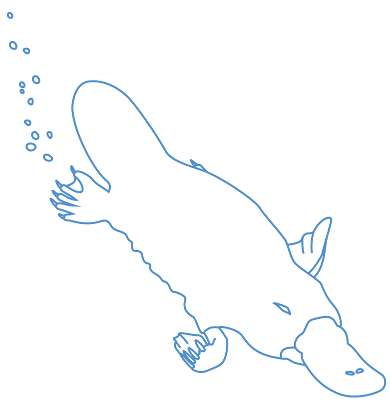
To meet a shortfall, the VEWH may look to use tools such as carryover and trade (as explained in subsection 1.4.2). If there is still a shortfall of water, the VEWH, in collaboration with waterway managers and other water holders if relevant, must prioritise between environmental watering actions.

Many factors influence prioritisation decisions (such as the likely environmental outcomes, the previous watering history in that river or wetland, environmental or public risk considerations and seasonal conditions in the region). Trade-offs may need to be made about watering actions undertaken in one year or at one site, and water may need to be provided at the expense of watering actions in the next year or at another site. Trade-offs may also need to be made about foregoing watering actions to sell water allocation and use the resulting revenue for complementary works and measures or to improve knowledge and capability to deliver better environmental outcomes.

In deciding to prioritise one environmental watering action or 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 the VEWH considers when making trade-off decisions and prioritising specific 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.



In deciding how to use the available Water Holdings (as explained in subsection 1.4.1) in any given year, the VEWH also considers additional factors, such as:

- decisions by other water holders about the use of their water for the environment
- State and Commonwealth government decisions about water resource policy
- the resources, knowledge and capability of the VEWH and its program partners
- storage managers meeting their obligations to the environment associated with the right to harvest and distribute water sustainably
- complementary works and measures being undertaken
- the availability of funds
- the merit of selling available water allocation to fund works or technical investigations to enhance environmental outcomes
- services associated with the management of Water Holdings and the delivery of water for the environment.

Prioritisation has historically occurred on a site-by-site basis, but many of the ecological processes that underpin waterway health operate at a landscape scale. The prioritisation process is currently evolving to consider the combination of watering actions that are needed across multiple waterways in a region to achieve the best environmental outcomes. The prioritisation criteria shown in Figure 1.3.1 can be equally applied at individual sites or at the broader landscape scale.

Figure 1.3.1 Criteria for prioritising environmental watering actions

Prioritisation criteria	Types of factors considered
Extent and significance of environmental benefit	▶ Size of the area being watered ▶ Expected ecological outcomes ▶ Expected scale of response ▶ Conservation status of the species or community that will benefit ▶ Expected contribution to regional environmental objectives
Likelihood of success	▶ Evidence that the desired outcomes are likely to be achieved ▶ External threats that may affect getting the desired results
Longer-term benefits	▶ Value added to previous watering undertaken 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 ▶ 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 ▶ Likelihood that planned management actions will mitigate external threats
Environmental or third party risks	▶ Adverse environmental outcomes that may arise ▶ Third-party risks associated with the event ▶ Effectiveness of mitigation to manage third-party and environmental risks
Cost effectiveness of the watering action	▶ Likely environmental benefit compared against: • costs to deliver and manage water • costs of interventions to manage 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 flows ▶ Risks of spills from storages in the upcoming water year and any carryover water (see section 1.4.2) that may be available
After consideration of above criteria	
Cultural, economic, social and Traditional Owner benefits	▶ Traditional Owner values and aspirations ▶ Recreation, community events and activities ▶ Economic benefits

Who is involved in the prioritisation process?

Waterway managers, environmental water holders, storage managers and communities (including recreational user groups, environmental groups, Traditional Owners and farming groups) all have a role in the process of prioritising environmental watering actions, depending on the nature and scale of the decisions 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. 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 and 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 consent to the delivery of environmental flows on their land, and they advise about the feasibility of delivery after considering 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 water for the environment (and other river health activities) that have high cultural, economic, environmental, social and Traditional Owner values.

Additional input from the community about prioritising water for the environment is provided annually where needed.

1.3.4 Do seasonal conditions affect how water for the environment is used?

In the same way that rainfall patterns influence how people water their gardens or paddocks, different climatic conditions influence how water for the environment 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 subsection 1.2.1). Waterway managers take seasonal conditions into account when prioritising the water for the environment needed at each site. Seasonal planning scenarios 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 outcomes they can achieve using water for the environment by considering factors including:

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

Planning scenarios are presented in the seasonal watering plan and provide the basis for the adaptive management of water for the environment 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 water for the environment is managed in a year.

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 Conditions	No or negligible contributions from unregulated flows. Waterways may stop flowing at times, more likely during summer/autumn	Minor contributions from unregulated reaches and tributaries, more likely in winter/spring	Unregulated flows provide extended low flows and multiple freshes, more likely in winter/spring. Minor storage spills may occur	Extended unregulated high flows, multiple large storage spills and overbank flooding, more likely in winter/spring but possible any time of year
Management Objectives	Protect	Maintain	Recover	Enhance
	• Avoid critical loss • Maintain refuges • Avoid catastrophic events	• Maintain river functioning with reduced reproductive capacity • Maintain key functions of high-priority wetlands • Manage within dry-spell tolerances	• Improve ecological health and resilience • Improve recruitment opportunities for key plant and animal species	• Restore key floodplain wetland linkages • Maximise recruitment opportunities for key animal and plant species
Example watering actions to support management objectives	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 low flows to maintain habitat connectivity to support fish movement	Maintain year-round low flows and seasonal freshes to improve the quality 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	Maintain connectivity and the exchange of nutrients between the river and floodplain
			Provide seasonal freshes to support the establishment and maintenance 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 low flows and spring peaks

1.3.5 How are shared cultural, economic, recreational, social and Traditional Owner benefits considered in environmental watering decisions?

By improving the health of rivers, wetlands and floodplains, environmental flows also provide benefits to communities. Community benefits may be direct: for example, water for the environment can increase populations of popular angling fish species, sustain healthy Country and totem species for Aboriginal communities and improve water quality to the benefit of irrigators. Or it may be opportunistic: for example, the delivery of an environmental flow might be timed to increase opportunities for kayakers and so the public know about the flow and can take advantage of it.

In planning for environmental flows, the primary purpose is to optimise environmental benefits. Year by year and case by case, the VEWH and its partners consider opportunities raised by communities to use water for the environment to provide additional cultural, economic, recreational, social and Traditional Owner benefits. Where possible, these opportunities are incorporated into watering decisions, provided they do not compromise environmental outcomes.

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

When planning for and delivering environmental flows, the VEWH and its program partners look for opportunities to achieve shared community benefits in both the short and longer terms, without compromising environmental outcomes. Longer-term community benefits may sometimes require short-term inconvenience. For example, floodplain watering in Hattah Lakes may limit access and so inconvenience campers for a short time, but the environmental benefits of the watering are likely to improve tourism and recreational opportunities in the longer term. In such cases, waterway managers work closely with land managers to limit disruption to users as much as possible.

Waterway managers work with communities to identify the cultural, economic, recreational, social and Traditional Owner values of waterways and to consider them in regional catchment strategies, regional waterway strategies, environmental water management plans and seasonal watering proposals.

The opportunities identified for 2020–21 are summarised in the introduction to each region in sections 2 to 5 of this plan. In each system section, watering actions are specifically planned to an Aboriginal cultural, social or recreational objective are identified with the icons shown in Figure 1.3.3. This is a new way for the VEWH to identify cultural and recreational values in the seasonal watering plan, and it expects to refine this approach in future years to better capture these values.

Figure 1.3.3 Cultural, social and recreational objectives icons

Icon	Objective
	Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses
	Watering planned to support water sports activities (e.g. canoeing, kayaking, rowing, swimming, water skiing)
	Watering planned to support waterbird-related recreational activities
	Watering planned to support angling activities
	Watering planned to support peaks in visitation (e.g. camping or other public activities on long weekends or school holidays)

Program partners will continue to work with stakeholders to look for opportunities to achieve shared community benefits from water for the environment throughout the year.

1.3.6 How are risks managed?

Risk management is an integral part of managing water for the environment. Program partners consider risks continually during long-term and annual planning, implementation and review.

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

The seasonal watering proposals on which this seasonal watering plan is based identify potential risks associated with the specific watering actions proposed for the coming water year. A collaborative approach is the best way to manage the shared environmental watering risks; so, as part of developing the proposals, partners jointly assess risks and identify and commit to mitigation actions.

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, forecast heavy rain that coincides with a planned environmental flow could increase the risk of nuisance flooding. Program partners review risks immediately before a planned environmental flow and implement measures to mitigate the risks as agreed with relevant program partners. Watering actions will not be implemented if unacceptable risks to the public or the environment cannot be mitigated.

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 the capacities of water systems and monitor water levels at key locations to inform daily water release decisions to ensure impacts do not eventuate. • Consider potential catchment run-off from forecast rainfall before deciding on the timing of releases of water for the environment. • Implement a communication strategy which may include media releases, public notices and signage before environmental flows, to ensure people are informed of significant deliveries of water for the environment 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 responses to water for the environment. • 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)	• Plan the timing, frequency, duration and variability of environmental flows to limit negative effects. • Monitor environmental watering outcomes and adapt future deliveries and/or scientific recommendations if necessary.

Even with best practice risk management controls, there may be unintended effects from environmental flows or situations where environmental flows cannot be delivered as planned. In those situations, program partners work together to respond to incidents 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.

1.3.7 How are environmental watering emergencies managed?

An emergency watering action is where water for the environment may be required to prevent, mitigate or respond to an acute environmental threat. Common threats are to water quality from low oxygen levels, toxic levels of blue-green algae, high temperatures or high salinity and water levels at a refuge habitat or breeding site that drop and pose an immediate risk to native aquatic biota.

Due to the unpredictability of acute environmental threats, potential emergency watering actions may not be specifically described in sections 2 to 5 of this seasonal watering plan. The VEWH has developed an emergency watering procedure to allow unplanned emergency environmental watering actions to be taken at short notice.

Emergency watering procedure

Emergency environmental watering actions typically fall into two scenarios.

- Where the required watering action is not described (adequately or at all) in the current seasonal watering plan, but there is a valid seasonal watering statement with water available that covers other watering actions for the affected system and authorises a total volume that is sufficient for the proposed emergency watering action.
- Where there is no authorised seasonal watering statement for the affected system or there is insufficient water available under the seasonal watering statement to cover the proposed emergency watering action.

Under the first scenario, waterway managers may reprioritise watering actions authorised under the existing seasonal watering statement to allow an emergency watering action to be delivered without impacting the overall resource. Under the second scenario, waterway managers must request an emergency seasonal watering statement from the VEWH before water for the environment can be used for an emergency watering action. The VEWH has administrative processes to support emergency environmental watering decisions and to expedite requests for emergency seasonal watering statements.

1.4 Managing available water for the environment

Environmental entitlements are held in 15 water supply systems across Victoria. Sections 2 to 5 detail where water made available under these entitlements may be delivered in 2020–21.

In this section ...

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

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

VEWH environmental entitlements

Water for the environment is made available under the environmental entitlements held by the VEWH. Table 1.4.1 shows the entitlements held by the VEWH as at 31 May 2020, including those held in trust for the Living Murray program. The VEWH's environmental entitlements can be viewed at waterregister.vic.gov.au/water-entitlements/bulk-entitlements.

Table 1.4.1 Environmental entitlements held by the VEWH (as at 6 May 2020)[1]

System	Entitlement	Volume (ML)	Class of entitlement
Central region			
Barwon	Barwon River Environmental Entitlement 2011	N/A[2]	Unregulated
	Upper Barwon River Environmental Entitlement 2018	2,000[3]	Share of inflow
Moorabool	Moorabool River Environmental Entitlement 20104	7,086[3]	Share of inflow
Tarago	Tarago and Bunyip Rivers Environmental Entitlement 2009	3,000[3]	Share of inflow
Werribee	Werribee River Environmental Entitlement 2011	N/A[3]	Share of inflow
Yarra	Yarra Environmental Entitlement 2006[4]	17,000 55	High Unregulated
Gippsland region			
Latrobe	Lower Latrobe Wetlands Environmental Entitlement 2010	N/A[2]	Unregulated
	Blue Rock Environmental Entitlement 2013	18,737[3]	Share of inflow
Macalister	Macalister River Environmental Entitlement 2010	12,461 6,230	High Low
Thomson	Bulk Entitlement (Thomson River – Environment) Order 2005[4]	10,000 8,000[3]	High Share of inflow
Western region			
Wimmera and Glenelg	Wimmera and Glenelg Rivers Environmental Entitlement 2010[4,5]	40,560 1,000	Pipeline product Wetland product
Northern region			
Broken	Water shares	90 19	High Low

System	Entitlement	Volume (ML)	Class of entitlement
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
Goulburn	Goulburn River Environmental Entitlement 2010	26,555 5,792	High Low
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625 156,980	High Low
	Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012	1,398[6]	High
	Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004	30,252 8,156	High Low
	Water Shares – Snowy River Environmental Reserve	8,321 17,852	High Low
	Water Shares – Living Murray program	5,559	High
	Silver and Wallaby Creeks Environmental Entitlement 2006[4]	N/A	Passing flow only
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
Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	45,267 8,523 49,000	High Low Unregulated
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah–Millewa Forest Environmental Water Allocation	50,000 25,000	High Low
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	9,589 101,850 34,300	High Low Unregulated
	Environmental Entitlement (River Murray – NVIRP Stage 1) 2012	1,155[6]	High
	Bulk Entitlement (River Murray – Snowy Environmental Reserve) Conversion Order 2004	29,794	High
	Water shares – Snowy Environmental Reserve	14,671 6,423	High Low
	Water Shares – Living Murray program	12,267	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 all years between 2013–14 and 2018–19 inclusive.

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 9.5 percent, Tarago Reservoir 10.3 percent, Werribee system 10.0 percent, Moorabool system 11.9 percent, Thomson Reservoir 3.9 percent, West Barwon Reservoir 3.8 percent). The actual volume available in any year varies according to inflows. Entitlement volumes presented in this table indicate the entitlement share of storage.

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

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

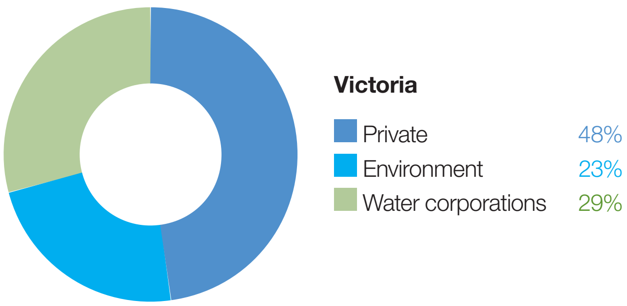
6 This entitlement volume is the mitigation water savings from the Goulburn-Murray Water Connections Project Stage 1, as verified in the latest audit.

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

Figure 1.4.1 shows the proportion of water entitlements held in Victoria by private users (such as irrigators and other businesses), water corporations (for household supply) and environmental water holders: the VEWH and the CEWH.

The proportions are based on the total volume of surface water entitlements recorded in the Victorian Water Register at 30 June 2019. The VEWH has incorporated its storage share volumes for some entitlements (such as for the Barwon and Latrobe systems) that are not represented volumetrically in the register. The proportions do not include water entitlements that are not accounted for in the register (such as passing flows and other rules-based environmental water like the Barmah-Millewa Environmental Water Account or River Murray Increased Flows).

Figure 1.4.1 Proportions of Victorian water entitlements, at 30 June 2018



Where possible, the proportion of water entitlements held by each user group is shown in each system section. For some systems, the way water entitlements have been accounted for in the Victorian Water Register or the connected nature of some water supply systems across multiple river basins means that it is not possible to represent water entitlements proportionally for some systems.

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.

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 in which it was donated including for actions identified in the seasonal watering plan, or it could be carried over for use in the future: see subsection 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 specified wetland or to protect a certain tree species). In these instances, the VEWH would consider the costs and benefits of each donor proposal before agreeing to accept the donation.

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 and program partners in New South Wales and South Australia — to optimise the benefits of all water for the environment in Victorian waterways. The seasonal watering plan considers the use of all water for the environment held in Victorian river systems.

Usually, when Commonwealth water is to be delivered in Victoria, the CEWH transfers the agreed amount of water to the VEWH. That amount then becomes part of the Victorian environmental Water Holdings until used or transferred back.

Table 1.4.2 shows the environmental water entitlements held by the CEWH in Victoria. The CEWH also holds water in New South Wales and South Australia, and both New South Wales and South Australia also hold water, which could potentially be made available for environmental watering in Victoria.

Table 1.4.2 Environmental water entitlement held in Victoria by the Commonwealth Environmental Water Holder, as at 6 May 2020

System	Volume (ML)	Class of entitlement
Broken	534	High-reliability water share
	4	Low-reliability water share
Campaspe	6,624	High-reliability water share
	395	Low-reliability water share
Goulburn	317,557	High-reliability water share
	42,467	Low-reliability water share
Loddon	3,356	High-reliability water share
	527	Low-reliability water share
Murray	362,360	High-reliability water share
	35,413	Low-reliability water share
Ovens	123	High-reliability water share
Wimmera-Mallee	28,000	Low-reliability water share

Water for the environment and non-government agencies

In 2007, the Murray–Darling Wetlands Working Group (MDWWG) and the Nature Conservancy — both non-government organisations — partnered to own and manage the Environmental Water Trust. To date, the MDWWG has been very active in wetland protection and management in New South Wales through partnerships with state and federal governments. Since 2017–18, the MDWWG has partnered with some catchment management authorities in northern Victoria to deliver water for the environment to wetlands on private land. These deliveries are outside the Victorian Water Holdings and are therefore not covered by this seasonal watering plan.

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

1.4.2 What options are available to effectively and efficiently manage water for the environment?

Other water sources

Water for the environment 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 sources of water. The timing of environmental releases can be coordinated with other sources of water to achieve greater benefits than an environmental release alone could achieve. Other sources of water can include:

- **system operating water** including passing flows, which maintains a minimum flow for operational and/or environmental purposes in many rivers, to which water for the environment 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 or could be added to extend a natural flow
- **alterations to the timing and route of delivery of consumptive water**, which can achieve environmental objectives without detriment to consumptive water users: water for the environment is sometimes used to cover any additional losses associated with the altered delivery of consumptive water.

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 water for the environment, and to achieve the greatest benefit to the environment.

Return flows

In some systems, water for the environment delivered through upstream sites can be used again downstream. This helps to ensure water for the environment is used efficiently and effectively, to achieve the greatest environmental benefits.

This reuse policy (known as return flows) is available in many systems across northern Victoria. It makes use of water for the environment more efficient, and it helps reduce the volume of water that needs 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 The Living Murray program, 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, VEWH, Living Murray and CEWH return flows will continue to flow across the border to South Australia where they will be used to provide environmental benefits at sites such as the Coorong, Lower Lakes and Murray Mouth area.

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 water for the environment 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.

Water trading

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

- administrative water transfers between the VEWH's entitlements
- administrative water transfers with other 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: essentially, if it optimises environmental outcomes in Victorian waterways.

The VEWH has bought or sold a small amount of water allocation each year since it was established in 2011. Water has been purchased to enhance environmental outcomes in systems where insufficient water for the environment was available. Water has also been sold to raise revenue for investment in projects which optimise environmental watering outcomes. The VEWH has typically only sold water where it was not required for a foreseeable environmental demand.

The VEWH can use the 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 the future management of water for the environment
- invest in structural works and other on-ground activities that will improve the performance of Victoria's environmental watering program.

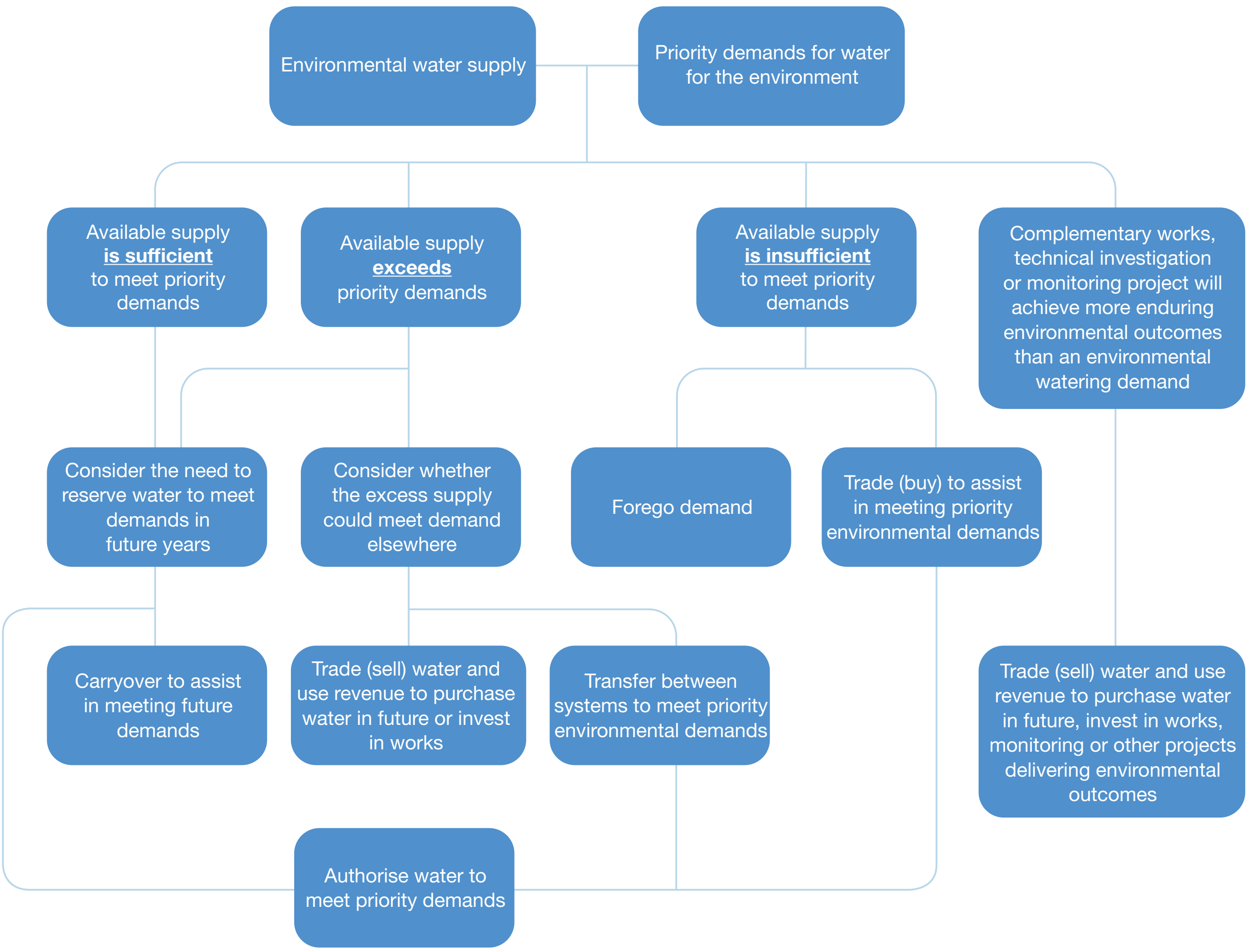
There may be occasions when the VEWH decides to sell water to invest in complementary works, measures, technical studies or other priorities, rather than use it or carry it over. This may occur if projects are shown to optimise environmental watering outcomes for an enduring benefit, beyond what could be achieved with delivering the equivalent volume of traded water in a single year. The VEWH consults with DELWP where these projects have government policy or program implications.

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

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

Figure 1.4.2 shows the key considerations that guide the VEWH's use, carryover and trade decisions. The VEWH regularly assesses its water demand and supply position throughout the year.

Figure 1.4.2 Key considerations guiding use, carryover and trade decisions



1.5 How to read the seasonal watering plan

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

The plan must ensure that the scope, objectives and potential watering activities for each waterway are clear, and it must enable decisions about possible water use to be made effectively and transparently.

Sections 2 to 5 of the seasonal watering plan represent four broad geographic regions of Victoria: the Gippsland, central, western and northern regions. Each regional overview includes:

- a description of the region
- an acknowledgement of the role of Traditional Owners of the area
- a description of how communities and program partners are engaged
- examples of the community benefits of environmental watering
- examples of integrated catchment management in the region
- a description of how risks are managed
- a seasonal outlook for the region.

Each region is divided further into system sections for waterways and wetlands that are supplied with water for the environment from an environmental entitlement. Each system's environmental values, recent conditions, environmental watering objectives and planned actions for the year are presented in its section.

Information in the system sections includes:

- **a system introduction page**, which includes:
  - the names of the waterway manager, storage manager and environmental water holders for the system
  - images of the system and some of its important environmental values
  - an interesting fact about the system or an Aboriginal name or definition for the system
  - a pie chart showing the proportion of water entitlements in the system for environmental, urban, industry and irrigation uses
- **a system overview**, which describes the location of the system, its waterways and major features
- **environmental values**, which outlines the primary water-dependent species, communities, ecological processes and habitats that rely on healthy waterways and form the basis for environmental objectives
- **a table of environmental objectives in the system**, which summarises the measurable outcomes that are sought for each environmental value in the system. Each objective will likely rely on the ongoing implementation of one or more watering actions as well as complementary actions (such as control of invasive species or installation of fishways). Target outcomes may take years or several decades to achieve. Figure 1.5.1 is an example of this table.
- **Traditional Owner and recreational values**, which are included for systems where benefits to Traditional Owner values or recreational opportunities may be achieved by modifying potential watering actions, provided environmental outcomes are not compromised.

Figure 1.5.1 Example environmental objectives table

Environmental objectives in the Macalister system

	Restore populations of native fish, specifically Australian grayling Maintain/enhance the structure of native fish communities
	Increase the recruitment and growth of native riparian vegetation

In this example, environmental flows that provide optimal spawning opportunities for Australian grayling will contribute to achieving this objective, as will complementary works such as the construction of fishways to increase the habitat range for native fish.

- **recent conditions**, which describes the factors that will be considered when planning environmental flows in the coming year (such as the past watering regime, climate and rainfall, water availability, system operations, monitoring results and environmental observations)
- **scope of environmental watering**, which is a table of potential environmental watering actions in 2019–20, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions. Figure 1.5.2 is an example of this table.

Figure 1.5.2. Example potential environmental watering actions and objectives tables

Potential environmental watering actions describe the timing, magnitude, duration and frequency of environmental flows to rivers or the timing of releases to wetlands. Subsection 1.3.3 explains how watering actions are prioritised. The seasonal watering statements issued by the VEWH authorise waterway managers to undertake environmental watering actions described in this table. Subsection 1.2.2 explains how seasonal watering statements fit into the environmental watering planning framework.

Environmental objectives are those listed in the environmental objectives table for each system (as the Figure 1.5.1 example above shows). Each environmental objective will be supported by one or more watering actions and functional watering objectives.

Potential environmental watering action	Functional watering objectives	Environmental objectives
Macalister River reaches 1 and 2		
Winter to summer low flow (up to 90 ML/day in June to December) 	• Provide hydraulic habitat for fish by increasing water depth in pools • Provide fish passage for local movement through minimum depth over riffles • Provide permanent wetted habitat for water bugs through minimum water depth in pools • Provide connectivity throughout the river for local movement of platypus and water rats, as well as protection from predation, access to food sources and maintain refuge habitats • Provide flows with low water velocity and appropriate depth and to improve water clarity and enable establishment of in-stream vegetation • Provide sustained wetting of low-level benches (increasing water depth) to limit terrestrial vegetation encroachment	
Summer-autumn low flow (35-90 ML/day in January-May)	• Maintain water depth in pools and hydraulic habitat for native fish. • Maintain permanent wetted habitat in pools and riffles for waterbugs • Maintain shallow, slow-flowing habitat to enable establishment of in-stream vegetation • Maintain a minimum depth in pools to allow for turnover of water and slow water quality degradation • Expose and dry lower channel features for re-oxygenation	

These example icons demonstrate which potential watering actions may be modified to increase benefits to Traditional Owner values or recreational opportunities, provided environmental outcomes are not compromised.

The ability of the VEWH and its partners to modify flows to deliver these benefits will depend on the weather, climate considerations, the available water and the way the system is being operated to deliver water for other purposes.

A **functional watering objective** is the physical or biological effect that a potential watering action aims to achieve. Each potential watering action will have one or more functional watering objectives.

- **scenario planning**, which indicates in text and table form the range and priority of potential environmental watering actions that might be delivered in the coming year under different climate and water availability scenarios. For example, it may show which environmental flows may be most important if there is less water for the environment available in a dry year, compared to an average year where there is more water available. The climate scenarios considered are drought, dry, average and wet. Section 1.3.4 explains how seasonal conditions are considered in planning. Potential environmental watering actions are listed in order of priority. Figure 1.5.3 is an example of the planning scenario table.

Figure 1.5.3 Example scenario planning table

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Passing flows at reduced	• Possible spills from in spring, minor flood levels may occur • Passing flows at may be reduced	• Regular spills from in spring, minor to moderate flood levels may occur	• Large and frequent spills from moderate to major flood levels may occur
Expected availability of water for the environment	• 11,600 ML	• 14,900 ML	• 16,900 ML	• 21,400 ML
Potential environmental watering – tier 1a (high priorities)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2) • 1 spring fresh (reach 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2) • 1 spring fresh (reach 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2) • 1 spring fresh (reach 2)
Potential environmental watering – tier 1b (high priorities)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2)
Potential environmental watering – tier 2 (additional priorities)	• 1 winter fresh	• 1 winter fresh	• Increase duration of spring fresh	• 1 winter fresh
Possible volume of water for the environment required to meet objectives	• 10,700 ML (tier 1) • 4,000 ML (tier 2)	• 13,400 ML (tier 1) • 4,000 ML (tier 2)	• 15,600 ML (tier 1) • 1,200 ML (tier 2)	• 19,000 ML (tier 1) • 4,000 ML (tier 2)
Priority carryover requirements	• 900 to 1,800 ML			

Assumed volume of water for the environment that will be available over the entire year: the assumed supply.

Tier 1a denotes the high-priority potential environmental watering actions that could be achieved with the assumed supply.[1]

Tier 1b denotes the high-priority potential environmental watering actions that are unlikely to be achieved with the assumed supply.

Additional water may need to be transferred or traded in to the system to meet demand for these watering actions. If tier 1b actions are not delivered, there may be a decline in environmental condition. Section 1.4.2 explains the VEWH's options for efficiently managing water for the environment.[1]

Tier 2 potential environmental watering actions identified are critical to achieving environmental objectives in the long term and could be delivered in the current year if circumstances allow, but they can likely be deferred without significant environmental harm.

The volume that is planned to be kept in storage to achieve high-priority watering actions the following year. For the seasonal watering plan, predictions of volumes of water available and carryover are made before the beginning of a water year and are based on the best-available information. They are estimates only, and the VEWH and its program partners revise these estimates continually throughout the water year.

1 Where system supply cannot be reliably determined in advance the highest priority watering actions for the year are all classified as Tier 1.

Thomson River Horseshoe Bend by VEWH

Section 2

Gippsland region

Snowy system
Thomson, Macalister & Latrobe systems

2.1 Gippsland region overview

The systems in the Gippsland region that can receive water from the VEWH's environmental entitlements are the Latrobe River and wetlands, Thomson River and Macalister River. The Snowy River also receives water for the environment, but this is managed by the New South Wales (NSW) Department of Planning, Industry and Environment.

Environmental values, recent conditions, environmental watering objectives and planned actions for each system in the Gippsland region are presented in the system sections that follow this regional overview.

Traditional Owners in the Gippsland region

Traditional Owners in the Gippsland region continue to have a deep connection to the region's rivers, wetlands and floodplains.

The Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC), on behalf of the Gunaikurnai people, hold Native Title and is a Registered Aboriginal Party over an area that extends from near Warragul, east to the Snowy River and north to the Great Dividing Range. This area includes the Latrobe, Thomson, Macalister and Snowy rivers and the lower Latrobe wetlands covered by this section of the seasonal watering plan.

The State of Victoria has also entered into a Recognition and Settlement Agreement with the Gunaikurnai people. The Recognition and Settlement Agreement, executed under the *Traditional Owner Settlement Act 2010*, affords Gunaikurnai people rights relating to the use of public land within their agreement area.

Other Registered Aboriginal Parties in this geographic area are the Bunurong Land Council Aboriginal Corporation and Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation, but their boundaries do not extend to the waterways managed with water for the environment in the Gippsland region.

Engagement

Seasonal watering proposals are informed by community, stakeholder and program partner engagement, as well as longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flows studies and environmental water management plans). Program partners and other stakeholders help to identify environmental watering priorities and opportunities for the coming year. The strategies and technical reports collectively describe a range of environmental, cultural, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence environmental watering actions and priorities.

The International Association for Public Participation's Public Participation Spectrum (IAP2 Spectrum) has been used to categorise the levels of participation of stakeholders involved in the environmental watering planning process. Table 2.1.1 shows the IAP2 Spectrum categories and participation goals.

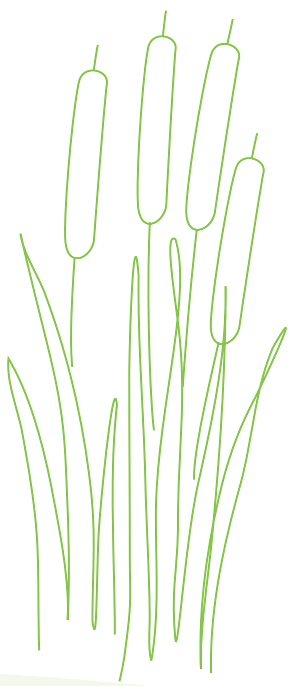


Table 2.1.1 International Association for Public Participation's Public Participation Spectrum categories and participation goals[1]

IAP2 level	Engagement goal
Inform	Provide balanced and objective information to assist understanding, alternatives, opportunities and/or solutions
Consult	Obtain feedback on analysis, alternatives and/or decisions
Involve	Work directly throughout a process to ensure that concerns and aspirations are consistently understood and considered
Collaborate	Partner in each aspect of the decision including the development of alternatives and the identification of the preferred solution
Empower	Place final decision making in the hands of the stakeholder

[1] The VEWH has the permission of the International Association for Public Participation to reproduce the IAP2 Spectrum.

Table 2.1.2 shows the partners, stakeholder organisations and individuals with which West Gippsland CMA engaged when preparing the Latrobe River, lower Latrobe wetlands, Thomson and Macalister systems' seasonal watering proposals. This includes engagement conducted as part of developing the seasonal watering proposals as well as engagement during the preparation of key foundational documents that directly informed the proposals. VEWH staff were also consulted for operational information as part of the development of all annual seasonal watering proposals by CMAs.

The table also shows the level of engagement between West Gippsland CMA and stakeholders of the environmental watering program in the Gippsland region based on the CMA's interpretation of the IAP2 Spectrum.

The level of engagement differs between organisations and between systems, depending on the availability, capacity or interest of stakeholders to participate, roles and responsibilities of organisations in managing a site or system, and potential interaction of proposed watering with other activities on the waterway. For example, in the Gippsland region, Parks Victoria is more involved in planning and management of water for the environment for the lower Latrobe wetlands than for other systems, because it is the land manager for Dowd Morass and Sale Common and it operates the regulators used to release water to these sites.

Table 2.1.2 Partners and stakeholders engaged by West Gippsland CMA in developing seasonal watering proposals for the Latrobe River, lower Latrobe wetlands, Thomson River and Macalister River systems and other key foundation documents that have directly informed the proposals

<table>
<tr><th></th><th>Latrobe River</th><th>Lower Latrobe wetlands</th><th>Thomson River</th><th>Macalister River</th></tr>
<tr><td rowspan="2">Community groups and environment groups</td><td rowspan="2">IAP2 level: Inform
• Greening Australia
• Latrobe Valley Field Naturalists
• Native Fish Australia</td><td rowspan="2">IAP2 level: Inform
• Greening Australia
• Latrobe Valley Field Naturalists
• Native Fish Australia</td><td>IAP2 level: Involve
• Heyfield Wetlands Committee
• Cowwarr Landcare Group
• Waterwatch volunteers</td><td rowspan="2">IAP2 level: Involve
• Environment Victoria
• Maffra and districts Landcare network
• Native Fish Australia</td></tr>
<tr><td>IAP2 level: Inform
• Landcare groups
• Birdlife Australia</td></tr>
</table>

Table 2.1.2 Partners and stakeholders engaged by West Gippsland CMA in developing seasonal watering proposals for the Latrobe River, lower Latrobe wetlands, Thomson River and Macalister River systems and other key foundation documents that have directly informed the proposals *(continued)*

	Latrobe River	Lower Latrobe wetlands	Thomson River	Macalister River
Government agencies	**IAP2 level: Collaborate** • Parks Victoria **IAP2 level: Consult** • Gippsland Water **IAP2 level: Inform** • Department of Land, Environment, Water and Planning (Latrobe Valley Regional Water Study) • Department of Land, Environment, Water and Planning (Waterways and Catchments) • East Gippsland CMA	**IAP2 level: Collaborate** • Parks Victoria **IAP2 level: Consult** • Gippsland Water **IAP2 level: Inform** • Department of Land, Environment, Water and Planning (Latrobe Valley Regional Water Study) • Department of Land, Environment, Water and Planning (Waterways and Catchments) • East Gippsland CMA	**IAP2 level: Collaborate** • Melbourne Water • Southern Rural Water **IAP2 level: Involve** • Gippsland Water • Department of Environment, Land, Water and Planning - Water and Catchments	**IAP2 level: Collaborate** • Southern Rural Water **IAP2 level: Involve** • Gippsland Water
Landholders/ farmers	**IAP2 level: Inform** • Individual landholders	**IAP2 level: Collaborate** • Field and Game Australia (Heart Morass) **IAP2 level: Inform** • Individual landholders	**IAP2 level: Involve** • Individual landholders	**IAP2 level: Involve** • Macalister Irrigation District irrigators/ diverters • Other landholders
Local businesses	**IAP2 level: Inform** • Port of Sale Heritage River Cruises	**IAP2 level: Inform** • Port of Sale Heritage River Cruises		
Recreational users	**IAP2 level: Inform** • VRFish	**IAP2 level: Collaborate** • Field and Game Australia (Dowd Morass and Sale Common) **IAP2 level: Inform** • VRFish	**IAP2 level: Involve** • Tourism operators • VRFish	**IAP2 level: Involve** • VRFish
Technical experts			**IAP2 level: Collaborate** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Collaborate** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Collaborate** • Gunaikurnai Land and Waters Aboriginal Corporation	**IAP2 level: Collaborate** • Gunaikurnai Land and Waters Aboriginal Corporation	**IAP2 level: Collaborate** • Gunaikurnai Land and Waters Aboriginal Corporation	**IAP2 level: Involve** • Gunaikurnai Land and Waters Aboriginal Corporation

The NSW Government is responsible for planning environmental flows in the Snowy River in consultation with the Victorian Government. The Snowy Advisory Committee was formed in 2018 and provides community and expert advice about the pattern of environmental flows to the Snowy River. The committee's participants represent Aboriginal, local community and environmental interests, alongside NSW and Victorian government agencies. East Gippsland CMA is a member of the Snowy Advisory Committee, and the VEWH is an observer.

How have Traditional Owners' values and uses of waterways been considered?

The waterways of the Gippsland region are important resources for the Gunaikurnai people, with thousands of years of connection to Country evident through numerous registered Gunaikurnai cultural heritage sites. Today, water is no less important to the Gunaikurnai: access to water and being empowered to make decisions and manage natural resources including waterways and water bodies are integral to customary practices, to protecting cultural values and uses and to healing Country.

GLaWAC is the Registered Aboriginal Party for waterways managed with environmental flows in the Gippsland region, and it holds Native Title and a Recognition and Settlement Agreement over this area. GLaWAC representatives are working closely with the West Gippsland CMA to understand and find alignment between environmental watering objectives and cultural watering objectives.

GLaWAC has been represented on the environmental flows study review panels for the Thomson and Latrobe rivers. GLaWAC together with Gunaikurnai community members are undertaking Aboriginal Waterway Assessments in the Latrobe River system, and as part of this are assessing how to document, protect and further the cultural values and uses of waterways in the Gippsland region including the Thomson, Latrobe and Macalister rivers and Lower Latrobe wetlands which receive water for the environment.

GLaWAC and the West Gippsland CMA have a strong working relationship and a collaborative plan to nominate priority sites and determine flows that support Gunaikurnai cultural and environmental values during 2020–21. The teams share the CMA's Traralgon office. This proximity increases opportunities for knowledge exchange and an appreciation of the broader objectives of each organisation.

For the Thomson and Latrobe rivers, GLaWAC identified species of high cultural value that depend on water and water management that mimics nature. GLaWAC also expressed the importance of Sale Common and Dowd Morass and the need to protect the freshwater status as much as possible, and to manage invasive species that threaten native plants and animals.

Community benefits from environmental watering

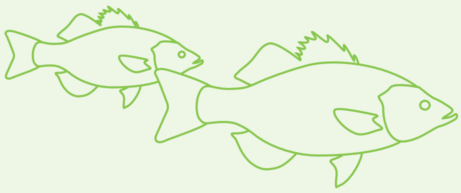
Healthy rivers and wetlands support vibrant and healthy communities. By improving the health of rivers, wetlands and floodplains, environmental flows also provide benefits to communities.

The VEWH and its program partners consider Aboriginal cultural values and uses and social and recreational values and uses of waterways when planning for environmental watering activities. Through engagement with community representatives, waterway managers aim to determine how community benefits from environmental flows can be optimised with environmental priorities for the year ahead.

Healthy waterways provide community benefits (such as providing nice places to walk or picnic and opportunities for recreational fishing). Community benefits can sometimes be enhanced by modifying environmental flows (such as timing a flow to support a community water skiing or fishing event), provided the environmental objective is not compromised.

Collaboration with Traditional Owner partners enables the VEWH and its partners to measure healthy waterways through a different lens: for instance for the Gunaikurnai, Country is connected, so achieving healthy Country means encouraging decision-making to benefit the whole system. For the Latrobe River system, that means from the source to the Gippsland Lakes, and not only what is in-stream but also the plants and animals on streamside land.

The VEWH and its partners seek to deliver these benefits throughout the water year, though opportunities can depend on the weather, climate or environmental conditions, water availability and the way the system is being operated to deliver water for other purposes.



How have economic, recreational and social values and uses of waterways been considered?

Environmental outcomes provide some direct economic, recreational, social benefits to communities. Waterway managers, in consultation with communities, have identified numerous opportunities to support these community benefits including activities such as tourism, kayaking, birdwatching, fishing, water skiing and hunting. Examples of these opportunities in the Gippsland region include:

- encouraging the spawning and recruitment of Australia bass, a popular recreational angling species in the Macalister and Thomson systems
- supporting waterbirds in the lower Latrobe wetlands, which are valued by birdwatchers and duck hunters. Duck-hunting seasons may be considered in the timing of wetland filling
- delivering flows in the Thomson River that refresh waterholes and improve summer swimming conditions. This is particularly important in the upper reaches of the river, where camping, hiking and swimming are popular recreational activities
- complementing community efforts to rehabilitate the Heyfield wetlands. An environmental watering trial in the western portion of the wetlands will assist the growth of native, semi-aquatic vegetation planted by students and other volunteers, support community educational programs, provide amenity adjacent to public walking tracks and provide opportunities to engage with nature
- increasing opportunities for canoers and kayakers to take advantage of high flows and white water on the Thomson and Snowy rivers.

Summaries of the social, recreational and economic values considered are provided for each system. Where the timing or management of planned environmental flows may be modified to align with a community benefit, this is identified alongside the potential watering actions.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental flows need to be part of an integrated approach to catchment management. Many of the environmental objectives from water for the environment in the Gippsland region will not be fully met without simultaneously addressing issues such as barriers to fish movement, high nutrient loads, invasive species and loss of stream bank vegetation.

Victorian and Australian government agencies, Traditional Owner groups, community groups and private landholders collectively implement a wide range of programs that aim to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments.

Examples of complementary programs that are likely to support environmental watering outcomes in the Gippsland region include:

- works by West Gippsland CMA to protect and enhance stream banks along priority reaches of rivers and their tributaries including fencing to exclude stock, revegetation of riverbanks, willow removal and erosion control
- West Gippsland CMA's work with farmers along the Thomson and Macalister rivers on grazing and soil management, and on nutrient and water-use-efficiency projects that help to improve water quality and river health
- construction of a fishway on the Thomson River by West Gippsland CMA to improve fish passage near the heritage-listed Horseshoe Bend Tunnel, completed in August 2019. The fishway now allows Australian grayling, which are specifically targeted with releases of water for the environment, and other migratory fish, to access over 200 km of river habitat from the upper reaches of the Aberfeldy River down to the Latrobe River. Tupong have since been found above the Horseshoe Bend Tunnel in surveys conducted by the Arthur Rylah Institute
- a weed and willow control program by East Gippsland CMA in remote parts of the Snowy River catchment, which led to 200 km of the river now being willow-free: native vegetation is flourishing in areas where willows have been removed.

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

Risk management

During the development of the seasonal watering proposals for the Latrobe, Thomson and Macalister systems, environmental watering program partners assessed risks associated with potential environmental watering actions for 2020–21 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

In the Snowy system, when weather conditions increase the risk of flooding, the NSW Department of Planning, Industry and Environment works with the NSW State Emergency Service, the Bureau of Meteorology, East Gippsland CMA and the VEWH to inform the community about the management of planned releases. Releases may be cancelled or rescheduled to limit flood impacts on private land.

Seasonal outlook 2020–21

Water for the environment for the Latrobe, Thomson and Macalister systems is held in Blue Rock Reservoir, Thomson Reservoir and Lake Glenmaggie respectively.

Environmental entitlements in these systems have unique characteristics that influence planning for environmental flows. The Thomson system receives a share of the daily inflows to the Thomson Reservoir and a secure annual allocation which is available on 1 July each year. In the Latrobe and Macalister systems, the availability of water for the environment depends on system inflows to Blue Rock Reservoir and Lake Glenmaggie respectively. Winter and spring are the peak inflow periods for all systems, so annual allocations are usually well-known before the start of summer. With several planned watering actions being met with natural flows in 2019–20 and the watering year ending with good inflows to storages, high carryover is likely in all systems and waterway managers will start 2020–21 with good water availability to deliver potential watering actions throughout the year.

During December 2019 and January 2020, severe bushfires burnt vast areas of east Gippsland. Heavy rainfall in these areas may wash ash and sediment into waterways including the Snowy River, which could have adverse effects on water quality and environmental values. Flushing flows planned for the Snowy River in winter and spring 2020 may help to mitigate some water quality impacts. West Gippsland was largely untouched by the recent bushfires, and waterways in that area may be essential for sustaining and restoring regional populations of aquatic animals. Environmental flows delivered to the Latrobe, Thomson and Macalister systems in 2020–21 aim to grow local populations of native fish, platypus and waterbirds, and some of these animals may disperse and contribute to the recovery of populations in nearby fire-affected areas in future years.

Most of the Gippsland region experienced below-average rainfall in 2017–18 and 2018–19, but climatic conditions varied considerably across the region in 2019–20. East Gippsland generally remained dry, although autumn rainfall was closer to the long-term average. West Gippsland had above-average rainfall in late winter 2019, near-average rainfall in spring 2019 and above-average rainfall in summer and autumn 2020. The higher rainfall and associated increase in natural streamflow in west Gippsland met many of the priority environmental watering actions for the Latrobe, Thomson and Macalister systems during 2019–20.

The Bureau of Meteorology climate outlook indicates wet conditions may continue into 2020–21, with winter rainfall predicted to be close to or slightly above the long-term average. Significant winter rain will deliver increased inflows to storages in west Gippsland that hold Victorian environmental water entitlements, and it may lead to high flow or overbank flows in some systems. Natural flows may meet many of the environmental flow requirements for the Latrobe, Thomson and Macalister systems early in 2020–21, and there may be opportunities to release environmental water — on top of natural freshes or as larger flows recede — to enhance environmental outcomes. For example, the duration of a fresh after a storage spill from Lake Glenmaggie could be extended to meet objectives for fringing vegetation and reduce the risk of bank slumping and flush the Latrobe River estuary to export excess salt from the upper water column. If conditions are drier through spring and summer 2020 and into autumn 2021, environmental water will be used to protect high-value environmental assets (such as by providing critical flows for threatened migratory fish, particularly with bushfire potentially affecting waterway habitat in east Gippsland), and set aside sufficient reserves to deliver early-season watering priorities in 2021–22.

Allocations across the west Gippsland systems are largely influenced by storage inflows during winter and spring, and so by late spring waterway managers can determine which potential watering actions they will likely be able to deliver for the rest of the 2020–21 water year. Where critical demands cannot be met by existing allocations, the VEWH and its program partners may investigate alternative supply options (such as transfers or trades). The VEWH also works with storage managers to identify opportunities to adjust the pattern of consumptive water deliveries to support environmental watering outcomes while still meeting the needs of consumptive water users.

The NSW Department of Planning, Industry and Environment plans and manages environmental flows in the Snowy system in consultation with Victorian and Australian governments and relevant stakeholder groups. The water year for the Snowy system starts in May and finishes in April the following year, which differs from how water is managed in the other Gippsland systems. The total volume for release and daily release targets for the Snowy River from May 2020 to April 2021 were endorsed by the Snowy Advisory Committee in February 2020, and daily releases will not vary unless flows increase the risk of flooding downstream or operational constraints prevent delivery.

2.2. Latrobe system

Waterway manager – West Gippsland Catchment Management Authority

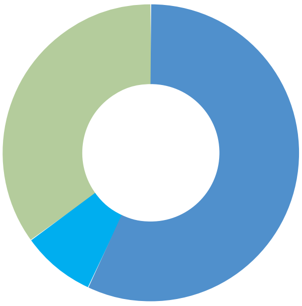
Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The Latrobe River is known to the Gunaikurnai people as *Durt-Yowan*, which means 'forefinger.'

The volume attributed to the environment in the Latrobe system does not include water that is available to the lower Latrobe wetlands because there is no limitation on the volume of water that can be supplied to the wetlands from the Latrobe River.



Proportion of water entitlements in the Latrobe basin held by private users, water corporations or environmental water holders at 30 June 2019

Top: Dowd Morass, Lower Latrobe wetlands, by West Gippsland CMA
Above: Lower Latrobe wetlands monitoring, by West Gippsland CMA

The Latrobe system includes the Latrobe River and lower Latrobe wetlands: Sale Common, Heart Morass and Dowd Morass.

2.2.1 Latrobe River

System overview

The Latrobe River originates on the Baw Baw Plateau and passes through relatively flat to undulating plains cleared for agriculture, before flowing into Lake Wellington (the westernmost point of the Gippsland Lakes). Notable tributaries include the Tanjil River, Narracan Creek, Morwell River, Tyers River, Traralgon Creek and the Thomson River.

Water for the environment is supplied to the Latrobe River from Blue Rock Reservoir on the Tanjil River. Blue Rock Reservoir also supplies water for electricity generators and a paper mill in the Latrobe Valley and urban supply.

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

Environmental values

The upper Latrobe River flows through state forest and is relatively intact and ecologically healthy. It contains continuous stands of river red gums and intact streamside vegetation, and it supports native animals including barred galaxias, river blackfish, Gippsland spiny crayfish and nankeen night herons.

The Latrobe River below Lake Narracan is regulated and highly degraded due to historic river management practices. Most large woody habitat has been removed from the river and many sections have been artificially straightened. These practices have caused significant erosion and widened the channel, which has in turn reduced the quality and quantity of habitat for aquatic plants and animals.

Endangered and vulnerable vegetation are found in all but the most modified sections of the Latrobe River. The banks along the lower reaches support stands of swamp scrub, 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 supports several native estuarine and freshwater fish including black bream, Australian bass, Australian grayling and short- and long-finned eel.

The Latrobe River and its tributaries provide an essential source of freshwater to the Gippsland Lakes system, of which the lower Latrobe wetlands are an important component.

Environmental watering objectives in the Latrobe River

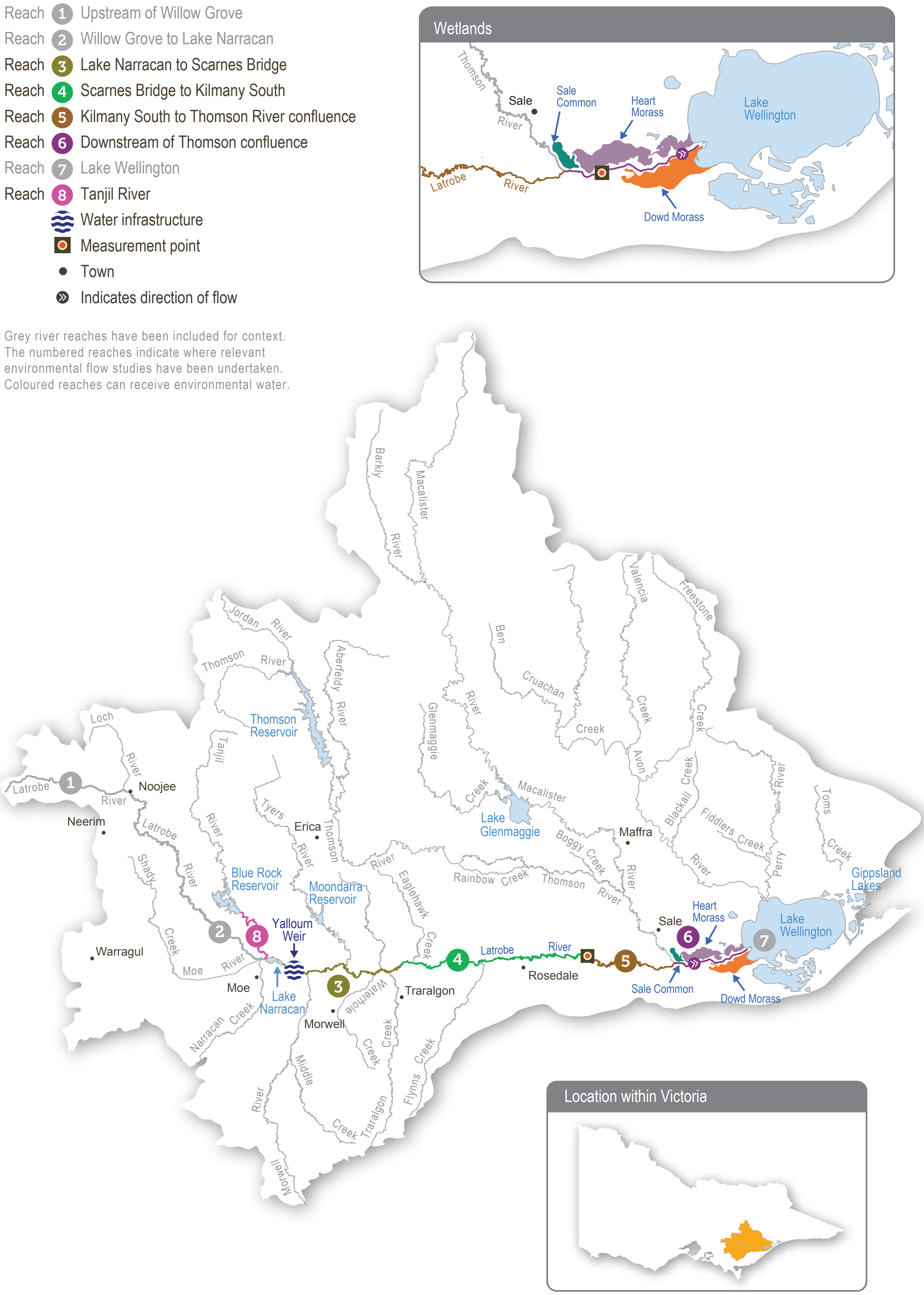
Maintain or increase native fish (migratory, resident and estuary) populations
Maintain or increase in-stream geomorphic diversity
Improve the condition and increase extent and diversity of submerged, emergent and streamside native vegetation Reduce the extent and density of invasive plants
Increase the abundance of all macro- and micro-invertebrates
Avoid adverse water quality conditions (such as high salinity) in the lower Latrobe River and estuary

Traditional Owner cultural values and uses

The Gunaikurnai have had a continued connection to Gunaikurnai Country for thousands of years, including with the waterways in the Latrobe River system. For the Gunaikurnai as traditional custodians there are immense challenges to heal, protect and manage Country which has been drastically altered since colonisation. Gunaikurnai see all of Country as connected with no separation between landscapes, waterways, coasts and oceans and natural and cultural resources – the cultural landscape is interdependent.

Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC) is working with the West Gippsland CMA to determine how to express Gunaikurnai objectives for water in a way that contributes to seasonal watering proposals from the perspective of traditional custodians, with traditional knowledge.

Figure 2.2.1 The Latrobe system



For the Latrobe River system this has included:

- Aboriginal Waterway Assessments to examine cultural values and uses
- identification of primary objectives under the modified water regime
- expression of preliminary outcomes: watering actions that recognise and promote:
    - Healthy Country
    - the importance of the Latrobe River system to the Gunaikurnai songline of *Boran* (pelican) and *Tuk* (musk duck) and their respective water quality and habitat requirements
    - waterways as meeting places
    - preliminary accommodation of water quality and management requirements of species with cultural values and uses.

GLaWAC shared with the West Gippsland CMA plant and animal species of cultural significance in and around the waterways of the Latrobe Valley, and the importance of specific watering decisions to support them.

Watering requirements to support cultural values and uses include:

- timing of environmental watering planned in partnership with GLaWAC to support a seasonal flow regime and wet and dry periods that embody Healthy Country
- maintaining freshwater supply to Latrobe estuary, Dowd Morass, Sale Common and Heart Morass and associated freshwater habitats. The lower Latrobe wetlands are an important resource for the Gunaikurnai
- providing connectivity between reaches and onto floodplains to support dependent plants and animals with cultural values and uses of significance to the Gunaikurnai
- maintaining water quality to support health of native plants and animals with cultural values and uses of significance to the Gunaikurnai.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 2.2.1, West Gippsland CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as water-skiing and fishing)
- riverside recreation and amenity (such as hunting)
- socio-economic benefits (such as commercial fishing, diverters for irrigation and farming, urban water supplies and power generation).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 2.2.1 with an icon.

Watering planned to support water sports activities (e.g. canoeing, kayaking, rowing, swimming, water skiing)

West Gippsland CMA communicates with Lake Narracan Ski Club so environmental water releases can be timed to not affect the water levels in the lake during water skiing events, which typically take place between January and March.

Recent conditions

The Latrobe system experienced average to above-average rainfall throughout 2019–20, despite drier-than-average conditions occurring elsewhere in west Gippsland. By summer, environmental water allocations reached 100 percent of the entitlement volume.

Local rainfall and inflows from unregulated tributaries provided flow conditions that met all the watering actions that were planned for the Latrobe River from July 2019 until February 2020. High rainfall caused bankfull flows in winter and minor flooding in some reaches of the Latrobe River in late spring 2019, which provided ecologically important flow events that cannot be delivered through managed environmental flows. Water for the environment was used to partly deliver two freshes in mid-autumn 2020. Heavy rainfall occurred during these events, which reduced the amount of environmental water that needed to be released. The autumn freshes were timed to coincide with environmental flows in the Thomson and Macalister rivers to optimise outcomes for native fish (especially Australian grayling migration and spawning) and outcomes for the Latrobe estuary.

Scope of environmental watering

Table 2.2.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 2.2.1 Potential environmental watering actions and objectives for the Latrobe River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (250 ML/day or natural during December to May)	• Maintain an adequate depth in pool habitat to support aquatic animals and submerged vegetation • Limit encroachment by terrestrial vegetation and support the growth of emergent macrophyte vegetation • Maintain oxygen levels in pools • Maintain sediments in suspension to prevent pools filling	
Summer/autumn river fresh (one to four freshes of 920 ML/day for one to five days during December to May)	• Wet benches to maintain habitat and support the growth of emergent macrophyte vegetation • Freshen water quality to support waterbug and zooplankton communities • Flush sediment (sands and silts) from pools and mix water in pools, helping to provide spawning conditions for Australian grayling and breeding substrate for river blackfish • Provide longitudinal connectivity for aquatic animals	
Summer/autumn estuary fresh (one to three freshes of 2,200 ML/day at reach 6 for seven to 10 days during December to May)	Objectives listed for the summer/autumn river fresh and additional objectives for the Latrobe River estuary: • upper estuary: fully flush with freshwater to support submerged vegetation, provide suitable conditions including oxygen levels for aquatic animals, transport silt, wet benches and deliver freshwater to connected wetlands • mid-estuary: partially/fully flush the upper layer of the water column to improve water quality, support emergent macrophytes, provide freshwater habitat and associated food sources for freshwater fish and provide breeding opportunities for estuary fish • lower estuary: partially flush the upper layer of the water column; a flow of this magnitude will also provide opportunities to fill to the lower Latrobe wetlands Note: This event requires contributions of at least 1,280 ML/day from the Thomson River at Bundalaguah over the equivalent period to meet objectives	
Winter/spring fresh (one to two freshes of 3,200 ML/day at reach 6 for two days during June to November)[1]	Latrobe River objectives: • wet banks and higher benches to improve the condition of streamside vegetation • provide a variety of wetted areas for emergent macrophytes • maintain channel capacity and bench habitat Additional objectives for the Latrobe River estuary: • upper estuary: fully flush with freshwater to support submerged vegetation, increase oxygen levels for aquatic animals, transport silt, wet benches and deliver freshwater to connected wetlands • mid-estuary: partially/fully flush the upper layer of the water column to improve water quality, support emergent macrophytes, provide freshwater habitat and associated food sources for freshwater fish and provide breeding opportunities for estuary fish • lower estuary: partially flush the upper layer of the water column; a flow of this magnitude will also provide opportunities to fill to the lower Latrobe wetlands Note: Delivering the target flow event in the estuary will require contributions of 1,000–2,200 ML/day from the Thomson River at Bundalaguah over the equivalent period to meet objectives	

Table 2.2.1 Potential environmental watering actions and objectives for the Latrobe River *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Winter/spring low flow (620 ML/day during June to November)	• Wet benches to maintain habitat and support the growth of emergent macrophyte vegetation • Maintain oxygen levels in pools and maintain sediment (sands and silts) in suspension to prevent pools filling and depositing on substrates, helping to maintain habitat for waterbugs and breeding substrate for river blackfish • Longitudinal connectivity to allow movement/dispersal of aquatic animals	

[1] This fresh may involve inundating private land if delivered at higher magnitude, and it will be subject to obtaining landholder agreement. The magnitude of delivery depends on the relative contribution possible from the Thomson system.

Scenario planning

Table 2.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Under all scenarios, summer/autumn freshes are a high priority in the Latrobe system. At durations of one to five days, these events aim to maintain the physical form of the river bed and improve water quality by flushing sediments and mixing water in pools, which supports aquatic animals including waterbugs. Longer duration freshes (seven to 10 days) will also meet water quality, fish and vegetation objectives for the Latrobe estuary and are a high priority under dry, average and wet scenarios. To meet the flow requirements for the Latrobe estuary, these longer-duration freshes need to coincide with releases in the Thomson River, as the full estuary fresh cannot be delivered from Blue Rock Reservoir without inundating some private land.

Summer/autumn low flows are a high priority under a drought scenario, to maintain oxygen and connectivity between pools. Water for the environment is unlikely to be required to deliver these flows under other scenarios because they are expected to be met naturally.

If more environmental water is available under a drought scenario, it may be used to increase the duration of summer/autumn low flows and/or deliver a summer/autumn estuary fresh. Under a dry scenario, extra environmental water would be used to deliver an additional summer/autumn estuary fresh.

Winter/spring freshes will improve environmental outcomes under average and wet scenarios. They are considered a high priority under a wet scenario, but there may not be enough available water to deliver them under an average scenario, so they are identified as a tier 1b priority. Large winter/spring freshes may wet private land and therefore landholder agreements will be needed before they are delivered as a managed environmental flow.

Winter/spring low flows and freshes are considered a lower priority under drought and dry scenarios. No tier 2 watering actions have been identified for the Latrobe River under average or wet scenarios, as natural inflows are expected to meet the remaining demands.

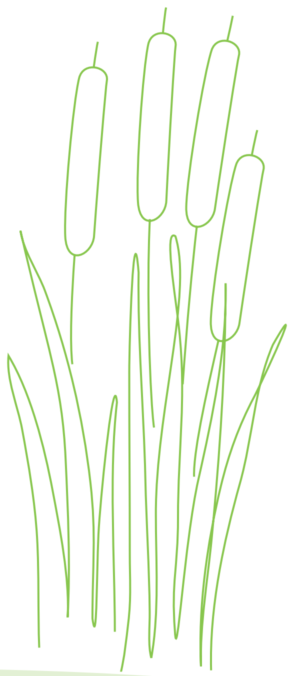


Table 2.2.2 Potential environmental watering for the Latrobe River under a range of planning scenarios

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 natural flow that contributes to low flows and freshes • Consumptive demand from Blue Rock Reservoir will be high and contribute to low flows	• Natural flow will provide low flow throughout the year, and multiple freshes (most likely in winter/spring) • Some spills are likely and there will be releases for consumptive users which will partly contribute to low flows	• Natural flow will provide strong low flow throughout the year • Multiple spills from Blue Rock Reservoir will provide extended durations of freshes, high flows and overbank flows • No significant releases from consumptive entitlements in Blue Rock Reservoir are likely
Expected availability of water for the environment	• 15,000 ML	• 17,000 ML	• 22,000 ML	• 30,000 ML
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flow (delivered in February to March) • Three summer/autumn river freshes (no extended freshes)	• Two summer/autumn river freshes • One summer/autumn estuary fresh (or river fresh if estuary freshening not required)	• One summer/autumn river fresh • Three summer/autumn estuary freshes (or river freshes if estuary freshening not required)	• One summer/autumn river fresh • Three summer/autumn estuary freshes (or river freshes if estuary freshening not required) • Two winter/spring freshes
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn low flow delivered continuously • One summer/autumn estuary fresh	• One additional summer/autumn estuary fresh	• One winter/spring fresh	• N/A
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring low flow (deliver for one month)[1]	• One winter/spring fresh • Winter/spring low flow (deliver for one month)	• N/A	• N/A
Possible volume of environmental water required to achieve objectives[2]	• 12,800 ML (tier 1a) • 16,300 ML (tier 1b) • 9,000 ML (tier 2)	• 13,200 ML (tier 1a) • 7,200 ML (tier 1b) • 15,400 ML (tier 2)	• 7,400–15,200 ML (tier 1a) • 8,900 ML (tier 1b)	• 15,000–21,600 ML (tier 1a)
Priority carryover requirements	• N/A[3]			

[1] As low flows over winter and spring have a demand of 6,200–9,000 ML per month, only one month of continuous flow will likely be feasible.

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

[3] There are no carryover provisions in the Blue Rock environmental entitlement.

2.2.2 Lower Latrobe wetlands

System overview

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 habitat for a variety of waterbirds of state, national and international conservation significance. The wetlands are located on the floodplain of the Latrobe River between its confluence with the Thomson River, and they form part of the Gippsland Lakes system.

River regulation and water extraction from the Latrobe, Thomson and Macalister rivers has reduced the frequency of small- and medium-sized floods that naturally wet the lower Latrobe wetlands. Construction of levees and drains and filling 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 with regulators connected to the Latrobe River.

Environmental values

Sale Common is one of only two remaining freshwater wetlands in the Gippsland Lakes system. It provides sheltered feeding, breeding and resting habitat for a large range of waterbirds, including the Australasian bittern.

Dowd Morass is a large, brackish wetland that regularly supports rookeries of colonial nesting waterbirds including Australian white ibis, straw-necked ibis, little black and little pied cormorants, royal spoonbills and great egrets.

Heart Morass is also a large brackish wetland, with open expanses providing shallow feeding habitat for waterbirds including black swans, Eurasian coots and a variety of ducks.

Together, the lower Latrobe wetlands function as a diverse and complementary ecological system. Colonial nesting waterbirds breed among swamp paperbark trees at Dowd Morass in spring. Migratory shorebirds feed on the mudflats that are exposed as the wetlands draw down and dry over summer. Waterfowl and fish-eating birds use open-water habitat at the wetlands year-round. The wetlands also support threatened vegetation communities including swamp scrub, brackish herbland and aquatic herbland.

Environmental watering objectives in the lower Latrobe wetlands

Maintain the abundance of frog populations
Maintain the abundance of freshwater turtle populations
Maintain or restore a variety of self-sustaining submerged and emergent aquatic vegetation types Maintain or restore the diversity, condition and/or extent of native streamside vegetation fringing wetlands Discourage the introduction and spread, or reduce the extent and density of undesirable/invasive plants (Sale Common)
Maintain or enhance waterbird breeding, recruitment, foraging and sheltering opportunities
Provide suitable physio-chemical conditions to support aquatic life Avoid catastrophic water quality conditions (such as acid sulfate soil exposure) (Heart Morass)

Traditional Owner cultural values and uses

The Gunaikurnai have had a continued connection to Gunaikurnai Country for thousands of years, including with the waterways that feed into the lower Latrobe wetlands. For the Gunaikurnai as traditional custodians there are immense challenges to heal, protect and manage Country which has been drastically altered since colonisation. Gunaikurnai see all of Country as connected with no separation between landscapes, waterways, coasts and oceans and natural and cultural resources – the cultural landscape is interdependent.

GLaWAC are working with the West Gippsland CMA to determine how to express Gunaikurnai objectives for water in a way that contributes to seasonal watering proposals from the perspective of traditional custodians, with traditional knowledge.

Leading up to the 2020-21 Seasonal Watering Plan, focus on the lower Latrobe wetlands has included:

- on Country discussions with GLaWAC and Gunaikurnai Elders and Community to examine cultural values and uses
- discussions regarding the importance of maintaining the wetlands as a freshwater system to support culturally significant species, including totem species
- the importance of the lower Latrobe wetlands to the Gunaikurnai traditionally, and today
- concerns regarding water quality, increasing salinity
- concerns regarding pest species including carp.

GLaWAC are sharing with the West Gippsland CMA plant and animal species of cultural significance in and around the waterways of the Latrobe Valley, and the importance of specific watering decisions to support them.

Watering requirements to support cultural values and uses include:

- timing of environmental watering planned in partnership with GLaWAC to support a seasonal flow regime and wet and dry periods that embody Healthy Country
- maintaining freshwater supply to Latrobe estuary, Dowd Morass, Sale Common and Heart Morass and associated freshwater habitats. The lower Latrobe wetlands are an important resource for the Gunaikurnai
- providing connectivity between reaches and onto floodplains to support dependent flora and fauna with cultural values and uses of significance to the Gunaikurnai
- maintaining water quality to support health of native flora and fauna with cultural values and uses of significance to the Gunaikurnai.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 2.2.3, the West Gippsland CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing)
- riverside recreation and amenity (such as camping, birdwatching, duck hunting and amenity for access tracks)
- socio-economic benefits (such as commercial fishing).

Recent conditions

Climatic conditions in the lower Latrobe wetlands' catchment varied throughout 2019–20. Total rainfall was below average, but there were still some significant rain events that increased river levels throughout winter and spring 2019, particularly from the Latrobe River catchment, and they caused minor overbank flooding in late spring 2019 and again in late autumn 2020. The VEWH's entitlement for the lower Latrobe wetlands is not limited in volume, and regulator gates may be opened opportunistically based on water height in the Latrobe River at Swing Bridge.

Heart Morass, Dowd Morass and Sale Common were allowed to draw down in 2018–19 to allow the die-off of aquatic vegetation, promote nutrient cycling and allow terrestrial grasses and sedges to establish. Overbank flows in late winter and early spring 2019 partly refilled the wetlands. Environmental water was subsequently delivered as required (and when salinity in the Latrobe River estuary was not too high) to maintain water quality and habitat for aquatic and terrestrial animals, and to support the growth and flowering of semi-aquatic vegetation. Complete and near-complete fills were achieved at Dowd Morass and Heart Morass respectively in 2019–20, and a partial fill was achieved at Sale Common. A flushing flow was delivered to Heart Morass in spring 2019 to export salts and sulfates. Water levels at all wetlands were drawn down partially over summer to expose mudflats, which created feeding opportunities for wading birds and oxygenated soils to promote seed germination. High rainfall in late April and May 2020 caused minor flooding, allowing deliveries of freshwater to the lower Latrobe wetlands again in autumn.

Some water was retained in Dowd Morass and Sale Common to maintain habitat for Australasian bittern and other significant waterbirds that were observed at these sites during summer. Maintaining this habitat will likely be a priority throughout 2020–21.

Scope of environmental watering

Table 2.2.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 2.2.3 Potential environmental watering actions and objectives for the lower Latrobe wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Sale Common		
Partial fill (during July to December, with top-ups as required to maintain water height above 0.3m AHD [Australian Height Datum])	Maintain a water level at 50 percent or greater (0.3m AHD) to: • encourage the growth and flowering of semi-aquatic plants • provide appropriate wetland habitat for frogs and turtles • provide conditions that support waterbug communities and food resources for waterbirds • wet key habitats within the wetland for sufficient duration to discourage invasive plants, particularly the excessive spread of giant rush	
Fill (during August to November and maintain at full level for at least two months)[1]	• Wet the outer boundaries of the wetland to support the growth and flowering of streamside and fringing wetland plants, increasing foraging opportunities for waterbirds • Encourage bird breeding by providing nesting habitat to wet reed beds and provide deep water next to reedbeds • Provide connectivity between the river and wetlands and increase habitat and feeding opportunities for frogs and turtles	
Top-up (anytime, following bird breeding event if required)	• Prolong wetting of reed beds to maintain habitat and food resources for nesting waterbirds and protect chicks from predators	
Dowd Morass		
Partial fill (during April to December, with top-ups over summer to maintain surface coverage)[2]	• Provide seasonal variation in water depth throughout the wetland to support the growth and flowering of semi-aquatic plants • Wet vegetation and soils at middle elevations within the wetland to increase the abundance of waterbugs and other food resources for frogs, turtles and waterbirds • Provide connectivity between the river and wetlands and between wetlands, increasing available habitat for frogs and turtles • Support bird breeding (when delivered in spring/early summer following earlier fill) by maintaining wetted habitat around reed beds	
Fill (during August to November)	• Wet reed beds and deep water next to reedbeds to provide waterbird nesting habitat and to stimulate bird breeding • Wet high-elevation banks and streamside zone to support vegetation growth, creating nesting habitat for waterbirds • Wet vegetation and soils at higher elevations to stimulate ecosystem productivity and increase the abundance of waterbugs and other food resources for frogs, turtles and waterbirds • Provide connectivity between the river and wetlands and between wetlands, increasing available habitat for frogs and turtles	
Trigger-based fill or partial fill to control salinity (any time)[3]	• Dilute salt concentrations within the wetland that may be caused by king tides from Lake Wellington (likely occurring between March to May) or other sources • This watering action is likely to be triggered[4] if electrical conductivity is rising and reaches 7,000 µS/cm	
Top-up (anytime, following bird breeding event if required)	• Prolong wetting of reed beds to maintain habitat for waterbirds and protect chicks from predators, following an observed breeding event	

Table 2.2.3 Potential environmental watering actions and objectives for the lower Latrobe wetlands *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Heart Morass		
Partial fill (during August to December, with top-ups as required to maintain water level above -0.3 m AHD[5])	• Maintain water levels above -0.3 m AHD year-round to avoid exposing acid sulfate soils • Provide seasonal variation in water depth throughout the wetland to support the growth and flowering of semi-aquatic plants • Provide appropriate wetland fringing habitat for frogs and turtles • Provide conditions that support waterbug communities and food resources for frogs, turtles and waterbirds • Stimulate bird breeding by providing nesting habitat via inundating reed beds and deep water next to reedbeds	
Partial wetland flush (during June to November)	• Fill wetland to 0.5m AHD and allow water to flush through the wetland to export accumulated salts and sulfates • Allow the import and export of nutrients, dissolved organic carbon and seed dispersal between the Latrobe River and Heart Morass	
Trigger-based fill or partial fill to respond to acid sulfate soil exposure or control salinity (any time)[3]	• Respond to decreasing pH from the rewetting of exposed acid sulfate soils (most likely during high-wind events) • Dilute salt concentrations within the wetland that may be caused by king tides from Lake Wellington or other sources. This watering action is likely to be triggered[6] if wetland overtopping appears likely; based on rising water levels at Lake Wellington (reaching or exceeding +0.5m AHD)	
Top-up (anytime, following bird breeding event if required)	• Prolong wetting of reed beds to maintain habitat for waterbirds and protect chicks from predators, following an observed breeding event	

1 While a full fill is the target, if salinity in the Latrobe River is too high a partial fill may be provided instead, helping to achieve some of the listed functional watering actions. This is most likely to eventuate under drought conditions.

2 Timing of this flow changes depending on the scenario. An extended partial fill may be required under a drought scenario, however under dry to wet scenarios, partial fills either side of the full fill over late winter and spring are preferred. Top-ups over summer are unlikely under a drought scenario, as reduced flow in the Latrobe River is likely to increase salinity levels beyond a tolerable limit for wetland filling.

3 Trigger-based events may override other planned watering actions if required, to maintain conditions at the site.

4 If salinity level in the Latrobe River exceeds 15,000 µS/cm, a fill or partial fill will not be provided.

5 Maintaining the water level above -0.3m AHD is a high priority, to avoid exposing acid sulfate soils.

6 If the salinity level in the Latrobe River exceeds 10,000 µS/cm, a fill or partial fill will not be provided.

Scenario planning

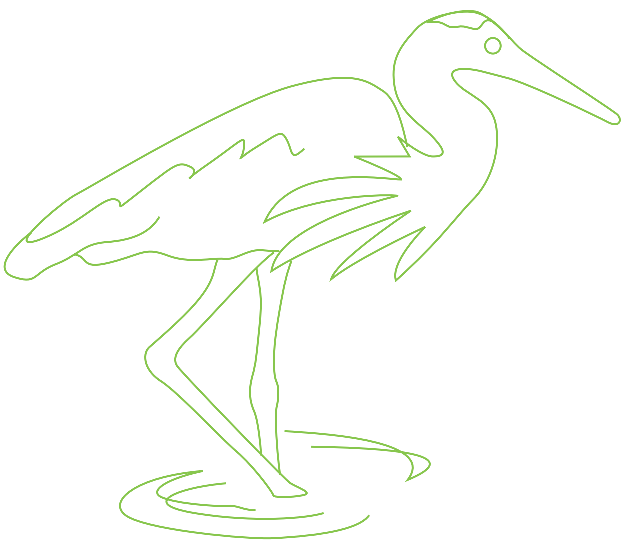
Table 2.2.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The planned approach in 2020–21 at the lower Latrobe wetlands is to mimic natural flows in the system by controlling flow through the regulators when water levels and water quality in the Latrobe River allow. Following extended drying in 2018–19 and 2019–20, actively-managed drying is not prioritised under any scenario, although this will likely occur naturally at all wetlands under drought, particularly as reduced flow in the Latrobe River leads to high salinity that may exceed recommended wetland tolerances.

The preferred watering regime for Sale Common involves:

- partially filling the wetland in winter and providing top-ups as needed to maintain water levels above 0.3 m AHD throughout the year to support wetland plant communities and habitat for frogs, turtles and waterbirds, and
- filling the wetland for at least two months from late winter or early spring to connect the wetland to the Latrobe River, stimulate the growth and recruitment of plant communities at the outer margins of the wetland and encourage waterbird breeding by providing appropriate nesting habitat.

Further top-ups may be delivered in response to a significant waterbird breeding event, if needed to protect the nests from ground-based predators and to maintain adequate food resources for nesting adults and chicks. Maintaining a target water level of 0.3 m AHD will wet about half of Sale Common, and it is considered important for ecological communities that experienced near-complete drying in 2018–19 and 2019–20. These watering actions are planned to be delivered under all scenarios, where possible.



The preferred watering regime for Dowd Morass involves:

- partially filling the wetland in autumn to maintain wetland plant communities and provide habitat and food resources for waterbirds, frogs and turtles
- filling the wetland in winter and spring to trigger waterbird breeding and improve the condition of streamside vegetation communities
- maintaining water at suitable levels through spring and summer to maintain habitat for aquatic plants and animals.

Additional water may be delivered to Dowd Morass at any time of year as needed and as water levels in the Latrobe River allow, to manage high salinity (caused by king tides from Lake Wellington) or to help waterbirds successfully fledge. The preferred water regime is likely to be delivered under dry, average and wet scenarios, but flow in the Latrobe River may not be high enough to allow Dowd Morass to fill under a drought scenario. Waterbird breeding is also a lower priority under a drought scenario, because there are unlikely to be sufficient resources in the surrounding landscape to support chicks and juveniles.

The preferred water regime for Heart Morass involves:

- maintaining water levels above -0.3 m AHD year round to prevent exposing acid sulfate soils
- partially filling the wetland from winter through to early summer to support wetland plant communities, maintain habitat and food resources for frogs, turtles and waterbirds, and to provide breeding opportunities for waterbirds
- briefly filling the wetland to allow a partial flush during a winter/spring high flow event in the Latrobe River to remove accumulated salt and sulphides.

Additional water may be delivered to Heart Morass at any time of year as needed and as water levels in the Latrobe River allow, to control water quality — that is, to respond to a low pH or a high-salinity event — or to help waterbirds successfully fledge. Water levels in the Latrobe River are not expected to be high enough to support a partial flush of Heart Morass under a drought scenario, and under a wet scenario the partial flush is likely to be replaced by a natural flood that will flush the whole wetland.

Table 2.2.4 Potential environmental watering for the lower Latrobe wetlands 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>• No natural inflows from the Latrobe River, and wetlands are likely to dry completely</td><td>• Minor natural inflows from the Latrobe River in winter/spring; expect moderate-to-substantial drying in summer</td><td>• Moderate winter/spring flows in the Latrobe River likely to fill or partially fill the wetlands; expect minor drying in summer</td><td>• Major flows in the Latrobe River in winter/spring and possibly autumn/winter likely to fill all wetlands with very little drying in summer</td></tr>
<tr><td>Sale Common</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td colspan="4">• Partial fill (during July to December, with top-ups as required to maintain height above 0.3m AHD)
• Fill (during August to November)
• Top-up (anytime, following bird breeding)</td></tr>
<tr><td>Dowd Morass</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td>• Partial fill (during April to December)
• Trigger-based fill or partial fill (anytime)
• Top-up (anytime, following bird breeding)</td><td colspan="3">• Partial fill (during April to June and in December, with top-ups over summer to maintain surface coverage)
• Fill (during August to November)
• Trigger-based fill or partial fill (anytime)
• Top-up (anytime, following bird breeding)</td></tr>
<tr><td>Heart Morass</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td>• Partial fill (during August to December with top-ups as required to maintain water level above -0.3m AHD)
• Trigger-based fill or partial fill (anytime)
• Top-up (anytime, following bird breeding)</td><td colspan="2">• Partial fill (during August to December with top-ups as required to maintain water level above -0.3m AHD)
• Fill to 0.5 m AHD followed by partial flushing flow (during June to November)
• Trigger-based fill or partial fill (anytime)
• Top-up (anytime, following bird breeding)</td><td>• Partial fill (during August to December with top-ups as required to maintain water level above -0.3m AHD)
• Trigger-based fill or partial fill (anytime)
• Top-up (anytime, following bird breeding)</td></tr>
</table>

[1] Potential environmental watering at the lower Latrobe wetlands is not classified as tier 1a, tier 1b or tier 2, because there is no limitation on the volume of water that can be supplied to the site from the Latrobe River. Water can be diverted to the lower Latrobe wetlands at any time of the year when flows are above -0.7 m AHD at the Latrobe River at the Swing Bridge gauging station.

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

Did you know...?

The Thomson River is known to the Gunaikurnai people as *Carran Carran*, which means 'brackish water.'

Top: Thomson River, by West Gippsland CMA
Above: Vegetation at Heyfield wetlands, by VEWH

System overview

The Thomson River flows from the slopes of the Baw Baw Plateau to join the Latrobe River south of Sale. The major tributaries of the Thomson River are the Aberfeldy and Jordan rivers in the upper reaches and the Macalister River in the lowest reach. Most natural flow originates from the Aberfeldy River. Two major structures regulate flow on the Thomson River: Thomson Reservoir — the largest water supply storage for metropolitan Melbourne — and Cowwarr Weir — a regulating structure which supplies irrigation water to parts of the Macalister Irrigation District.

Thomson Reservoir harvests most of the flow from the Thomson River upper catchment and has a significant effect on flow in all downstream reaches. Natural flow from the Aberfeldy River, which meets the Thomson River below Thomson Reservoir, is essential for providing natural freshes and high flows in the Thomson River.

Water for the environment is held in the Thomson Reservoir and released into the river as required. 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, high-value native streamside vegetation, high-quality in-stream habitat and low abundance of exotic fish species.

At Cowwarr Weir, the Thomson River splits into the old Thomson River course (reach 4a) and Rainbow Creek (reach 4b) (see Figure 2.3.1). Passing flows throughout the year are split two-thirds down reach 4a and one-third down 4b to avoid impacts to irrigators located on Rainbow Creek. Water for the environment is primarily delivered to the old Thomson River course (reach 4a) to support fish migration, because Cowwarr Weir impedes fish movement through Rainbow Creek.

The Heyfield wetlands is a cluster of several pools located between the Thomson River and the township of Heyfield. Due to the construction of levees and weirs along the Thomson River, natural wetting of river waters to the wetland rarely occurs; and while the largest pool receives stormwater from the Heyfield township, smaller ponds rely on rainfall or pumped water for the environment to maintain environmental values. These values include significant revegetation that has been done in recent years.

Environmental values

The Thomson River supports six native species of migratory fish that need to move between the sea and freshwater environments to complete their life cycles. A focus for environmental flows management is the Australian grayling, which is listed as a threatened species in Victoria. Australian grayling spawn in response to autumn freshes, and the larvae and juveniles spend time at sea before returning to the freshwater sections of coastal rivers.

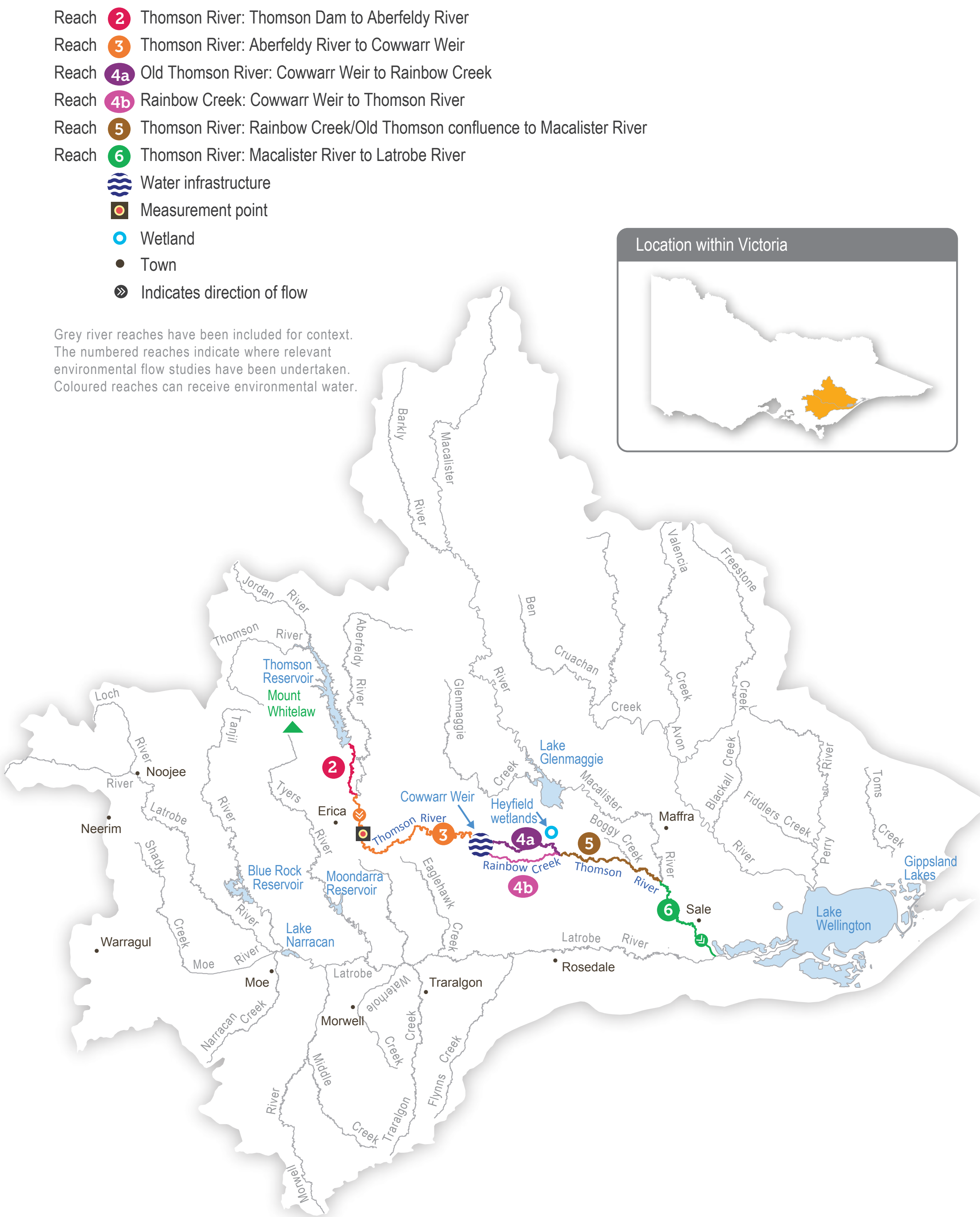
The composition and condition of streamside vegetation varies throughout the Thomson River catchment. The vegetation is intact and near-natural condition above Thomson Reservoir in the Baw Baw National Park. Streamside vegetation between Thomson Reservoir and Cowwarr Weir is mostly in good condition but is affected by exotic weeds including blackberry and gorse. Below the Cowwarr Weir, the vegetation is degraded due to stock access and widespread weed invasion.

The Heyfield wetlands are one of the few remaining freshwater wetland sites in the Gippsland Plains landscape area, and they are a source of habitat for aquatic and terrestrial animals that prefer shallow, slow-moving waterbodies, including threatened migratory birds.

Environmental watering objectives in the Thomson system

Restore populations of native fish, specifically Australian grayling Maintain/enhance the structure of native fish communities Reduce competition from exotic fish
Maintain the existing frog population and enhance opportunities for breeding
Maintain channel form diversity including pools, to provide a variety of habitats for aquatic animals
Increase the abundance of platypus
Maintain and restore the structural diversity and zonation of streamside vegetation and reduce terrestrial encroachment/invasion (Thomson River) Increase the recruitment and growth of native in-stream, fringing and streamside vegetation (Thomson River) Maintain the existing vegetation, promote the growth and establishment of semi-aquatic species (Heyfield wetlands) Enhance the resilience of semi-aquatic and streamside woodland species (Heyfield wetlands)
Restore and maintain the natural invertebrate community
Provide freshwater habitat for migratory and non-migratory wetland birds within the Gippsland Plains landscape Continue to support observed terrestrial woodland and grassland birds by maintaining their streamside woodland habitat

Figure 2.3.1 The Thomson system



Traditional Owner cultural values and uses

The Gunaikurnai have had a continued connection to Gunaikurnai Country for thousands of years, including with the waterways in the Latrobe River system (which the Thomson River feeds into). For the Gunaikurnai as traditional custodians there are immense challenges to heal, protect and manage Country which has been drastically altered since colonisation. Gunaikurnai see all of Country as connected with no separation between landscapes, waterways, coasts and oceans and natural and cultural resources – the cultural landscape is interdependent.

Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC) are working with the West Gippsland CMA to determine how to express Gunaikurnai objectives for water in a way that contributes to seasonal watering proposals from the perspective of traditional custodians, with traditional knowledge.

Traditionally, *Carran Carran* (Thomson River) was an important meeting place and a place to camp. Today, the majority of *Carran Carran* is inaccessible to the Gunaikurnai making it difficult to meet and yarn along the river. Assessments for watering requirements of *Carran Carran* for the Gunaikurnai have been based on cultural indicators, including:

- the condition of the lower Latrobe wetlands (which *Carran Carran* helps supply)
- the condition and prevalence of plants and animals with cultural values and uses
- species known to be indicators of water quality, water regimes and Healthy Country.

GLaWAC are sharing with the West Gippsland CMA plant and animal species of cultural significance in and around the waterways of the Latrobe Valley, and the importance of specific watering decisions to support them.

Watering requirements to support cultural values and uses include:

- timing of environmental watering planned in partnership with GLaWAC to support a seasonal flow regime and wet and dry periods that embody Healthy Country
- maintaining freshwater supply to Latrobe estuary, Dowd Morass, Sale Common and Heart Morass, and associated freshwater habitats. The lower Latrobe wetlands are an important resource for the Gunaikurnai
- providing connectivity between reaches and onto floodplains to support dependent plants and animals with cultural values and uses of significance to the Gunaikurnai
- maintaining water quality to support the health of native plants and animals with cultural values and uses of significance to the Gunaikurnai.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 2.3.1, West Gippsland CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as kayaking, canoeing, fishing and swimming)
- riverside recreation and amenity (such as camping, hiking, duck hunting and birdwatching)
- community events and tourism (such as community education and events at the Heyfield wetlands, and visitation by locals and non-locals)
- socio-economic benefits (such as outdoor education companies).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 2.3.1 with an icon.

	Watering planned to support water sports activities (e.g. canoeing, kayaking, rowing, swimming, water skiing)
	Watering planned to support peaks in visitation (e.g. camping or other public activities on long weekends or school holidays)

Autumn, winter and spring freshes create ideal whitewater rafting conditions for kayakers and canoers in the Thomson River. The timing of environmental flows may be adjusted to optimise opportunities to support these recreation activities, where it does not compromise environmental outcomes. Recreational kayakers and outdoor companies can take advantage of the whitewater rafting conditions as a result of these freshes.

For example, the spring fresh, which aims to cue the migration of Australian grayling, may be delivered over the Melbourne Cup racing carnival weekend in November when many people take advantage of the Tuesday public holiday to spend a long weekend kayaking on the Thomson River.

Recreational users interested in this shared benefit can register on the West Gippsland CMA website to receive a notification of the upcoming watering event.

Recent conditions

The start of the 2019–20 water year was warmer and drier than average in the Thomson River catchment, but above-average rainfall over summer increased inflows to the Thomson Reservoir and boosted water availability. Thomson Reservoir did not spill, so moderate releases were made throughout the year to supply minimum passing flow requirements, to meet irrigation demand and for environmental watering. Environmental watering actions were delivered in line with dry conditions during the first half of the year and average conditions from late summer.

Other than bankfull and overbank flows (which cannot be managed with water for the environment), all recommended environmental flows for the Thomson River were achieved through natural flows, managed environmental flows, operational deliveries or a combination of these.

Water for the environment was used to meet high-priority freshes in spring and autumn and to maintain target low flows as needed. The spring and autumn freshes are particularly important to cue native fish to move between habitats, supporting their breeding and recruitment.

Water for the environment was delivered to Heyfield wetlands in August and October 2019 to enhance the growth of recently planted aquatic and streamside vegetation and to increase feeding habitat for waterbirds.

Scope of environmental watering

Table 2.3.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

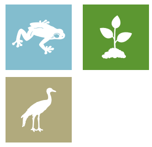
Table 2.3.1 Potential environmental watering actions and objectives for the Thomson River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Autumn fresh (two freshes of 800 ML/day for seven days during April to May)	• Trigger the downstream migration (and spawning) of Australian grayling (April) • Trigger the downstream migration of tupong and Australian bass (May) • Carry plant seeds from the upper catchment for deposition downstream • Deposit sediments on benches, to provide substrate for vegetation • Wet the bank/bench to deliver dissolved and/or fine particulate organic matter • Scour substrates to remove accumulated fine sediment	
Spring fresh (one to two freshes of 800 ML/day for seven days during September to November)	• Trigger upstream fish migration from marine/estuarine habitats and the recruitment of juvenile native species including Australian grayling and Australian bass (October to November) • Improve and maintain streamside vegetation by inundating the benches and providing variable water levels for plant zonation • Carry plant seeds from the upper catchment for deposition downstream • Deposit fine particulate sediments on the benches • Scour substrates to remove accumulated fine sediment	
Summer/autumn fresh (two freshes[1] of 230–350 ML/day for seven days during December to March)	• Increase the water depth to provide habitat for native fish • Wet aquatic and fringing vegetation to maintain its condition and support its growth • Maintain the physical form and functioning of the channel through mobilisation of fine sediments	
Autumn/winter/spring low flow (125–350 ML/day during May to November)[2]	• Increase the available habitat for waterbugs • Regulate the water temperature and wet large woody debris to provide food and shelter for waterbugs and fish • Increase the water depth to facilitate platypus and fish movement between localised habitats and increase foraging opportunities • Wet low-lying benches to prevent encroachment by invasive plants and permit seed dispersal	

[1] Additional summer freshes are likely to be met with operational water releases.

[2] Passing flows may be flexibly managed at rates less than 230 ML per day in July.

Table 2.3.1 Potential environmental watering actions and objectives for the Thomson River *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (340 ML/day at reach 6 during December to May)	• Partially flush the upper water column in the Thomson estuary, helping to sustain waterbug communities and fish by maintaining oxygen levels • Prevent high salinity levels, helping to maintain emergent macrophyte vegetation • Provide freshwater to the Latrobe River system	
Heyfield wetlands		
Fill (in August)	• Wet ponds to capacity, to stabilise the banks and support the spring growth of semi-aquatic vegetation • Provide freshwater habitat for waterbirds and frogs (such as growling grass frogs and golden bell frogs)	
Top-ups to maintain water level, as required (during October to November)	• Top up ponds before summer to maintain the existing vegetation and enhance its recruitment by triggering seed dispersal • Provide freshwater habitat for waterbirds and frogs (such as growling grass frogs and golden bell frogs)	
Partial drying (during December to February)	• Oxygenate surface soils, break down accumulated organic matter and cycle nutrients • Enhance waterbird food availability by exposing the mudflats and provide access to burrowing invertebrates	

Scenario planning

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

The highest-priority potential watering actions in the Thomson River under all scenarios in 2020–21 are freshes in autumn, for which the primary objective is to trigger the migration and spawning of Australian grayling. It is critical to provide autumn freshes under all scenarios in 2020–21 to achieve the minimum two required spawning cues for Australian grayling over a three-year period: autumn freshes were achieved in 2019–20 but not delivered in 2018–19 due to construction of the Horseshoe Bend fishway. Spring freshes, smaller-magnitude summer/autumn freshes and winter/spring low flows are also planned to be delivered under all scenarios. The only difference between scenarios is the intention to deliver an extra fresh in early spring under average and wet conditions, to improve outcomes for streamside vegetation.

If possible, spring and autumn freshes in the Thomson system will be timed to coincide with releases in the Macalister and Latrobe systems, to optimise fish movement and optimise outcomes in the Latrobe estuary and lower Latrobe wetlands. Outcomes for the Latrobe estuary rely on flow contributions from all three systems.

The second of a two-year watering trial at the Heyfield wetlands is planned to continue in 2020–21 under all scenarios. The trial involves filling the wetlands in winter and providing top-ups as needed throughout spring, to maintain water levels for aquatic vegetation and to provide habitat for waterbirds and frogs. It is then intended the wetlands will be allowed to draw down over summer and autumn, to oxygenate the soil and allow nutrient cycling.

There are no critical watering actions that cannot be delivered with expected environmental water holdings (that is, there are no tier 1b priorities). Additional environmental watering priorities (tier 2) have been identified for the Thomson River under drought and dry scenarios. Additional water is required to deliver summer/autumn low flows in the Thomson River estuary (reach 6) to freshen water quality and support estuarine fish.

The tier 2 potential environmental watering actions identified are critical to achieving environmental objectives in the long term. They could be delivered in the current year if circumstances allow, but they can likely be deferred without significant environmental harm. The summer/autumn low flow targeting reach 6 is currently a tier 2 action, as further research is required to establish the specific salinity level tolerances and management triggers for determining when critical flushing of the Thomson River estuary is required, including whether the salt wedge pushing too high upstream could affect breeding and egg drift. In 2020–21 this watering action is not prioritised over freshes and winter/spring low flows, as it requires a significant volume of water and it can be partially met by passing flows from both the Thomson and Macalister rivers. In addition, freshes in both rivers may be timed to coincide, potentially achieving some of the functional objectives.

Under all scenarios, 5,500 ML of water for the environment is prioritised for carryover at the end of 2020–21, to meet critical early season demands in the Thomson River — spring low flows and freshes — under a drought scenario in 2021–22.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Limited natural flow • Large volume of consumptive water released from storage	• Natural flow from Aberfeldy River and other tributaries contributes to low flow and freshes • Moderate volume of consumptive water released from storage	• Natural flow from Aberfeldy River and other tributaries contributes to low flow, freshes and high flows • Small volume of consumptive water released from storage	• Natural flow from Aberfeldy River and other tributaries contributes to low flow, freshes and sustained high flows • Minimal volume of consumptive water released from storage
Expected availability of water for the environment	• 29,000 ML	• 32,000 ML	• 35,000 ML	• 38,000 ML
Potential environmental watering – tier 1a (high priorities)	• Two autumn freshes • One spring fresh • Two summer/autumn freshes • Winter/spring low flow		• Two autumn freshes • Two spring freshes • Two summer/autumn freshes • Winter/spring low flow	
Potential environmental watering – tier 1b (high priorities with shortfall)	• N/A			
Potential environmental watering – tier 2 (additional priorities)	• Summer/autumn low flow			• N/A
Possible volume of environmental water required to achieve objectives[1]	• 27,000 ML (tier 1a) • 16,700 ML (tier 2)	• 31,200 ML (tier 1a) • 16,700 ML (tier 2)	• 34,500 ML (tier 1a) • 6,300 ML (tier 2)	• 37,300 ML (tier 1a)
Priority carryover requirements	• 5,500 ML[2]			
Heyfield wetlands				
Potential environmental watering – tier 1a (high priorities)	• Fill (in August) • Top-ups to maintain water level as required (during October to November) • Partial drying (during December to February)			
Possible volume of environmental water required to achieve objectives	• 15–25 ML (tier 1a)		• 10–17 ML (tier 1a)	• 7–12 ML (tier 1a)

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

[2] Priority carryover volumes have been incorporated into tier 1a demands.

2.4 Macalister system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

Australian grayling, short-finned eels, long-finned eels, tupong, Australian bass, short-headed lamprey and common galaxias all migrate between the Macalister River, its estuary and the sea to complete their life cycles with the help of environmental flows.

Top: Macalister River at Lanigans Bridge, by West Gippsland CMA
Above: Monitoring, by West Gippsland CMA

System overview

The Macalister River flows from Mt Howitt in the Alpine National Park and joins the Thomson River south of Maffra. The river winds its way in a south-easterly direction through mostly forested, confined valleys and narrow floodplains above Lake Glenmaggie. The downstream reaches flow through wide alluvial floodplains that have been cleared for agriculture. The Wellington River and Glenmaggie Creek are the main tributaries of the Macalister River.

Lake Glenmaggie is the major water-harvesting storage regulating the Macalister River. Maffra Weir is a small diversion weir located further downstream in Maffra.

Before the construction of Lake Glenmaggie, the Macalister River would regularly receive high and medium flows in winter and spring. Although Lake Glenmaggie regularly spills, high flows are less frequent than natural because much of the water is captured by the storage. A notable impact of irrigation and water-harvesting is reversed seasonality of flows between Lake Glenmaggie and Maffra Weir. Summer flows through this reach are much higher than natural due to the delivery of irrigation water. Winter flows in this reach are lower than natural because a high proportion of the inflows are captured and there are no irrigation demands over winter. Below Maffra Weir, most flows are diverted for irrigation in summer/autumn. The changed hydrology restricts fish migration, limits the growth and recruitment of in-stream and streamside plants and reduces the quality of in-stream habitat.

Water for the environment is stored in Lake Glenmaggie and released to the Macalister River. The river is divided into two reaches for the purposes of managing environmental flows: Lake Glenmaggie to Maffra Weir (reach 1) and Maffra Weir to the Thomson River (reach 2).

Maffra Weir is a major barrier to fish movement along the river, so environmental watering for migratory fish objectives mainly focus on reach 2. All other objectives apply to both reaches 1 and 2.

Environmental values

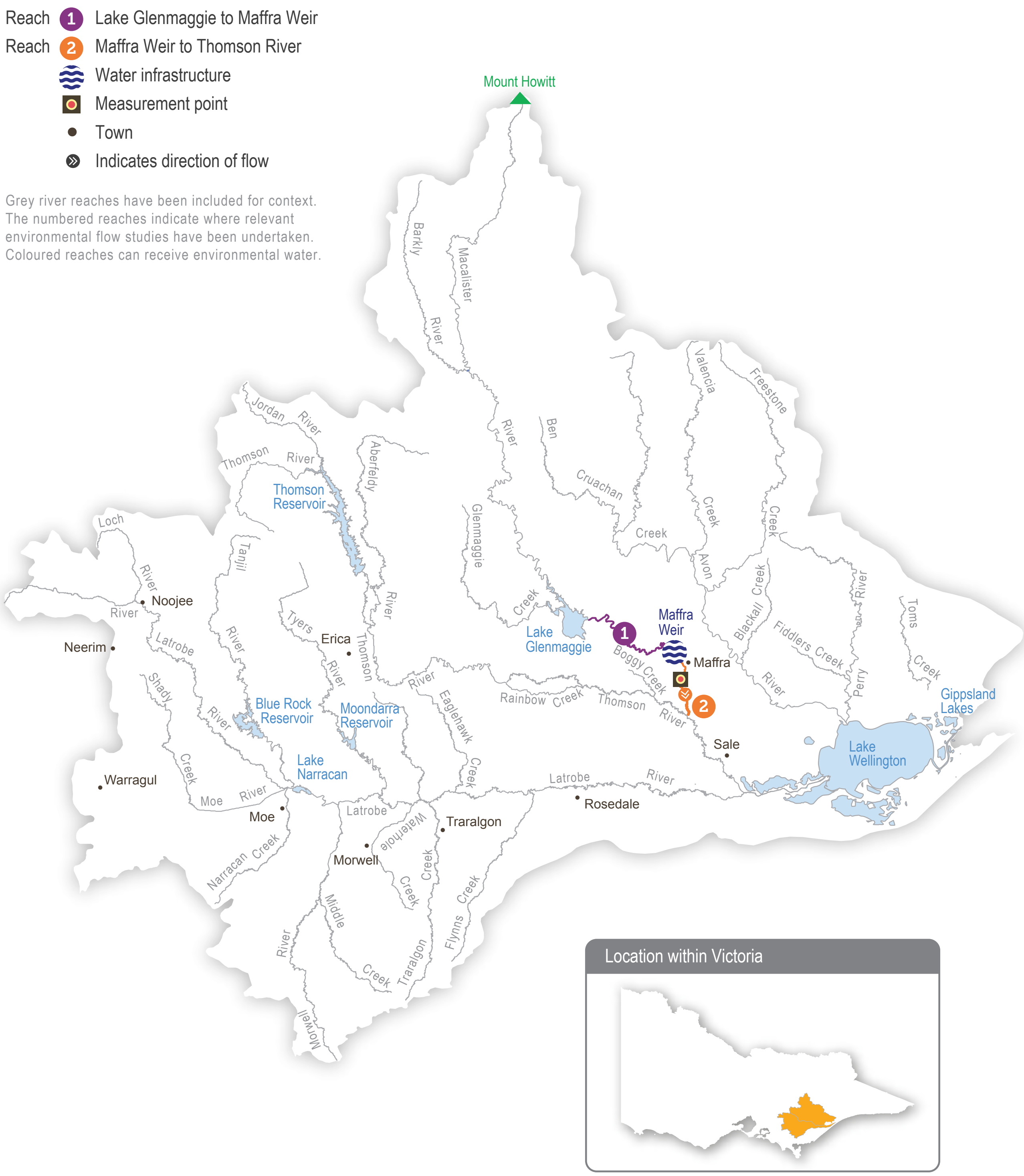
There are seven migratory native fish species that move between the Macalister River, the estuary and the sea to complete their life cycle. These species include the Australian grayling, short-finned eel, long-finned eel, tupong, Australian bass, short-headed lamprey and common galaxias. Yellow-eye mullet, which is an estuarine species, has been recorded in the river. Platypus and rakali (water rats) are widely distributed through the Macalister River and its tributaries.

The streamside vegetation corridor along the regulated reaches of the Macalister River is fragmented. Immediately below Lake Glenmaggie, the vegetation is in good condition and includes remnant river red gums and good-quality stands of shrubs, particularly in areas where revegetation has occurred in combination with stock exclusion. Further downstream, the vegetation is degraded. In recent years, the cover of in-stream vegetation has declined, which may be due to a combination of increased water turbidity, erosion and a lack of an appropriate water regime to encourage plant growth. The cover of non-woody plants (such as reeds, sedges and rushes) along the fringes of the river is patchy.

Environmental watering objectives in the Macalister River

Increase the distribution, recruitment and abundance of all native fish, and increase opportunities for the spawning and recruitment of native migratory fish (such as the Australian grayling)
Improve and maintain the form of the riverbank and bed to provide physical habitat for aquatic animals and plants
Increase the abundance of platypus and rakali (water rats)
Improve native emergent (non-woody) and fringing (woody) vegetation in the streamside zone Reinstate or instate submerged aquatic vegetation
Increase the abundance and number of functional groups of waterbugs

Figure 2.4.1 The Macalister system



Traditional Owner cultural values and uses

The Gunaikurnai have had a continued connection to Gunaikurnai Country for thousands of years, including with the waterways in the Latrobe River system (which the Macalister River feeds into). For the Gunaikurnai as traditional custodians there are immense challenges to heal, protect and manage Country which has been drastically altered since colonisation. Gunaikurnai see all of Country as connected with no separation between landscapes, waterways, coasts and oceans and natural and cultural resources – the cultural landscape is interdependent.

Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC) are working with the West Gippsland CMA to determine how to express Gunaikurnai objectives for water in a way that contributes to seasonal watering proposals from the perspective of traditional custodians, with traditional knowledge.

GLaWAC expressed that more water needs to go down the Macalister River between Lake Glenmaggie and Lake Wellington, to improve water quality including the threat of salinity, and support plants and animals with cultural values and uses.

Timing of watering events has also been raised by GLaWAC. This includes providing increased water depth to promote downstream fish migration and spawning, deeper water pools to prevent water quality degradation, and more variation to water levels to better mimic natural conditions.

Traditionally the landscape – which includes the Macalister River, anabranches, and associated floodplains – has been a rich source of food, medicine and resources for the Gunaikurnai people. In the area, there are many sites of cultural significance near the river and around Lake Glenmaggie. The Gunaikurnai people have moved through the landscape along the waterways for thousands of years, sourcing food and plants along the way.

From the perspective of the Gunaikurnai people, the land and waterways flowing to the Gippsland Lakes are interconnected and cannot be considered separately where decisions made can impact downstream. The lower Latrobe wetlands and the rivers that feed them, including the Macalister, have important cultural significance to the Gunaikurnai people.

Watering requirements to support cultural values and uses include:

- timing of environmental watering planned in partnership with GLaWAC to support a seasonal flow regime and wet and dry periods that embody Healthy Country
- maintaining freshwater supply to Latrobe estuary, Dowd Morass, Sale Common and Heart Morass, and associated freshwater habitats. The lower Latrobe wetlands are an important resource for the Gunaikurnai
- providing connectivity between reaches and onto floodplains to support dependent plants and animals with cultural values and uses of significance to the Gunaikurnai
- maintaining water quality to support the health of native plants and animals with cultural values and uses of significance to the Gunaikurnai.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 2.4.1, West Gippsland CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as kayaking, fishing and swimming)
- socio-economic benefits (such as preventing erosion and potential land loss for local landholders).

Recent conditions

The Macalister River catchment has observed ongoing very dry climatic conditions over the last three years. Rainfall has been below average and temperatures warmer than average. In June 2019, the storage level at Lake Glenmaggie was exceptionally low: just 6.1 percent of the full reservoir capacity. Opening allocations of 45 percent towards high-reliability water shares were declared by the storage manager, and this increased to 80 percent by mid-August after inflows improved the water storage level. Despite the dry start, continued inflows over spring led to full allocations for high-reliability water shares by the end of September 2019, boosting water available for environmental watering. Low-reliability water shares also increased throughout the year in response to inflows, reaching full allocation in April 2020.

As of 1 June 2020, Lake Glenmaggie had not spilled in 2019–20. This is an unusual occurrence: historically, Lake Glenmaggie spills most years, as it is a relatively small reservoir in a productive water catchment. 2019–20 was the second consecutive year without a spill, demonstrating how dry the system has been in recent times. Without a spill, the natural high and bankfull flows that usually occur in the Macalister River in winter/spring were absent, but above Maffra Weir the river flowed steadily for most of the year, because water for irrigation and urban supply is delivered between Lake Glenmaggie and the offtake at Maffra Weir. Below Maffra Weir, some moderate natural flows occurred in spring and late summer after heavy rainfall.

Environmental flows were delivered year-round to provide several objectives in the Macalister system. Flows were delivered over winter to maintain habitat for aquatic animals and to support the establishment of in-stream vegetation. This included a winter fresh in August 2019, and again in June 2020, which aimed to cue the downstream migration of tupong and Australian bass towards the Latrobe estuary for breeding and spawning. A spring fresh was delivered in early November 2019, to encourage juvenile fish to migrate into the Macalister River from their estuary nurseries as well as to wet bankside vegetation and enable native seed dispersal.

In autumn 2020, a fresh to cue the downstream migration of Australian grayling towards the Latrobe River estuary for spawning was delivered. This event coincided with an equivalent fresh in the Thomson River system to optimise fish responses across both systems.

All tier 1a watering actions planned for 2019–20 under both a dry and average scenario were met. As Lake Glenmaggie did not spill, there were no tier 1b actions, either with releases of water for the environment or natural and operational flows in the system.

Scope of environmental watering

Table 2.4.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

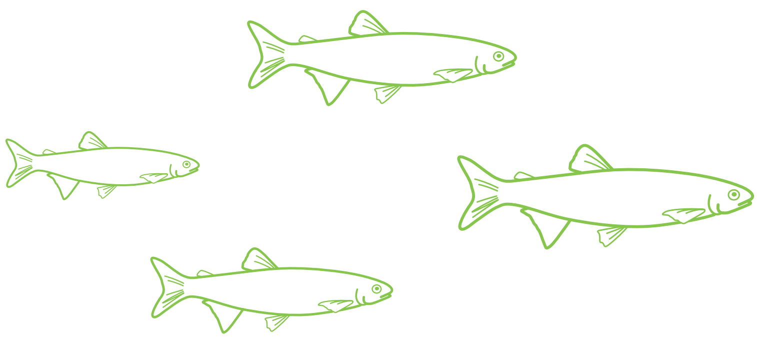


Table 2.4.1 Potential environmental watering actions and objectives for the Macalister River

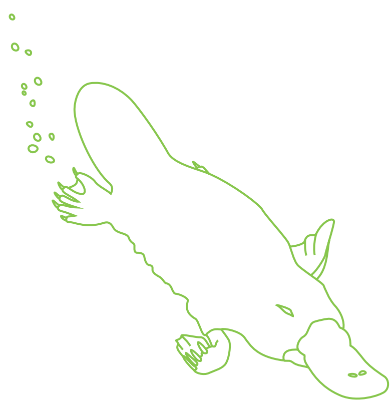
Potential environmental watering action	Functional watering objectives	Environmental objectives
Macalister River reaches 1 and 2		
Autumn/winter low flow (90 ML/day during March to August)	• Provide minimum depth over riffles for fish species that are migrating (i.e. Australian grayling) or about to migrate (i.e. tupong and Australian bass) downstream towards estuary habitat for spawning or breeding • Provide permanent wetted habitat for waterbugs through minimum water depth in pools • Provide connectivity throughout the river for the local movement of platypus and rakali (water rats), as well as protection from predation, access to food sources and to maintain refuge habitats • Provide flows with low water velocity and appropriate depth to improve water clarity and enable establishment of submerged vegetation • Provide sustained wetting of low-level benches (increasing water depth) to limit terrestrial vegetation encroachment	
Spring/summer low flow (90 ML/day during September to January)	• Maintain the water depth in pools and hydraulic habitat for native fish • Maintain permanent wetted habitat in pools and riffles for waterbugs • Maintain shallow, slow-flowing habitat to enable the establishment of in-stream vegetation • Maintain a minimum depth in pools to allow for turnover of water and to slow degradation of water quality to support aquatic life • Expose and dry lower channel features for re-oxygenation	
Spring/summer fresh (one to two freshes of 1,500 ML/day for three days during September to December)[1]	• Cue the upstream migration of adult fish (e.g. short-headed lamprey), and the recruitment of juveniles (e.g. Australian grayling, tupong, common galaxias, Australian bass, short and long-finned eels) from marine/ estuarine environments • Wet a greater area of the stream channel (increasing water depth) to limit terrestrial vegetation encroachment • Wet mid- and higher-level benches to water woody vegetation • Flush pools to improve the water quality and increase wetted habitat for waterbugs • Provide flows with sufficient shear stress to flush fine sediment from small gaps to improve geomorphic habitat	
Macalister River reach 2		
Autumn fresh (one fresh of 350 ML/day for three to seven days during April to May)	• Cue the downstream migration for Australian grayling towards the estuary for spawning • Fully flush the upper Thomson estuary (when delivered for greater than three days and combined with freshes in the Thomson River) to flush sediments from substrates, provide water quality conditions that support waterbugs and to provide freshwater to the lower Latrobe River and wetlands	
Winter fresh (one to two freshes of 700 ML/day for four to five days during June to August)	• Cue the downstream migration towards the estuary of Australian bass for spawning and of tupong for breeding	

Table 2.4.1 Potential environmental watering actions and objectives for the Macalister River *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Spring fresh (one fresh of 700 ML/day for five days during September to November)	• Cue the upstream migration of adult fish (e.g. short-headed lamprey), and recruitment of juveniles (e.g. Australian grayling, tupong, common galaxias, Australian bass, short and long-finned eels) from marine/ estuarine environments • Wet a greater area of the stream channel (increasing water depth) to limit terrestrial vegetation encroachment • Wet low and mid-level benches to facilitate the dispersal of emergent and fringing vegetation throughout the reach	
Summer/autumn fresh (one to three freshes of 140 ML/ day for three to 10 days during December to May)	• Increase the depth to allow fish to move throughout the reach • Flush pools to maintain water quality for aquatic animals • Flush substrates and improve the quality of existing waterbug habitat and food supply • Wet low benches to facilitate the longitudinal dispersal of emergent vegetation • Provide flows with sufficient shear stress to flush fine sediment from small gaps to improve geomorphic habitat	
Trigger-based summer/ autumn low flow (35–60 ML/day during December to May)[2]	• Maintain permanent wetted habitat in pools and riffles for aquatic animals • Maintain shallow, slow-flowing habitat to maintain in-stream vegetation • Maintain a minimum depth in pools to allow for turnover of water and to slow degradation of water quality to support aquatic life	

[1] This fresh is only planned to be delivered following a spill in Lake Glenmaggie (if the magnitude is lower than minor flood level), to extend or slow the rate of ramp-down. If a spill occurs, delivering this fresh will meet the functional flow objectives of the lower magnitude spring/summer fresh.

[2] A low flow of 35–60 ML per day may be triggered if passing flows from Maffra Weir reduce or cease.



Scenario planning

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

The assumed supply of environmental water for 2020–21 enables planning for a suite of freshes and low flows in winter, spring and autumn under all climate scenarios. An autumn fresh to cue the downstream migration of Australian grayling is the highest-priority fresh, to achieve the minimum two required spawning cues for this species over a three-year period; autumn high flows were achieved in 2019–20 but not delivered in the Macalister or Thomson rivers during 2018–19 due to construction of the Horseshoe Bend fishway.

A winter fresh to cue the downstream movement of tupong and Australian bass towards the Latrobe estuary for breeding and spawning, and a spring fresh to cue the upstream migration of adult fish from estuarine environments and promote the recruitment of juveniles are also planned. Low flows may be delivered either side of freshes or when operational flows supplying irrigators are insufficient to maintain water quality and connectivity through the river system, particularly below Maffra Weir and during autumn and winter when there is little delivery of water to supply irrigation customers. Depending on the magnitude of the fresh and whether or not it follows a storage spill, additional objectives for watering floodplain vegetation and flushing pools may be achieved.

In a dry, average or wet scenario, a spill at Lake Glenmaggie is expected in spring. Water for the environment may be used following the peak of the spill to extend the event and ensure the water level does not drop off too suddenly. Freshes in spring aim to cue the upstream migration of adult migratory fish from estuarine environments and promote the recruitment of juveniles. Under a drought scenario, Lake Glenmaggie is not expected to spill, and a smaller fresh will likely be delivered in late spring instead (still meeting flow objectives for migratory fish), followed by low flows to maintain water depth and hydraulic habitat for native fish. During summer and autumn, small-magnitude freshes (to improve water quality and maintain connectivity between habitats for aquatic animals) are planned under all scenarios, but the duration and frequency of the freshes is variable. For example, under drought and dry scenarios, it may be necessary to increase the duration of summer autumn freshes from three to 10 days to prevent pools stagnating. If passing flows provided below Maffra Weir reduce or cease under a drought scenario, water for the environment may be used to supplement reduced passing flows to maintain connectivity and oxygen levels below Maffra Weir.

If additional water for the environment is available under any scenario, it will potentially be used to extend the duration and magnitude of winter/spring low flows or to deliver an additional winter/spring fresh to increase flow variability and provide more opportunities for fish and platypus to move throughout the system.

A critical carryover volume of at least 1,500 ML is identified into 2021–22 under all scenarios, to ensure there is enough water to deliver winter low flows in July and August 2021.

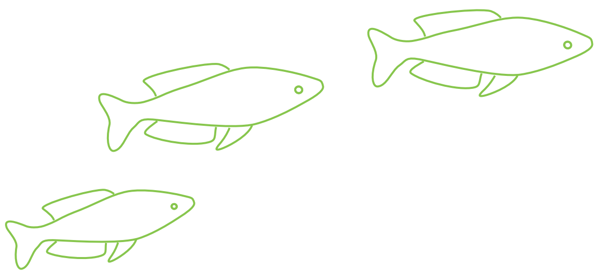


Table 2.4.2 Potential environmental watering for the Macalister River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural flow • 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 water for the environment	• 16,500 ML	• 19,800 ML	• 21,800 ML	• 26,300 ML
Potential environmental watering – tier 1a (high priorities)	• One autumn fresh (reach 2) • Autumn/winter low flow (reach 1 and 2) • Spring/summer low flow (reach 1 and 2) • One winter fresh (reach 2) • One spring fresh (reach 2) • One summer/autumn fresh (reach 2) • Trigger-based summer/autumn low flow (reach 2)	• One autumn fresh (reach 2) • Autumn/winter low flow (reach 1 and 2) • Spring/summer low flow (reach 1 and 2) • One winter fresh (reach 2) • One spring fresh (reach 2) or spring/summer fresh (reach 1 and 2) following spill • One summer/autumn fresh (reach 2) • Trigger-based summer/autumn low flow (reach 2)	• One autumn fresh (reach 2) • Autumn/winter low flow (reach 1 and 2) • Spring/summer low flow (reach 1 and 2) • One winter fresh (reach 2) • One spring fresh (reach 2) or spring/summer fresh (reach 1 and 2) following spill • One summer/autumn fresh (reach 2)	• One autumn fresh (reach 2) • Autumn/winter low flow (reach 1 and 2) • Spring/summer low flow (reach 1 and 2) • One winter fresh (reach 2) • One spring/summer fresh (reach 1 and 2) following spill • One summer/autumn fresh (reach 2)
Potential environmental watering – tier 1b (high priorities with shortfall)	• Two additional summer/autumn freshes (reach 2)	• Two additional summer/autumn freshes (reach 2) • Extend low flow duration through winter/spring if Lake Glenmaggie spills	• Extend low flow duration through winter/spring following Lake Glenmaggie spill	• Extend low flow duration through winter/spring following Lake Glenmaggie spill
Potential environmental watering – tier 2 (additional priorities)	• Extend duration of delivering low flows through winter/spring months	• One additional winter fresh (reach 2)	• One additional winter fresh (reach 2)	• One additional spring/summer fresh (reach 2)
Possible volume of environmental water required to achieve objectives[1]	• 16,200 ML (tier 1a) • 6,600 ML (tier 1b) • 1,200–3,600 ML (tier 2)	• 18,000 ML (tier 1a) • 7,800–10,200 ML (tier 1b) • 4,900 ML (tier 2)	• 20,400 ML (tier 1a) • 1,200–3,600 ML (tier 1b) • 4,900 ML (tier 2)	• 25,800 ML (tier 1a) • 1,200–3,600 ML (tier 1b) • 4,900 ML (tier 2)
Priority carryover requirements	• 1,500–1,900 ML[2]			

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

[2] Priority carryover volumes have been incorporated into tier 1a demands.

2.5 Snowy system

Waterway managers – East Gippsland Catchment Management Authority and New South Wales Department of Planning, Industry and Environment

Storage manager – Snowy Hydro Limited

Environmental water holders – Victorian Environmental Water Holder, New South Wales Department of Planning, Industry and Environment

Did you know...?

The Snowy River is a popular spot for whitewater rafting, canoeing and kayaking. Most flows from the upper Snowy River catchment are captured in lakes Eucumbene and Jindabyne. Environmental flows released from Lake Jindabyne provide important paddling opportunities that are no longer available from natural flows.

Top: Snowy River rafting, by East Gippsland CMA
Above: Swans on the Snowy River at Marlo, by Bruce Paton, VEWH

System overview

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

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

Construction and operation of the Snowy Mountains Hydro-electric Scheme previously diverted 99 percent of the Snowy River's mean annual natural flow at Jindabyne. The loss of flow changed 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.

The Victorian, NSW and Commonwealth governments have recovered water to help restore damage done by decades of limited flow. Victorian water for the environment 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 water for the environment replaces water that was earmarked for transfer from the Snowy to Victoria to support irrigation demands. The NSW Department of Planning, Industry and Environment plans environmental flow releases in the Snowy River, in consultation with the Victorian Government.

Environmental values

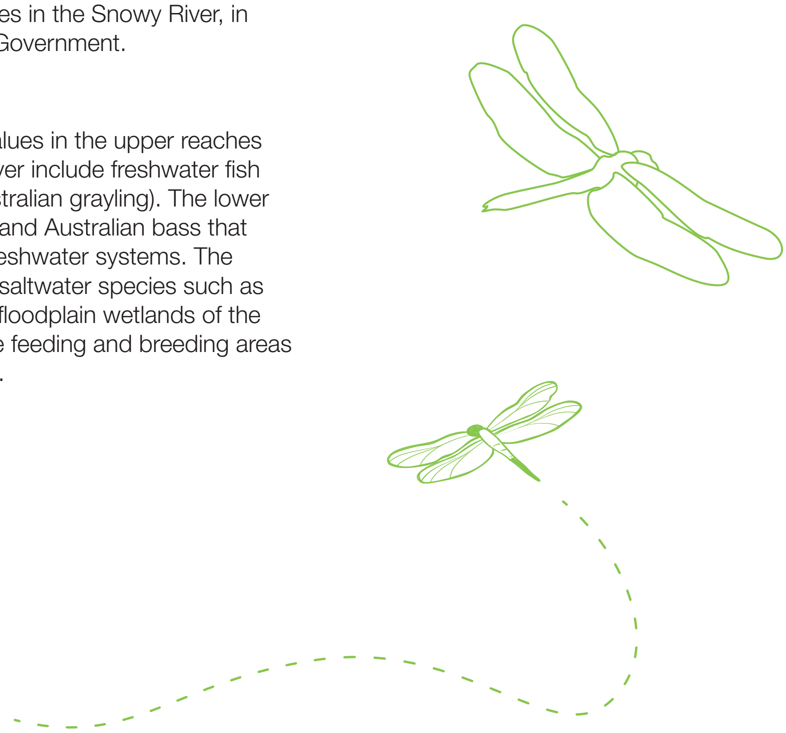
The remaining environmental values in the upper reaches and tributaries of the Snowy River include freshwater fish (such as river blackfish and Australian grayling). The lower reaches support estuary perch and Australian bass that move between saltwater and freshwater systems. The estuary contains estuarine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

Recent conditions

Drought conditions in 2018–19 resulted in reduced environmental flow allocations for the Snowy River in 2019–20, which resulted in smaller peaks to high flows and shorter durations of freshening flow events. The Snowy River catchment continued to experience below-average rainfall and above-average temperatures throughout 2019–20. Below-average inflows to Lake Jindabyne occurred, which similarly have influenced the magnitude and duration of high flow events in 2020–21. In Victoria, most of the Snowy River catchment experienced below-average rainfall and above-average temperatures for most of 2019–20, with this easing to average conditions in autumn 2020.

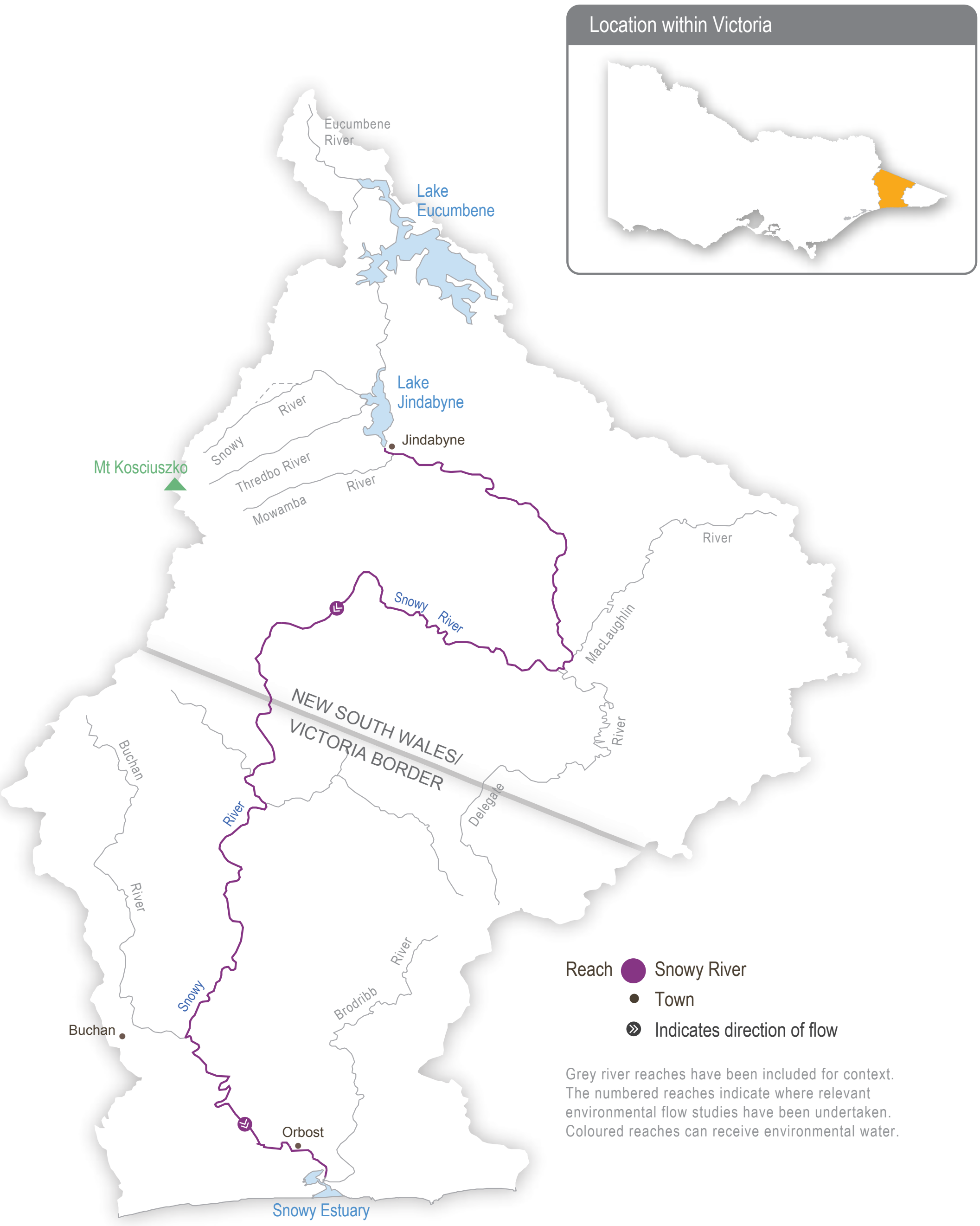
The water year in the Snowy system runs from May to April. In 2019–20, approximately 117,871 ML[1] of water for the environment was used to deliver five winter/spring high-flow events in the Snowy River. A major flushing flow occurred in October 2019.

The Snowy River catchment above Lake Jindabyne in NSW was not severely impacted by the widespread bushfires in south-eastern Australia in December 2019 and January 2020. The catchment area within Victoria, particularly near the estuary mouth in East Gippsland, was severely burnt. If there is heavy rainfall in fire-damaged catchments, it is likely to flush sediment and ash into waterways and degrade water quality in the Snowy River, which may have flow-on effects for river ecology in 2020–21.



[1] Preliminary figure of total releases in 2019–20. This volume may alter slightly due to accounting adjustments, and it will be verified in Snowy Hydro Limited's annual water operating plan.

Figure 2.5.1 The Snowy system



Scope of environmental watering

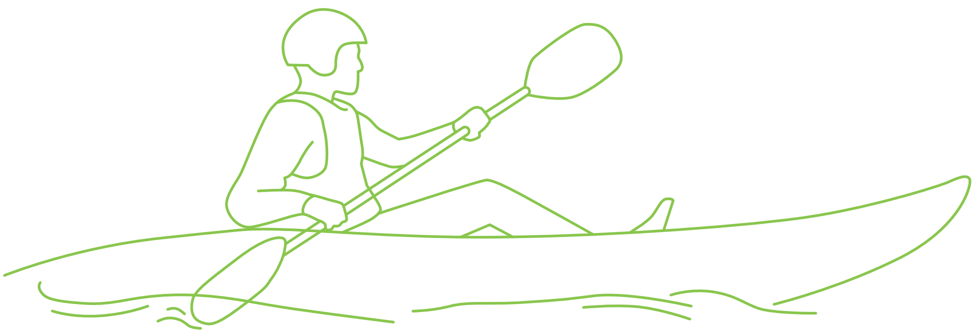
The total volume planned for release to the Snowy River in 2020–21 is 91,476 ML[2].

Due to operating rules in the system, the flow regime that will be delivered in 2020–21 is pre-planned: the storage manager will make daily releases of varying magnitude from Lake Jindabyne between May 2020 and April 2021 to mimic the typical flow pattern of a mixed snowmelt/rainfall river system characteristic of the Snowy Mountains. The continuous daily releases will 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 that existed before the river was regulated.

Following several years of dry conditions resulting in lower water availability, fewer high flow events and lower peak magnitudes are planned in 2020–21, but overall flow patterns will be similar. Four high-flow releases are scheduled between June and November 2020. This includes a large flushing flow in early September 2020, which involves an eight-hour peak at a rate equivalent to 4,500 ML per day. Other peak flows will mimic winter rainfall events. This variable flow regime aims to improve the physical attributes of the river by scouring and depositing sediment and increasing available aquatic habitat. High flows will be sustained from July to December, to help mix water in the estuary to benefit plants and fish (such as Australian bass). Low flows will then be released until the end of the water year in April 2021.

Daily releases from Lake Jindabyne will help to mitigate water quality impacts caused by rain that flushes in water from fire-damaged land; but due to the pre-planned annual flow regime process for this system, there is no opportunity to release environmental water in response to serious water quality risks.

East Gippsland CMA has monitored the lower reaches and estuary over the past eight years. The results show that the managed environmental flows help improve physical and ecological processes, increase ecosystem productivity and improve aquatic habitat.



[2] Including contributions from water savings in Victoria and New South Wales.

Yarra River at Dights Falls, by Alistair Paton

Section 3

Central region

Werribee system
Maribyrnong system
Moorabool system
Yarra system
Barwon system
Tarago system

3.1 Central region overview

There are six systems in the central region that can receive managed environmental flows: the Yarra and Tarago in the east and the Werribee, Maribyrnong, Moorabool and Barwon (upper Barwon River and lower Barwon wetlands) in the west.

Environmental values, recent conditions, environmental watering objectives and planned actions for each system in the central region are presented in the system sections that follow.

Traditional Owners in the central region

Traditional Owners in the central region have a deep connection to the region's rivers, wetlands and floodplains.

The Bunurong Land Council Aboriginal Corporation, Eastern Maar Aboriginal Corporation, Wathaurung Aboriginal Corporation (trading as Wadawurrung) and Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation are the Registered Aboriginal Parties for the areas incorporating waterways covered by this section of the seasonal watering plan.

Gunaikurnai Land and Waters Aboriginal Corporation is also a Registered Aboriginal Party within the geographic area, but the Gunaikurnai waterways managed with water for the environment are covered under the Gippsland region section of the seasonal watering plan.

Engagement

Seasonal watering proposals are informed by community, stakeholder and program partner engagement, as well as longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flows studies and environmental water management plans). Program partners and other stakeholders help to identify environmental watering priorities and opportunities for the coming year. The strategies and technical reports collectively describe a range of environmental, cultural, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence environmental watering actions and priorities.

The International Association for Public Participation's Public Participation Spectrum (IAP2 Spectrum) has been used to categorise the levels of participation of stakeholders involved in the environmental watering planning process. Table 3.1.1 shows the IAP2 Spectrum categories and participation goals.

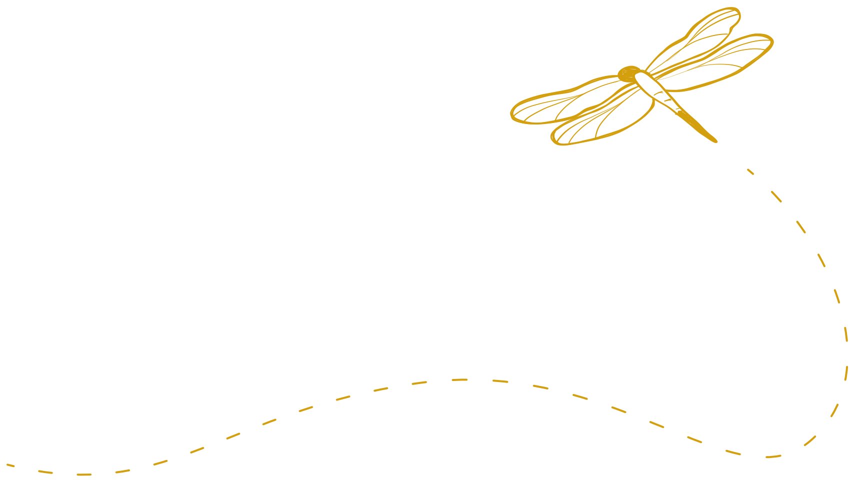


Table 3.1.1 International Association for Public Participation's Public Participation Spectrum categories and participation goals[1]

IAP2 level	Engagement goal
Inform	Provide balanced and objective information to assist understanding, alternatives, opportunities and/or solutions
Consult	Obtain feedback on analysis, alternatives and/or decisions
Involve	Work directly throughout a process to ensure that concerns and aspirations are consistently understood and considered
Collaborate	Partner in each aspect of the decision including the development of alternatives and the identification of the preferred solution
Empower	Place final decision making in the hands of the stakeholder

[1] The VEWH has the permission of the International Association for Public Participation to reproduce the IAP2 Spectrum.

Tables 3.1.2 and 3.1.3 show the partners, stakeholder organisations and individuals that Melbourne Water and Corangamite CMA engaged with when preparing seasonal watering proposals. This includes engagement conducted as part of developing the seasonal watering proposals as well as engagement during the preparation of key foundational documents that directly informed the proposals. VEWH staff were also consulted for operational information as part of the development of all annual seasonal watering proposals by CMAs and Melbourne Water.

The table also shows the level of engagement between Melbourne Water and Corangamite CMA and stakeholders of the environmental watering program in the central region based on Melbourne Water's and Corangamite CMA's interpretation of the IAP2 Spectrum.

The level of engagement differs between organisations and between systems, depending on the availability, capacity or interest of stakeholders to participate, the roles and responsibilities of organisations in managing a site or system, and potential interaction of proposed watering with other activities on the waterway. For example, a landholder on a waterway may only wish to be informed of what's planned, while another may wish to participate in the planning. A government agency may collaborate in planning where it has a land management responsibility for a site, but only need to be informed for another site where it does not affect its responsibilities.

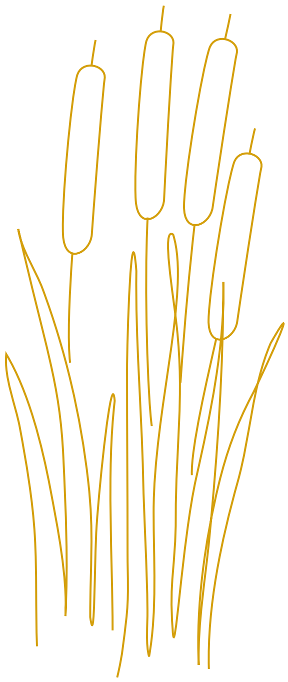


Table 3.1.2 Partners and stakeholders engaged by Corangamite CMA in developing seasonal watering proposals for the Moorabool, upper Barwon and lower Barwon wetlands systems and other key foundation documents that have directly informed the proposals

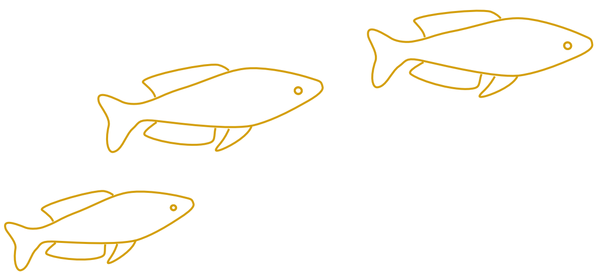
	Moorabool	Upper Barwon River	Lower Barwon wetlands
Community groups and environment groups	**IAP2 level: Consult** • Australian Platypus Conservancy • Geelong Landcare Network • Local community groups • Moorabool Stakeholder Advisory Committee • People for a Living Moorabool	**IAP2 level: Involve** • Upper Barwon Surface Water Advisory Group **IAP2 level: Consult** • Land and Water Resources Otway Catchment	**IAP2 level: Involve** • Community members on the Lower Barwon Community Advisory Committee • Members of the Lower Barwon Review Project Advisory Group **IAP2 level: Consult** • Environment Victoria • Geelong Environment Council • Geelong Field Naturalists Club
Government agencies	**IAP2 level: Collaborate** • Barwon Water • Central Highlands Water • Department of Environment, Land, Water and Planning - Water and Catchments • Southern Rural Water • Parks Victoria	**IAP2 level: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning Water and Catchments • Southern Rural Water **IAP2 level: Consult** • Colac Otway Shire Council	**IAP2 level: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water **IAP2 level: Consult** • Greater Geelong City Council • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Consult** • Landholders on the Moorabool Stakeholder Advisory Committee	**IAP2 level: Consult** • Landholders on the Upper Barwon Surface Water Advisory Group	**IAP2 level: Consult** • Landholders • Farmers
Local businesses			**IAP2 level: Consult** • Commercial eel fishers
Recreational users	**IAP2 level: Consult** • Recreational users on the Moorabool Stakeholder Advisory Committee	**IAP2 level: Consult** • Recreational users on the Upper Barwon Surface Water Advisory Group	**IAP2 level: Consult** • Geelong Field and Game • Geelong Gun and Rod Association • VR Fish
Technical experts			**IAP2 level: Involve** • Lower Barwon Review 2020 Expert Review Panel
Traditional Owners	**IAP2 level: Consult** • Wathaurung Aboriginal Corporation	**IAP2 level: Involve** • Eastern Maar Aboriginal Corporation • Wathaurung Aboriginal Corporation	**IAP2 level: Involve** • Wathaurung Aboriginal Corporation

Table 3.1.3 Partners and stakeholders engaged by Melbourne Water in developing seasonal watering proposals for the Yarra, Tarago Maribyrnong and Werribee systems and other key foundation documents that have directly informed the proposals

	Yarra system	Tarago system	Maribyrnong River	Werribee River
Community groups and environment groups	**IAP2 level: Inform** • Environment Victoria • Native Fish Australia • Yarra Riverkeeper	**IAP2 level: Inform** • Friends of Robin Hood Reserve • Waterwatch co-ordinators	**IAP2 level: Inform** • Friends of Holden Flora Reserve • Friends of the Maribyrnong Valley Inc. • Jacksons Creek Eco-network	**IAP2 level: Inform** • Werribee Riverkeeper
Government agencies	**IAP2 level: Collaborate** • Banyule City Council • Boroondara City Council • Department of Environment, Land, Water and Planning | Water and Catchments • Manningham City Council • Melbourne Water Service Delivery • Parks Victoria	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning | Water and Catchments • Melbourne Water Service Delivery • Parks Victoria • Southern Rural Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning | Water and Catchments • Southern Rural Water • Western Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning | Water and Catchments • Southern Rural Water • Western Water
	IAP2 level: Inform • Environment Protection Authority • Port Phillip and Westernport Catchment Management Authority • Nillumbik City Council • Yarra Ranges Shire Council	**IAP2 level: Inform** • Baw Baw Shire Council • Cardinia Shire Council • Environment Protection Authority • Port Phillip and Westernport Catchment Management Authority	**IAP2 level: Inform** • Environment Protection Authority • Port Phillip and Westernport Catchment Management Authority	**IAP2 level: Inform** • Environment Protection Authority • Parks Victoria (land manager) • Port Phillip and Westernport Catchment Management Authority • Wyndham City Council
Landholders/ farmers	**IAP2 level: Inform** • Individual landholders • Licensed diverters	**IAP2 level: Inform** • Individual landholders	**IAP2 level: Inform** • Licenced diverters from the Maribyrnong River at Keilor	**IAP2 level: Inform** • Zoos Victoria
Local businesses	**IAP2 level: Inform** • Warburton Holiday Park	**IAP2 level: Inform** • Glen Cromie Caravan Park		
Recreational users	**IAP2 level: Inform** • Paddle Victoria • VRFish • Whitehorse Canoe Club	**IAP2 level: Inform** • Local Anglers • VRFish		**IAP2 level: Inform** • Werribee Anglers Club

Table 3.1.3 Partners and stakeholders engaged by Melbourne Water in developing seasonal watering proposals for the Yarra, Tarago Maribyrnong and Werribee systems and other key foundation documents that have directly informed the proposals *(continued)*

	Yarra system	Tarago system	Maribyrnong River	Werribee River
Technical experts	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University
	IAP2 level: Inform • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Inform** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Inform** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Inform** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Collaborate** • Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation	**IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation • Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation	**IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation • Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation	**IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation • Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation • Wathaurung Aboriginal Corporation
	IAP2 level: Consult • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation			



How have Traditional Owners' values and uses of waterways been considered?

In recognition of the cultural importance of water, caring for Country and their long-standing traditional ecological knowledge, Traditional Owners are increasingly working with waterway managers to plan for and deliver environmental flows. Examples in the central region in 2020–21 include:

- ongoing work by Wadawurrung (Wathaurung Aboriginal Corporation) and Corangamite CMA to share knowledge of cultural values and environmental water planning. Wadawurrung have shared knowledge of significant sites (such as refuge pools and river confluences traditionally used as meeting places for clans) and animals with cultural value including platypus, eels and blackfish, and they have recommended how these can be supported by environmental flows. Corangamite CMA has incorporated this into its environmental water planning and management of environmental flows in collaboration with Wadawurrung
- ongoing work with the Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation and Melbourne Water to implement initiatives under the *Yarra River Strategic Plan*, in particular the restoration of billabongs on the lower Yarra floodplain. Wurundjeri Woi-Wurrung people and the Narrap ranger team are helping identify the cultural and environmental values of the billabongs, supporting environmental water planning and management and monitoring outcomes of environmental water deliveries at the billabongs.

Where the involvement of Traditional Owners in planning and delivering water for the environment has explicitly identified environmental flows supporting cultural outcomes, these are identified in the system sections.

How have economic, recreational and social values and uses of waterways been considered?

Environmental outcomes provide some direct economic, recreational, social benefits to communities. Waterway managers, in consultation with communities, have identified numerous opportunities to support these community benefits including activities such as tourism, fishing, birdwatching, boating and hunting. Examples of these opportunities in the central region include:

- enhancing major events (such as Moomba and the Inflatable Regatta) through summer and autumn flows that improve water quality in the Yarra River
- supporting recreational fishing in the Barwon River by allowing species including river blackfish and short-finned eel to move between pools to breed, feed and find new habitats.

Summaries of the social, recreational and economic values considered are provided for each system. Where the timing or management of planned environmental flows may be modified to align with a community benefit, this is identified alongside the potential watering actions.

Community benefits from environmental watering

Healthy rivers and wetlands support vibrant and healthy communities. By improving the health of rivers, wetlands and floodplains, environmental flows also provide benefits to communities.

The VEWH and its program partners consider Aboriginal cultural values and uses and social and recreational values and uses of waterways when planning for environmental watering activities. Through engagement with community representatives, waterway managers aim to determine how community benefits from environmental flows can be optimised with environmental priorities for the year ahead.

Healthy waterways provide community benefits (such as providing nice places to walk, picnic or fish recreationally, and sustaining Healthy Country for Aboriginal communities). Community benefits can sometimes be enhanced by modifying environmental flows (such as timing a flow to support a community rowing or fishing event), provided the environmental objective is not compromised.

The VEWH and its partners seek to deliver these benefits throughout the water year, though opportunities can depend on the weather, climate or environmental conditions, water availability and the way the system is being operated to deliver water for other purposes.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental flows need to be part of an integrated approach to catchment management. Many of the environmental objectives for water for the environment in the central region will not be fully met without simultaneously addressing issues such as barriers to fish movement, limited volumes of environmental entitlement, poor water quality, reduced contribution of groundwater to surface water flows and loss of stream bank vegetation and invasive species.

Victorian and Australian government agencies, Traditional Owner groups, community groups and private landholders collectively implement a wide range of programs that aim to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments.

Examples of complementary programs that are likely to support environmental watering outcomes in the central region include:

- Corangamite CMA's ongoing investigations into the surface water and groundwater interactions in the Moorabool River and their continued partnership with the Batesford Quarry operators to allow water from the quarry to be discharged to the river (an important contribution to flow)
- the review of the effectiveness of recent wetting and drying regimes at Reedy Lake and recommended future directions for water management at Reedy Lake and Hospital Swamps
- Melbourne Water's performance review and rectification works for the Dights Falls fishway on the Yarra River, which will allow native fish to move upstream under a wider range of flows
- Corangamite CMA's scoping of channel restoration in the upper Barwon River, investigating options to remediate constriction points along the upper Barwon River to improve environmental water deliveries from the West Barwon Reservoir
- continued works by Corangamite CMA and Melbourne Water to protect and enhance streambanks along priority reaches in the catchments including willow removal, revegetation and fencing to exclude stock
- Melbourne Water's landscape-scale approach to improve the management of billabongs along the Yarra River to help meet cultural, ecological and liveability objectives.

For more information about integrated catchment management programs in the central region, refer to the Corangamite CMA and Melbourne Water regional catchment strategies and regional waterway strategies.

Risk management

During the development of the seasonal watering proposals for the Yarra, Tarago, Maribyrnong, Werribee, Moorabool and Barwon systems, environmental watering program partners assessed risks associated with potential environmental watering actions for 2020–21 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

Seasonal outlook 2020–21

Rainfall in 2019–20 was highly variable both within and between seasons across the central region's systems. The Yarra catchment experienced above-average conditions with natural inflows achieving many planned watering actions including low flows and freshes. Lal Lal Reservoir in the Moorabool system filled in spring 2019, and Pykes Creek Reservoir and Melton Reservoir in the Werribee system both filled and spilled. In contrast, inflows to Rosslynne Reservoir were well-below average, which meant the VEWH was unable to purchase any water to support environmental flows in the Maribyrnong system.

The Bureau of Meteorology is predicting above-average rainfall across the central region for the first three months of the 2020–21 water year, which could increase storage levels and produce some larger flow events that cannot be delivered through managed environmental flows. These conditions may allow the VEWH, Melbourne Water and Corangamite CMA to deliver watering actions that are only planned under average or wet scenarios and aim to improve rather than just maintain environmental values in the region's waterways. This may include delivering flows over winter/spring of increased magnitude or duration, such as in the Moorabool system to provide a cue for fish (like the adult tupong) to migrate downstream to spawn.

If the central region experiences relatively dry conditions throughout 2020–21, water for the environment will mostly be used to deliver minimum low flows and freshes to maintain habitat and water quality and prevent significant decline in populations of aquatic plants and animals.

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The Yarra River is known to Wurundjeri Woi-Wurrung people as *Birrarung*.

Top: Lower Yarra River, by Melbourne Water
Above: Platypus by the Yarra, by Doug Gimesy

System overview

The Yarra River flows west from the Yarra Ranges above Warburton, through the Yarra Valley and then opens out into a wider plain as it meanders through the suburbs and city of Melbourne before entering Port Phillip Bay. Over time, the lower Yarra River (below Warrandyte) has been straightened, widened and cleared of natural debris as Melbourne has developed.

Up to 400,000 ML per year (long-term average diversion limit) can be harvested from the Yarra River system for consumptive use in Melbourne and surrounding areas. The Upper Yarra, O'Shannassy and Maroondah reservoirs harvest water from headwater tributaries, and a pump station at Yering is used to divert water from the Yarra River to Sugarloaf Reservoir.

Flow in the upper reaches of the Yarra River is influenced by tributaries (such as Armstrong Creek, McMahons Creek, Starvation Creek, Woori Yallock Creek, Watts River and Little Yarra River). Urbanised tributaries (such as Olinda Creek, Mullum Mullum Creek, Diamond Creek, Plenty River and Merri Creek) provide additional water to the middle and lower reaches of the Yarra River.

Environmental flows can be released from the Upper Yarra, Maroondah and O'Shannassy reservoirs to support ecological processes and environmental outcomes in downstream river reaches and wetlands. The priority environmental flow reaches in the Yarra River are reaches 2 and 5, shown in Figure 3.2.1. Water for the environment that is delivered to reaches 2 and 5 will help meet flow targets in downstream reaches.

Plenty River rises from the slopes of Mt Disappointment in the Great Dividing Range about 50 km north of Melbourne. It flows downstream through rural and semi-rural areas and Plenty Gorge before joining the Yarra River near Viewbank, east of Banyule Flats Reserve. Yan Yean Reservoir is located off the waterway, north of Plenty Gorge, and it receives flows from Toorourrong Reservoir via a channel. The Plenty River has not received managed environmental flows before, but there may be opportunities to deliver water for the environment from Yan Yean Reservoir from 2020–21 onwards.

Environmental values

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

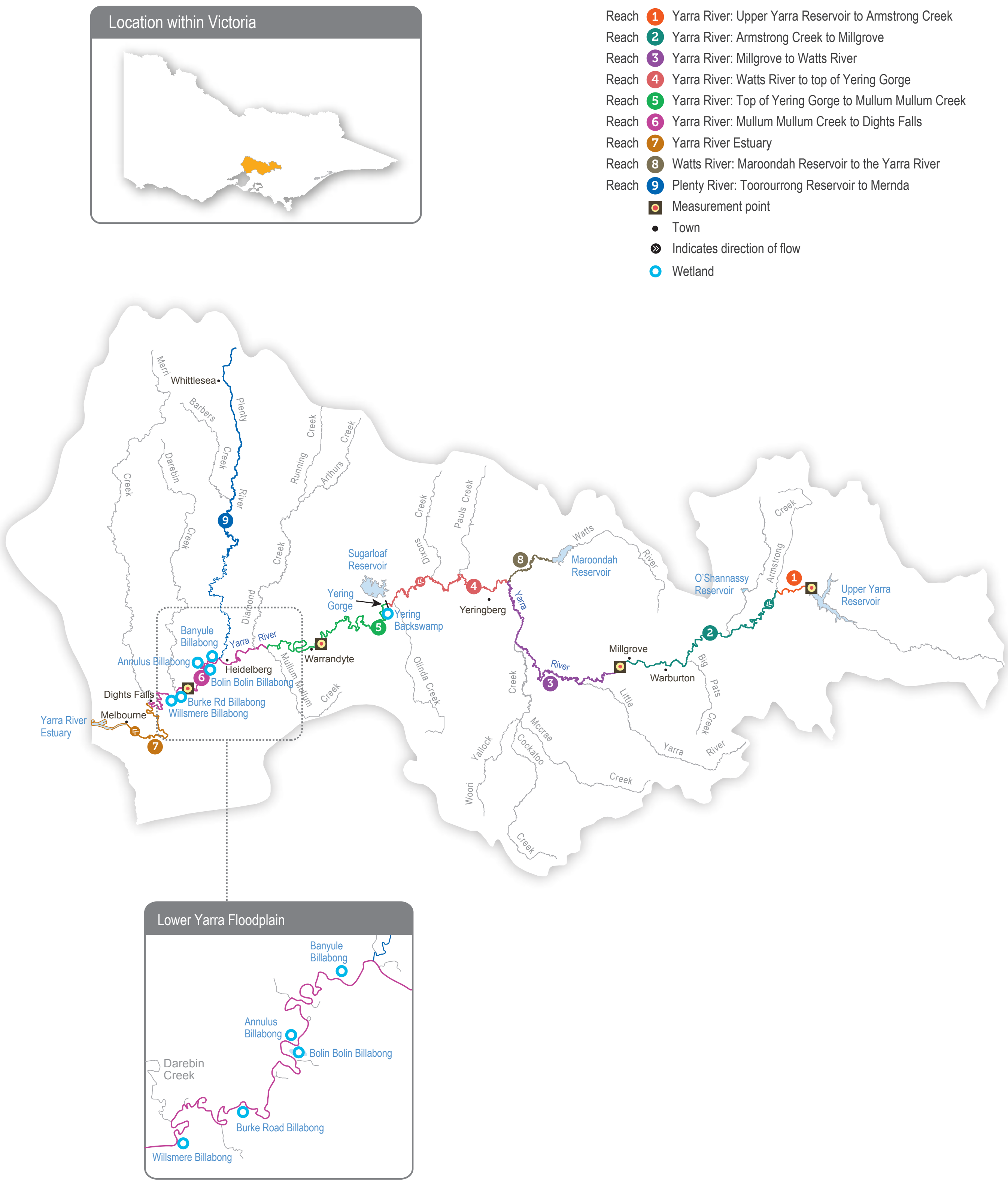
The Plenty River (reach 9) provides habitat for waterbug populations and native fish species (such as common galaxias and river blackfish). Platypus have been detected in the Plenty River in the past, but none have been recorded in recent surveys.

Billabongs are an important feature of the Yarra River floodplain between Millgrove and Yering Gorge and in the lower reaches 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.

Environmental watering objectives in the Yarra River, Plenty River and Yarra billabongs

Protect and increase populations of native fish including threatened species (such as the Australian grayling, Macquarie perch and river blackfish)
Maintain the population of frogs, particularly on the mid-Yarra floodplain
Maintain the form of the river channel Scour silt from riffles and clean cobbles
Maintain the population of resident platypus
Increase, strengthen and maintain native streamside and aquatic vegetation on the riverbank and in the channels Increase, strengthen and maintain the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows on the floodplain and billabongs
Protect and increase communities of waterbugs, which break down dead organic matter and support the river's food chain
Improve water quality in river pools, ensuring adequate oxygen concentration in the water to support fish, crustaceans and waterbugs

Figure 3.2.1 The Yarra system



Traditional Owner cultural values and uses

Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation and Melbourne Water are working towards an integrated approach that includes Wurundjeri as active participants in the planning, delivery, and monitoring of all works on the lower Yarra floodplain. Melbourne Water has also made initial contact with Bunurong Land Council Aboriginal Corporation and Boon Wurrung Foundation to discuss environmental watering in the Yarra system.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 3.2.1 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

In November 2019 Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation completed the Bulleen-Banyule Flats Cultural Values Study, which details places of Traditional Owner tangible and intangible significance. Melbourne Water has supported this project by attending on-Country visits with Elders and hope to link this study and the identified potential cultural benefits with environmental watering.

Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation's *Narrap* team undertakes on-ground activities, such as water quality and frog monitoring, through the cultural water program at billabong sites along the lower Yarra floodplain. Monitoring is underway at Banyule Billabong following a delivery of water for the environment in 2019–20 and similar work will likely be undertaken at Annulus Billabong in 2020–21.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.2.1, Melbourne Water considered how environmental flows could support values and uses including:

- water-based recreation (such as kayaking, canoeing, fishing and swimming)
- riverside recreation and amenity (such as walking, running, cycling, camping and birdwatching)
- community events and tourism (such as the Moomba Festival and the Inflatable Regatta)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and Melbourne's water supply).

Recent conditions

Rainfall in 2019–20 in the Yarra catchment was above the long-term average, and tributary inflows significantly contributed to flow in the Yarra and Plenty rivers throughout the year. O'Shannassy Reservoir was offline for most of the year for maintenance, so most flow in the O'Shannassy River passed directly into the Yarra River.

Natural rainfall events, combined with the larger-than-normal inflows from the O'Shannassy River, achieved most of the high-priority planned watering actions for 2019–20, and some lower-priority watering actions (such as winter/spring freshes) provided important flow variability. One of the highest-priority planned watering actions for the Yarra River was an autumn high flow to support the migration and spawning of Australian grayling. The planned environmental flow release in April 2020 coincided with a natural rain event, which reduced the volume of environmental water needed to achieve the target flow.

In September 2019, water for the environment was used to partially fill Banyule Billabong on the lower Yarra floodplain near Heidelberg for the first time since 2016–17. Monitoring by Melbourne Water indicated that the watering action drowned some of the terrestrial plants that had colonised the bed of the wetland in recent years and stimulated growth of some native wetland plant species. Water for the environment was used to fill Yering Backswamp in May 2020, to maintain water-dependent vegetation and aquatic animals.

Scope of environmental watering

Table 3.2.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 3.2.1 Potential environmental watering actions and objectives for the Yarra River, Plenty River and Yarra billabongs

Potential environmental watering action	Functional watering objectives	Environmental objectives
Yarra River		
Summer/autumn low flow (80–200 ML/day during December to May)	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish, waterbugs and platypus	
Winter/spring low flow (200–350 ML/day during June to November)	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish, waterbugs and platypus • Wet bank vegetation to promote growth	
Summer/autumn fresh (one to three freshes of 350–750 ML/day for two to four days during December to May)	• Flush pools to prevent a decline in water quality • Scour sediment and biofilm from gravel in riffles and pools to maintain habitat quality for fish and waterbugs • Provide opportunities for localised movement of fish and platypus • Wet the banks of the river to maintain flood-tolerant vegetation on the banks	
Autumn high flow (one fresh of 560–1,300 ML/day for seven to 14 days during April to May)	• Cue the migration of Australian grayling • Scour sediment and biofilm from gravel in riffles and pools to maintain habitat quality for fish and waterbugs	
Winter/spring fresh (one to two freshes of 700–2,500 ML/day for three to seven days during June to November)	• Scour sediment and biofilm from gravel in riffles to improve spawning opportunities for Macquarie perch • Wet native streamside vegetation on the banks of the river to promote growth • Provide cues for upstream migration of juvenile migratory fish (e.g. Australian grayling and tupong)	
Spring high flow (one high flow of 700–2,500 ML/day for 14 days in September)	• Scour sediment and biofilm from gravel in riffles • Provide prolonged wetting to favour flood-tolerant native vegetation in the streamside zone • Provide cues for upstream migration of juvenile migratory fish (e.g. Australian grayling and tupong) • Promote spawning of Macquarie perch	

Table 3.2.1 Potential environmental watering actions and objectives for the Yarra River, Plenty River and Yarra billabongs *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Plenty River		
Winter/spring low flow (20 ML/day during June to November)	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish and waterbugs • Wet bank vegetation to promote growth	
Winter/spring freshes (four freshes of 70 ML/day for three days during June to November)	• Scour sediment and biofilm from gravel in riffles • Provide access to habitats for fish and waterbugs • Wet native streamside vegetation on the banks of the river to promote growth	
Billabong watering		
Annulus Billabong (partial fill in winter/spring)	• Prime wetland for a fill • Wet the wetland bed for up to three months to support the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows • Provide habitat for frogs, waterbugs and eels	
Yering Backswamp (partial or complete fill in autumn and winter/spring)	• Wet the deepest parts of the wetland to about 80 cm to provide habitat for fish, frogs and waterbugs • Wet remaining areas of wetland to about 40–60 cm to support the growth of threatened wetland plant species and encourage the regeneration of spreading aquatic herbs	

Scenario planning

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

Environmental flow planning in the Yarra River primarily focuses on providing sufficient low flow throughout the year to maintain habitat for aquatic life and providing high flows at critical times to support the migration and breeding requirements of native fish. The extent to which the required flows are met by natural tributary inflows varies between dry, average and wet scenarios. Water for the environment is used to fill the main shortfalls under each scenario, where possible.

The highest priorities for watering in the Yarra River are summer/autumn low flows and freshes, an autumn high flow, a spring high flow and winter/spring low flows and freshes. Summer/autumn low flows are not identified as a planned watering action under a wet scenario, as it is anticipated they would be met by natural flows.

The summer/autumn low flows and freshes help maintain water quality and improve aquatic habitats. A higher-than-normal carryover volume from 2019–20 will potentially allow an autumn high flow and a spring high flow to be delivered in 2020–21 under all scenarios. The autumn high flow is a priority because it was not delivered in 2017–18 or 2018–19 and is needed in most years to support Australian grayling breeding. Spring high flows trigger Australian grayling migration back up the system and scour sediments in the mid-reaches, to improve spawning habitat for Macquarie perch.

The potential watering actions for the Plenty River are winter/spring low flows and freshes. This is the first time that environmental flows are planned to be delivered in the Plenty River. Flows are planned as a trial to help waterway managers understand the operational and safety requirements for the system and to better understand the river's response to water for the environment.

Watering at Yering Backswamp and Annulus Billabong is considered a high priority under all scenarios in 2020–21. There are numerous billabongs throughout the Yarra catchment that are drier than natural, due to river regulation and modifications to natural flow paths. Melbourne Water is currently developing a landscape-scale approach to watering floodplain billabongs that will consider the ecosystem services provided by different billabongs and how many billabongs need to be watered at any given time to support regionally-important plant and animal populations. This is the first year that Annulus Billabong is planned to receive water for the environment. Water levels will be monitored at Annulus Billabong to inform future management of the site and the broader billabong assessment.

The environmental entitlement for the Yarra system is highly secure, and it is expected that the volume of water available for use in 2020–21 will be sufficient to deliver all the potential watering actions under the average and wet scenarios. Lower tributary inflows under a dry scenario means that larger volumes of environmental water will likely be needed to deliver potential watering actions in a dry year. The expected volume of available water should be sufficient to deliver all of the potential watering actions under a dry scenario except for winter/spring freshes in the Yarra River.

A critical carryover volume of 3,000 ML has been identified to provide sufficient water to deliver high-priority actions (summer/autumn low flows and freshes, an autumn high flow and targeted billabong watering) in 2021–22.

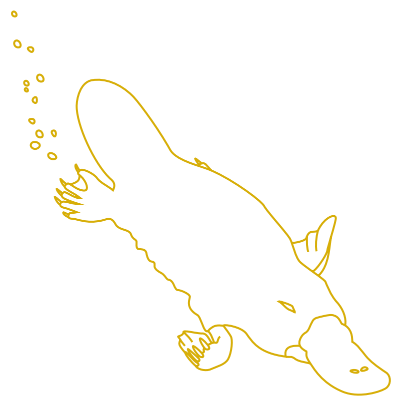


Table 3.2.2 Potential environmental watering for the Yarra River, Plenty River and Yarra billabongs under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflows year round • Lack of unregulated freshes and high flows • Passing flows are not likely to meet the minimum environmental flow recommendations • Potential poor water quality, particularly in summer • Pools may stratify • Plenty River may experience cease-to-flow events	• Minimum passing-flow recommendations are likely to be met • Natural flow may provide some freshes, but its duration and/or magnitude will likely be less than recommended environmental flows • Potentially poor water quality, particularly in summer • Pools may stratify • Small reservoirs may spill • Overbank flows are not likely	• Passing flow recommendations are likely to be met • High, natural flow will occur, most likely in winter/spring • Major spills from reservoirs may occur • Some natural wetting of billabongs may occur
Expected availability of water for the environment	• 43,000 ML		
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flows • One to three summer/autumn freshes • One autumn high flow • One spring high flow • Fill or partial fill of Yering Backswamp and Annulus Billabong • Winter/spring low flows • Winter/spring low flows (Plenty River) • Four winter/spring freshes (Plenty River)	• Summer/autumn low flows • One to three summer/autumn freshes • One autumn high flow • One spring high flow • Fill or partial fill of Yering Backswamp and Annulus Billabong • Winter/spring low flows • One to two winter/spring freshes • Winter/spring low flows (Plenty River) • Four winter/spring freshes (Plenty River)	• One to three summer/autumn freshes • One autumn high flow • One spring high flow • Fill or partial fill of Yering Backswamp and Annulus Billabong • Winter/spring low flows • One to two winter/spring freshes • Winter/spring low flows (Plenty River) • Four winter/spring freshes (Plenty River)
Potential environmental watering – tier 1b (high priorities with shortfall)	• One to two winter/spring freshes	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A	• N/A	• N/A
Possible volume of environmental water required to achieve objectives	• 40,000 ML (tier 1a) • 7,500 ML (tier 1b)	• 38,000 ML (tier 1a)	• 29,000 ML (tier 1a)
Priority carryover requirements	• 3,000 ML		

3.3 Tarago system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

Diadromous fish spend some of their life in freshwater and some in saltwater. Scientists tagged over 150 diadromous fish in the Tarago River in March 2020, and they will now be able to track how the Australian grayling, short-finned eels, tupong and common galaxia move in response to environmental flows in real time.

Top: Tarago River fish ladder, by Melbourne Water
Above: Australasian darter dries its wings at Bunyip Main Drain, by Melbourne Water

System overview

The Tarago River rises in the Tarago State Forest and flows into the Tarago Reservoir at Neerim. The reservoir harvests inflows from all upstream tributaries to supply towns on the Mornington Peninsula and around the Western Port area, and it is also used to manage flows for downstream irrigators. Below the reservoir, the river flows close to the town of Rokeby before meeting the Bunyip River at Longwarry North. From there, the Bunyip River flows through a modified, straightened channel — Bunyip Main Drain — that discharges into Western Port. The Bunyip Main Drain supplies many irrigators in the catchment.

Water available under the Tarago environmental entitlement is stored in and released from Tarago Reservoir. This water is primarily used to meet environmental objectives in reach 2, which is between the reservoir and the confluence of the Tarago and Bunyip rivers, as Figure 3.3.1 shows. Water for the environment that is delivered to reach 2 also supports environmental flow recommendations in reach 6 (Bunyip Main Drain).

Year-round passing flows in the Bunyip and Tarago rivers are stipulated under both the environmental entitlement and Melbourne Water's bulk entitlement. These passing flows are generally sufficient to meet the minimum low-flow requirements in summer/autumn, but are much less than the recommended minimum flows in winter/ spring; and do not provide any of the freshes or higher flows that are needed throughout the year to support environmental outcomes.

Water releases to meet irrigation demands create variable flow patterns in the Tarago and Bunyip rivers throughout the year. The magnitude and timing of these releases can influence environmental outcomes, and Melbourne Water continues to work with Southern Rural Water to optimise the shared value derived from irrigation releases.

Environmental values

The Tarago system contains several significant and threatened native plant and animal species including Australian grayling, long pink-bells, tree geebung and swamp bush-pea. The upper catchment (reach 2) has healthy streamside vegetation and diverse in-stream habitat that supports platypus and native fish including river blackfish and mountain galaxias. The lower catchment (reach 6) has been highly modified, but it still contains patches of remnant vegetation and healthy populations of Australian grayling and platypus.

Environmental watering objectives in the Tarago River

- Increase populations of native fish including threatened species (such as the Australian grayling)
- Maintain channel form and structure
- Increase platypus populations
- Increase native streamside and aquatic plant communities on the riverbank and in the channel
- Increase the diversity and biomass of waterbugs, to support aquatic foodwebs

Traditional Owner cultural values and uses

Melbourne Water has made initial contact with Boon Wurrung Foundation, Bunurong Land Council Aboriginal Corporation and Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation, to discuss environmental watering in the Tarago/Bunyip system.

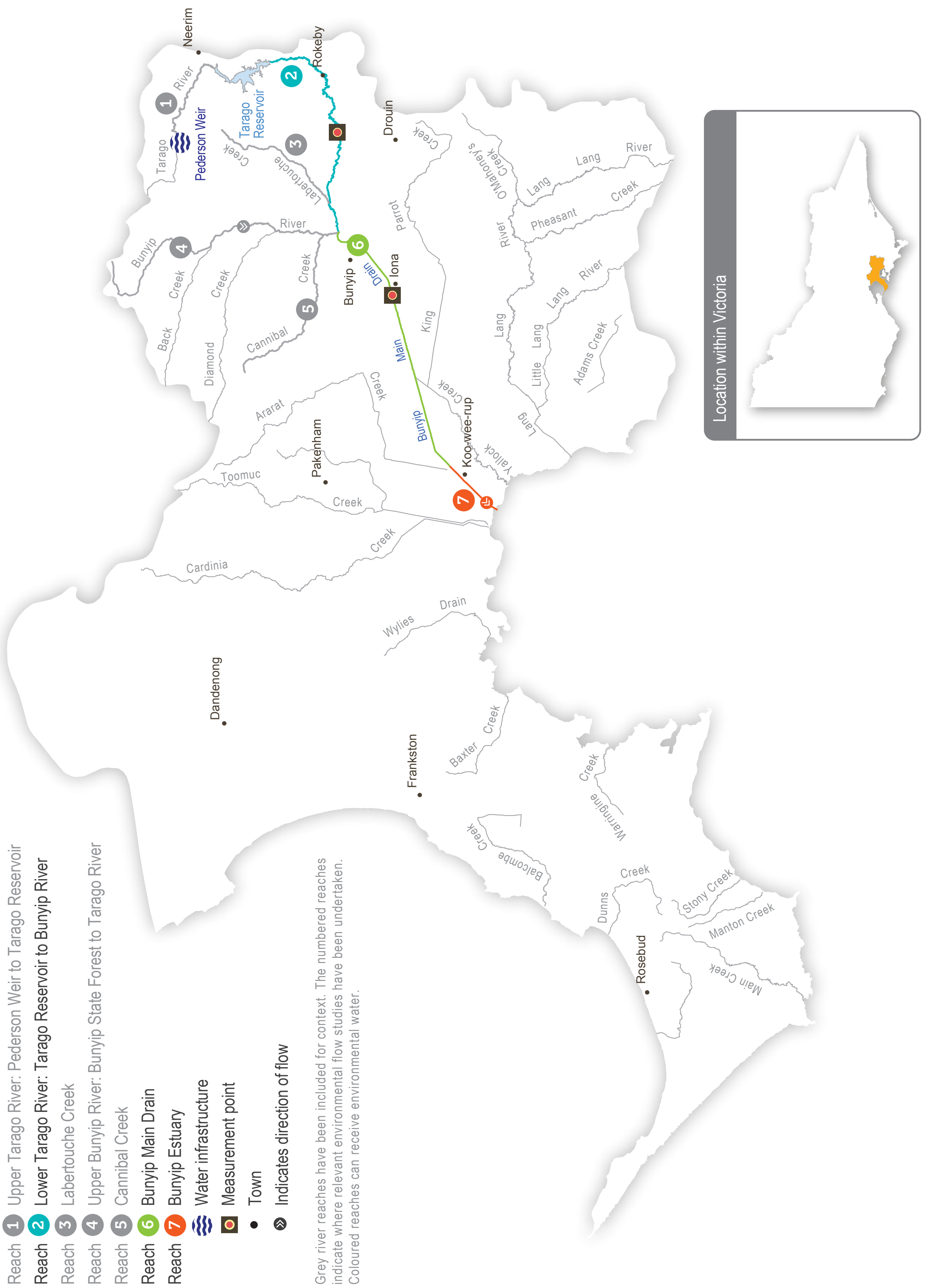
Social, recreational and economic values and uses

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 3.3.1 with an icon.

- Watering planned to support peaks in visitation (e.g. camping or other public activities on long weekends or school holidays)

Melbourne Water may time a summer fresh in the Tarago River to occur on the long weekends in January or March 2020, so visitors and long-term residents of the Glen Crombie Caravan Park alongside the river can enjoy the additional flows in the river.

Figure 3.3.1 The Tarago system



Recent conditions

The Tarago River catchment received below-average rainfall in winter 2019 but above-average rainfall in spring 2019 and summer 2020. Most of the rain fell downstream of the Tarago Reservoir, so although it provided natural flow in the river it did not translate to significant inflows into the storage.

Winter/spring high flows, winter/spring freshes, spring high flow and autumn high flow requirements and most of the recommended summer/autumn freshes were met from natural flows. Summer/autumn freshes were the highest-priority potential watering actions for all scenarios in 2019–20; they play a critical role in providing habitat for native fish species (such as short-finned eels and common galaxias) and maintaining water quality throughout the system.

A volume of 1,000 ML of water for the environment will be carried over to help meet critical priorities in 2020–21.

Scope of environmental watering

Table 3.3.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn fresh (one to five freshes of 75 ML/day for two days during December to May)	• Scour sediment from holes and around large woody debris to maintain habitat for native fish in low-flow periods • Allow the localised movement of native fish • Prevent terrestrial vegetation growth on sandbars • Maintain water quality by aeration in times of low flow	
Autumn high flow (one fresh with a peak of 100 ML/day for two days in a minimum seven-day duration during April to May)	• Form and maintain scour holes around large wood • Cue spawning for diadromous fish (e.g. Australian grayling) • Allow the downstream movement of Australian grayling • Assist the dispersal of juvenile platypus	
Spring high flow (two to three high flows with a peak of 200–300 ML/day for two days in a seven-to-10 day duration during September to October)	• Form and maintain scour holes around large wood • Prevent the encroachment of terrestrial vegetation into the channel • Cue the upstream migration of juvenile diadromous fish (such as Australian grayling) from the sea or estuary into the river • Wet higher benches to maintain the fringing aquatic vegetation and ensure vertical zonation of the fringing vegetation • Provide a cue for platypus to select nesting burrows above high water level	
Winter/spring fresh (one to two freshes with a peak of 100–200 ML/day for two days during June to September)	• Prevent sediment build-up and remove biofilm from large woody debris to maintain habitat for macroinvertebrates and fish including river blackfish • Maintain access to habitats by ensuring sufficient depth through riffles to allow fish movement between pools and reaches • Cue the downstream migration of species such as eel and tupong • Wet the banks, wetting the lower benches to maintain the fringing aquatic vegetation	
Winter/spring low flow (75 ML/day [or natural] during June to November)	• Prevent the encroachment of terrestrial vegetation in the channel • Wet the banks to promote streamside vegetation growth • Maintain an adequate depth through riffles to allow access to habitats for fish and platypus • Maintain water quality through increased low flows to flush the system and wet additional habitat for fish and macroinvertebrates • Maintain foraging habitat for platypus	

Scenario planning

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

Summer and autumn freshes are considered high priority under all climatic conditions. These freshes aim to top up pool habitats and improve water quality, which helps to maintain the quality and quantity of available habitat for fish, macroinvertebrates and platypus. Freshes temporarily increase river depth in riffles and run habitats between pools, allowing native fish to move within and between reaches. Freshes also wet sand bars and lower sections of the riverbank, which helps to prevent the encroachment and growth of unwanted terrestrial species in the waterway.

An autumn high flow is needed to cue Australian grayling to spawn. As this is a short-lived species, the autumn high flow should be delivered in at least two out of every three years. In average and wet years, this increases to an annual requirement. The autumn high flow was partially achieved in 2018–19 and fully achieved in 2019–20. Hence, full delivery of an autumn high flow is a tier 2 priority for 2020–21, although a partial autumn high flow using a lesser volume of water may be delivered under dry and average conditions.

Under average and wet scenarios, a spring high flow may be delivered to support the migration of native fish. This flow has not been achieved with environmental flows since 2012–13, and although reach 6 has received some natural spring high flows, reach 2 has not. The spring high flow will encourage movement and cue the upstream migration of juvenile native fish species including Australian grayling, common galaxias and tupong.

The spring high event is a higher priority than the winter/spring freshes, because previous monitoring has shown it triggers more fish to move.

A carryover volume of 700–1,000 ML is required to support high-priority actions (such as summer/autumn freshes) in 2021–22.

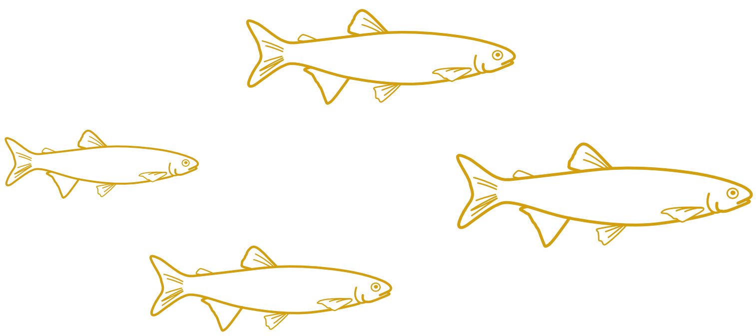


Table 3.3.2 Potential environmental watering for the Tarago River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Very low streamflow • Very low inflows • Reduced passing flows • Irrigation releases likely	• Low streamflow • Some reduction to passing flows • Irrigation releases likely	• Average streamflows • Partial freshes naturally provided	• Above-average streamflows • Partial or full freshes naturally provided • Irrigation releases unlikely
Expected availability of water for the environment	• 1,700 ML	• 2,000–2,500 ML	• 2,500–3,500 ML	• 3,800–5,000 ML
Potential environmental watering – tier 1a (high priorities)	• One to three summer/autumn freshes	• One to three summer/autumn freshes • One autumn high flow (partial achievement)	• One to five summer/autumn freshes • One autumn high flow (partial achievement) • Winter/spring high flow (partial achievement)	• One to five summer/autumn freshes • One autumn high flow • Winter/spring high flow • One to two winter/spring freshes
Potential environmental watering – tier 1b (high priorities with shortfall)	• Winter/spring high flow (partial achievement) • One autumn high (partial achievement)	• Winter/spring high flow (partial achievement) • One to two winter/spring freshes	• Winter/spring high flow • One to two winter/spring freshes	• N/A
Potential environmental watering – tier 2 (additional priorities)	• One autumn high flow • One to two winter/spring high flow • One to two winter/spring freshes	• One autumn high flow • One to two winter/spring high flows	• One autumn high flow	• N/A
Possible volume of environmental water required to achieve objectives[1]	• 1,000 ML (tier 1a) • 1,000 ML (tier 1b) • 800 ML (tier 2)	• 1,000–1,500 ML (tier 1a) • 1,000–1,200 ML (tier 1b) • 400 ML (tier 2)	• 2,000–3,000 ML (tier 1a) • 1,500–1,800 ML (tier 1b) • 3,000 ML (tier 2)	• 0–3,000 ML (tier 1a) • N/A (tier 1b) • N/A(tier 2)
Priority carryover requirements	• 700–1,000 ML			

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

3.4 Maribyrnong system

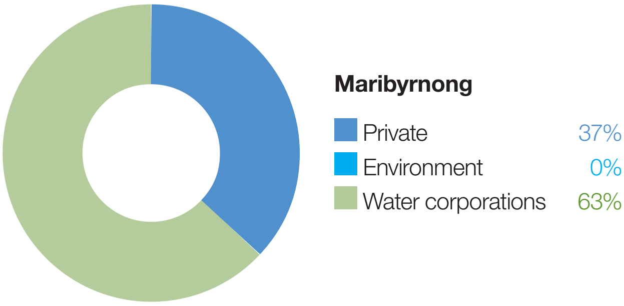
Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – No entitlement held in this system

Did you know...?

The Maribyrnong River is the second major river in metropolitan Melbourne, after the Yarra. It runs for 160 km from its source on the slopes of Mount Macedon to Port Phillip Bay, where it meets the sea.



Proportion of water entitlements in the Maribyrnong basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Maribyrnong River walk, by Melbourne Water
Above: Maribyrnong vegetation, by Melbourne Water

System overview

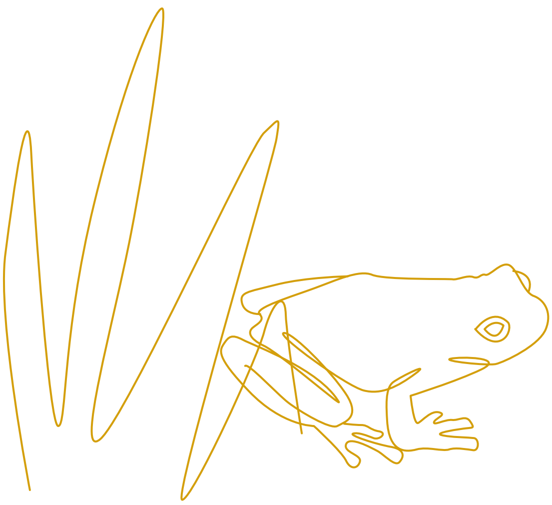
The Maribyrnong catchment is located to the north-west of Melbourne. The main waterways in the catchment are Jacksons Creek, which flows south-east from Mount Macedon, and Deep Creek, which flows south from Lancefield. These two tributaries join at Keilor North to form the Maribyrnong River, which flows south to join the Yarra River at Yarraville, before flowing into Port Phillip Bay.

Rosslynne Reservoir is in the upper reaches of Jacksons Creek near Gisborne, and it is the only major storage in the Maribyrnong catchment. The reservoir has a release capacity of 20 ML per day, which significantly constrains the environmental outcomes that can be achieved in the Maribyrnong system. Water for the environment is primarily used to support environmental outcomes in Jacksons Creek between Rosslynne Reservoir and the confluence with Deep Creek (that is, environmental flow reaches 6 and 7 shown in Figure 3.4.1). These two reaches are described as upper and lower Jacksons Creek respectively.

The VEWH does not hold an environmental entitlement in the Maribyrnong system, and it relies on opportunistic, temporary trade to meet demands. Melbourne Water and the VEWH work with local diversion licence holders to purchase unused water when it is available to support environmental outcomes. This arrangement is negotiated each year, and it only occurs with the agreement of all parties involved.

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. A large population of waterbugs provides abundant food for a significant platypus population in several reaches in the Maribyrnong system.



Environmental watering objectives in the Maribyrnong system

Protect and increase populations of native small-bodied fish
Maintain channel morphology
Maintain platypus population
Maintain and improve the condition, abundance, diversity and structure of instream and streamside vegetation
Support a wide range and high biomass of waterbugs, to break down dead organic matter and support the river's food chain
Maintain water quality, particularly oxygen concentrations

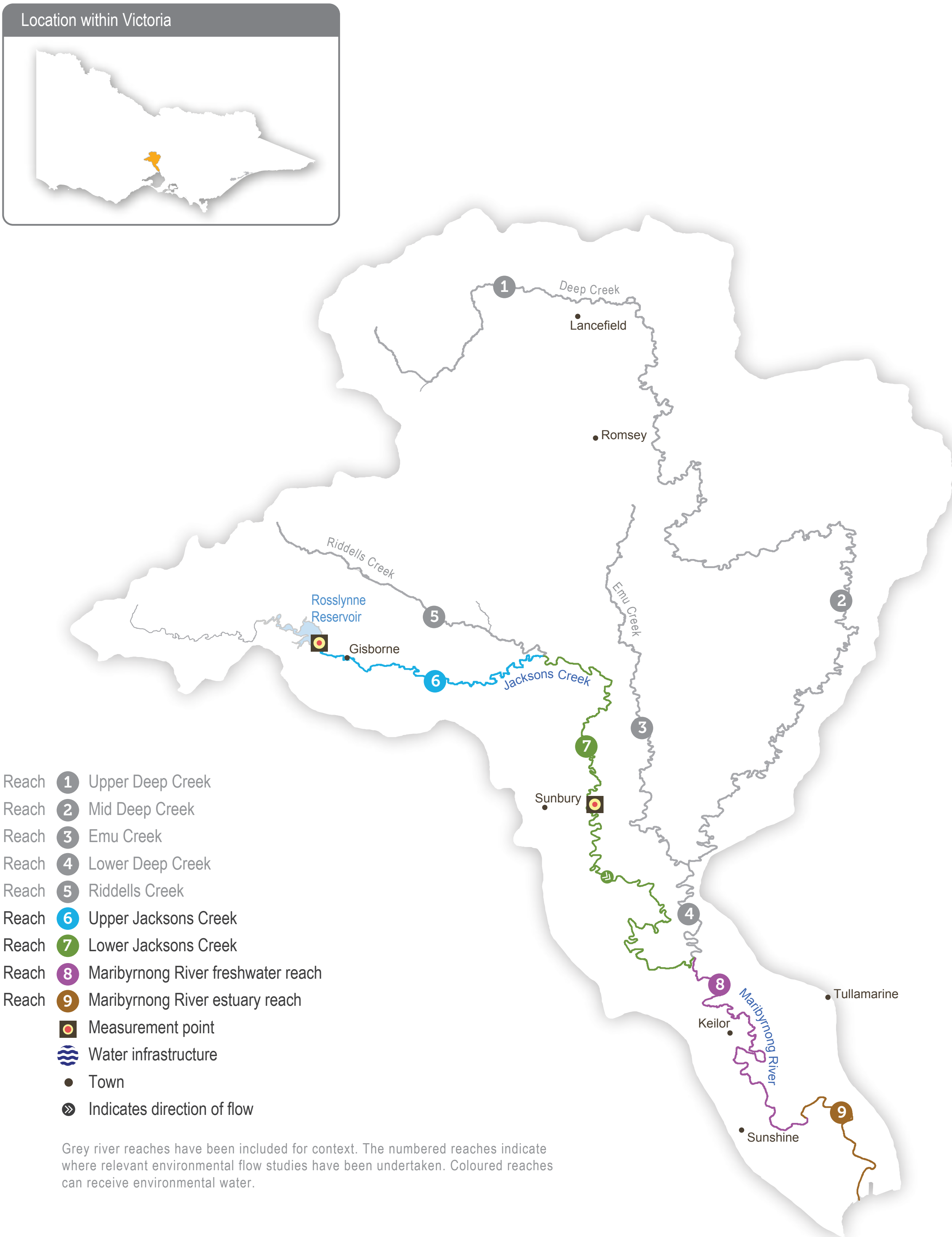
Traditional Owner cultural values and uses

Melbourne Water has made initial contact with Boon Wurrung Foundation, Bunurong Land Council Aboriginal Corporation and Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation, to discuss environmental watering in the Maribyrnong system.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.4.1, Melbourne Water considered how environmental flows could support social values (such as community connection and amenity). This includes repeating the outcomes of watering in 2019–20, where releases into the upper reaches of the Maribyrnong helped maintain healthy habitat and improve water quality.

Figure 3.4.1 The Maribyrnong 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

The Maribyrnong catchment has experienced below-average rainfall since the summer of 2016–17, and inflows to Rosslynne Reservoir in 2019–20 continued to track well-below average. The VEWH did not purchase allocation from licence holders in 2019–20, due to low water availability in the Maribyrnong system.

The dry conditions meant that winter/spring low-flow, winter/spring and summer/autumn freshes were not achieved in 2019–20. Summer/autumn low flows were achieved in reach 6, but only partially achieved in reach 7 (below Riddles Creek) by passing flows delivered under Southern Rural Water's bulk entitlement. These flows prevented poor water quality conditions and maintained suitable habitat and food resources for small-bodied native fish, waterbugs and platypus.

Scope of environmental watering

Table 3.4.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (four to six ML/day during December to May)	• Maintain waterbug habitat by providing suitable depth over riffles, maintaining pools and inundating large woody debris • Provide passage for small-bodied native fish and platypus between habitats	
Summer/autumn fresh (one to five freshes of 20–40 ML/day for up to seven days during December to May)	• Flush pools to maintain water quality • Scour substrates to remove fine sediment • Wet the in-stream vegetation and streamside benches to support the growth of native streamside plants and to limit encroachment by terrestrial plant species • Provide passage for small-bodied native fish and platypus between habitats	
Winter/spring low flow (20–40 ML/day during June to November)	• Wet the in-stream vegetation and streamside benches to support the growth of native plants and to limit encroachment by terrestrial plant species • Scour substrates to remove fine sediment • Provide passage for small-bodied native fish and platypus between habitats	

Scenario planning

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

Under drought or dry conditions, any water purchased for the environment would be used to maintain suitable habitat for plants and animals in Jacksons Creek (reaches 6 and 7). Summer/autumn low flows and freshes aim to maintain the health of native fish, waterbugs and platypus populations, by providing access to food and habitat resources in drier conditions.

Under average and wet conditions, natural flow is expected to meet some of the environmental flow objectives. Water for the environment may be used to improve and enhance environmental outcomes for aquatic plants and animals, by filling gaps not met by natural flow (for example, by providing additional freshes) or by extending the duration of unregulated events.

If more water is made available in 2020–21, the priority will be to deliver additional freshes year-round and increase the duration and magnitude of low flows during winter and spring.

If Rosslynne Reservoir receives limited inflows in winter and spring 2020, there will be little if any opportunity to purchase water to support environmental flows in the Maribyrnong system during 2020–21. The VEWH is unable to carry over any water in the Maribyrnong system to support multi-year planning.

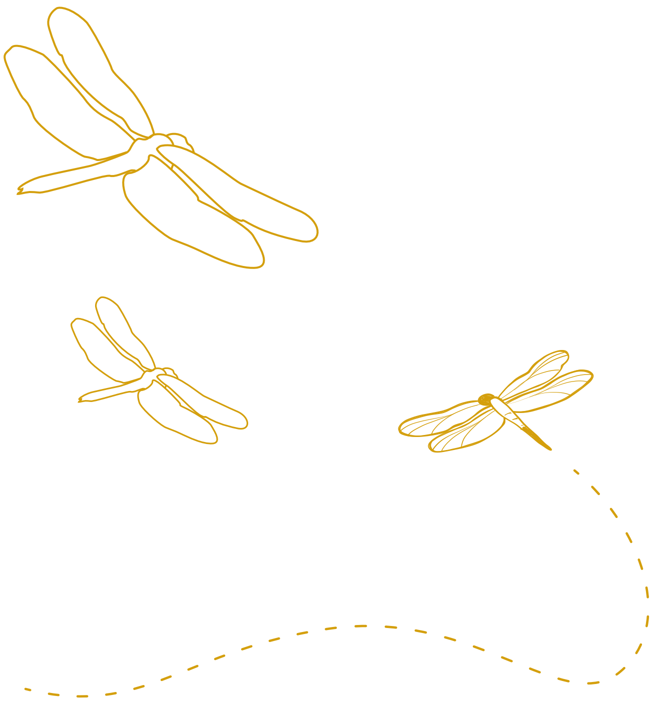


Table 3.4.2 Potential environmental watering for the Maribyrnong system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flows unlikely • Passing flows ceased • Some baseflow from groundwater contributions in lower Jacksons Creek	• Low volumes of unregulated flows • Passing flows may meet some low-flow objectives • Some baseflow from groundwater contributions in lower Jacksons Creek	• Unregulated flows meet some objectives • Passing flows may meet several low-flow objectives • Groundwater contributions provide baseflow in lower Jacksons Creek	• Unregulated flows meet most objectives • Passing flows may meet most low-flow objectives • Groundwater contributions provide baseflow in lower Jacksons Creek
Potential environmental watering – tier 1a (high priorities)	• Due to a lack of formal environmental entitlement, the Maribyrnong system will not receive an environmental allocation in 2020–21 and therefore no tier 1a watering actions have been identified. Water will need to be purchased from willing sellers to support tier 1b or tier 2 watering actions			
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn low flows • Two summer/autumn freshes	• Three summer/autumn freshes	• Three summer/autumn freshes • Winter/spring low flows (up to 14 days)	• Two summer/autumn freshes • Winter/spring low flows (up to 21 days)
Potential environmental watering – tier 2 (additional priorities)	• Two summer/autumn freshes	• Two summer/autumn freshes	• Two summer/autumn freshes • Increased duration winter/spring low flows	• Two summer/autumn freshes • Increased duration winter/spring low flows
Possible volume of environmental water required to achieve objectives[1]	• 300 ML (tier 1b) • 200 ML (tier 2)	• 300 ML (tier 1b) • 200 ML (tier 2)	• 600 ML (tier 1b) • 200 ML (tier 2)	• 600 ML (tier 1b) • 200 ML (tier 2)

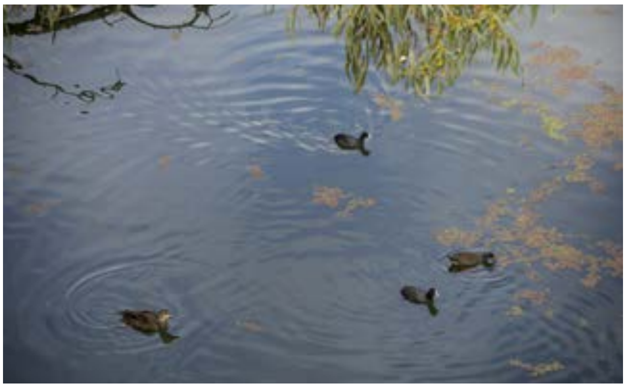
[1] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

3.5 Werribee system

Waterway manager – Melbourne Water

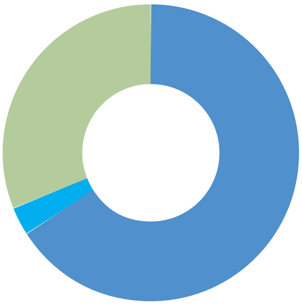
Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder



Did you know...?

The Werribee River is known to Wadawurrung people as *Wirribi yulluk*, which means 'wide river with big red gums.'



Werribee

Private	66%
Environment	3%
Water corporations	31%

Proportion of water entitlements in the Werribee basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Werribee River walk, by Melbourne Water
Above: Werribee River pool waterbirds, by Melbourne Water

System overview

The Werribee River flows south-east from the Wombat State Forest near Ballan, through the Werribee Gorge to Bacchus Marsh and then 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.

The four reaches in the Werribee system that can receive water for the environment are Pyrites Creek between Lake Merrimu and Melton Reservoir (reach 6), the Werribee River between Melton Reservoir and the Werribee Diversion Weir (reach 8), the Werribee River between the Werribee Diversion Weir and Werribee Park Tourism Precinct (reach 9) and the Werribee estuary below the Werribee Park Tourism Precinct (the estuary).

Environmental watering that targets environmental objectives in reach 9 and the estuary is delivered from Melton Reservoir and therefore also benefits reach 8. Water for the environment released from Lake Merrimu is re-harvested in Melton Reservoir, where it can be held and released at an appropriate time to achieve environmental objectives in the lower Werribee River.

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. Several species of frogs and diverse waterbug communities 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.

Environmental watering objectives in the Werribee system

Protect and increase populations of native freshwater fish species including galaxiids Protect and increase populations of black bream in the estuary
Maintain native frog populations
Maintain channel beds and pool habitats Maintain clean substrate surfaces to support biological processes
Maintain the platypus population
Maintain the health and increase the cover of in-stream, streamside and estuary plants Limit the spread of terrestrial plants, and promote the recruitment of native water-dependent plant species on the banks and benches of waterways
Maintain and enhance the population of waterbugs, to break down dead organic matter and support the river's food chain
Maintain oxygen and salinity levels in pools

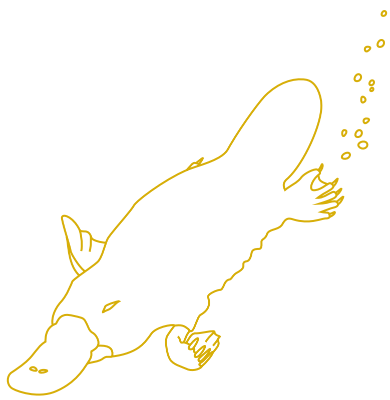


Figure 3.5.1 The Werribee system

Reach 1 Werribee River: Upstream of Upper Werribee Diversion Weir
Reach 2 Pykes Creek: Pykes Creek Reservoir to Werribee River
Reach 3 Werribee River: Upper Werribee Diversion Weir to Pykes Creek
Reach 4 Werribee River: Pykes Creek to Bacchus Marsh Weir
Reach 5 Werribee River: Bacchus Marsh Weir to Lerderderg River
Reach 6 Pyrites Creek: below Lake Merrimu to Melton Reservoir
Reach 7 Djerriwarrh Creek: below Djerriwarrh Weir to Melton Reservoir
Reach 8 Werribee River: Melton Reservoir to Lower Werribee Diversion Weir
Reach 9 Werribee River: Lower Werribee Diversion Weir to estuary
Reach Werribee Estuary
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.

Traditional Owner cultural values and uses

Melbourne Water has made initial contact with Wathaurung Aboriginal Corporation (Wadawurrung) and Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation, to discuss environmental watering in the Werribee system.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.5.1, Melbourne Water considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing)
- riverside recreation and amenity (such as improved water quality for communities)
- tourism (such as Werribee Zoo).

Recent conditions

Total rainfall in the Werribee system during 2019–20 was close to the long-term annual average, but rainfall was not evenly distributed across all reaches or storages. Pykes Creek Reservoir and Melton Reservoir both spilled in winter and spring 2019, which delivered large flows to the lower Werribee River. Inflows to Lake Merrimu remained low throughout the year, and environmental flows provided some flow in Pyrites Creek in spring 2019. By early March 2020, holders of high-reliability water shares in the Werribee system had received 100 percent allocations, and holders of low-reliability water shares had received 60 percent allocations. Small volumes of inflows into Lake Merrimu were attributed to the environmental entitlement throughout 2019–20.

Most of the potential watering actions for the lower Werribee River were delivered in 2019–20. Natural events provided regular freshes throughout the year, and water for the environment was used to deliver additional summer freshes and some low flows in June 2020. One of the summer freshes was used to flush an algal bloom that developed in the lower Werribee River during early summer. Low flows during autumn and winter were achieved by passing flows delivered by the storage manager.

In Pyrites Creek, water for the environment was used to deliver low flows and two spring freshes. These flows connected habitat pools for frogs, waterbugs and native fish, flushed sediment from pools and supported the recruitment and growth of native vegetation in the stream and along the margins of the banks. About one-third of flow in Pyrites Creek seeps into groundwater reserves or evaporates, but all flow that reached Melton Reservoir was re-harvested for later use.

Scope of environmental watering

Table 3.5.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

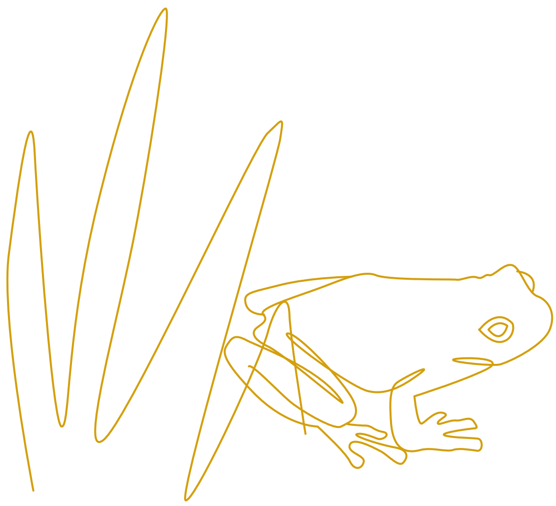


Table 3.5.1 Potential environmental watering actions and objectives for the Werribee system

Potential environmental watering action	Functional watering objectives	Environmental objectives
Pyrites Creek (reach 6)		
Spring fresh (one to four freshes of 40 ML/day for two days during September to October)	• Drown terrestrial plant species that encroach into the waterway • Increase the growth and recruitment of streamside and in-stream vegetation • Scour silt, biofilms and algae from substrates to maintain the quality and quantity of food and habitat for waterbugs • Wet depressions adjacent to the stream that frogs can use for breeding	
Spring/summer high flow (one to three high flows of 130 ML/day for two days during September to December)	• Drown terrestrial plant species that encroach into the waterway • Increase the growth and recruitment of streamside and in-stream vegetation • Transport carbon to drive aquatic food webs • Scour silt, biofilms and algae from substrates to maintain the quality and quantity of food and habitat for waterbugs • Wet depressions adjacent to the stream that frogs can use for breeding	
Winter/spring/summer low flow (two ML/day [or natural] during June to December)	• Maintain access to food and habitat for waterbugs, native fish and frogs • Increase the growth and recruitment of in-stream vegetation	
Lower Werribee River (reaches 8, 9 and estuary)		
Summer/autumn fresh (one to five freshes of 80 ML/day for two days during November to May)	• Support the growth and recruitment of water-dependent streamside vegetation • Flush silt and scour biofilms and algae from substrates on the stream bed and maintain pools and channel dimensions • Maintain access to habitat and improve water quality for native fish, frogs and platypus • Provide enough flow for native fish to move downstream past natural or artificial barriers • Maintain the quality and quantity of food and habitat for waterbugs	
Winter/spring fresh (one to two freshes of 350 ML/day for three days during June to October)	• Support the growth and recruitment of water-dependent streamside vegetation • Flush silt and scour biofilms and algae from substrates on the stream bed and maintain pools and channel dimensions • Provide movement cues and enough flows for fish to move upstream past natural and artificial barriers • Maintain water quality and quantity of food and habitat for waterbugs and platypus • Wet depressions adjacent to the stream that frogs can use for breeding	
Summer/autumn low flow (six ML/day during December to May)	• Maintain the growth and recruitment of in-stream vegetation • Support the growth and recruitment of water-dependent streamside vegetation • Maintain water quality and food in pool habitats for native fish • Maintain access to habitat for native fish, frogs, platypus and waterbugs • Maintain flow through pool habitats to allow mixing or suppression/dilution of saline groundwater intrusion	

Table 3.5.1 Potential environmental watering actions and objectives for the Werribee system *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Increased winter/spring low flow (up to 80 ML/day or natural during June to November)	• Provide flows to allow fish to move upstream past natural and artificial barriers • Drown terrestrial plant species and support the growth and recruitment of water-dependent streamside vegetation • Maintain permanent pools and increase the extent of habitat for waterbugs, platypus and frogs • Maintain flow through pool habitats to allow mixing or suppression/dilution of saline groundwater	

Scenario planning

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

The highest-priority potential watering actions for Pyrites Creek under all scenarios are spring freshes, spring/summer high flows and winter/spring/summer low flows. These flows will maintain connected aquatic habitats from winter to summer, maintain streamside and in-stream vegetation zones and periodically wet channel margins that can support frog breeding. Fish and other aquatic animals will retreat to permanent pools that are maintained by groundwater in summer and autumn. The highest-priority watering actions for the lower Werribee River under all scenarios are summer/autumn freshes and winter/spring freshes. Passing flows and operational deliveries for irrigation customers are expected to meet most low-flow requirements in the lower Werribee River, but managed environmental flows are important to control water quality and provide regular opportunities for fish and platypus to move throughout the lower Werribee River and to support streamside and aquatic vegetation.

The number of freshes delivered to both Pyrites Creek and the lower Werribee River will vary between dry, average and wet scenarios, depending on water availability. Water for the environment may be used to supplement summer/autumn low flows in the lower Werribee River under a wet scenario, but more environmental water would need to be secured to deliver these flows under dry or average scenarios. A minimum of 980 ML is planned to be carried over into 2021–22 to ensure high-priority flows can be delivered to Pyrites Creek (reach 6) and the lower Werribee River, if environmental water allocations are low.

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

Planning scenario	Dry	Average	Wet
Expected river conditions	• No natural flow below Melton Reservoir • Minimal passing flows to reach 6, possible transfers during summer • Some consumptive releases out of storage into reach 8 in summer/autumn	• Unregulated spills in winter/spring from Melton Reservoir into reaches 8 and 9 and the estuary; most low flows in reach 6 met by passing flows • Consumptive releases out of storage into reach 8 in summer/autumn	• Unregulated spills in winter/spring from Melton Reservoir into reaches 8 and 9 and the estuary; all low flows in reach 6 provided • Consumptive releases out of storage into reach 8 in summer/autumn
Expected availability of water for the environment[1]	• 2,154 ML	• 2,789 ML	• 3,039 ML
Potential environmental watering – tier 1a (high priorities)	• Three spring freshes (reach 6) • One spring/summer high flow (reach 6) • Winter/spring/summer low flows (reach 6) • Three summer/autumn freshes lower Werribee River • One winter/spring fresh lower Werribee River	• Four spring freshes (reach 6) • Three spring/summer high flows (reach 6) • Winter/spring/summer low flows (reach 6) • Five summer/autumn freshes lower Werribee River • One winter/spring fresh lower Werribee River	• Four spring freshes (reach 6) • Three spring/summer high flows (reach 6) • Winter/spring/summer low flows (reach 6) • Five summer/autumn freshes lower Werribee River • Two winter/spring freshes lower Werribee River • Summer/autumn low flows lower Werribee River
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn low flows lower Werribee River • Additional winter/spring fresh lower Werribee River	• Summer/autumn low flows lower Werribee River • Additional winter/spring fresh lower Werribee River	• Increased duration summer/autumn low flows lower Werribee River
Potential environmental watering – tier 2 (additional priorities)	• Increased winter/spring low flows lower Werribee River	• Increased winter/spring low flows lower Werribee River	• Increased winter/spring low flows lower Werribee River
Possible volume of environmental water required to achieve objectives[2]	• 930 ML (tier 1a) • 1,580 ML (tier 1b) • 10,000 ML (tier 2)	• 1,250 ML (tier 1a) • 1,580 ML (tier 1b) • 10,000 ML (tier 2)	• 1,880 ML (tier 1a) • 900 ML (tier 1b) • 10,000 ML (tier 2)
Priority carryover requirements	• 980 to 1,060 ML[3]		

[1] Includes water shares held by Melbourne Water that may be transferred to the VEWH for use in the Werribee system.

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

[3] A minimum volume of 200 ML is required to be carried over in Lake Merrimu to meet demands in Pyrites Creek.

3.6 Moorabool system

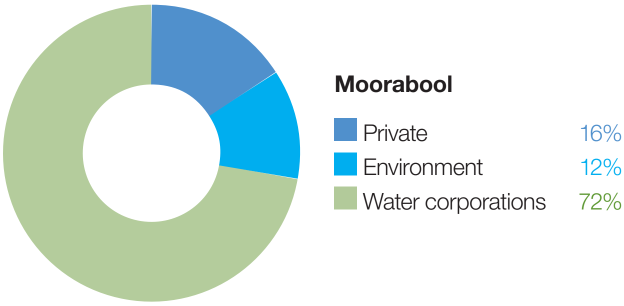
Waterway manager – Corangamite Catchment Management Authority

Storage manager – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The Moorabool River is on the traditional lands of the Wadawurrung people who have had an ongoing connection with the river for thousands of years. Moorabool means 'monster' in the language of the Wadawurrung. It's the local name of the stone curlew, a bird that used to be common by the river. Of a nighttime, the stone curlew is renowned for its eerie, high-pitched wailing. The parents in the Wadawurrung communities would use the stone curlew's frightening call to warn their children away from the river, "Moorabool, Moorabool (Monster Monster)" they would tell the children to make sure they didn't stray close to the dangers of the river in the dark.



Proportion of water entitlements in the Moorabool basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: At Moorabool River, by Corangamite CMA
Above: Moorabool River streamside vegetation, by Sarah Martin

System overview

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.

The lower section of the Moorabool River between She Oaks and Batesford has nine private diversion weirs that are significant barriers to fish. These barriers have increased the extent of slow-flowing habitat and reduced habitat diversity.

The Moorabool is a water supply catchment for Barwon Water and Central Highlands Water. Releases from Lal Lal Reservoir for urban water supply contribute to environmental outcomes in reach 3a and 3b (above Barwon Water's diversion point at She Oaks) and allow more efficient delivery of water for the environment to reach 4. Barwon Water and Corangamite CMA coordinate to make releases in tandem, where possible, to optimise these benefits.

Water allocated to the Moorabool River environmental entitlement is stored in Lal Lal Reservoir. The entitlement includes passing flows that are a significant component of annual streamflows and help maintain low flows through winter. The priority reaches for deliveries of water for the environment are between Lal Lal Reservoir and She Oaks Weir (reaches 3a and 3b, as shown in Figure 3.6.1), as that is where the small amount of available water can have the most benefit: water use is limited by both inflow to the reservoir and by a use cap specified in the entitlement. Environmental flows may also provide some benefits to flow-dependent values in the reach between She Oaks Weir and the confluence with the Barwon River.

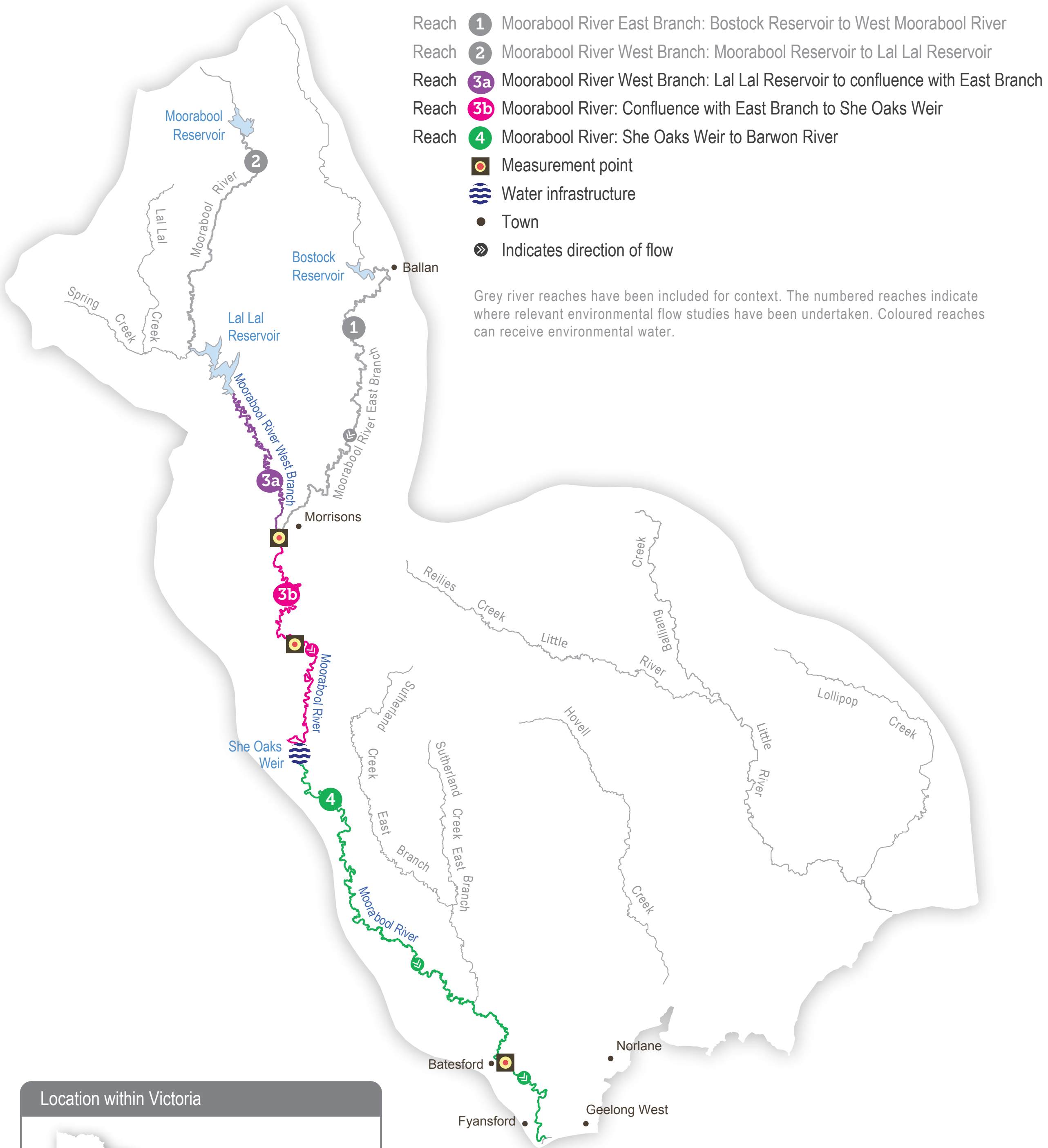
Environmental values

The Moorabool river is a highly flow-stressed system, but it does retain significant environmental values. The 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 also contains extensive areas of endangered remnant vegetation including streambank shrubland and streamside woodland ecological vegetation communities. Platypus, rakali (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.

Environmental watering objectives in the Moorabool River

Improve and increase the distribution, abundance and diversity of migratory species (tupong, short-finned eel, common galaxias, spotted galaxias, short-headed lamprey and Australian grayling) Maintain and increase the distribution, abundance and diversity of non-migratory species (flat-headed gudgeon, Australian smelt, southern pygmy perch and river blackfish)
Maintain channel form and processes Maintain physical habitat diversity
Maintain and improve a self-sustaining breeding population of platypus and support the dispersal of juveniles and the movement of adults
Maintain in-stream macrophyte communities Maintain streamside vegetation communities and promote recruitment
Maintain the abundance and diversity of waterbug communities
Maintain water quality Prevent hypoxic blackwater events

Figure 3.6.1 The Moorabool system



Traditional Owner cultural values and uses

The Wadawurrung are Traditional Owners of the land of the Moorabool River and parts of the Barwon, Leigh and Yarrowee rivers. Eastern Marr Aboriginal Corporation also have Country within areas of the Barwon River.

During 2019, the Wadawurrung partnered with Corangamite CMA to complete an environmental flows study for the upper Barwon, Yarrowee and Leigh rivers. Environmental flows studies are essential technical references for river managers which identify the types of flows needed to support environmental and cultural values in a river system.

The cultural values identified in the flows study are applicable to all waterways within Wadawurrung Country, including the Moorabool River. The values include:

- significant aquatic species such as *buniya* (eels), *ware-up* (river blackfish), *tark* (common reed) and *bal-yun* (cumbungi) which are traditional food, materials or medicinal sources
- waterway confluences and deep pools which are places for meeting, ceremonies and trade and mark clan boundaries.

Potential watering actions for the Moorabool River that support these values are identified in Table 3.6.1 using the icon below.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.6.1, Corangamite CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as kayaking, canoeing, fishing and swimming)
- riverside recreation and amenity (such as birdwatching, walking, camping, picnicking and using parks and lookouts)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and Geelong's water supply).

Recent conditions

Total rainfall in the Moorabool catchment in 2019–20 was slightly below the long-term average, but there was significant variation between and within seasons. Winter 2019 was wetter than average, and Lal Lal Reservoir filled to 99 percent capacity in November 2019. The second half of spring and the first half of summer were drier than average, but February through to April 2020 saw a return to wetter-than-average conditions.

The wet winter provided some minor and moderate peaks in discharge in July and August 2019 as inflows continued to run off the catchment. As such, the recommended minimum low flows for winter and spring were met by natural inflows in 2019–20. Water for the environment was used to deliver freshes in August and October 2019, maintain low flows in reaches 3a and 3b throughout summer and autumn and to deliver targeted freshes throughout the system in summer and autumn.

The Moorabool River near Batesford (reach 4) stopped flowing in January 2020. This part of the river is directly connected to the underlying groundwater table and often ceases to flow in summer. As a result, low flow releases from Lal Lal Reservoir in January were increased from five ML per day to 10 ML per day over a week to extend flow into reach 4. Water for the environment was also used to deliver freshes in late summer and autumn 2020 to cue the downstream migration of native fish, support platypus dispersal, flush the system and water the fringing vegetation.

Scope of environmental watering

Table 3.6.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (five ML/day continuous during December to May)	• Maintain pool and riffle habitats for fish, waterbugs, platypus and submerged aquatic vegetation • Maintain water quality for biota during summer/autumn by reducing periods of low oxygen, high temperature and high electrical conductivity	
Winter/spring low flow (10–60 ML/day continuous during June to November)	• Maintain connectivity and allow fish movement through the reach • Reduce intrusion by terrestrial vegetation into the stream bed	
Autumn fresh (one fresh of 60 ML/day for five days during April to May)	• Provide a cue for the downstream migration and spawning of Australian grayling • Allow fish and platypus to move through the reach to access habitat • Maintain the condition of streamside vegetation • Flush silt and scour biofilms and algae from streambed and substrates to improve habitat quality for waterbugs	
Summer fresh (one fresh of 60 ML/day for five days during January to February)	• Provide a cue for downstream spawning and migration of short-finned eel • Allow fish and platypus to move through the reach to access habitat • Maintain the condition of streamside vegetation • Flush silt, scour pools and remove biofilms from hard substrates • Maintain water quality for biota by reducing periods of low oxygen, high water temperature and salinity	
Spring fresh (one or two freshes of 80–162 ML/day for five days during September to November)	• Trigger the upstream migration of juvenile galaxias, tupong, short-finned eel and Australian grayling • Provide connectivity to support fish and platypus movement and maintain access to habitat • Scour biofilms and algae from the streambed and transport organic matter • Promote the growth and recruitment of streamside vegetation	
Winter fresh (one fresh of 80–162 ML/day for five days during May to August)	• Trigger the downstream spawning migration of tupong • Allow fish and platypus to move through the reach and maintain access to habitat • Scour biofilms and algae from the streambed to maintain waterbug communities and transport organic matter to prevent blackwater events • Promote the growth and recruitment of streamside vegetation	
Summer/autumn fresh (one fresh of 30 ML/day for five days during February to March)[1]	• Maintain water quality for biota by reducing periods of low oxygen, high water temperature and salinity	

[1] This event is trigger-based, to be delivered if water quality deteriorates to an extent that is harmful to aquatic life.

Scenario planning

Table 3.6.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The highest environmental flow priority under all scenarios in the Moorabool River in 2020–21 will be to provide continuous low flows during summer and autumn to maintain habitat for fish, waterbugs, platypus and aquatic vegetation, to allow fish and platypus to disperse and to protect water quality. Maintaining continuous low flows in winter and spring is also a high priority when these flows are not met naturally. Spring freshes are a high priority under dry, average and wet scenarios to cue the upstream migration of juvenile galaxias, tupong, short-finned eel and Australian grayling.

Summer and autumn freshes are important under drought and dry scenarios, to help mitigate against extreme water quality conditions that may threaten fish and other aquatic animals in refuge pools. Autumn and winter freshes may be delivered under average and wet conditions to cue tupong and Australian grayling to migrate and spawn. Freshes at any time of year will help transport nutrients through the system and scour biofilms and algae from the streambed and other hard surfaces.

Although environmental watering in the Moorabool River primarily targets outcomes in reaches 3a and 3b, deliveries will be planned where possible to also provide benefits in reach 4.

Critical carryover of 1,000 ML has been identified to allow delivery of trigger-based freshes in 2021–22, if there is low allocation.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Regular periods of no flow in some reaches	• Periods of no flow or very low flow in some reaches	• Continuous flow with low flow over summer and high peaks in winter months	• Continuous flow year-round • Bankfull flows persistent throughout winter • Overbank conditions in some parts during spring/autumn
Expected availability of water for the environment[1]	• 3,900 ML	• 4,700 ML	• 5,700 ML	• 7,700 ML
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn fresh (trigger based) • Summer/autumn low flows • Winter/spring low flows • Autumn fresh	• Summer/autumn fresh (trigger based) • Summer/autumn low flows • Winter/spring low flows • Autumn fresh • Summer fresh	• Summer/autumn low flows • Winter/spring low flows • Autumn fresh • Summer fresh • Spring fresh	• Summer/autumn low flows • Winter/spring low flows • Autumn fresh • Summer fresh • Spring fresh • Winter fresh • Spring fresh • Summer fresh
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer fresh • Spring fresh • Winter fresh • Spring fresh • Summer fresh	• Spring fresh • Winter fresh • Spring fresh • Summer fresh	• Winter fresh • Spring fresh • Summer fresh	
Potential environmental watering – tier 2 (additional priorities)	• As per tier 1, but at higher peak flows	• As per tier 1, but at higher peak flows	• As per tier 1, but at higher peak flows	• As per tier 1, but at higher peak flows
Possible volume of environmental water required to achieve objectives[2]	• 2,318 ML (tier 1a) • 4,860 ML (tier 1b) • 6,600 (tier 2)	• 2,508 ML (tier 1a) • 4,433 ML (tier 1b) • 6,600 (tier 2)	• 2,461 ML (tier 1a) • 3,735 ML (tier 1b) • 6,600 (tier 2)	• 1,682 ML (tier 1a) • 6,600 (tier 2)
Priority carryover requirements	• Up to 1,000 ML			

[1] The expected availability of water for the environment is the estimated volume of water that may be held in the VEWH's share of storage capacity in Lal Lal Reservoir during 2020–21 under drought, dry, average and wet scenarios. *The Moorabool River Environmental Entitlement 2010* entitles the VEWH to up to 7,500 ML of water from the VEWH's share of storage capacity in any consecutive three-year period including the current year, so the volume of water available to be delivered may be less than the total expected water availability.

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

3.7 Barwon system

Waterway manager – Corangamite Catchment Management Authority

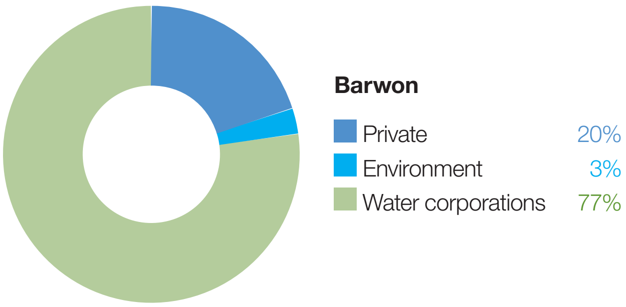
Storage manager – Barwon Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The Barwon River is known to the Wadawurrung people as *Barra Warre yulluk* which means 'from the mountains to the sea.'

The volume attributed to the environment in the Barwon system does not include water that is available to the lower Barwon wetlands because there is no limitation on the volume of water that can be supplied to the wetlands from the Barwon River.



Proportion of water entitlements in the Barwon basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Upper Barwon River, by Corangamite CMA
Above: Upper Barwon River revegetation site at Birregurra, by Sarah Martin

The Barwon system includes the upper Barwon River and lower Barwon wetlands.

The Barwon River flows east from the Otway Ranges passing the towns of Forrest, Birregurra, Winchelsea and Inverleigh and the City of Geelong before discharging into Bass Strait at Barwon Heads. The Leigh and Moorabool rivers are major tributaries, joining the Barwon River at Inverleigh and Fyansford respectively. Other tributaries including Birregurra, Boundary, Callahan, Dewing, Matthews, Pennyroyal, Deans Marsh and Gosling creeks flow into the Barwon River above Winchelsea. The main storages in the Barwon River catchments are the West Barwon and Wurdee Boluc reservoirs.

The Barwon estuary contains a Ramsar-listed system of wetlands and lakes collectively called the lower Barwon wetlands. Water for the environment can be used to manage flows in the upper Barwon River and manage water levels in Reedy Lake and Hospital Swamps, which connect to the lower Barwon River.

3.7.1 Upper Barwon River

System overview

Flows in the upper Barwon River are regulated by the operation of the West Barwon Reservoir upstream of Forrest. Water can be released directly from the reservoir into the west branch, or into the east branch via a diversion channel. The junction of the two branches is near Boundary Creek. Upstream of Birregurra, water can be diverted into the Wurdee Boluc inlet channel, a 57 km, concrete-lined channel that transfers water to Wurdee Boluc Reservoir.

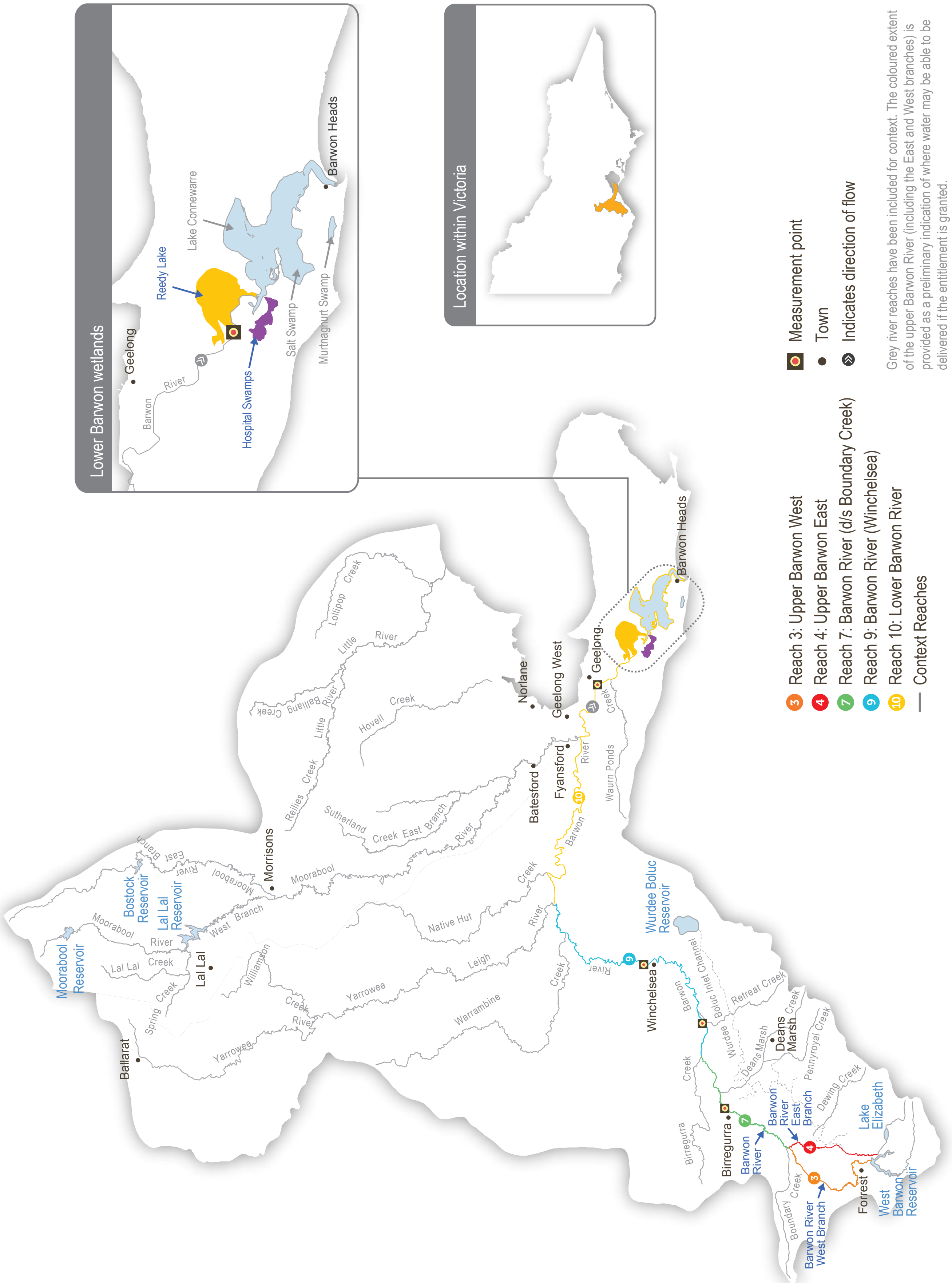
Barwon Water releases passing flows in the order of 1–5 ML per day in both the upper east and west branch (and up to 15 ML per day in September during a wet year) from the West Barwon Reservoir. Flood spills from the reservoir and natural inflows from unregulated and partly regulated tributaries add to the passing flows.

The *Upper Barwon River Environmental Entitlement 2018* enables water to be made available for the environment from the West Barwon Reservoir. The entitlement provides an average of 1,000 ML per year and up to 2,000 ML of the total storage capacity at full supply. Water for the environment was first delivered to the upper Barwon in 2018–19. The current entitlement provides only enough water to meet the highest ecological objectives in the upper Barwon east branch (reach 4) and the upper Barwon west branch (reach 3).

Environmental values

The upper Barwon River is home to native fish species including the Australian grayling, river blackfish, short-finned eel, southern pygmy perch, Australian smelt and various galaxias. The system retains some submerged aquatic vegetation, undercut banks, overhanging vegetation and riffle-pool sequences: these provide important habitat for fish and other aquatic animals.

Figure 3.7.1 The Barwon system



Environmental watering objectives in the upper Barwon River

Maintain the abundance, and improve the breeding and recruitment of migratory fish species including short-finned eels, Australian grayling and tupong, broad-finned galaxias and common galaxias Maintain the abundance, and improve the breeding and recruitment of resident freshwater fish including several species of galaxias, Australian smelt, big-headed gudgeon, Yarra and southern pygmy perch and river blackfish
Maintain the abundance and improve the condition and extent of platypus populations
Improve the condition and extent of instream vegetation, to provide structural habitat for waterbugs and various fish species Improve the condition, extent and diversity of emergent macrophyte vegetation and streamside vegetation to provide structural habitat and stabilise the channel and lower banks
Increase the abundance and improve the breeding and recruitment of waterbugs as a food source for fish, frog and platypus populations
Maintain water quality for native fish, waterbugs, aquatic vegetation and other water-dependent animals

Traditional Owner cultural values and uses

The Corangamite CMA is working with Eastern Maar and Wadawurrung Traditional Owners to understand opportunities to provide for both groups' respective cultural values and uses and other aspirations for environmental water management throughout the Barwon system.

The reaches of the Barwon River that can be most influenced by water delivered from the West Barwon Reservoir sit in Eastern Maar Country. Good opportunities exist within these reaches for actively managed shared benefits in the future.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.7.1, Corangamite CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing, kayaking and swimming)
- riverside recreation and amenity (such as bird watching, walking, camping, picnicking and using parks and lookouts)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses).

Recent conditions

Total rainfall in the Barwon River catchment was slightly below average during 2019–20 but varied within and between seasons. Significant rain in July and August 2019 filled the West Barwon Reservoir from 26 percent capacity to 60 percent capacity, and rainfall between January and May 2020 was above the long-term average.

Natural inflows maintained an average flow of 50 to70 ML per day at Winchelsea throughout winter and spring 2019 and delivered several high-flow events and freshes including a peak flow of 3,560 ML per day at Winchelsea in mid-July 2019. Water for the environment was used to maintain minimum low-flow targets (up to five ML per day) in the east branch of the upper Barwon River during summer, to maintain water quality and instream habitat for native fish and platypus and to maintain aquatic vegetation. Small freshes up to 15 ML per day were delivered in January and March 2020 to allow fish and other aquatic animals to disperse and maintain vegetation higher up the banks. The recommended fresh of 35 ML per day cannot currently be delivered due to channel constraints.

Scope of environmental watering

Table 3.7.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 3.7.1 Potential environmental watering actions and objectives for the upper Barwon River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (continuous 0.5–30 ML/day during December to May)	• Maintain an adequate depth of permanent water in the channel/pools to support resident fish, platypus and waterbugs • Promote the recruitment of native aquatic vegetation • Reduce encroachment by terrestrial plants into aquatic zone • Provide minimum velocity to maintain mixing in pools	
Summer/autumn freshes (two freshes of nine to 35 ML/day for two days during December to May: east branch only)	• Provide longitudinal connectivity with water over riffles to allow fish to move between pools to breed, feed and find new habitats • Submerge woody debris and clean hard surfaces to provide breeding substrate • Maintain waterbug communities in the dry period by flushing organic matter into the channel to provide food after inundating benches • Maintain emergent and streamside vegetation on terraces, the channel edge and lower bank • Provide minimum velocity to mix and flush pools	
Winter/spring low flow (continuous 10–50 ML/day or natural during April to November)	• Maintain an adequate water depth in the channel/pools to support fish and platypus foraging and breeding habitat • Maintain an adequate depth of permanent water in the channel to promote the recruitment of aquatic and streamside plants and to limit the encroachment of terrestrial species • Provide minimum velocity, to mix pools	

Scenario planning

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

The upper Barwon environmental entitlement can only support a small proportion of the environmental flow recommendations for the upper Barwon River. The highest-priority potential watering actions under all scenarios are summer/autumn low flows and freshes. The size of these events is likely to be less than recommended in the latest environmental flows study, due to system constraints and expected water availability.

Watering actions in the east branch of the Barwon River will be prioritised, because it has higher environmental values than the west branch and because relatively small flows in the east branch have the potential to deliver significant environmental outcomes. Some low flows may be delivered down the west branch under dry, average or wet scenarios to help meet target flow objectives further downstream.

An additional 18,000 ML of water for the environment is required to achieve the remaining potential watering actions (tier 1b) in the upper Barwon River. The tier 1a watering actions described here should help to maintain current environmental values and conditions in the upper Barwon River, but larger environmental entitlements and complementary works that address non-flow-related impacts in the catchment will be needed to significantly improve environmental conditions.

It is intended to carry over up to 500 ML at the end of 2020–21 to ensure the highest-priority flows can be achieved under any scenario in the following year.

Table 3.7.2 Potential environmental watering for the upper Barwon River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No flow at Ricketts Marsh for six months • Disconnected pools	• No flow at Ricketts Marsh for four months • Cease-to-flow events	• Low flow at Ricketts Marsh for two months • Low summer flow, high peaks in winter	• High flow throughout winter with very high peaks; constant steady summer flow
Expected availability of water for the environment	• 1,000 ML	• 1,300 ML	• 1,500 ML	• 2,500 ML
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes) • Summer/autumn low flow (west branch, reduced volume)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes) • Summer/autumn low flow (west branch, reduced volume)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes) • Summer/autumn low flow (west branch, reduced volume)
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch, reduced volume)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch, reduced volume)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch)
Potential environmental watering – tier 2 (additional priorities)	• There are no tier 2 watering demands because additional watering actions cannot be delivered within the existing infrastructure and flow constrictions			
Possible volume of environmental water required to achieve objectives	• 250 ML (tier 1a) • 18,200 ML (tier 1b)	• 800 ML (tier 1a) • 17,900 ML (tier 1b)	• 1,000 ML (tier 1a) • 17,700 ML (tier 1b)	• 2,000 ML (tier 1a) • 16,700 ML (tier 1b)
Priority carryover requirements	• Up to 250 ML	• Up to 500 ML		

3.7.2 Lower Barwon wetlands

System overview

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. Water for the environment can be used to manage water levels in Reedy Lake and Hospital Swamps, which connect to the Barwon River.

The environmental entitlement for the lower Barwon wetlands does not provide access to water held in storage. Instead, it allows water to be diverted 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 wetting of the wetlands.

Environmental values

Reedy Lake and Hospital Swamps form part of the internationally-recognised Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site, which is used by many thousands of migratory birds from around the world. The wetlands support 47 known threatened plant and animal 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. Reedy Lake was a partly ephemeral system, but river regulation meant the lake was permanently wetted from the 1970s until 2016. This long-term wetting resulted in a decline in biodiversity. The full water levels reduced the extent and diversity of vegetation communities including coastal saltmarsh, and they reduced the availability of shallow wading habitat which in turn has resulted in lower waterbird diversity.

In 2016–17, Corangamite CMA and the VEWH implemented a four-year watering regime trial at Reedy Lake to reinstate a more natural wetting and drying cycle. The 2019–20 water year was the final year of the trial — three years of partial drying and one year completely full — and a review of the recommended regime is currently underway. The recommendations from the review will inform the 2020–21 watering actions and determine future directions. The lower Barwon wetlands section of the seasonal watering plan will be updated by September 2020 to reflect the review's recommendations.

Hospital Swamps is made up of five wetland basins that support important ecological processes and significant ecological values including large areas of threatened coastal saltmarsh and diverse waterbird communities. Vegetation communities in Hospital Swamps have remained largely unchanged over time due to the maintenance of natural wetting and drying cycles.

Environmental watering objectives in the lower Barwon wetlands

Provide habitat for fish breeding and growth and improved conditions for migration and dispersal, when wetlands are connected to the Barwon River Reduce carp populations
Provide varying water levels and conditions to promote soil salinisation, to support the persistence and growth of threatened salt-dependent ecological vegetation communities Improve soil health and enable the weathering of heavy metals in vegetation fringe soils
Increase the diversity of ecological vegetation communities in the wetlands and improve the recruitment of aquatic vegetation Increase the growth and extent of coastal saltmarsh, herbfields and lignum shrubland ecological vegetation communities Reduce tall reed extent and increase open water habitat
Maintain and improve the waterbug population and its biomass
Maintain nutrient cycling and improve lake productivity Provide flushing inflows to remove accumulated salts Maintain surface water and groundwater interactions
Provide suitable feeding and breeding habitat for waterbirds, including mud flats and shallow water for wading birds, flooded vegetation and wetland fringes Maintain and increase waterbird breeding events

Traditional Owner cultural values and uses

Corangamite CMA worked with Wadawurrung Traditional Owners during the development of environmental watering plans for the lower Barwon wetlands, as part of an ongoing conversation to ensure Wadawurrung knowledge and culture is incorporated into decision-making, and that watering requirements for culturally-significant species are maintained.

As part of this partnership, the Wadawurrung have identified cultural values which are applicable to all waterways within Wadawurrung Country. Values that have been identified in the lower Barwon wetlands include:

- culturally significant wetland species, such as *Porronggitj* (brolga), *Toolim* (black duck), *Kunuwarra* (black swan), *Buniya* (eel), *Tark* (common reed) and *Bal-yan* (bull rush)
- recognition of wetlands as meeting, ceremony and trade places
- maintaining access to culturally important story places and ceremonial places
- protection of artefact sites.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.7.3, Corangamite CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing and duck hunting)
- riverside recreation and amenity (such as birdwatching and spending time outdoors)
- socio-economic benefits (such as commercial fishing).

Recent conditions

Rainfall across the lower Barwon River catchment in 2019–20 was close to the long-term average. High rainfall in winter 2019 and in late summer to autumn 2020 contributed high flows in the river and delivered water to Reedy Lake and Hospital Swamps.

Water levels in Reedy Lake varied between 0.6 m and 1.0 m AHD throughout 2019–20. This followed three successive years of managed partial drying, where the lake was filled in winter and then allowed to draw down during summer and autumn. Monitoring at Reedy Lake over the last four years indicates the drying regime has improved the diversity of vegetation, increased species richness of brackish aquatic herbland plants and increased the abundance of waterbirds including Australasian bitterns and magpie geese.

In 2019–20, Hospital Swamps was filled in winter and then drawn down to 0.3 m AHD over summer.

Scope of environmental watering

Table 3.7.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

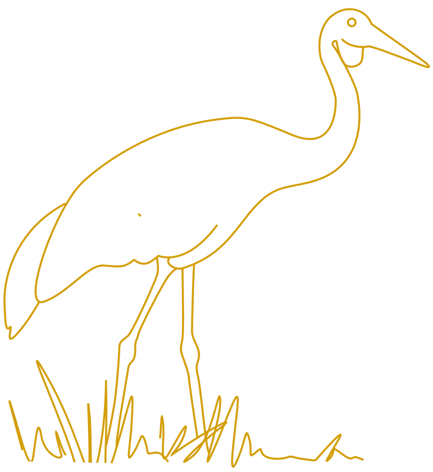
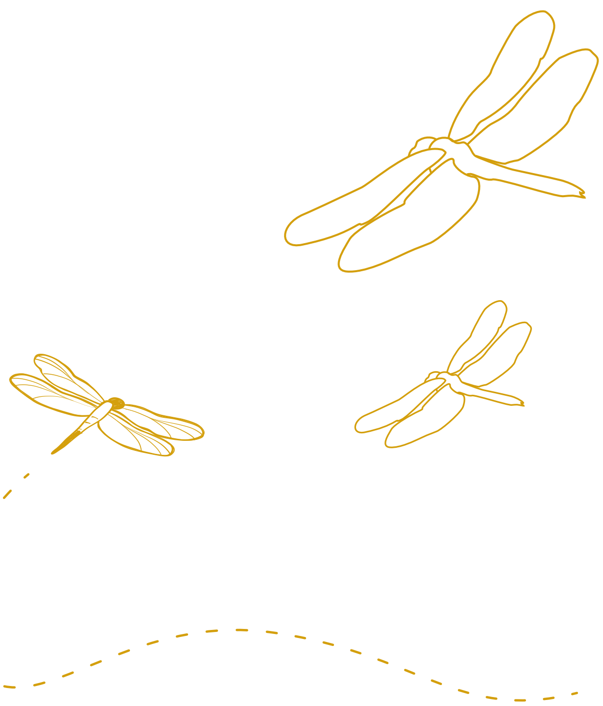


Table 3.7.3 Potential environmental watering actions and objectives for the lower Barwon wetlands[1]

Potential environmental watering action	Functional watering objectives	Environmental objectives
Reedy Lake		
Winter/spring fill (July to September) *The inlet to Reedy Lake will be opened to allow high flows in the Barwon River to flow into the wetland*	• Maintain the water level to 0.8 m AHD (allowing for natural fluctuations) • Maintain waterbird breeding events • Wet the vegetation at the wetland margins to provide feeding habitat for waterbirds • Maintain fish breeding and recruitment opportunities • Allow fish to move between the river, lake and estuary	
Hospital Swamps		
Winter/spring fill (July to September) *Hospital Swamps will be connected to the Barwon River for at least six weeks by keeping the inlet and outlet open*	• Maintain the water level at 0.5 m AHD (allowing for natural fluctuations) • Create habitat to support waterbug and fish populations • Improve fish and waterbird breeding • Allow fish to access the wetland from the river • Dilute salt in the soil and surface water over winter • Promote and sustain the growth of important wetland vegetation communities	

[1] The table only includes potential watering actions for July–September 2020. Potential watering actions for the rest of the year will be based on the independent review of the lower Barwon wetlands watering trial 2016–17 to 2019–20.



Scenario planning

Table 3.7.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

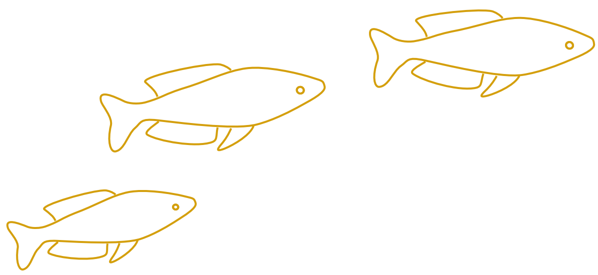
The environmental watering regime for Reedy Lake and Hospital Swamps will be informed by the outcomes of an independent review of the lower Barwon wetlands watering trial 2016–17 to 2019–20, which is due to be completed early in 2020–21.

After the independent review of the lower Barwon wetlands watering trial is complete, Corangamite CMA will consult with the Lower Barwon Community Advisory Committee to determine the recommended watering regime for both wetlands from October 2020 to June 2021. Any future management of Reedy Lake and Hospital Swamps is expected to include a winter filling phase under all scenarios and so that watering action has been included in the table. This section of the seasonal watering plan will be formally varied before October 2020 to describe the potential watering actions that may be delivered for the rest of the 2020–21 water year. Variations to the seasonal watering plan will be published on the VEWH website (www.vewh.vic.gov.au) before the planned watering actions are delivered.

Table 3.7.4 Potential environmental watering for the lower Barwon wetlands under a range of planning scenarios[1]

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 drying of the wetlands	• Some natural inflows from the Barwon River in winter/spring • Conditions over summer may assist drying of the wetland water levels	• Overbank flows are likely to wet the wetlands as a result of higher river flows, stormwater inflows and local rain/run-off • Extensive drying of the wetlands is unlikely
Reedy Lake	• Winter/spring fill	• Winter/spring fill	• Winter/spring fill
Hospital Swamps	• Winter/spring fill	• Winter/spring fill	• Winter/spring fill

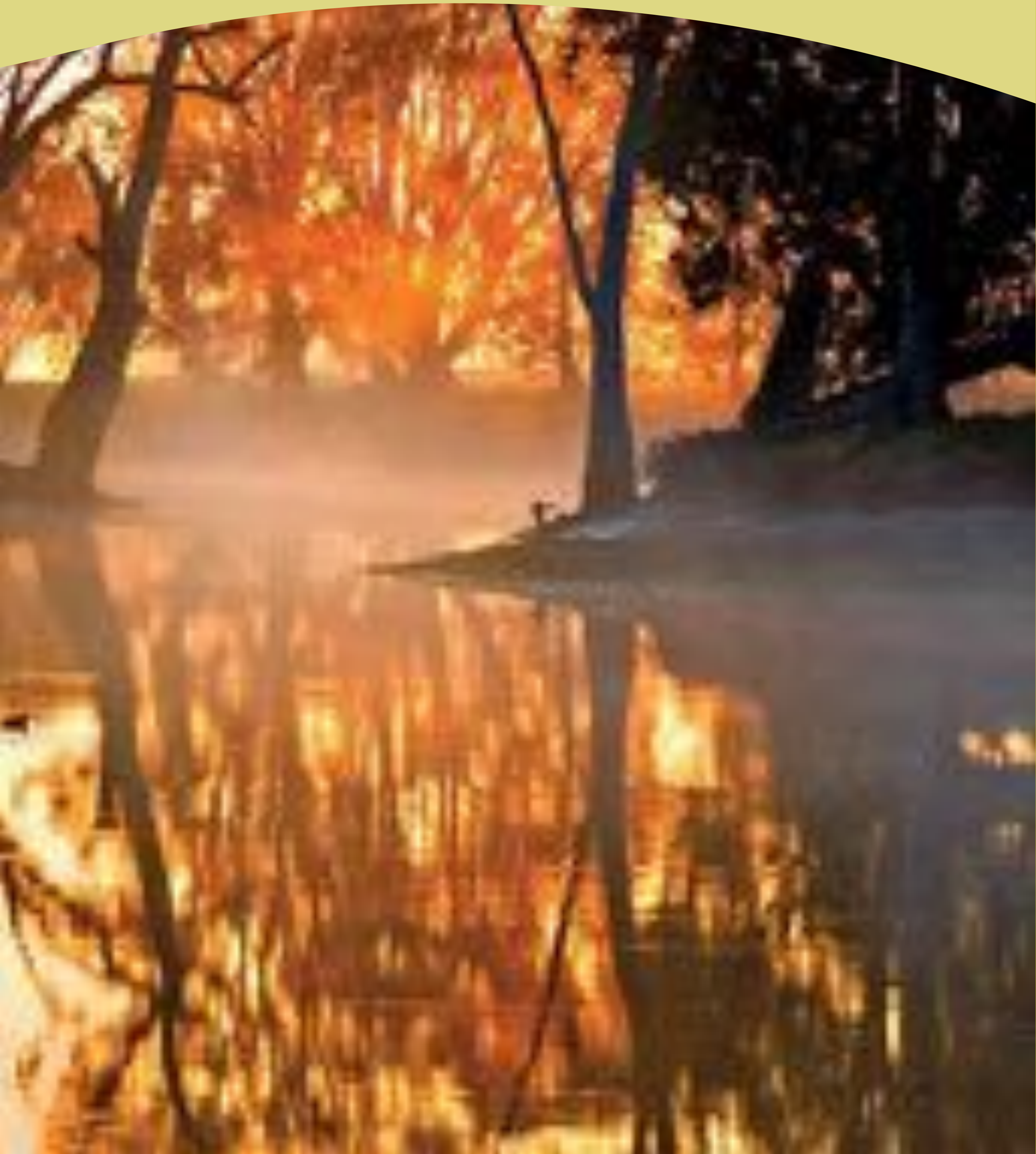
[1] The table only includes potential watering actions for July–September 2020. Potential watering actions for the rest of the year will be based on the independent review of the lower Barwon wetlands watering trial 2016–17 to 2019–20.



Sunrise over the Wimmera River, by David Fletcher

Section 4

Western region



Wimmera system
Wimmera-Mallee wetlands
Glenelg system

4.1 Western region overview

The systems in the western region that can receive water from the VEWH's environmental entitlements are the Glenelg River, the Wimmera River system and the Wimmera-Mallee wetlands. The Wimmera River system and Wimmera-Mallee wetlands are part of the Murray-Darling Basin, although the Wimmera River ends in terminal lakes without directly flowing into the Murray River.

Water for the environment in the western region is supplied from the Wimmera-Mallee headworks system. The Wimmera and Glenelg systems share water available under the environmental entitlement and the VEWH works with the Wimmera and Glenelg Hopkins CMAs to determine how the available allocation will be used in each river in a given year. There is an additional volume of water available to the Glenelg River, as a compensation flow account. The Commonwealth Environmental Water Holder (CEWH) also holds entitlement in the Wimmera system that can be used to supply the Wimmera River and lower Mount William Creek systems. Water for the environment available to the Wimmera-Mallee wetlands is provided under the same entitlement but not shared with the Glenelg system. Instead, the water is available for use in small wetlands supplied by the Wimmera-Mallee pipeline across the Wimmera, Mallee and North Central CMA regions.

Environmental values, recent conditions, environmental watering objectives and planned actions for each system in the western region are presented in the system sections that follow this regional overview.

Traditional Owners in the western region

Traditional Owners in the western region have a deep connection to the region's rivers, wetlands and floodplains.

The Barengi Gadjin Land Council Aboriginal Corporation, Dja Dja Wurrung Clans Aboriginal Corporation and Gunditj Mirring Traditional Owners Aboriginal Corporation are the Registered Aboriginal Parties for the areas incorporating waterways covered by this section of the seasonal watering plan.

Burrandies Aboriginal Corporation (based in South Australia [SA]) represent the Boandik Traditional Owners for the south-west corner of the Glenelg River catchment.

In 2005, the Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagalk peoples, who are often referred to collectively as the Wotjobaluk Peoples and who are represented by Barengi Gadjin Land Council, were recognised in a Native Title Consent Determination. Barengi Gadjin Land Council also entered into an Indigenous Land Use Agreement with the Victorian and Australian governments in 2005.

In 2007, the Gunditjmara people were granted nonexclusive native title rights and interests over almost 140,000 ha of vacant Crown land, national parks, reserves, rivers, creeks and sea in Victoria's western district, and the State of Victoria reached an Indigenous Land Use Agreement with the Gunditjmara People that establishes how they will exercise their rights and interests in the determination area.

In 2013, the Dja Dja Wurrung Clans Aboriginal Corporation entered into a recognition and settlement agreement under the *Traditional Owner Settlement Act 2010* in Victoria. Under the agreement, Dja Dja Wurrung people have rights to access and use water for traditional purposes, providing the take of water does not affect other parties.

The Eastern Maar Aboriginal Corporation is also a Registered Aboriginal Party within the geographic area, but its boundaries do not incorporate waterways managed with water for the environment in this section of the seasonal watering plan.

Engagement

Seasonal watering proposals are informed by community, stakeholder and program partner engagement, as well as longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flow studies and environmental water management plans). Program partners and other stakeholders help to identify environmental watering priorities and opportunities for the coming year. The strategies and technical reports collectively describe a range of environmental, cultural, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence environmental watering actions and priorities.

The International Association for Public Participation's Public Participation Spectrum (IAP2 Spectrum) has been used to categorise the levels of participation of stakeholders involved in the environmental watering planning process. Table 4.1.1 shows the IAP2 Spectrum categories and participation goals.

Table 4.1.1 International Association for Public Participation's Public Participation Spectrum categories and participation goals[1]

IAP2 level	Engagement goal
Inform	Provide balanced and objective information to assist understanding, alternatives, opportunities and/or solutions
Consult	Obtain feedback on analysis, alternatives and/or decisions
Involve	Work directly throughout a process to ensure that concerns and aspirations are consistently understood and considered
Collaborate	Partner in each aspect of the decision including the development of alternatives and the identification of the preferred solution
Empower	Place final decision making in the hands of the stakeholder

[1] The VEWH has the permission of the International Association for Public Participation to reproduce the IAP2 Spectrum.

Tables 4.1.2, 4.1.3 and 4.1.4 show the partners, stakeholder organisations and individuals with which Glenelg Hopkins CMA, Mallee CMA, North Central CMA and Wimmera CMA engaged when preparing their seasonal watering proposals. This includes engagement conducted as part of developing the seasonal watering proposals as well as engagement during the preparation of key foundational documents that directly informed the proposals. VEWH staff were also consulted for operational information as part of the development of all annual seasonal watering proposals by CMAs.

The tables also show the level of engagement between the CMAs and stakeholders of the environmental watering program in the western region based on the CMAs' interpretations of the IAP2 Spectrum.

The level of engagement differs between organisations and between systems depending on the availability, capacity or interest of stakeholders to participate; the roles and responsibilities of organisations in managing a site or system; and the potential interaction of proposed watering with other activities on the waterway. For example, in the Wimmera region, councils have a strong involvement in environmental flows planning and delivery, because they manage town weir pools in Horsham, Dimboola and Jeparit through which environmental flows must pass. Councils in the Wimmera region have also expressed a strong interest in water for the environment, because of the benefits watering provides the region's economy, tourism and environment. The Wimmera CMA works with these councils in the planning process and during the year to incorporate any aspirations or concerns. In other parts of the western region, local governments are less involved in management and may only need to be informed of the seasonal watering proposals.

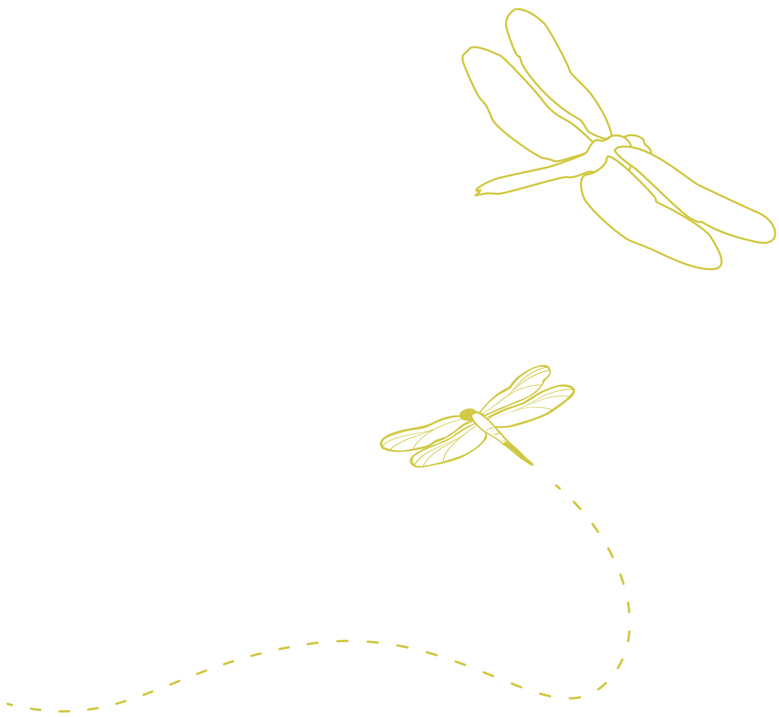


Table 4.1.2 Partners and stakeholders engaged by Glenelg Hopkins CMA in developing seasonal watering proposals for the Glenelg system and other key foundation documents that have directly informed the proposal

Partner/stakeholder	Glenelg system
Community groups and environment groups	**IAP2 level: Collaborate** • Friends of the Glenelg River • Glenelg River User Group
Government agencies	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Grampians Wimmera Mallee Water • Parks Victoria • Victorian Fisheries Authority • Wimmera Catchment Management Authority
Landholders/farmers	**IAP2 level: Collaborate** • Individual landholders
Local businesses	**IAP2 level: Inform** • Balmoral Bush Nursing Centre • Balmoral Post Office • Glenelg River Boat Cruises • Grampians Resort • Nelson Boat and Canoe Hire • Paestan Canoe Hire • Vickery Brothers (sand extraction)
Recreational users	**IAP2 level: Collaborate** • Balmoral Angling Club • Casterton Angling Society • Dartmoor Angling Club • Individual anglers • South-west Fishing Reports • VRFish
Traditional Owners	**IAP2 level: Collaborate** • Gunditj Mirring Traditional Owner Corporation • Barengi Gadjin Land Council • Burrandies Aboriginal Corporation

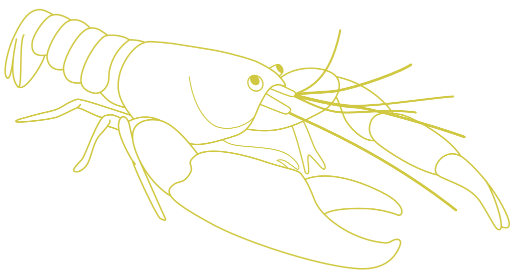


Table 4.1.3 Partners and stakeholders engaged by Wimmera CMA in developing the seasonal watering proposal for the Wimmera system and other key foundation documents that have directly informed the proposal

Partner/stakeholder	Wimmera system
Community groups and environment groups	**IAP2 level: Consult** • Lake Lonsdale Action Group • Yarriambiack Creek Advisory Committee • Friends of Bungalally and Burnt Creek
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning – Grampians Region • Glenelg Hopkins CMA • Grampians Wimmera Mallee Water
	IAP2 level: Involve • Hindmarsh Shire Council • Horsham Rural City Council
	IAP2 level: Consult • Northern Grampians Shire Council • Parks Victoria • Victorian Fisheries Authority • Yarriambiack Shire Council
Landholders/farmers	**IAP2 level: Inform** • Wimmera community members, especially landholders
Recreational users	**IAP2 level: Consult** • Natimuk and District Field and Game • 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 • Horsham Fishing Competition Committee • Canoeing Victoria
Technical experts	**IAP2 level: Collaborate** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Collaborate** • Barengi Gadjin Land Council

Table 4.1.4 Partners and stakeholders engaged by Mallee CMA, North Central CMA and Wimmera CMA seasonal watering proposals for the Wimmera-Mallee wetlands and other key foundation documents that have directly informed the proposals

Partner/stakeholder	Wimmera Mallee wetlands
Community groups and environment groups	**IAP2 level: Inform** • Local Landcare groups
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Holder • Department of Environment Land, Water and Planning (Crown Land Management) • Grampians Wimmera Mallee Water • Parks Victoria
	IAP2 level: Inform • Buloke Shire Council • Yarriambiack Shire Council
Landholders/ farmers	**IAP2 level: Collaborate** • Landholders
	IAP2 level: Inform • Birchip Cropping Group • Community members
Local businesses	**IAP2 level: Inform** • Wimmera Mallee Tourism
Recreational users	**AP2 level: consult** • Natimuk and District Field and Game
	IAP2 level: Inform • Cokum community group • Green Lake Regional Park • Ouyen Lake Project • Lake Tchum Committee • Wimmera Bushwalking Club
Technical experts	**IAP2 level: Collaborate** • Mallee CMA Land and Water Advisory Committee
	IAP2 level: Involve • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Collaborate** • Barenji Gadjin Land Council • Dja Dja Wurrung Clans Aboriginal Corporation

Community benefits from environmental watering

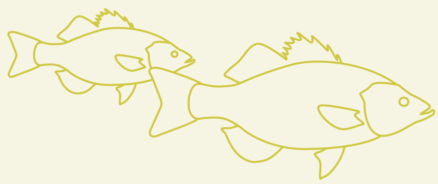
Healthy rivers and wetlands support vibrant and healthy communities. By improving the health of rivers, wetlands and floodplains, environmental flows also provide benefits to communities.

The VEWH and its program partners consider Aboriginal cultural, social and recreational values and uses of waterways when planning for environmental watering activities. Through engagement with community representatives, waterway managers aim to determine where community benefits from environmental flows can be optimised, while achieving environmental priorities for the year ahead.

Healthy waterways provide community benefits (such as providing nice places to walk, picnic or fish recreationally and sustaining healthy Country for Aboriginal communities).

Community benefits can sometimes be enhanced by modifying environmental flows (such as timing a flow to support a community rowing or fishing event), provided the environmental objective is not compromised.

The VEWH and its partners seek to deliver these benefits throughout the water year, though the opportunities can depend on the weather, climate or environmental conditions, water availability and the way the system is being operated to deliver water for other purposes.



How have Traditional Owners' values and uses of waterways been considered?

In recognition of the cultural importance of water, caring for Country and their long-standing traditional ecological knowledge, Traditional Owners are increasingly working with waterway managers to plan for and deliver environmental flows. The following are examples in the western region:

- repeating the successful watering of Ranch Billabong at Dimboola. The Barengi Gadjin Land Council highlighted Ranch Billabong as a significant site during an Aboriginal Waterways Assessment in 2017. Water for the environment was delivered to the site in 2018–19 and 2019–20 to reduce salinity, improve the condition of vegetation and native wildlife and improve its suitability for Traditional Owner gatherings and events (such as earth oven and bark canoe re-creations)
- building on the achievements of the Towards Cultural Flows project (an ongoing partnership between Glenelg Hopkins CMA, Gunditj Mirring Traditional Owners Aboriginal Corporation, Barengi Gadjin Land Council and Burrandies Aboriginal Corporation in south-eastern SA), Traditional Owners and Glenelg Hopkins CMA will continue to identify opportunities for environmental flows to support cultural values and uses in the Glenelg River
- Glenelg Hopkins CMA will liaise with Traditional Owners about the timing of a summer fresh in the Glenelg River to align with the Johnny Mullagh Cup cricket match held in Harrow; the match is played by Aboriginal descendants of the first Australian international team that toured England in 1868.

Where participation of Traditional Owners in the planning and delivery of water for the environment has explicitly identified particular flows supporting cultural outcomes, these are identified in the system sections.

How have economic, recreational and social values and uses of waterways been considered?

Environmental outcomes provide some direct economic, recreational, social benefits to communities. Waterway managers, in consultation with communities, have identified numerous opportunities to support these community benefits, including activities such as tourism, fishing, birdwatching, boating, and hunting. Examples in the western region include:

- improving fishing opportunities throughout the upper and middle reaches of the Glenelg catchment, where environmental flows support numerous fishing competitions and the Balmoral, Casterton and Dartmoor angling clubs
- keeping the Wimmera River flowing through late spring and summer/autumn, supporting many community activities including water-skiing at the Horsham and Dimboola Weir pools, the Dimboola (rowing) Regatta, the Wimmera River Duck Race (to raise money for the Wimmera Health Care Group) and the Horsham, Dimboola and Jeparit fishing competitions.

Investigations into the socio-economic benefits of water for the environment in waterways in the Wimmera over the last three years have indicated that Horsham and Dimboola continue to be hot-spots for recreational enjoyment along the Wimmera River. Results have also shown an increase in expenditure for locations along the Wimmera River over the three-year period. Physical and mental health benefits were also quantified and results demonstrate that the Wimmera River at Jeparit, Horsham and Dimboola is a key contributor.

Feedback from local landholders and the community is that they enjoy and support the delivery of environmental water to the Wimmera-Mallee wetlands. In a landscape characterised by a very dry climate and defined by hot, hard, farming work, these wetlands provide refuge for wildlife as well as local people by providing opportunities for swimming, boating, picnicking and walking, and venues for functions, meals, meetings and other community-based activities.

Summaries of the social, recreational and economic values considered are provided for each system. Where the timing or management of planned environmental flows may be modified to align with a community benefit, these are identified alongside the potential watering actions.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental flows need to be part of an integrated approach to catchment management. Many of the environmental objectives for water for the environment in the western region will not be fully met without simultaneously addressing issues such as barriers to fish movement, high nutrient loads, loss of stream bank vegetation and invasive species.

Victorian and Australian government agencies, Traditional Owners, community groups and private landowners collectively implement a wide range of programs that aim to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments.

Examples of complementary programs that are likely to support environmental watering outcomes in the western region include:

- major works recently completed by Glenelg Hopkins CMA to improve fish passage at Sandford Weir, Dergholm Gauge and Warrock will be used in combination with delivery of water for the environment to facilitate the movement of migratory fish from the estuary to the upstream reaches of the Glenelg and Wannon rivers
- installation of artificial wetland pontoons in the Dimboola weir pool and walking tracks to manage recreational access along the Wimmera River to reduce bank erosion
- weed and rabbit control by Wimmera CMA to prevent bank erosion in the upper Wimmera catchment to improve water quality, stream form and increase native biodiversity
- stock-exclusion fencing along priority waterways by Wimmera and Glenelg Hopkins CMAs throughout the Wimmera and Glenelg catchments, to support the re-establishment of streamside and in-stream vegetation, with over 2,000 km of fencing along the Glenelg River alone
- carp management activities in both the Wimmera and Glenelg systems to reduce the number of carp and to build understanding about their behaviour in both rivers to facilitate better environmental watering outcomes
- extensive installation of large woody fish habitat in Glenelg River reach 2 using red gum trunks and root balls to restore complex habitat
- control of invasive species and stock exclusion fencing in 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 CMA's regional catchment strategies and regional waterway strategies.

Risk management

During the development of the seasonal watering proposals for the Glenelg, Wimmera and Wimmera-Mallee wetland systems, environmental watering program partners assessed risks associated with potential environmental watering actions for 2020–21 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

Seasonal outlook 2020–21

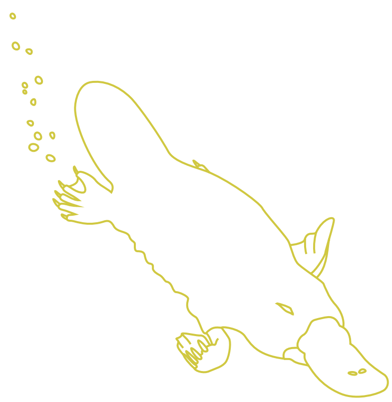
Rainfall across the western region in 2019–20 was below the long-term average for the third consecutive year. Despite the overall dry conditions, there were some periods of higher rainfall that contributed flow to the Wimmera and Glenelg rivers. Winter rain caused the Wimmera River above Huddlestons Weir to flow for the first time in more than a year, which met the planned watering actions in the Wimmera and Glenelg systems for the first few months of 2019–20. Water for the environment was needed to supplement flows in the Wimmera and Glenelg systems from October 2019 onwards. Continuous flow was maintained in the Glenelg River between Rocklands Reservoir and to the top of the estuary at Dartmoor throughout 2019–20 and periodic flow in the Wimmera River to Dimboola. However, environmental watering in some parts of the MacKenzie River, Burnt Creek and Mount William Creek was lower than planned, due to release limits at selected storages.

Water storages across the Wimmera-Mallee headworks were collectively below 30 percent of capacity at the end of April 2020. The VEWH received 42 percent allocation against its environmental entitlement in 2019–20. The CEWH did not receive any allocation in 2019–20, but all remaining carryover held from previous years' allocations was delivered in the Wimmera River and Mount William Creek during summer 2019–20.

Above-average rainfall and above-average temperatures are predicted for the western region in winter 2020, but the Wimmera-Mallee headworks storages will need significant inflows before any allocations are made to the environmental entitlement. The storage manager has indicated that entitlement holders will only receive low volumes of allocations in 2020–21 under drought, dry and average scenarios, and they are unlikely to receive full allocations even under a wet scenario.

If environmental allocations do not significantly increase in winter/spring 2020, environmental water for the rest of 2020–21 will be managed in line with drought or dry scenarios in both the Wimmera and Glenelg systems. The focus will be on delivering minimum low flow and small freshes as needed to maintain continuous river flow where possible, to maintain refuge pools where continuous flow cannot be achieved and to protect water quality. Carryover from 2019–20 will be critical in supporting these watering actions. If system inflows deliver higher environmental allocations, environmental water may be used to deliver winter/spring freshes and low flow in the Glenelg River through to reach 2, deliver additional winter/spring freshes in the Wimmera River and extend the summer/autumn low flow and freshes through to reach 3 of the MacKenzie River. Winter/spring inflows to the Wimmera-Mallee headworks storages will need to be well above average, to allow wet-scenario watering actions to be delivered in 2020–21.

The Wimmera-Mallee wetlands entitlement is not likely to receive any allocation in 2020–21 under drought, dry or average scenarios, so managed environmental deliveries to those sites will rely on carryover from 2019–20. The continuing focus of environmental watering in the Wimmera-Mallee wetlands will be to provide refuge and maintain habitat in the dry landscape, to support local plants and animals.



4.2 Glenelg system

Waterway manager – Glenelg Hopkins Catchment Management Authority

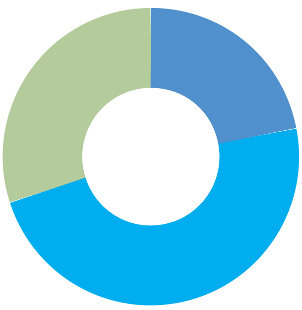
Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The Glenelg River, known as *Bochara* in Dhawurd Wurrung, *Pawur* in Bunganditj and *Bogara* in Wergaia-Jadawadjali, features in creation stories from south-western Victoria and is a traditional boundary between the Gunditjmara, Boandik and Jadawadjali people.

The Wimmera-Mallee headworks system captures run-off from both the Wimmera and Glenelg catchments. Entitlements to water held in this system cannot be accounted for separately in the two river basins, therefore this figure shows the proportion of entitlements across both systems.



Proportion of water entitlements held across the Wimmera and Glenelg basins held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Glenelg River at Harrow, by Glenelg Hopkins CMA
Above: Tupong, by Glenelg Hopkins CMA

System overview

The Glenelg River rises in the Grampians and flows west through Harrow and then south to Casterton and Dartmoor. The Glenelg River estuary flows west from Dartmoor and passes through South Australia for a short distance before returning to Victoria and flowing into the sea at Nelson. At over 500 km, the Glenelg River is one of the longest rivers in Victoria.

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. Water for the environment is actively managed in the Glenelg River below Rocklands Reservoir. Passing flow rules are in place for the Glenelg River and upper Wannon River.

The priority reaches of the Glenelg River that can be targeted by environmental flow releases are Rocklands Reservoir to 5-Mile Outlet (reach 1a), 5-Mile Outlet to the confluence with the Chetwynd River (reach 1b), Chetwynd River to the Wannon River (reach 2) and Wannon River to the tidal extent just below the confluence with Crawford River (reach 3). Water for the environment in the Glenelg system is released from Rocklands Reservoir for reach 1a via the reservoir wall outlet and for reaches 1b, 2 and 3 via the 5-Mile and 12-Mile outlets.

The Glenelg River estuary benefits from releases of water for the environment to upstream reaches, but releases do not currently target the estuary. The Glenelg Hopkins CMA is investigating the influence of managed environmental water on the Glenelg River estuary, which is listed as a heritage river reach and a site of international significance under the Ramsar Convention.

Trial releases were delivered from Moora Moora Reservoir above Rocklands Reservoir (reach 0) in 2017–18, 2018–19 and 2019–20. The results of that trial will be analysed to inform future decisions about potential environmental water use in reach 0.

Environmental values

The Glenelg River starts in the Grampians (Gariwerd) National Park and flows to the sea through the Lower Glenelg National Park. The lower reaches of the Glenelg River are part of a landscape recognised as one of Australia's 15 national biodiversity hotspots, and the Glenelg Estuary and Discovery Bay site is Australia's most recent listing under the Ramsar Convention.

The Glenelg River supports a range of rare and unique aquatic life including the endangered Glenelg freshwater mussel and Glenelg spiny crayfish. It is also home to platypus and populations of native fish including river blackfish, estuary perch, kooyang (short-finned eel), tupong and three species of pygmy perch including the threatened variegated and Yarra pygmy perches. Some of these fish species migrate long distances to and from the Glenelg River estuary to complete their life cycles.

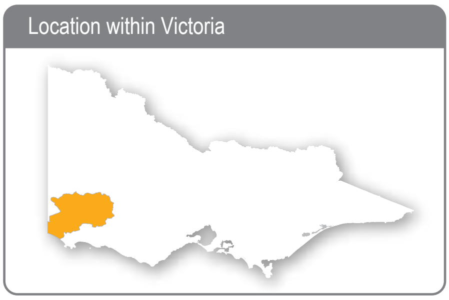
Frasers Swamp is another important feature of the upper Glenelg system, and is home to a healthy growling grass frog population.

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

Environmental watering objectives in the Glenelg River

- Protect and increase populations of native fish
- Maintain deep pool habitats and connectivity along the river
- Maintain the platypus population
- Maintain the health and increase the abundance of in-stream and streamside vegetation (such as river red gums and Wimmera River bottlebrush)
- Maintain a wide range and large number of waterbugs to provide energy, break down organic matter and support the river's food chain
- Maintain water quality for native fish, waterbugs, aquatic vegetation and other water-dependent animals

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.

Traditional Owner cultural values and uses

The Glenelg River, known as *Bochara* in Dhawuard Wurrung, *Pawur* in Bunganditj and *Bogara* in Wergaia-Jadawadjali languages, is a significant feature in the cultural landscape of south-western Victoria. The river features in creation stories from the region. *Bochara-Bugara-Pawur* continues to be an important place for Traditional Owners, who have inhabited the area for thousands of years, using the rich resources available along the river and associated habitats.

In planning for environmental flows in the Glenelg River, Gunditj Mirring Traditional Owners Aboriginal Corporation, Barengi Gadjin Land Council, Burrandies Aboriginal Corporation and Glenelg Hopkins CMA have considered:

- supporting the health of cultural heritage sites, such as scar trees and the health of native plants which are sources of traditional foods and medicines
- improved health and abundance of totem species and their habitat resulting from environmental watering also has benefits for Traditional Owner spiritual wellbeing
- supporting contemporary cultural events (such as the Johnny Mullagh Cup).

Aboriginal peoples across the Glenelg catchment have retained a strong identity and connection to the traditional lands for which they have custodial rights and responsibilities. Traditional Owner values in the *Bochara-Bugara-Pawur* system align strongly with environmental values. Traditional Owner values are holistic and interrelated.

These values are bound up in the health of the river system overall, and the Country that the river is part of. Traditional Owner wellbeing is connected to the health of the river and the Country.

The Season Flows Calendar (Figure 4.2.2) illuminates flow regimes along one reach of the Glenelg River (reach 1b 5-Mile Outlet to Chetwynd River) and aligns them with corresponding environmental events and observations.

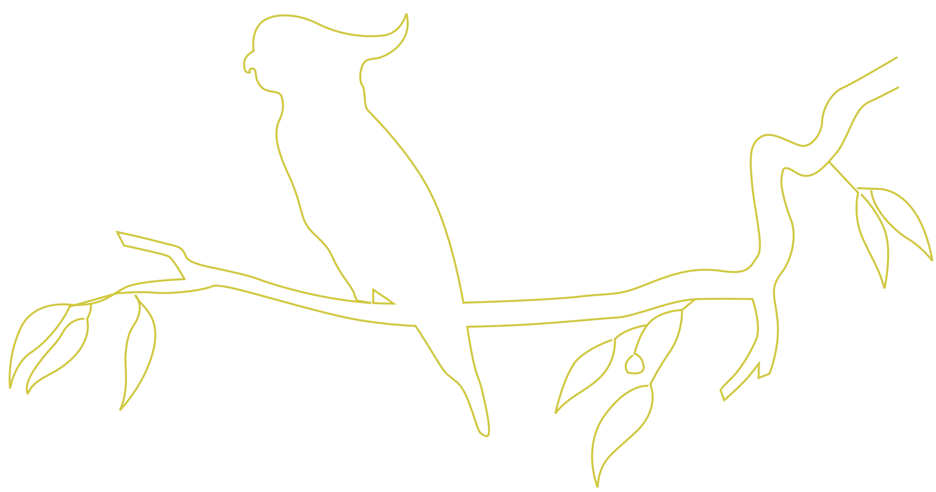
The value of the calendar is in its clear visual depiction of Traditional Owner knowledge, developed over many generations, of how varying flows correspond to seasonal conditions and broader environmental patterns. It is planned to embed the six seasons in the flow recommendations and scenario planning in the Glenelg Hopkins CMA watering proposal in future years.

The seasonal calendar arises from the six seasons of Gunditjmara country and was produced by Gunditj Mirring Traditional Owners Aboriginal Corporation. The northern part of the river upstream of Harrow area is in Jadawadjali Country and the south west part of the system is in Boandik Country. The calendar reflects seasonal flow conditions recognised by all the Traditional Owner groups.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 4.2.1 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

The timing of the summer fresh is planned to support the annual Jonny Mullagh Cup cricket match between the Gunditj Mirring and Barengi Gadjin Traditional Owners. The fresh will improve water quality in swimming holes and improve amenity for the Traditional Owners attending the cricket event, which is an important cultural event held on the river.



Right: Figure 4.2.2 Seasonal Flows Calendar

Glenelg River Environmental Flow Seasonal Calendar

Reach 1b Harrow

6 seasons of Gunditjmara Country

Flow component and rate

Flow asset and objective

This is the first attempt at incorporating Aboriginal values and knowledge into environmental watering for the Glenelg River. Please note that the information provided is not exhaustive, further work is still required to ensure that all Aboriginal and environmental values are considered appropriately for the Glenelg River.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 4.2.1, Glenelg Hopkins CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing)
- riverside recreation and amenity (such as camping)
- community events and tourism (such as the Johnny Mullagh Cup and visitation)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 4.2.1 with an icon.

	Watering planned to support angling activities
	Watering planned to support water sports activities (e.g. canoeing)
	Watering planned to support peaks in visitation (e.g. camping or other public activities on long weekends or school holidays)

Environmental flow releases support the spawning and recruitment of popular angling species like estuary perch and bream. Local anglers continue to report increased fish activity associated with the delivery of freshes, improving fishing opportunities in the river. Releases support numerous fishing competitions including those of the Balmoral, Casterton and Dartmoor angling clubs.

The planning of the summer fresh improves accessibility, water quality and amenity for canoeists planning trips on the Glenelg River over the summer holiday period.

Summer and spring freshes provide a freshening flow which improves conditions at popular riverside campgrounds in the upper reaches of the Glenelg River including Fulham Reserve near Balmoral and the Johnny Mullagh Reserve at Harrow.

Recent conditions

The Glenelg region had near-average rainfall and above-average temperatures during 2019–20, with large rain events during winter/spring and throughout autumn contributing flows via tributaries below Rocklands Reservoir. Inflows into the Wimmera-Mallee headworks tracked well below average, although milder conditions meant that evaporation losses were lower than normal over summer/autumn. On 1 April 2020, allocations reached 42 percent for the year for the Wimmera-Glenelg environmental entitlement. These allocations supplemented the 28,515 ML of environmental water carried over from 2018–19.

Natural flow in the Glenelg River provided required low flow and freshes during winter/spring 2019. These natural flows meant a proportion of prescribed passing flows could be withheld in winter and released in spring to meet Glenelg River flow objectives. Water for the environment was released from Rocklands Reservoir between November 2019 and May 2020 to maintain low flow and deliver summer/autumn freshes to provide habitat for native fish, platypus and waterbugs, allow fish and platypus to disperse and support instream and streamside vegetation. A trial watering event from Moora Moora Reservoir to the upper Glenelg River (reach 0) was delivered in November and December 2019, to better understand how managed flows could be used to support plant, waterbug and animal populations above Rocklands Reservoir.

All of the high-priority potential watering actions for the Glenelg River below Rocklands Reservoir were met in 2019–20 through natural flows, passing flows, managed environmental flows or a combination of these. Continuous flows were maintained through the whole system, and several freshes were delivered during summer and autumn to flush pools and improve the quality of habitat for native fish and platypus. Different release patterns were trialled from Rocklands Reservoir, 5-Mile Outlet and 12-Mile Outlet during summer/autumn 2019–20 to understand the most efficient way of meeting environmental flow targets.

Low storage levels across the Wimmera-Mallee headworks mean that if dry conditions persist, environmental watering actions in the Glenelg River during 2020–21 will primarily focus on protecting water quality and refuge habitat in reaches 1 and 2, to prevent significant declines in native fish and platypus populations.

Scope of environmental watering

Table 4.2.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow in reach 1a (10 ML/day or natural during December to May)	• 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 wetted stream channel to promote the growth of in-stream vegetation and prevent encroachment by terrestrial plants	
Summer/autumn low flow in reach 1b (15 ML/day or natural during December to May/Big Dry to Early Wet*)		
Summer/autumn low flow in reach 2 (25 ML/day or natural during December to May)		
Summer/autumn low flow in reach 3 (80 ML/day or natural during January to April)		
Summer/autumn freshes in reach 1a (two freshes of 60 ML/day for two to three days during December to May)	• Scour sand from pools to increase the quality and quantity of fish and waterbug habitat • Wet emergent vegetation on the lower banks to improve its condition and prevent the encroachment of terrestrial species • Flush pools to improve water quality and lower temperatures • Provide sufficient flow to allow native fish and platypus to access habitat	
Summer/autumn fresh in reach 1b (two freshes of 100 ML/day for two to three days during December to May/Big Dry to Early Wet*)		
Summer/autumn fresh in reach 2 (two freshes of 150 ML/day for two to three days during December to May)		
Summer/autumn fresh in reach 3 (two freshes of 150 ML/day for three days each or natural during January to April)		

* The six seasons of Gunditjmara country match to reach 1b watering, as Figure 4.2.2 shows.

Table 4.2.1 Potential environmental watering actions and objectives for the Glenelg River *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Winter/spring fresh in reach 1b (one to five freshes of 250 ML/day for one to five days during June to November/Big Wet to Fattening Up*)	• Wet benches to improve the condition of emergent vegetation and maintain habitat diversity • Provide adequate depth for fish passage and cue fish movement • Provide triggers for platypus burrow selection • Scour sand from pools to improve the quality of fish habitat • Wet vegetation in the river channel and on the channel benches to support recruitment and growth	
Winter/spring fresh in reach 2 (one to five freshes of 300 ML/day for one to five days during June to November)		
Winter/spring low flow in reach 1a (60 ML/day or natural during June to November)	• Maintain water quality for fish and waterbugs • Wet aquatic vegetation to maintain its condition and prevent encroachment by terrestrial species • Maintain shallow-water habitat for fish, waterbugs and platypus	
Winter/spring low flow in reach 1b (100 ML/day or natural during June to November/Big Wet to Fattening Up*)		
Winter/spring low flow in reach 2 (160 ML/day or natural during June to November)		
Winter/spring low flow in reach 3 (400 ML/day or natural during July to December)	• Wet benches to increase habitat and allow widespread fish passage and keep the estuary mouth open (based on estuary mouth flows)	

* The six seasons of Gunditjmara country match to reach 1b watering, as Figure 4.2.2 shows.

Scenario planning

Table 4.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The highest priority under all conditions is to provide summer/autumn low flow in reach 1b and reach 2 to maintain connectivity and water quality between pool habitats above Casterton. This is the only flow that is expected to be delivered under the drought scenario.

Increased water availability under dry, average and wet scenarios will allow summer/autumn low flow to be delivered to reach 1a to provide additional swamp habitat and connection for native fish and frogs, and summer/autumn freshes may also be delivered in reaches 1b and 2. These freshes are a high priority as they provide a cue for fish movement, allow native fish and platypus to disperse and wet streamside vegetation.

Under dry and wet conditions, delivering summer/autumn freshes in reaches 1a and reach 3 are a high priority to increase the habitat availability for native fish and platypus to move throughout the river system. Under average and wet conditions, delivering winter/spring low flow in reach 1a is a high priority, to support swamp habitat for native fish and frogs because it receives little natural flow even during wet years.

Delivering winter/spring freshes in reaches 1b and reach 2 is a high priority in the average scenario, to trigger native fish movement and platypus burrow selection in years when breeding is likely. Providing winter/spring low flow in reach 1b under wet conditions will increase habitat for native fish and platypus, which will also help breeding success. The magnitude and/or duration of some freshes may be increased in the average and wet scenarios to extend the benefit of specific events further downstream.

If more water is available, the next priorities under all scenarios will be to deliver summer/autumn low flow through to the end of reach 3. Under the dry and average scenarios, additional priorities will be to provide winter/spring low flow in reach 1b, with summer/autumn freshes through to reach 3 in average conditions only. Delivering winter/spring freshes through to reach 2 under the dry and wet scenarios is a high priority, to support streamside vegetation and provide additional flows to increase access for native fish and platypus to feeding and breeding habitat.

Reserving water for carryover into the 2021–22 water year will be a priority under all scenarios, to ensure sufficient water is available to deliver the highest-priority flows during summer and autumn 2022. The volume carried over against the Wimmera-Glenelg environmental entitlement will be decided in consultation with the Wimmera and the Glenelg Hopkins CMAs during the year, and it will be based on use during 2020–21, seasonal conditions and seasonal outlooks for 2021–22.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Low volumes of passing, compensation and natural flow	• Some passing, compensation and natural flow	• Some passing, compensation and significant natural flow, particularly in winter/spring	• Passing, compensation and natural flow meet some watering requirements in winter/spring
Expected availability of water for the environment[1]	• 19,600 ML	• 36,635 ML	• 50,426 ML	• 60,160 ML
Potential environmental watering – tier 1a (high priorities)[2]	• Summer/autumn low flow reach 1b • Summer/autumn low flow reach 2	• Summer/autumn low flow reach 1a • Summer/autumn low flow reach 1b • Summer/autumn low flow reach 2 • Two summer/autumn freshes reach 1a • Two summer/autumn freshes reach 1b • Two summer/autumn freshes reach 2 • Two summer/autumn freshes reach 3	• Summer/autumn low flow reach 1a • Summer/autumn low flow reach 1b • Summer/autumn low flow reach 2 • Three winter/spring freshes reach 1b • Three winter/spring freshes reach 2 • Two summer/autumn freshes reach 1b • Two summer/autumn freshes reach 2 • Winter/spring low flow reach 1a	• Summer/autumn low flow reach 1a • Summer/autumn low flow reach 1b • Summer/autumn low flow reach 2 • Two summer/autumn freshes reach 1a • Two summer/autumn freshes reach 1b • Two summer/autumn freshes reach 2 • Two summer/autumn freshes reach 3 • Winter/spring low flow reach 1a • Winter/spring low flow reach 1b
Potential environmental watering – tier 1b (high priorities with shortfall)[2]	• Summer/autumn low flow reach 1a • Summer/autumn low flow reach 3 • Two summer/autumn freshes reach 1a • Two summer/autumn freshes reach 1b • Two summer/autumn freshes reach 2 • Two summer/autumn freshes reach 3	• Summer/autumn low flow reach 3 • Two winter/spring freshes reach 1b • Two winter/spring freshes reach 2 • Winter/spring low flow reach 1a • Winter/spring low flow reach 1b	• Summer/autumn low flow reach 3 • Two summer/autumn freshes reach 1a • Two summer/autumn freshes reach 3 • Winter/spring low flow reach 1b	• Five winter/spring freshes 1b • Five winter/spring freshes reach 2 • Summer/autumn low flow reach 3

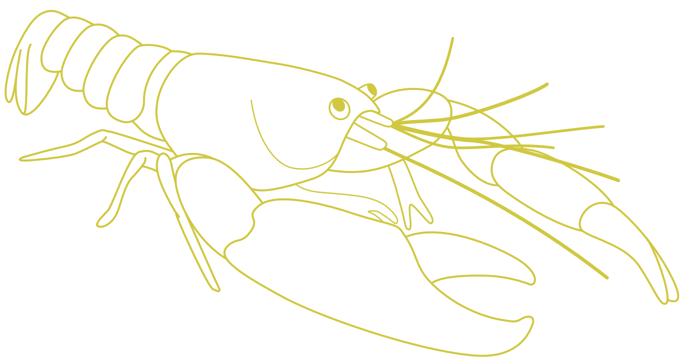
Table 4.2.2 Potential environmental watering for the Glenelg River under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 2 (additional priorities)[2]	• Two winter/spring freshes reach 1b • Two winter/spring freshes reach 2 • Winter/spring low flow reaches 1a • Winter/spring low flow reaches 1b • Winter/spring low flow reaches 2	• Winter/spring low flow reach 2 • Winter/spring low flow reach 3	• Winter/spring low flow reach 2 • Winter/spring low flow reach 3	• Winter/spring low flow reach 2 • Winter/spring low flow reach 3
Possible volume of environmental water required to achieve objectives[3]	• 8,977 ML (tier 1a) • 9,918 ML (tier 1b) • 35,063 ML (tier 2)	• 13,635 ML (tier 1a) • 26,313 ML (tier 1b) • 12,190 ML (tier 2)	• 23,651 ML (tier 1a) • 14,644 ML (tier 1b) • 19,813 ML (tier 2)	• 26,523 ML (tier 1a) • 17,420 ML (tier 1b) • 12,349 ML (tier 2)

[1] Environmental water in the Glenelg and Wimmera systems held by the VEWH is shared between the Wimmera and Glenelg river systems. Additionally, entitlement held by the Commonwealth Environmental Water Holder may become available in the Wimmera system. A prioritisation process will be undertaken with the Wimmera and Glenelg Hopkins catchment management authorities to share available resources during 2020–21.

[2] Potential watering actions are not listed in priority order.

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



4.3 Wimmera system

Waterway manager – Wimmera Catchment Management Authority

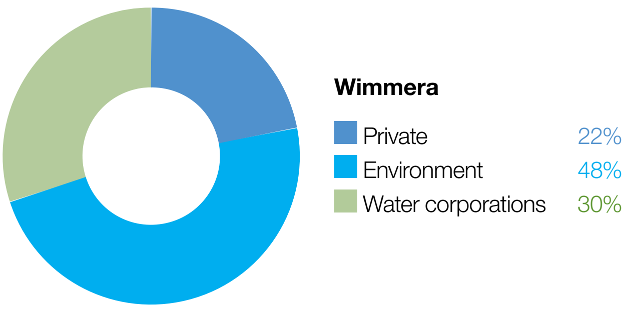
Storage manager – GWMWater

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

Did you know...?

The Wimmera River is known as *Barringgi Gadyin* to the Wotjobaluk Traditional Owners and is a key feature of the local creation stories.

The Wimmera-Mallee headworks system captures run-off from both the Wimmera and Glenelg catchments. Entitlements to water held in this system cannot be accounted for separately in the two river basins, therefore this figure shows the proportion of entitlements across both systems.



Proportion of water entitlements held across the Wimmera and Glenelg basins held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Wimmera River at O'Bree's Crossing, by Greg Fletcher, Wimmera CMA
Above: White neck heron, by Jenny Stephens

System overview

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 freshwater lake and the first of a series of terminal lakes. The Wimmera River receives flows from several regulated tributaries including the MacKenzie River and the Mount William and Burnt creeks. These tributaries, Bungalally Creek and the Wimmera River below Mount William Creek can receive environmental flows. In exceptionally wet periods, Lake Hindmarsh may overflow into Outlet Creek and on to Lake Albacutya, which is an internationally recognised Ramsar-listed wetland. There are numerous wetlands beyond Lake Albacutya as well, which have not filled with water for decades.

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 moved between several storages. Water can also be transferred from Rocklands Reservoir in the Glenelg system to the Wimmera system via the Rocklands-Toolondo Channel and from Moora Moora Reservoir via the Moora Channel. The connected storages and channels are collectively called the Wimmera-Mallee system headworks, and harvested water is 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.

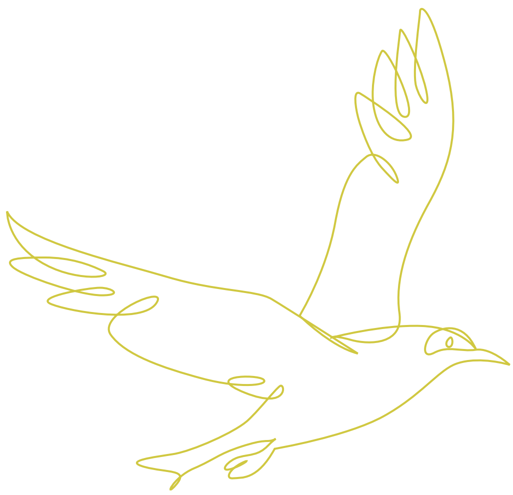
Priority reaches in the Wimmera system that can receive water for the environment are Wimmera River reaches 3 and 4, MacKenzie River reaches 2 and 3, upper and lower Mount William Creek, upper and lower Burnt Creek and Bungalally Creek.

Yarriambiack Creek is a distributary of the upper Wimmera River that would have naturally received some flows during high-flow events. Modifications to the Yarriambiack Creek offtake increase flow rates in Yarriambiack Creek compared to what would have naturally happened, but they reduce the flow rates to the high-priority reaches of the Wimmera River. During very dry years, flows entering Yarriambiack Creek may be blocked to ensure watering objectives in the Wimmera River are not compromised.

Two wetlands in the Wimmera system have been included in the environmental watering program in recent years.

Dock Lake, one of the Wimmera's large terminal lakes near Horsham, would have naturally filled when the nearby Green Lake filled and overflowed, due to high flow in small creeks that flow from the northern edge of the Grampians. In the 1930s, Dock Lake was modified to allow it to be used as a water storage for irrigation supply in the Wimmera-Mallee system. Dock Lake was removed from the supply system after the completion of the Wimmera-Mallee pipeline in 2010. In late 2016, flooding in the catchment partially filled Dock Lake when Green Lake filled and overflowed. Managed water deliveries can now only be delivered through a small channel from Green Lake, when there is enough water in Green Lake to gravity-feed Dock Lake.

Ranch Billabong, near Dimboola, is located on land managed by Barengi Gadjin Land Council Aboriginal Corporation. The billabong system was disconnected from the Wimmera River by changes to a road that traverses land between the river and the billabong. The roadworks and river regulation in the Wimmera River have significantly altered the natural water regime of Ranch Billabong. Restoring habitat for native animal and plant communities at Ranch Billabong is an important outcome for the environment, Traditional Owners and their Nations.



Environmental values

The Wimmera system is home to many plant and animal species. It supports populations of native fish such as flat-headed gudgeon, obscure galaxias, river blackfish, southern pygmy perch and Australian smelt. Populations of the critically endangered Wimmera bottlebrush occur along the MacKenzie River and several other locations near the Grampians.

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

The MacKenzie River contains the only population of platypus in the Wimmera system and supports locally-important populations of native fish including river blackfish and southern pygmy perch. It also supports threatened Glenelg spiny crayfish and western swamp crayfish and turtles. During dry periods, the middle and upper reaches of the MacKenzie River maintain regular flow (due to managed releases from Lake Wartook for urban supplies and environmental watering) and provide refuge for these populations.

Vegetation along Burnt and Bungalally creeks provide habitat corridors for terrestrial wildlife, 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 and southern pygmy perch and rakali (water rats).

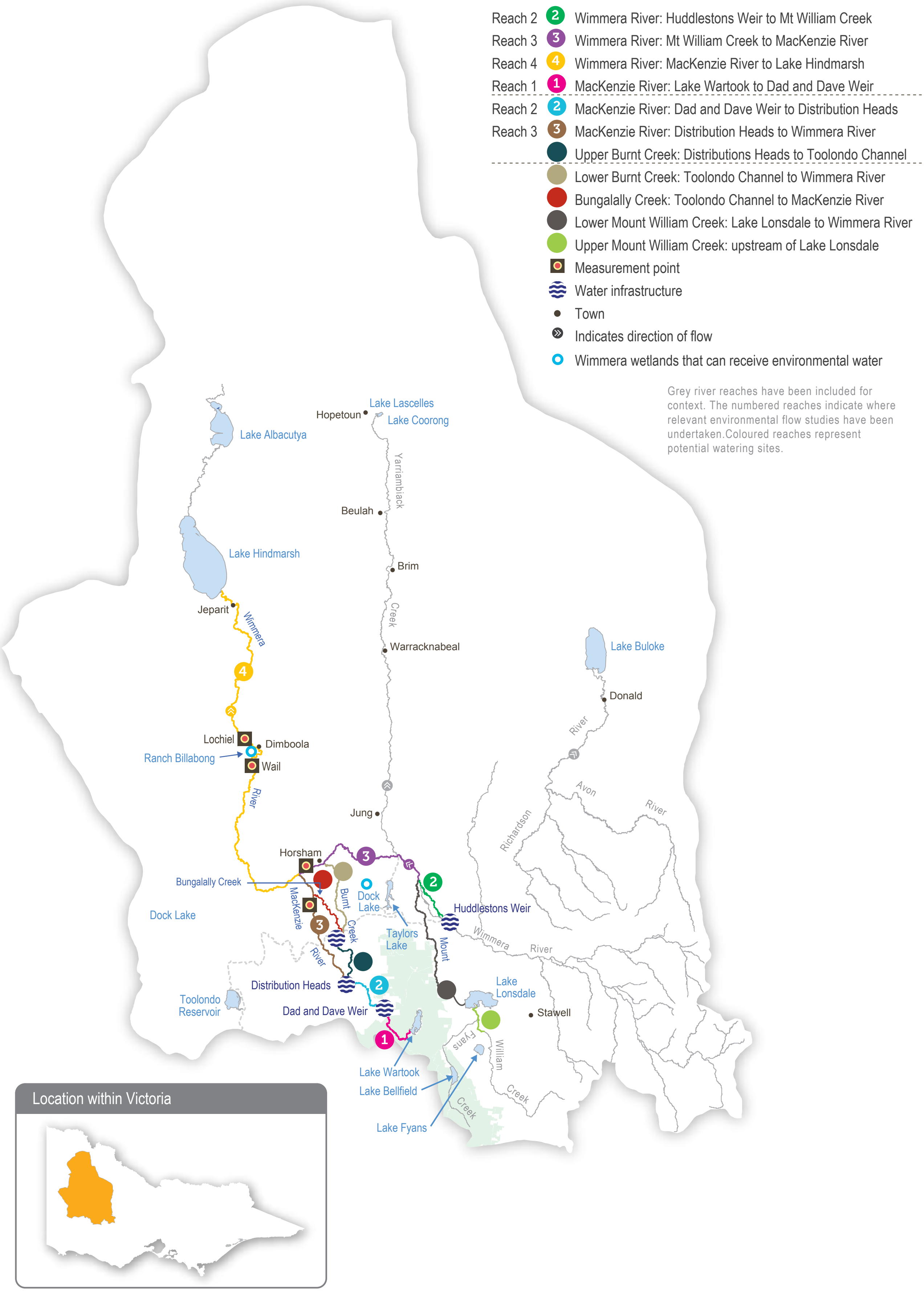
Dock Lake is a natural wetland that was modified and used as part of the Wimmera-Mallee headworks system until 2010. When it is wetted, Dock Lake supports large populations of feeding and breeding waterbirds. It also supports frogs and small-bodied native fish.

Ranch Billabong is a small wetland near Dimboola that supports river red gums, a variety of aquatic plant species, waterbirds and frogs.

Environmental watering objectives in the Wimmera system

Protect and increase populations of native fish including one of Victoria's few self-sustaining populations of freshwater catfish
Maintain the frog population by providing feeding and breeding habitat
Maintain channel capacity and diversity as well as prevent colonisation of waterways by terrestrial plant species
Maintain and increase the resident platypus population by providing places to breed and feed, as well as opportunities for juveniles to disperse
Maintain the turtle population by providing feeding and breeding habitat
Improve the condition, abundance and diversity of aquatic, emergent and streamside vegetation
Increase the waterbird population by providing roosting, feeding and breeding habitat in floodplain wetlands
Increase the abundance and diversity of waterbugs, which break down dead organic matter and support the waterway's food chain Maintain the crayfish population by providing feeding and breeding habitat
Maintain and improve water quality to provide suitable conditions for waterbugs, native fish and other water-dependent plants and animals

Figure 4.3.1 The Wimmera system



Traditional Owner cultural values and uses

The waterways within the Wimmera are important to the Wotjobaluk people and heritage values exist throughout the landscape. Native Title is held along much of the lower Wimmera River, reinforcing the cultural significance of these values. In planning for environmental flows in the Wimmera River, Barengi Gadjin Land Council and Wimmera CMA have considered these values as well as contemporary cultural events such as the Wotjobaluk festival.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 4.3.1 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

In the Wimmera system, Wimmera CMA and Barengi Gadjin Land Council, on behalf of the Wotjobaluk people, work in partnership to provide a variety of Aboriginal environmental outcomes at Ranch Billabong. The delivery of environmental water at Ranch Billabong, aims to return a more natural flooding regime, restore indigenous plant and animal habitats, control selected weed species and improve the site's amenity and suitability for gatherings and events, such as earth oven and bark canoe recreations.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 4.3.1, Wimmera CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing, rowing, water skiing and paddle boating)
- riverside recreation and amenity (such as running and walking)
- community events and tourism (such as fishing competitions at Dimboola, Jeparit and Horsham; Dimboola [rowing] Regatta; Kannamaroo Festival at Horsham, Wimmera River Duck Race; Peter Taylor Memorial Barefoot Water Ski Tournament and Night Jump at Dimboola; and general visitation).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 4.3.1 with an icon.

Watering planned to support angling activities

Watering planned to support water sports activities (e.g. rowing, water skiing)

Water for the environment can be used to temporarily raise water levels in the Horsham and Dimboola weir pools to improve conditions for community events including fishing competitions and water-skiing and rowing events. Following the events, the environmental water is released, to continue to improve ecological objectives downstream.

Recent conditions

The Wimmera region has had below-average rainfall and above-average temperatures for most of the last three years. Near-average rainfall in winter 2019 caused the upper Wimmera River (measured at Glenorchy) to flow for the first time in more than a year, and it contributed notable inflows into the Mount William Creek catchment including Lake Lonsdale. Much of spring and the first months of summer were drier than average, which meant inflows to storages across the Wimmera-Mallee headworks system were well below average for the 2019–20 water year, but the second half of summer and autumn were slightly wetter than average and mild temperatures limited evaporation losses. The Wimmera-Glenelg environmental entitlement received 42 percent allocation in 2019–20. The Commonwealth Environmental Water Holder (CEWH) did not receive any allocation in the Wimmera system for the third year in a row. CEWH water that was allocated in 2016–17 was carried over and used to support environmental outcomes in the Wimmera River and in Mount William Creek in 2018–19 and 2019–20.

Natural flow during winter and early spring 2019 provided low flow and some freshes which met some of the minimum environmental flow requirements in the Wimmera River, MacKenzie River and Burnt Creek. Passing flows from Lake Lonsdale were suspended in winter to conserve water for drier conditions predicted for spring and summer. The accumulated water was used to meet environmental flow requirements in the Wimmera River and in Mount William Creek in spring 2019.

Water for the environment was delivered from mid-October 2019 to June 2020, in line with very dry climate conditions to maintain low flow and small freshes in Wimmera River below Dimboola and to top up Ranch Billabong. Small volumes were also delivered to Mount William Creek, the MacKenzie River and upper Burnt Creek in line with drought conditions due to limited water availability in Lake Lonsdale and Lake Wartook. Environmental watering in summer and autumn 2020 primarily aimed to maintain habitat for native fish, platypus and waterbugs and to protect water quality. Without significant rain in winter and spring 2020, water quality and habitat quality in the Wimmera system will decline and there will be a greater reliance on water for the environment to protect critical refuges. There is less environmental water carried over from 2019–20 compared to the previous three years and under drought, very dry and dry seasonal conditions water availability in 2020–21 will be limited to only meeting the highest-priority demands (tier 1a) in the Wimmera system.

Scope of environmental watering

Table 4.3.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Wimmera River (reaches 2 & 3)		
Winter/spring low flow (100 ML/day during June to November)	• Provide fish passage to allow fish to move through the reach • Maintain soil moisture for streamside vegetation and a near-permanent wetted stream channel for aquatic vegetation • Prevent the growth of terrestrial plants in the stream bed	
Wimmera River (reach 4)		
Summer/autumn low flow (15 ML/day or natural during December to May)	• Maintain edge habitats in deeper pools and in-stream habitat to support native fish populations and waterbugs • Maintain soil moisture for streamside vegetation and near-permanent wetted stream channel for aquatic vegetation and to prevent the growth of terrestrial plants in the stream bed	
Winter/spring low flow (30 ML/day during June to November)	• Maintain access to habitat for native fish, waterbugs and in-stream vegetation	
Summer/autumn fresh (one to five freshes of 70 ML/day for one to four days during December to May)	• Flush pools to prevent decline of water quality and maintain habitat for fish and waterbugs • Provide fish passage to allow fish to move through the reach	
Small winter/spring fresh (one to three freshes of 70 ML/day for one to five days during June to November)	• Increase water depth to provide stimulus for fish movement • Provide flow variability to maintain water quality and diversity of fish habitats	
Large winter/spring fresh (one to three freshes of 200 ML/day for one to three days during June to November)	• Wet lower benches, entrain organic debris and increase habitat availability for waterbugs and fish	
MacKenzie River (reach 2)		
Summer/autumn low flow (two ML/day or natural during December to May)	• Maintain edge habitats and deeper pools and runs for waterbugs, platypus and fish • Maintain soil moisture for streamside vegetation and a near-permanent wetted stream channel for aquatic vegetation • Prevent the growth of terrestrial plants in the stream bed	
Winter/spring low flow (27 ML/day or natural during June to November)	• Facilitate the annual dispersal of juvenile platypus into the Wimmera River	

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

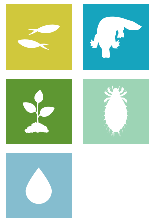
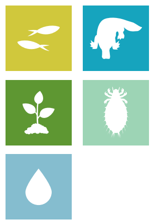
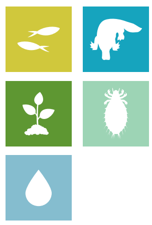
Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn fresh (two to four freshes of five to 50 ML/day for two to seven days during December to May)	• Provide variable flows in the low-flow season for fish movement • Maintain water quality and increase habitat availability for waterbugs and platypus	
Winter/spring fresh (five freshes of 55 ML/day for two to seven days during June to November)	• Stimulate and facilitate fish and platypus movement by increasing flow rates and water depth • Maintain water quality and improve habitat quality for waterbugs • Maintain soil moisture for streamside vegetation and a near-permanent wetted stream channel for aquatic vegetation • Prevent the growth of terrestrial plants in the stream bed	
MacKenzie River (reach 3)		
Year-round low flow (10 ML/day or natural, year-round)	• Maintain edge habitats and deeper pools and runs for waterbugs • Maintain soil moisture for streamside vegetation and a near-permanent wetted stream channel for aquatic vegetation • Prevent the growth of terrestrial plants in the stream bed • Maintain pool habitat for native fish and crayfish populations • Facilitate the dispersal of juvenile platypus into the Wimmera River during autumn/winter	
Summer/autumn freshes (three to four freshes of 35 ML/day for two to seven days each during December to May)	• Provide variable flows in the low-flow season for fish movement • Maintain water quality and increase habitat availability for waterbugs	
Small winter/spring fresh (one to five freshes of 35 ML/day for two to seven days during June to November)	• Stimulate fish movement by increasing flow rates and water depth and increase habitat availability for platypus and waterbugs • Maintain water quality • Maintain soil moisture for streamside vegetation and a near-permanent wetted stream channel for aquatic vegetation	
Large winter/spring fresh (one fresh of 190 ML/day for one to two days during June to November)	• Disturb biofilms present on rocks or woody debris, to stimulate new growth and provide food for waterbugs • Maintain water quality • Maintain soil moisture for streamside vegetation and a near-permanent wetted stream channel for aquatic vegetation • Stimulate fish movement by increasing flow rates and water depth and increase habitat availability for platypus	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Upper Burnt Creek		
Year-round low flow (one ML/day or natural, year-round)	• Maintain edge habitats and shallow-water habitat for waterbugs • Maintain soil moisture for streamside vegetation and near-permanent wetted stream channel for aquatic vegetation and to prevent the growth of terrestrial plants in the stream bed • Maintain a sufficient area of pool habitat for native fish and crayfish populations	
Summer/autumn freshes (three freshes of 30 ML/day for two to seven days during December to May)	• Prevent a decline in water quality by flushing pools in the low flow season • Allow fish to move throughout the reach • Flush sediments from hard substrates to increase biofilm production and food for waterbugs	
Small winter/spring fresh (one to five freshes of 55 ML/day for three to seven days during June to November)	• Allow fish to move throughout the reach • Flush sediments from hard substrates to increase biofilm production and food for waterbugs	
Large winter/spring fresh (one to three freshes of 160 ML/day for one to three days during June to November)	• Disturb biofilms present on rocks or woody debris, to stimulate new growth and provide food for waterbugs • Allow fish to move throughout the reach • Wet streamside vegetation to maintain plant condition and facilitate recruitment	
Lower Burnt Creek		
Bankfull fresh (one fresh of 45 ML/day for two days at any time)	• Wet streamside vegetation to maintain plant condition and facilitate recruitment • Move organic debris in the channel to support waterbugs • Maintain the structural integrity of the channel	
Overbank fresh (one fresh of 90 ML/day for one day during August to November)	• Wet floodplain vegetation to maintain plant condition and facilitate recruitment • Move organic debris from the floodplain to support waterbugs in channel • Maintain the structural integrity of the floodplain	
Bungalally Creek		
Bankfull (one fresh of 60 ML/day for two days at any time)	• Wet the streamside zone to maintain its condition and facilitate the recruitment of streamside vegetation communities • Maintain the structural integrity of the channel and prevent the loss of channel capacity	
Upper Mount William Creek		
Top-up pools (winter/spring and summer/autumn)	• Maintain habitat for native fish and waterbugs • Maintain water quality • Trigger native fish spawning	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Lower Mount William Creek		
Year-round low flow (five ML/day or natural)	• Maintain edge habitats and shallow-water habitat for waterbugs and endemic fish • Maintain soil moisture for streamside vegetation and near-permanent wetted stream channel for aquatic vegetation and to prevent the growth of terrestrial plants in the stream bed	
Summer/autumn freshes (three freshes of 20-30 ML/day for two to seven days during December to May)	• Prevent a decline in water quality by flushing pools during low flow • Provide variable flows and increase habitat availability during the low-flow season for waterbugs and fish	
Winter/spring fresh (one to five freshes of 100 ML/day for one to seven days during June to November)	• Wet benches to entrain organic debris and increase habitat availability for native fish • Flush surface sediments from hard substrates to support waterbugs • Wet the streamside zone to maintain its condition and facilitate the recruitment of streamside vegetation communities	
Dock Lake		
Winter/spring partial fill	• Maintain and improve the diversity and abundance of wetland vegetation • Support feeding and breeding habitat for waterbirds, frogs, waterbugs and turtles	
Ranch Billabong		
Top-ups (winter/spring and summer/autumn)	• Maintain and improve wetland vegetation diversity and abundance • Improve water quality for frogs and waterbirds	

Scenario planning

Table 4.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

If dry conditions continue in the Wimmera system, the type of environmental watering actions that can be delivered to individual reaches will likely be influenced by water availability in the storages directly above each target reach. This is especially true for the MacKenzie River, Burnt Creek and Mount William Creek, which rely on water from Lake Wartook and Lake Lonsdale. Management in the Wimmera system necessitates for periods of cease-to-flow in the rivers and creeks, with additional or longer periods without flow in drier conditions, and planned continuous flows during wetter conditions when there is additional water available through rainfall runoff and allocations made to the environment.

The highest-priority (tier 1a) watering actions are to deliver summer/autumn low flow, summer/autumn freshes, winter/spring low flow in MacKenzie River reaches 2 and 3, upper Burnt Creek, Wimmera River reach 4 and to provide top-ups to Ranch Billabong. These flows aim to improve water quality and provide habitat for native fish, platypus, crayfish and waterbugs.

Under extreme dry, very dry and dry scenarios, flows in tributaries will mostly target reach 2 of the MacKenzie River and upper Burnt Creek to protect habitat for native fish, platypus and instream vegetation. While these flows will not target reach 3 of the MacKenzie River, flows delivered in reach 2 may pass into the upper sections of reach 3 of the MacKenzie River and top up small refuge pools for native fish and waterbugs throughout 2020–21. During winter and spring, flows may be delivered through to reach 3 to support native vegetation and allow some fish and platypus to move between the MacKenzie River and Wimmera River. Small flows are also planned to be delivered to maintain refuge habitats in upper Mount William Creek under dry conditions. Environmental flows will not directly target lower Burnt Creek under dry conditions but flows from upper Burnt Creek will likely pass into the reach. Under drought and very dry conditions, water quality and a lack of water availability in Lake Lonsdale is likely to prevent the targeted delivery of water for the environment to lower Mount William Creek, although it may receive some water en route to the Wimmera River or passing flows if available. Under average or wet scenarios environmental water may be used to deliver bankfull flows to Bungalally Creek and lower Burnt Creek and to partially fill Dock Lake.

If more water is available, the next highest priority — tier 1b watering actions — will be to increase the duration of low flow to reduce the number of cease-to-flows and increase the magnitude and/or frequency of freshes in reach 4 of the Wimmera River, reach 3 of MacKenzie River, upper Burnt Creek and lower Mount William Creek.

Reserving water for carryover into the 2021–22 water year will be a priority under all scenarios, to ensure sufficient water to deliver the highest-priority flows during summer and autumn 2022. The volume carried over against the Wimmera-Glenelg environmental entitlement will be decided in consultation with the Wimmera and Glenelg Hopkins CMAs during the year, and it will be based on use during 2020–21, environmental conditions and seasonal outlooks for 2021–22.

With drier conditions expected in the western region, waterway managers are exploring contingency measures (such as using the Wimmera-Mallee pipeline network) to pipe water for the environment directly into critical refuges sites in some river systems.

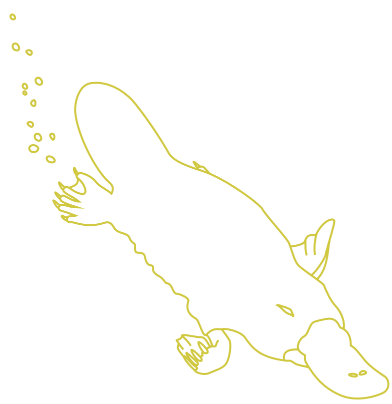


Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios

Planning scenario	Extreme drought	Drought	Dry	Average	Wet
Expected river conditions	• No passing flows or unregulated flows	• Some passing flows and minor contributions from unregulated flows	• Some passing flows and minor contributions from unregulated flows	• Passing and unregulated flows particularly in winter/spring	• Passing flows and unregulated flows year-round
Expected availability of water for the environment[1]	• 19,600 ML	• 23,656 ML	• 36,635 ML	• 50,426 ML	• 60,160 ML
Potential environmental watering – tier 1a (high priorities)					
Wimmera River reach 4	• Summer/ autumn low flow • One summer/ autumn fresh • Winter/spring low flow • One small winter/spring freshes	• Summer/ autumn low flow • Two summer/ autumn freshes • Winter/spring low flow • Two small winter/spring freshes	• Summer/ autumn low flow • Three summer/ autumn freshes • Winter/spring low flow • Two small winter/spring freshes	• Summer/ autumn low flow • Three summer/ autumn freshes • Winter/spring low flow • Three small winter/spring freshes	• Summer/ autumn low flow • Five summer/ autumn freshes • Winter/spring low flow • Three small winter/spring freshes
MacKenzie River reach 2	• Summer/ autumn low flow • Three summer/ autumn freshes • Winter/spring low flow • One winter/ spring fresh	• Summer/ autumn low flow • Three summer/ autumn freshes	• Summer/ autumn low flow • Four summer/ autumn freshes	• N/A	• N/A
MacKenzie River reach 3	• N/A	• Winter/spring low flow • Five small winter/spring fresh	• Winter/spring low flow • Five small winter/spring freshes	• Summer/ autumn low flow • Four summer/ autumn freshes • Winter/spring low flow • Five small winter/spring freshes	• Summer/ autumn low flow • Four summer/ autumn freshes • Winter/spring low flow • Five small winter/spring freshes
Upper Burnt Creek	• Summer/ autumn low flow • Winter/spring low flow	• Summer/ autumn low flow • Winter/spring low flow • Three summer/ autumn freshes • One small winter/spring fresh	• Summer/ autumn low flow • Three summer/ autumn freshes • Winter/spring low flow • Two small winter/spring freshes	• Summer/ autumn low flow • Three summer/ autumn freshes • Winter/spring low flow • Two small winter/spring freshes	• Summer/ autumn low flow • Three summer/ autumn freshes Winter/spring low flow • Three small winter/spring freshes
Lower Burnt Creek	• N/A	• N/A	• N/A	• Bankfull	• Bankfull
Upper Mount William Creek	• Top-ups	• Top-ups	• Top-ups	• N/A	• N/A

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

Planning scenario	Extreme drought	Drought	Dry	Average	Wet
Lower Mount William Creek	• N/A	• N/A	• Three summer/autumn freshes • Summer/autumn low flow • Three winter/spring freshes • Winter/spring low flow	• Three summer/autumn freshes • Summer/autumn low flow • Five winter/spring freshes • Winter/spring low flow	• Three summer/autumn freshes • Summer/autumn low flow • Five winter/spring freshes • Winter/spring low flow
Bungalally Creek	• N/A	• N/A	• N/A	• Bankfull	• Bankfull
Dock Lake	• N/A	• N/A	• N/A	• Partial fill	• Partial fill
Ranch Billabong	• Top-ups	• Top-ups	• Top-ups	• Top-ups	• Top-ups
Potential environmental watering – tier 1b (high priorities with shortfall)					
Wimmera River reach 4	• N/A	• One summer/autumn fresh • Increased duration winter/spring low flow • One large winter/spring freshes	• Increased duration summer/autumn low flow • Two summer/autumn freshes • Increased duration winter/spring low flow • One large winter/spring freshes	• Increased duration summer/autumn low flow • Two summer/autumn freshes • Increased duration winter/spring low flow • Two large winter/spring freshes	• Increased duration winter/spring low flow • Three large winter/spring freshes
MacKenzie River reach 3	• N/A	• Increased duration winter/spring low flow • One large winter/spring freshes	• Increased duration summer/autumn low flow • Three large summer/autumn freshes	• Increased duration summer/autumn low flow • Increased duration winter/spring low flow • One large winter/spring freshes	• Increased duration summer/autumn low flow • Increased duration winter/spring low flow • One large winter/spring freshes
Upper Burnt Creek	• N/A	• Increased duration summer/autumn low flow • Increased duration winter/spring low flow	• Increased duration summer/autumn low flow	• Increased duration summer/autumn low flow • Increased duration and magnitude summer/autumn freshes • Increased duration winter/spring low flow • Large winter/spring freshes	• Increased duration summer/autumn low flow • Increased duration and magnitude summer/autumn freshes • Increased duration winter/spring low flow • Large winter/spring freshes

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

Planning scenario	Extreme drought	Drought	Dry	Average	Wet
Upper Mount William Creek	• N/A	• Top-ups	• N/A	• N/A	• N/A
Lower Mount William Creek	• N/A	• One summer/ autumn fresh • Summer/ autumn low flow • One winter/ spring fresh	• Increased duration and magnitude summer/ autumn freshes • Increased duration summer/ autumn low flow • Two winter/ spring freshes • Increased duration winter/ spring low flow	• Increased duration and magnitude winter/spring freshes Increased duration winter/ spring low flow	• Increased duration and magnitude winter/spring freshes • Increased duration winter/ spring low flow
Potential environmental watering – tier 2 (additional priorities)					
Wimmera River reaches 2 & 3	• N/A	• N/A	• N/A	• Winter/spring low flow	• Winter/spring low flow
Wimmera River reach 4	• N/A	• N/A	• Increased duration summer/ autumn low flow	• Increased duration summer/ autumn low flow • One large winter/spring fresh	• Increased duration summer/ autumn low flow • One large winter/spring fresh
MacKenzie River reach 3	• N/A	• N/A	• Increased duration summer/ autumn low flow • One summer/ autumn fresh	• Increased duration summer/ autumn low flow • Increased duration and magnitude summer/ autumn freshes	• Increased duration summer/ autumn low flow • Increased duration and magnitude summer/ autumn freshes
Lower Mount William Creek	• N/A	• N/A	• Increased duration summer/ autumn low flow	• Increased duration summer/ autumn low flow	• Increased duration summer/ autumn low flow
Possible volume of environmental water required to achieve objectives[2]	• 10,000 ML (tier 1a)	• 11,900 ML (tier 1a) • 6,680 ML (tier 1b)	• 18,300 ML (tier 1a) • 11,810 ML (tier 1b) • 3,135 ML (tier 2)	• 25,215 ML (tier 1a) • 14,890 ML (tier 1b) • 15,670 ML (tier 2)	• 29,445 ML (tier 1a) • 14,265 ML (tier 1b) • 15,635 ML (tier 2)

[1] Environmental water in the Wimmera and Glenelg systems held by the VEWH is shared between the Wimmera and Glenelg river systems. Additionally, entitlement held by CEWH may become available in the Wimmera system. A prioritisation process will be undertaken with the Wimmera and Glenelg Hopkins CMAs to share available resources during 2020–21.

[2] Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.

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

Did you know...?

In 2019, Mallee CMA worked with eager citizen scientists to roll out a bird-monitoring program at some Wimmera-Mallee Pipeline wetlands. The data collected was loaded onto the BirdLife Australia national database, to make it available to a global audience.

Top: Crow Swap, by Michael Gooch
Above: Galah's at Crow Swamp, by Michael Gooch

System overview

The Wimmera-Mallee wetlands include 52 wetlands on public and private land spread across north-west Victoria. Historically, the deeper areas of these wetlands received water most years from the open channels associated with the Wimmera-Mallee Domestic and Stock Channel System.

The Wimmera-Mallee Pipeline Project (WMPP) replaced stock and domestic supply dams with tanks, and the open-channel distribution system with pipelines, to improve water efficiency. A portion of the water savings from the WMPP was converted to an environmental entitlement to improve the condition of the area's flow-stressed rivers, creeks and wetlands; the rest was used to create regional development opportunities and boost the reliability of supply for other users. The WMPP reduced the amount of open-water habitat in areas that were formerly supplied by the open-channel system, so a separate 1,000 ML environmental entitlement was created to water wetlands that were previously supplied through the channel system. There are 52 priority wetlands that can receive water from this environmental entitlement.

Water for the environment can only be delivered to the wetlands when there is sufficient capacity in the Wimmera-Mallee pipeline system, which can be affected by demand from other pipeline customers. The North Central, Mallee and Wimmera CMAs work closely with GWMWater and land managers (including Parks Victoria, the Department of Environment, Land, Water and Planning and private landowners) to take account of pipeline capacity constraints when ordering environmental deliveries to wetlands.

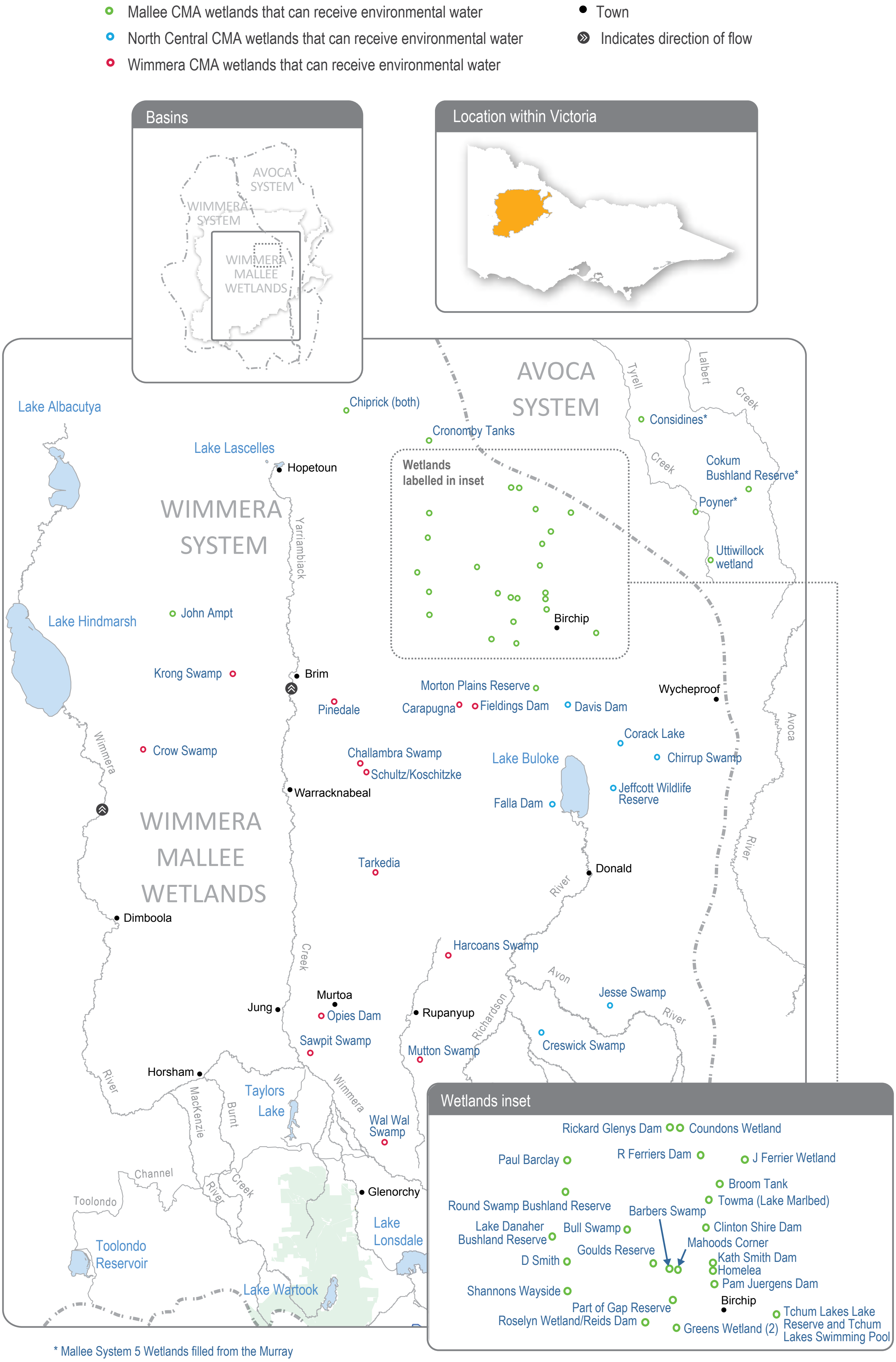
Environmental values

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 provides a range of different wetland habitats for plants and animals across the Wimmera-Mallee region. The wetlands also vary in size and consist of many different vegetation communities, and some are home to native waterbird populations including brolgas, egrets, blue-billed ducks, freckled ducks, Australian painted snipes and glossy ibis. The wetlands are used by the vulnerable growling grass frog, turtles and many other native animals that may use them as drought refuges and drinking holes. Rare and vulnerable vegetation species (such as spiny lignum, ridged water milfoil, chariot wheel and cane grass) are also present in some wetlands.

Environmental watering objectives in the Wimmera-Mallee wetlands

	Maintain and increase the population of frogs
	Maintain and increase the population of turtles
	Provide watering holes for native animals and terrestrial birds across the landscape
	Maintain and improve the condition of aquatic and fringing plants including lignum, river red gum and black box communities Improve the diversity of vegetation communities by providing watering regimes to support plant life cycles in and around the wetlands
	Maintain and increase populations of waterbirds and other native birds by providing resting, feeding and breeding habitat
	Maintain the population of waterbugs

Figure 4.4.1 The Wimmera-Mallee wetlands



* Mallee System 5 Wetlands filled from the Murray

Traditional Owner cultural values and uses

Spanning a broad geographic area, several Wimmera-Mallee wetlands show indications of the long-standing cultural heritage and importance of these sites to the various Traditional Owners of the region, including but not limited to 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 and could benefit from further cultural surveys to better inform environmental water management at those sites.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 4.4.1, the Mallee, North Central and Wimmera CMAs have considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing, kayaking, swimming and yabbying)
- riverside recreation and amenity (such as birdwatching, duck and quail hunting, picnicking and walking)
- community events and tourism (such as citizen science including the monitoring of birds and bats).

Recent conditions

The Wimmera-Mallee region received below-average rainfall and had above-average temperatures throughout 2017–18, 2018–19 and 2019–20. The dry conditions experienced over the last three years have delivered low inflows to storages in the Wimmera-Mallee headworks system, and as a result the Wimmera-Mallee Pipeline wetland environmental entitlement received no allocation in 2019–20. All environmental water deliveries to the wetlands in 2019–20 were supported by water that was carried over from previous years.

Rainfall during winter 2019 provided local run-off that topped up some wetlands, but most wetlands relied on deliveries of environmental water via the Wimmera-Mallee pipeline to provide their required water regime.

Water for the environment was delivered to 30 of the 41 wetlands planned under a dry scenario in 2019–20: 13 wetlands in the Mallee CMA area, 11 in the Wimmera CMA area and six in the North Central CMA area. Deliveries were made in winter/spring 2019 and autumn/winter 2020. Some wetlands received water once during 2019–20, while others received multiple deliveries to maintain their water-dependent values.

Remote, motion-sensor cameras and visual surveys at some wetlands have found that water for the environment delivered to Wimmera-Mallee wetlands provided feeding and breeding habitat for many animals (such as eastern long-necked turtles, frogs, yabbies, brolga, egrets, herons, ducks, grebes, stilts and other water and woodland birds). Many wetlands had vigorous growth of aquatic and semi-aquatic plants including nardoo, water milfoil, water ribbons, lignum and cane grass. The condition of black box trees, chariot wheels (a nationally threatened forb species) and lignum plants near watered wetlands also improved.

Scope of environmental watering

Table 4.4.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
North Central wetlands		
Chirrup Swamp	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbirds and turtles	
Corack Lake	• Provide a permanent water source for refuge and nursery habitat for turtles and frogs • Maintain varying depths of water to support aquatic and fringing plants' life cycles • Maintain varying depths of water to support a variety of feeding habitats for waterbirds	
Creswick Swamp	• Maintain varying depths of water to support the life cycle of aquatic plants including threatened marbled marshwort • Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs and turtles • Maintain water levels to prolong wetting and ensure successful waterbird breeding events, if they start	
Davis Dam	• Wet black box and rare cane grass to allow plants to complete their life cycles and to support juvenile plants • Provide a semi-permanent water source to support refuge and feeding and breeding opportunities for frogs • Provide a permanent water source for refuge and to support feeding and breeding opportunities for waterbirds and terrestrial species	
Falla Dam	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbirds and terrestrial species • Stimulate frog and turtle breeding by providing a deep, permanent water source in spring • Stimulate aquatic and fringing vegetation growth in winter/spring	
Jeffcott Wildlife Reserve	• Maintain a minimum depth of water to support the life cycles of aquatic plants • Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbugs, waterbirds and turtles	
Jesse Swamp	• Maintain varying depths of water to support aquatic and fringing plant life cycles • Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbirds and terrestrial species	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Wimmera wetlands		
Carapugna	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbirds and terrestrial species • Stimulate aquatic and fringing vegetation growth and allow plants including chariot wheels, ridged water milfoil, black box and spiny lignum to complete their life cycles	
Challambra Swamp		
Crow Swamp		
Fieldings Dam		
Harcoans Swamp		
Mutton Swamp		
Opies Dam		
Pinedale		
Sawpit Swamp		
Schultz/Koschitzke		
Tarkedia Dam		
Wal Wal Swamp		
Mallee wetlands		
Barbers Swamp	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for waterbirds and terrestrial species • Stimulate aquatic and fringing vegetation growth and allow the plants including ridged water milfoil, black box and spiny lignum to complete their life cycles	
Morton Plains Reserve		
Tchum Lakes Lake Reserve (North Lake – wetland)		
Tchum Lakes Swimming Pool (North Lake – dam)		
Goulds Reserve		
Lake Danaher Bushland Reserve		
Cokum Bushland Reserve	• Stimulate aquatic and fringing vegetation growth and allow the plants including ridged water milfoil, black box and spiny lignum to complete their life cycles • Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, turtles, waterbirds and terrestrial species	
Part of Gap Reserve		
Rickard Glenys Dam		
Broom Tank	• Stimulate aquatic and fringing vegetation growth and allow the plants including black box and lignum to complete their life cycles • Provide a permanent water source for refuge and to support feeding and breeding opportunities for waterbirds and terrestrial species	
Clinton Shire Dam		
Greens Wetland		
J Ferrier Wetland		
Considines	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs and turtles	
Cronomby Tanks		
Newer Swamp	• Stimulate aquatic and fringing vegetation growth and allow the plants including black box and lignum to complete their life cycles	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Mahoods Corner	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for waterbirds and terrestrial species	
R Ferriers Dam		
Shannons Wayside		
Chiprick		
Coundons Wetland		
D Smith Wetland		
Homelea Wetland		
John Ampt		
Kath Smith Dam		
Pam Juergens Dam		
Paul Barclay		
Poyner		
Roselyn Wetland	• Stimulate aquatic and fringing vegetation growth and allow the plants including black box and lignum to complete their life cycles • Provide a permanent water source for refuge and to support feeding and breeding opportunities for waterbirds, frogs, turtles and terrestrial species	
Uttiwillock Wetland		
Towma (Lake Marlbed)	• Stimulate aquatic and fringing vegetation growth and allow the plants including black box and lignum to complete their life cycles • Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, turtles and terrestrial species	

Scenario planning

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

The potential watering actions in 2020–21 have been determined by considering the environmental values, watering requirements and recent watering histories of the Wimmera-Mallee wetlands, as well as available water supply and ability to deliver water to individual sites. The list of wetlands to be watered under each scenario was determined according to the following principles.

Under drought conditions, the highest priority is to provide permanent water in the deeper sections of the wetlands, to provide drought refuge for waterbirds, frogs, turtles and terrestrial animals across the landscape and to support the growth and lifecycles of wetland plants. Under wetter scenarios, water for the environment may be delivered, depending on capacity in the pipeline system, to water larger areas of the wetland. Large rainfall events and catchment inflows may partially or fully fill some wetlands, and water for the environment may be used to top up, fill or over-top wetlands to improve fringing wetland plant growth and provide additional habitat for waterbirds, frogs and turtles.

Allocations to the environmental entitlement to supply the wetlands in the Wimmera-Mallee wetland system is highly variable, and the ability to carry over unused water from one year to another allows waterway managers and the VEWH to effectively manage the systems in dry periods. The North Central, Mallee and Wimmera CMAs and the VEWH have determined that between 122 and 130 ML should be carried over at the end of 2020–21, to support critical environmental demands in 2021–22.

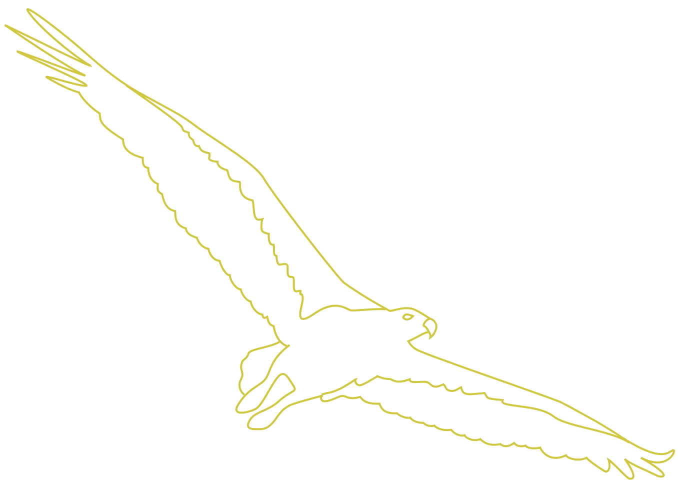


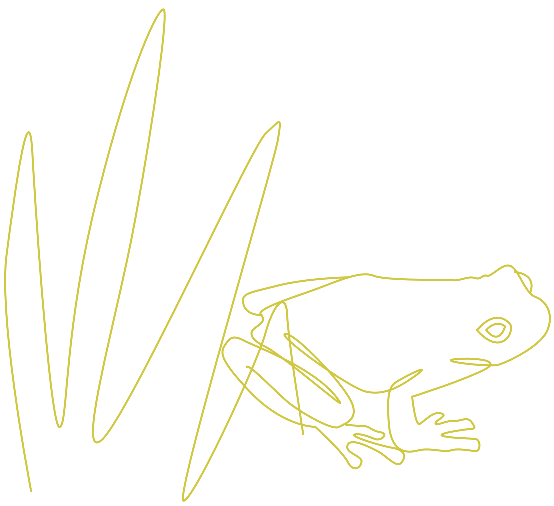
Table 4.4.2 Potential environmental watering for the Wimmera-Mallee wetlands under a range of planning scenarios

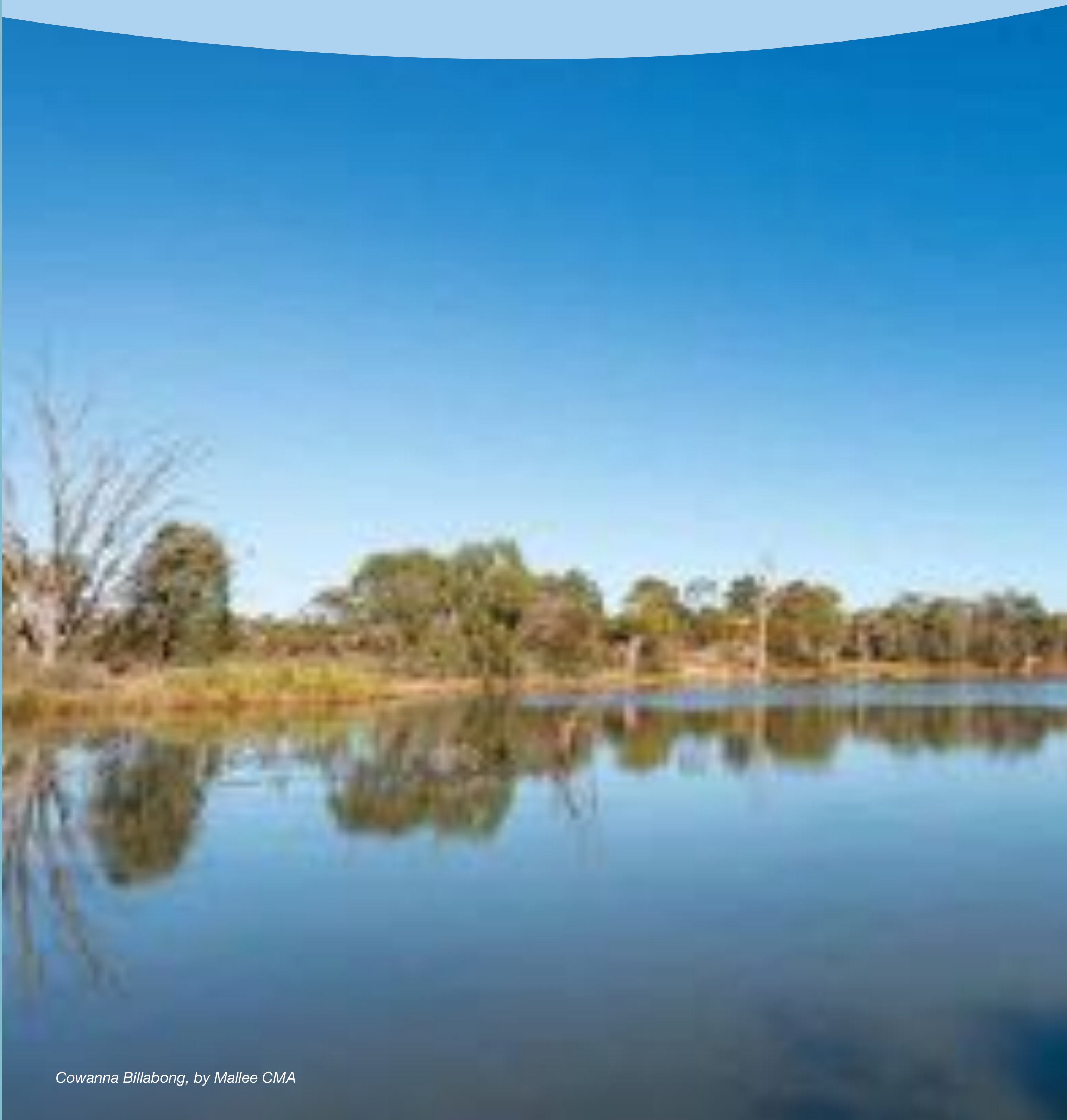
Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No catchment inflows to the wetlands are expected	• No catchment inflows to the wetlands are expected	• Some localised catchment inflows may increase water levels in some wetlands	• Catchment inflows are likely to increase water levels in most wetlands
Expected availability of water for the environment	• 700 ML	• 700 ML	• 900 ML	• 1,700 ML
Potential environmental watering[1]	• Barbers Swamp • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Cokum Bushland Reserve • Considines • Corack Lake • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Paul Barclay • Pinedale • Poyner • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Tarkedia Dam • Uttiwillock Wetland • Wal Wal Swamp	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • Homelea Wetland • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • Kath Smith Dam • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner • R Ferriers Dam	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • Homelea Wetland • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • Kath Smith Dam • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp • Opies Dam • Pam Juergens Dam • Paul Barclay • Part of Gap Reserve • Pinedale • Poyner	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • Homelea Wetland • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • Kath Smith Dam • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp • Opies Dam • Pam Juergens Dam • Paul Barclay • Part of Gap Reserve • Pinedale

[1] Wetlands are listed in alphabetical order rather than order of priority.

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
Potential environmental watering *(continued)*		• Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Tarkedia Dam • Uttiwillock Wetland • Wal Wal Swamp	• R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes (wetland) • Uttiwillock Wetland • Wal Wal Swamp	• Poyner • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes (wetland) • Uttiwillock Wetland • Wal Wal Swamp
Possible volume of environmental water required to achieve objectives	• 162 ML	• 201 ML	• 392 ML	• 543 ML
Priority carryover requirements	• 122 to 130 ML			

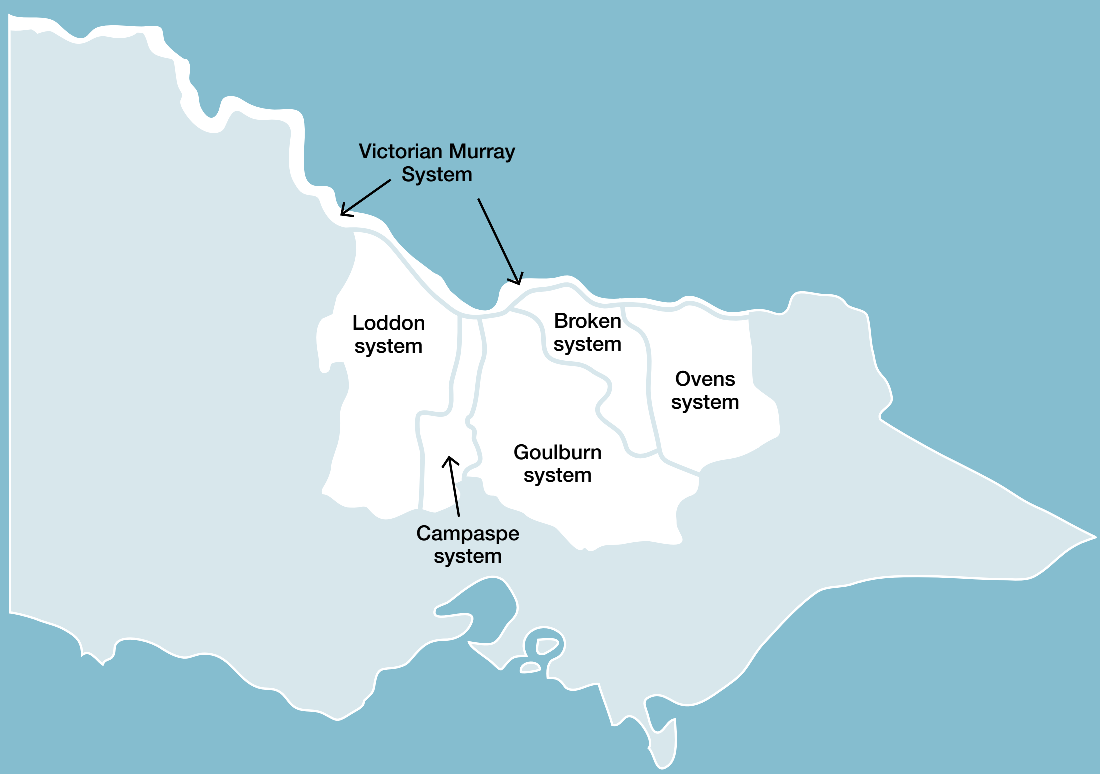




Cowanna Billabong, by Mallee CMA

Section 5

Northern region


Victorian Murray System
Loddon system
Broken system
Ovens system
Goulburn system
Campaspe system

5.1 Northern region overview

The northern region has six river systems, four major floodplain sites and many wetlands that can receive water for the environment. The Broken, Campaspe, Goulburn, Loddon and Ovens river systems are tributaries of the Murray River. The four major floodplain sites along the Murray River corridor are Barmah Forest, Gunbower Forest, Hattah Lakes and Lindsay, Mulcra and Wallpolla islands. The other wetlands are distributed across the Broken, Goulburn, Loddon and Murray floodplains. The rivers and wetlands in the northern region are managed by the North East, Goulburn Broken, North Central and Mallee CMAs.

Many of the water systems in the northern region are connected through infrastructure (such as Goulburn Weir and the Waranga Western Channel), which allows water to be physically delivered from the Goulburn River to the Loddon and Campaspe systems. Water trading also enables transfers of allocation between systems. Within the limitations of each mechanism, water for the environment can be moved between systems for delivery to environmental sites across northern Victoria, although most water for the environment is used to provide benefits in the systems in which the water is held.

Environmental values, recent conditions, environmental watering objectives and planned actions for each system in the northern region are presented in the system sections that follow.

Traditional Owners in the northern region

Traditional Owners in the northern region have a deep connection to the region's rivers, wetlands and floodplains.

The Traditional Owner groups in and around northern Victoria include Barapa Barapa, Dhudhuroa, Latji Latji, Ngintait, Nyeri Nyeri, Taungurung, Tati Tati, Wadi Wadi, Wamba Wemba, Waywurru, Weki Weki, Yorta Yorta and Yaithmathang. The Dja Dja Wurrung Clans Aboriginal Corporation, First People of the Millewa-Mallee Aboriginal Corporation (representing Latji Latji, Nyeri Nyeri, Ngintait and Wergaia), Taungurung Land and Waters Council Aboriginal Corporation and Yorta Yorta Nation Aboriginal Corporation are Registered Aboriginal Parties under the *Aboriginal Heritage Act 2006*.

There are several formal agreements in place with Traditional Owners in the northern region.

In 2013, the Dja Dja Wurrung Clans Aboriginal Corporation entered into a recognition and settlement agreement under the *Traditional Owner Settlement Act 2010* in Victoria. Under the agreement, Dja Dja Wurrung has rights to access and use water for traditional purposes, providing the take of water does not affect other parties.

In 2004, the Victorian Government entered into a cooperative management agreement with the Yorta Yorta to improve collaboration in the management of their Country including Barmah State Forest and reserves along the Goulburn River.

In 2010 the Yorta Yorta Nation Aboriginal Corporation and the State of Victoria entered into a Traditional Owner Land Management Agreement under the *Conservation, Forests and Lands Act 1987* over Barmah National Park. This established the Yorta Yorta Traditional Owner Land Management Board to jointly manage Barmah National Park.

In 2018, the Victorian Government, the Taungurung Clans Aboriginal Corporation and the Taungurung Traditional Owner group signed agreements under the *Traditional Owner Settlement Act 2010* and related legislation.

Engagement

Seasonal watering proposals are informed by community, stakeholder and program partner engagement, as well as longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flow studies and environmental water management plans). Program partners and other stakeholders help to identify environmental watering priorities and opportunities for the coming year. The strategies and technical reports collectively describe a range of environmental, cultural, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence environmental watering actions and priorities.

The International Association for Public Participation's Public Participation Spectrum (IAP2 Spectrum) has been used to categorise the levels of participation of stakeholders involved in the environmental watering planning process. Table 5.1.1 shows the IAP2 Spectrum categories and participation goals.

Table 5.1.1 International Association for Public Participation's Public Participation Spectrum categories and participation goals[1]

IAP2 level	Engagement goal
Inform	Provide balanced and objective information to assist understanding, alternatives, opportunities and/or solutions
Consult	Obtain feedback on analysis, alternatives and/or decisions
Involve	Work directly throughout a process to ensure that concerns and aspirations are consistently understood and considered
Collaborate	Partner in each aspect of the decision including the development of alternatives and the identification of the preferred solution
Empower	Place final decision making in the hands of the stakeholder

[1] The VEWH has the permission of the International Association for Public Participation to reproduce the IAP2 Spectrum.

Table 5.1.2 shows the partners, stakeholder organisations and individuals with which Goulburn Broken, North Central, North East and Mallee CMAs engaged when preparing seasonal watering proposals. This includes engagement conducted as part of developing the seasonal watering proposals as well as engagement during the preparation of key foundational documents that directly informed the proposals. VEWH staff were also consulted for operational information as part of the development of all annual seasonal watering proposals by CMAs.

The table also shows the level of engagement between Goulburn Broken, North Central, North East and Mallee CMAs and stakeholders of the environmental watering program in the northern region based on the CMAs' interpretation of the IAP2 Spectrum. The NSW Department of Planning, Industry and Environment also undertakes engagement in the development of the seasonal watering proposal for Barmah-Millewa in NSW, which is not included in Table 5.1.2.

The level of engagement differs between organisations and between systems, depending on the availability, capacity or interest of stakeholders to participate, roles and responsibilities of organisations in managing a site or system, and potential interaction of proposed watering with other activities on the waterway. For example, Moira Shire Council is one of two land managers for Kinnairds Wetland in the Goulburn and Broken wetlands systems, so Goulburn Broken CMA engages with them at a higher level than it does for other local councils in areas that receive environmental flows but do not have direct responsibilities.

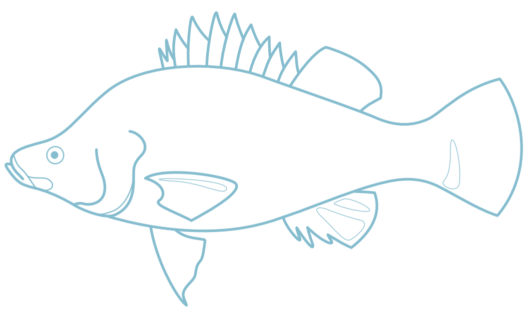


Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken CMA in developing seasonal watering proposals for the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek and lower Broken Creek systems and other key foundation documents that have directly informed the proposals

	Barmah Forest	Goulburn River	Goulburn wetlands and Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
Community groups and environment groups	**IAP2 level: Inform** • Goulburn Murray Landcare Network • Turtles Australia	**IAP2 level: Consult** • Goulburn Valley Environment Group	**IAP2 level: Consult** • BirdLife Australia – Murray Goulburn • Goulburn Murray Landcare Network • Kinnairds Wetland Advisory Committee • Turtles Australia	**IAP2 level: Consult** • Goulburn Valley Environment Group	**IAP2 level: Consult** • Goulburn Valley Environment Group
					IAP2 level: Inform • Broken Boosey Conservation Management Network • Broken Creek Field Naturalists Club • Goulburn Murray Landcare Network
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Parks Victoria • Murray-Darling Basin Authority (the Living Murray program)	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Murray-Darling Basin Authority (the Living Murray program) • Parks Victoria	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning (Land Manger, Environmental Water) • Goulburn-Murray Water (River Operations Planning, Diversions) • Greater Shepparton City Council • Moira Shire Council • Parks Victoria	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Parks Victoria	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Parks Victoria

Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken CMA in developing seasonal watering proposals for the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek and lower Broken Creek systems and other key foundation documents that have directly informed the proposals *(continued)*

	Barmah Forest	Goulburn River	Goulburn wetlands and Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
					IAP2 level: Inform • Moira Shire Council
Landholders/ farmers		**IAP2 level: Consult** • Individual landholders who are on the Goulburn Environmental Water Advisory Group	**IAP2 level: Consult** • Landholders	**IAP2 level: Consult** • Individual landholders who are on the Broken Environmental Water Advisory Group	**IAP2 level: Consult** • Individual landholders who are on the Broken Environmental Water Advisory Group
Local businesses	**IAP2 level: Consult** • Trellys Fishing and Hunting	**IAP2 level: Consult** • Local tourism operator • Trellys Fishing and Hunting	**IAP2 level: Consult** • Trellys Fishing and Hunting		
Recreational users	**IAP2 level: Consult** • Field and Game		**IAP2 level: Consult** • Field and Game		**IAP2 level: Consult** • EWAG members
					IAP2 level: Inform • Nathalia and Numurkah angling clubs
Technical experts		**IAP2 level: Consult** • Scientific leads from the CEWO Monitoring, Evaluation and Research Program – Goulburn River	**IAP2 level: Collaborate** • Goulburn Broken Wetlands Technical Reference Group (Waters Edge Consulting, Rakali Consulting, staff of Arthur Rylah Institute, from the Department of Environment, Land, Water and Planning)		

Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken CMA in developing seasonal watering proposals for the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek and lower Broken Creek systems and other key foundation documents that have directly informed the proposals *(continued)*

	Barmah Forest	Goulburn River	Goulburn wetlands and Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
Traditional Owners	**IAP2 level: Collaborate** • Yorta Yorta Nations Aboriginal Corporation	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land and Waters Council	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council
	IAP2 level: Consult • Taungurung Land & Waters Council				

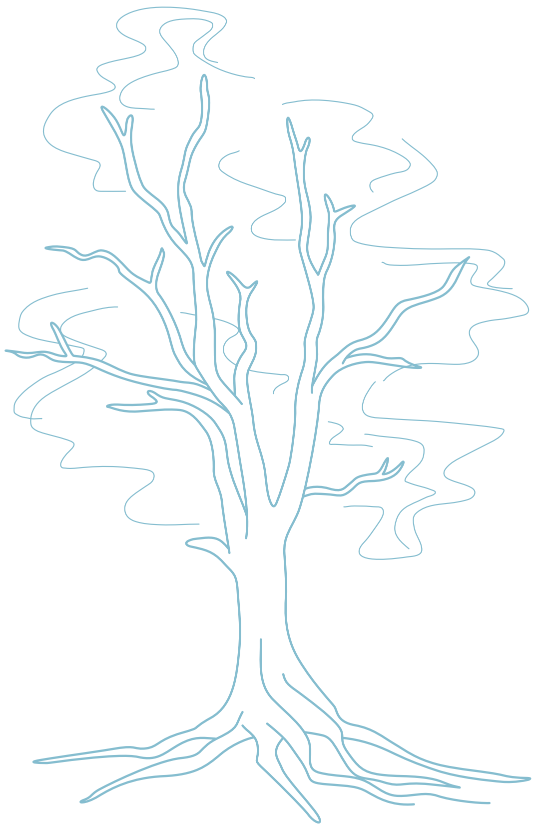
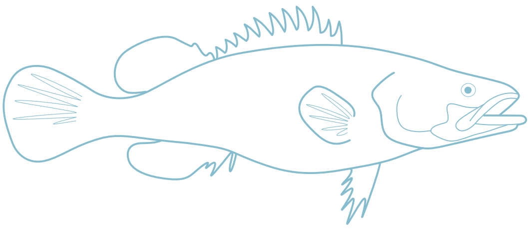


Table 5.1.3 Partners and stakeholders engaged by Mallee CMA in developing seasonal watering proposals for the Hattah Lakes, Lower Murray wetlands, Lindsay, Mulcra and Wallpolla islands systems and other key foundation documents that have directly informed the proposals

	Hattah Lakes	Lower Murray wetlands	Lindsay, Mulcra and Wallpolla islands
Community groups and environment groups	**IAP2 level: Inform** • Local Landcare groups • Mid-Murray Field Naturalists	**IAP2 level: Inform** • Cabarita Inc. • Community members on the Mallee CMA Land and Water Advisory Committee • Local Landcare groups • Mid-Murray Field Naturalists	**IAP2 level: Inform** • OzFish Unlimited • Community members on the Mallee CMA Land and Water Advisory Committee • Local Landcare groups
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Murray-Darling Basin Authority (the Living Murray program) • Parks Victoria **IAP2 level: Consult** • Goulburn-Murray Water	**IAP2 level: Collaborate** • Goulburn-Murray Water • Parks Victoria	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Murray-Darling Basin Authority (the Living Murray program) • NSW Department of Planning Industry and Environment • Parks Victoria • SA Water
	IAP2 level: Inform • Department of Environment Land, Water and Planning (Fire Forest and Regions) • Department of Environment Land, Water and Planning (Water and Catchments) • Mildura Rural City Council	**IAP2 level: Inform** • Department of Environment Land, Water and Planning (Fire Forest and Regions) • Department of Environment Land, Water and Planning (Water and Catchments) • Lower Murray Water • Loddon Mallee Waste and Resource Recovery Group • Mildura Rural City Council • Swan Hill Rural City Council	**IAP2 level: Inform** • Department of Environment Land, Water and Planning (Fire Forest and Regions) • Department of Environment Land, Water and Planning (Water and Catchments) • Lower Murray Water • Mildura Rural City Council • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Inform** • Landholders and farmers who live around the Hattah Lakes	**IAP2 level: Collaborate** • Trust for Nature • Local landowner	**IAP2 level: Consult** • Neighbouring landholder **IAP2 level: Inform** • Lindsay Point irrigators
Local businesses	**IAP2 level: Inform** • Hattah Store owners **IAP2 level: Inform** • Mallee Tours • Murray Offroad Adventures • Mildura Information Centre • Visit Mildura • Wild Side Outdoors • Sunrasia Apiarist Association	**IAP2 level: Inform** • Sunraysia Apiarist Association • Mallee Tours • Murray Offroad Adventures • Visit Mildura • Wildside Outdoors	**IAP2 level: Inform** • Mallee Tours • Murray Offroad Adventures • Wild Side Outdoors • Sunraysia Apiarist Association

Table 5.1.3 Partners and stakeholders engaged by Mallee CMA in developing seasonal watering proposals for the Hattah Lakes, Lower Murray wetlands, Lindsay, Mulcra and Wallpolla islands systems and other key foundation documents that have directly informed the proposals *(continued)*

	Hattah Lakes	Lower Murray wetlands	Lindsay, Mulcra and Wallpolla islands
Recreational users	**IAP2 level: Inform** • Birdlife Mildura • Sunraysia Bushwalkers • Four-wheel drive club	**IAP2 level: Inform** • Birdlife Mildura • Four-wheel drive club • Mildura Information Centre • Sunraysia Bushwalkers	**IAP2 level: Inform** • Birdlife Mildura • Sunraysia Bushwalkers • Sunraysia 4WD Club **IAP2 level: Inform** • Mildura Information Centre • Visit Mildura
Technical experts	**IAP2 level: Collaborate** • Mallee CMA Land and Water Advisory Committee	**IAP2 level: Collaborate** • Mallee CMA Land and Water Advisory Committee • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Collaborate** • Mallee CMA Land and Water Advisory Committee
Traditional Owners	**IAP2 level:** • CollaborateTraditional Owners of Hattah Lake (Aboriginal Victorians from Wadi Wadi, Tati Tati, Latje Latje and Munutunga)	**IAP2 level: Collaborate** • Robinvale Elders and communties • First People of the Millewa-Mallee Aboriginal Corporation	**IAP2 level: Collaborate** • Traditional owners of Lindsay-Mulcra-Wallpolla • First People of the Millewa-Mallee Aboriginal Corporation



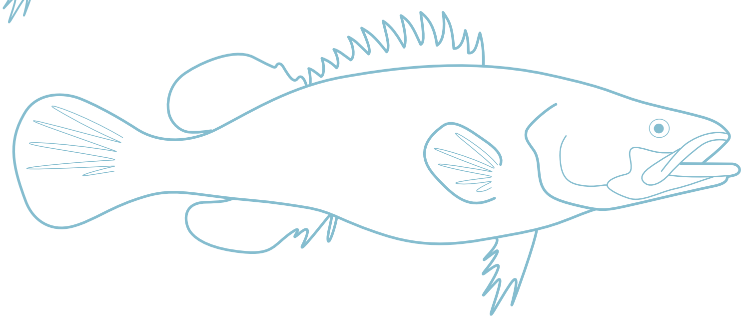


Table 5.1.4 Partners and stakeholders engaged by North Central CMA in developing seasonal watering proposals for the Gunbower Creek and Forest, Central Murray wetlands and Boort wetlands, Campaspe River, Coliban River, Loddon River, Birchs Creek and Guttrum Forest systems and other key foundation documents that have directly informed the proposals

	Gunbower Creek and Forest	Central Murray wetlands and Boort wetlands	Campaspe River	Coliban River	Loddon River	Birchs Creek	Guttrum Forest
Community groups and environment groups	**IAP2 level: Consult** • Gunbower Island Community Reference Group	**IAP2 level: Inform** • Birdlife Australia • BirdLife Australia	**IAP2 level: Inform** • Echuca Moama Landcare Group • Strathallan Family Landcare Group				
Government agencies	**IAP2 level: Collaborate** • Common-wealth Environmental Water Office • Department of Environ-ment, Land, Water and Planning • Goulburn-Murray Water • Murray-Darling Basin Authority (the Living Murray program and River Operations) • Forestry Corporation of NSW • Parks Victoria • Vic Forests	**IAP2 level: Collaborate** • Common-wealth Environmental Water Office • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Parks Victoria	**IAP2 level: Collaborate:** • Common-wealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Coliban Water • Common-wealth Environmental Water Office	**IAP2 level: Collaborate** • Common-wealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Goulburn-Murray Water	**IAP2 level: Collaborate** • Common-wealth Environmental Water Office • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Murray-Darling Basin Authority • Forestry Corporation of NSW • Parks Victoria • Vic Forests

Table 5.1.4 Partners and stakeholders engaged by North Central CMA in developing seasonal watering proposals for the Gunbower Creek and Forest, Central Murray wetlands and Boort wetlands, Campaspe River, Coliban River, Loddon River, Birchs Creek and Guttrum Forest systems and other key foundation documents that have directly informed the proposals *(continued)*

	Gunbower Creek and Forest	Central Murray wetlands and Boort wetlands	Campaspe River	Coliban River	Loddon River	Birchs Creek	Guttrum Forest
Government agencies *(continued)*	**IAP2 level: Inform** • Gannawarra Shire Council • Campaspe Shire Council	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager) • Gannawarra Shire Council • Campaspe Shire Council • Swan Hill Rural City Council • Loddon Shire Council	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager) • Game Management Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager) • Game Management Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager)	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager)	
Landholders/ farmers	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Inform** • Individual landholders and community members	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Inform** • Individual Landholders and community members	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Inform** • Individual landholders
Local businesses	**IAP2 level: Inform** • Forestry					**IAP2 level: Inform** • Central Highlands Water	**IAP2 level: Inform** • Forestry
Recreational users	**IAP2 level: Inform** • Field and Game Australia • Gateway to Gannawarra Visitor centre	**IAP2 level: Inform** • Field and Game Australia • Gateway to Gannawarra Visitor centre	**IAP2 level: Inform** • VRFish • Local Canoe Clubs	**IAP2 level: Inform** • VRFish	**IAP2 level: Consult** • VRFish • Field and Game Australia		
Technical experts	**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists	**IAP2 level: Consult** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Contracted ecologists	**IAP2 level: Collaborate** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)				**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists

Table 5.1.4 Partners and stakeholders engaged by North Central CMA in developing seasonal watering proposals for the Gunbower Creek and Forest, Central Murray wetlands and Boort wetlands, Campaspe River, Coliban River, Loddon River, Birchs Creek and Guttrum Forest systems and other key foundation documents that have directly informed the proposals *(continued)*

	Gunbower Creek and Forest	Central Murray wetlands and Boort wetlands	Campaspe River	Coliban River	Loddon River	Birchs Creek	Guttrum Forest
Traditional Owners	**IAP2 level: Collaborate** • Yorta Yorta Nation Aboriginal Corporation • Barapa Barapa Traditional Owners	**IAP2 level: Collaborate** • Dja Dja Wurrung Clans Aboriginal Corporation • Yorta Yorta Nation Aboriginal Corporation • Barapa Barapa Traditional Owners • Wemba Wemba Traditional Owners	**IAP2 level: Collaborate** • Dja Dja Wurrung Clans Aboriginal Corporation • Taungurung Land & Waters Council • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Dja Dja Wurrung Clans Aboriginal Corporation	**IAP2 level: Collaborate** • Dja Dja Wurrung Clans Aboriginal Corporation • Barapa Barapa Traditional Owners • Wemba Wemba Traditional Owners		**IAP2 level: Collaborate** • Barapa Barapa Traditional Owners • Wamba Wemba Traditional Owners

Table 5.1.5 Partners and stakeholders engaged by North East CMA in developing the seasonal watering proposal for the Ovens system and other key foundation documents that have directly informed the proposal

	Ovens system
Community groups and environment groups	**IAP2 level: Collaborate** • Wangaratta Landcare and Sustainability Incorporated
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water
	IAP2 level: Involve • City of Wangaratta • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Collaborate** • Catholic Education Department – Sandhurst Diocese
Technical experts	**IAP2 level: Involve** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Involve** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council

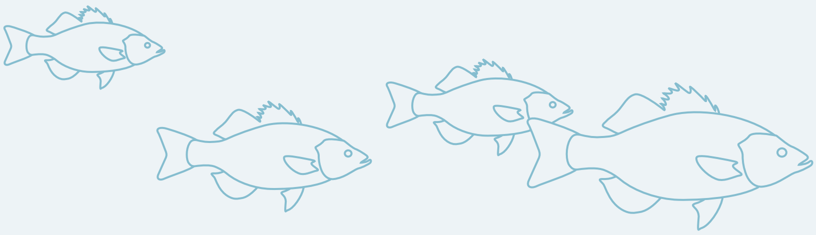
Community benefits from environmental watering

Healthy rivers and wetlands support vibrant and healthy communities. By improving the health of rivers, wetlands and floodplains, environmental flows also provide benefits to communities.

The VEWH and its program partners consider Aboriginal cultural and social and recreational values and uses of waterways when planning for environmental watering activities. Through engagement with community representatives, waterway managers aim to determine where community benefits from environmental flows can align with environmental priorities for the year ahead.

Healthy waterways provide community benefits (such as providing nice places to walk, picnic or fish recreationally, and sustaining healthy Country for Aboriginal communities). Community benefits can sometimes be enhanced by modifying environmental flows (such as timing a flow to support a community rowing or fishing event), provided the environmental objective is not compromised.

The VEWH and its partners seek to deliver these benefits throughout the water year, though the opportunities can depend on the weather, climate or environmental conditions, water availability and the way the system is being operated to deliver water for other purposes.



How have Traditional Owners' values and uses of waterways been considered?

In recognition of the cultural importance of water, caring for Country and their long standing traditional ecological knowledge, Traditional Owners are increasingly working with waterway managers to plan for and deliver environmental flows. Examples in the northern region include:

- supporting the Barapa Barapa Wamba Wemba Water for Country project, where Barapa Barapa people, Wamba Wemba people and North Central CMA work together to involve Traditional Owners in the planning, monitoring and reporting of watering in Guttrum Forest, Gunbower Forest and Gunbower Creek
- supporting restoration of significant floodplain sites with the First People of the Millewa-Mallee and other Traditional Owner groups across the lower Murray region
- supporting Taungurung Traditional Owners to achieve ecological goals as part of healing Country, including potentially using Taungurung water entitlements to deliver environmental flows in the King River
- ongoing work by Yorta Yorta Traditional Owners and Goulburn Broken CMA to incorporate Yorta Yorta values into environmental water planning in Barmah Forest and other sites across Yorta Yorta Country.

Where participation of Traditional Owners in the planning and delivery of water for the environment has explicitly identified particular flows supporting cultural outcomes, these are identified in the system sections.

Traditional Owners' cultural values and uses are also increasingly considered as part of Murray-Darling Basin Plan annual environmental water planning and management. The Murray Lower Darling Rivers Indigenous Nations have been working on the First Nations Environmental Water Guidance Project to support Nations to identify objectives, priorities and issues related to environmental watering and support increased participation in environmental water planning and management. The project was undertaken with support from Murray Darling Basin Authority and the Commonwealth Environmental Water Office.

A statement prepared by the Murray Lower Darling Rivers Indigenous Nations summarising the participating Nations' priorities for environmental watering in the southern Murray Darling Basin in 2020–21 is provided on page 190. This work has informed development of annual environmental water priorities at the Basin-scale and will support decision making as the year progresses.

The VEWH and its program partners will look for opportunities to continue strengthening the partnerships with and participation of Traditional Owners in environmental water planning and management in Victoria in ways that can support their objectives, cultural values and connection to Country. Through its role in the Southern Connected Basin Environmental Watering Committee, the VEWH will also support the environmental watering priorities and aspirations of Nations in the broader southern Murray-Darling Basin.

Southern Basin First Nations Environmental Watering Priorities Statement 2020-21

Representatives of sixteen First Nations across the Southern Murray Darling Basin have made information about their priorities for the use of environmental water in 2020–21 available, as part of the First Nations Environmental Water Guidance project.

First Nations share common concern for all major rivers across the region. Notably, multiple Nations submitted priorities relating to the Murrumbidgee, Baaka (Darling River), Lachlan, Campaspe, Murray and Edwards-Wakool systems. First Nations understand that declining river health and low-flows in one part of the Basin can affect communities and cultural outcomes across the region.

Nations want to see improvements in water quality and the volume and timing of flows in all major rivers, and particularly in degraded river systems. Improved seasonality of flows, informed by First Nations' science and traditional knowledge, is a key to sustaining the cultural health of major waterways. Addressing barriers and constraints, such as barriers to fish movement, is essential to sustain the interconnectivity, which underpins our stories and cultural values. Improving the health of tributary waterways and ensuring adequate flows, is also a key to revitalising major rivers. Nations recognise that Basin Plan targets for environmental water recovery are inadequate to support revival of the ecological and cultural health of our waterways. More must be done to restore the balance.

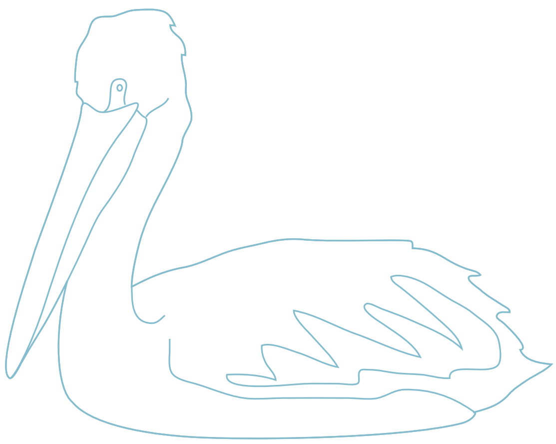
Participating Nations' contributions stressed the significance of wetlands, billabongs and floodplains. Nations want to see life return to these culturally significant places through watering activities that create connectivity between rivers and floodplains and restore the hydrological cycles of degraded wetlands, thereby supporting cultural values and resources.

Participating Nations identified key plant and animal species that are most in need of watering in the 2020–21 watering year. These species are all of totemic significance to diverse clans and Nations. Key culturally significant fish such as Murray cod, golden perch (yellowbelly) and catfish were identified as priorities by most Nations. More than half of all contributing Nations highlighted black swans, pelicans and duck species as culturally significant waterbirds that would benefit from environmental watering. Improved health and abundance of old man weed and other medicinal plants were noted as priorities for vegetation, alongside improved outcomes for river red gums, black box, cumbungi and lignum.

Critically, Nations stressed the importance of considering outcomes beyond fish, waterbirds and vegetation. Nations also want to see improved outcomes for aquatic fauna such as turtles, yabbies, mussels, frogs, platypus and rakali (water rat). The contributions also stressed the importance of environmental watering in sustaining healthy populations of important terrestrial fauna such as kangaroo and emu.

Participating Nations have identified a range of key threats to the cultural health of waterways as well as preferences for improved participation in environmental water planning for 2020–21. Water holders should consider these preferences alongside the detailed, locally specific watering objectives produced by Nations. It is essential that water Holders continue, and strengthen, direct engagement with First Nations to empower our participation in environmental water planning and delivery.

Murray Lower Darling Rivers Indigenous Nations
First Nations Environmental Water Guidance Project



How have economic, recreational and social values and uses of waterways been considered?

Environmental outcomes provide direct economic, recreational, social benefits to communities. Waterway managers, in consultation with communities, have identified numerous opportunities to support community benefits including activities tourism, fishing, birdwatching, boating and hunting activities. Examples of these opportunities in the northern region include:

- supporting populations of native fish species for recreational fishing including 120,000 juvenile golden perch and silver perch that were released into Walpolla Horseshoe Lagoon by the Victorian Fisheries Authority in March 2020. Watering planned for the lagoon will support the rapid growth and survival of juvenile fish
- providing habitat for native fish including Murray cod, golden perch and freshwater catfish in the waterways around Lindsay Island. The island is popular with recreational anglers, with local anglers nominating Mullaroo Creek as the number-one location for fishing in their area
- enhancing opportunities for recreational anglers along the Loddon, Campaspe and Goulburn rivers by using environmental flows to trigger the migration of recreational fishing species into these waterways
- providing nesting material for vulnerable brolga in Gaynor Swamp by increasing the growth of aquatic plants. The presence of brolga attracts birdwatchers from around the region, the state and Australia
- notifying canoers and kayakers of upcoming environmental flows on the Campaspe River, enabling them to schedule trips to popular sites (such as Rocky Crossing).

Summaries of the social, recreational and economic values considered are provided for each system. Where the timing or management of planned environmental flows may be modified to align with a community benefit, this is identified alongside the potential watering actions.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental flows need to be part of an integrated approach to catchment management. Many of the environmental objectives for water for the environment in the northern region will not be fully met without simultaneously addressing issues such as barriers to fish movement, high nutrient loads, loss of stream bank vegetation and invasive species.

Victorian and Australian government agencies, Traditional Owners, community groups and private landowners collectively implement a wide range of programs that aim to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments.

Examples of complementary programs that are likely to support environmental watering outcomes in the northern region include:

- the release of a strategic action plan for the protection of floodplain marshes in Barmah Forest, which identifies management actions addressing key threats to the delicate floodplain vegetation including removal of feral horses and other invasive animals and control of invasive plants. Parks Victoria and the Yorta Yorta Nations jointly manage Barmah National Park
- construction of fishways enabling fish passage through the Koondrook and Cohuna weirs in Gunbower Creek is planned for winter 2021. The fishways will provide migration opportunities for fish species (such as the iconic Murray cod)
- private land managers undertake vegetation management and carp removal actions at Mullinmur wetland on the Ovens River at Wangaratta. The rehabilitation works have enabled stocking of native catfish brood stock into the wetland, which will support future re-stocking efforts in the region
- manual removal of river red gum seedlings that are encroaching into open wetlands in Guttrum Forest to maintain areas of open-water habitat, which supports aquatic and mudflat plants and in turn provides habitat for a range of waterbird species.

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

Risk management

During the development of the seasonal watering proposals for the northern region systems, environmental watering program partners held a workshop to assess risks associated with potential environmental watering actions for 2020–21 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

What is the Basin Plan 2012?

Northern Victoria is a part of the Murray-Darling Basin and deliveries of water for the environment in the northern region are subject to the requirements of the Basin Plan 2012, also known as the Murray-Darling Basin Plan or just the Basin Plan. The Murray-Darling Basin Authority (MDBA) developed the Basin Plan under the *Commonwealth Water Act 2007* and it became law in November 2012. The Basin 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 Basin Plan 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 Basin 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 Basin Plan 2012.

What is River Murray Increased Flows (RMIF)?

River Murray Increased Flows (RMIF) is water for the environment that has been recovered as part of the Snowy Water Initiative, established in 2002 to address environmental impacts associated with the operation of the Snowy Mountains Scheme. RMIF is stored in Snowy Hydro Limited's storages and released to maintain and improve environmental values in the Murray River. RMIF becomes available when:

- Snowy Hydro Limited release more than their nominated annual release volume, as part of their power generation operations and/or
- environmental water managers request additional RMIF be made available when volumes in Murray River storages exceed specified limits.

The call for and use of RMIF are coordinated by the Southern Connected Basin Environmental Watering Committee, and they must be authorised by the VEWH and NSW Department of Primary Industry and Environment.

Northern Victoria and the southern Murray-Darling Basin

Rivers, creeks and floodplains in northern Victoria form part of the southern-connected Murray-Darling Basin. Water flows directly from the Victorian rivers and floodplains into the Murray River, which means that environmental flows delivered in northern Victorian systems can achieve ecological objectives at multiple sites throughout the Murray-Darling Basin. For example, water for the environment delivered in the Goulburn River flows into the Murray River and can be managed to ensure it flows all the way to the Lower Lakes and Coorong in South Australia (SA), providing environmental outcomes at Gunbower Forest, Hattah Lakes, Lindsay Island and the Chowilla floodplain along the way.

The *Basin Plan 2012 and the Basin-wide environmental watering strategy* (second edition, 2019) guide the long-term planning of water for the environment in the Murray-Darling Basin. Under the Basin Plan, environmental objectives are met by achieving outcomes for connectivity, native vegetation, waterbirds and native fish.

Objectives and outcomes under the Basin Plan reflect local site- and state-based objectives, though site-based objectives are often broader in scope and cover additional values (such as frogs, turtle, waterbugs and physical processes like sediment movement). Watering actions that support Basin Plan outcomes have significant benefits for many other species that rely on the surrounding landscape (such as squirrel gliders living along the lower Campaspe River or flocks of regent parrots moving into the Hattah Lakes floodplain after watering).

The VEWH coordinates its activities with other environmental water holders in northern Victoria, NSW and SA to achieve environmental outcomes at the southern-connected Murray-Darling Basin scale. Collaborative planning focuses on how upstream and downstream objectives align and how the broader operation of the Murray River system can help support environmental outcomes.

Environmental water holders are also increasingly considering the objectives and cultural values of First Nations in the Murray-Darling Basin in alignment with environmental water objectives, outcomes and priorities (for further information see 'How are Traditional Owners' values and uses considered?' on pages 189 and 190). It is recognised that the health of the Murray-Darling Basin benefits from meaningful partnerships with Traditional Owners and their involvement in water planning, coordination and delivery from the local to the basin scale is a priority for environmental water holders.

Annual planning is documented in basin annual environmental watering priorities (by the MDBA under the Basin Plan), in annual portfolio management plans (by the Commonwealth Environmental Water Office), and in the VEWH's annual seasonal watering plan (this document). In Victoria, all water for the environment must be delivered in line with the VEWH's seasonal watering plan, meaning coordination during annual planning is fundamental to successful basin-scale outcomes.

Environmental water holders in the Murray-Darling Basin are placing an increased emphasis on coordinating water deliveries to achieve landscape-scale environmental outcomes. Examples include:

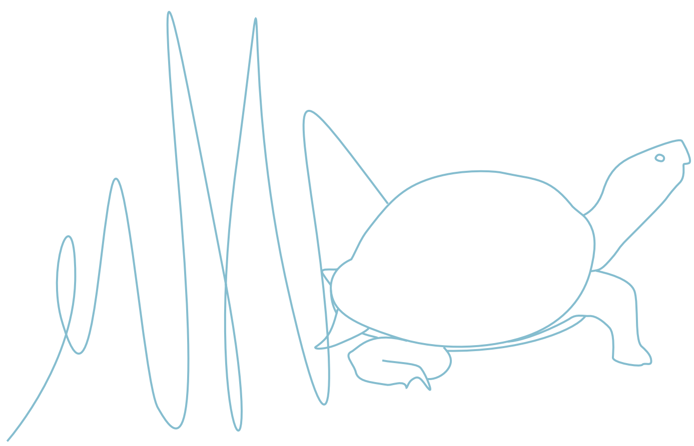
- delivering a winter fresh in the Goulburn River, which subsequently passed through to the Lower Lakes in SA and through the barrages to the Coorong to trigger upstream migration of fish (such as lamprey)
- efficient water use meant that all of the 12,700 ML delivered to Lake Kramen in the Hattah Lakes complex in 2019–20 were return flows from environmental watering actions in the Goulburn River. The same parcel of environmental water helped to meet environmental watering actions in the Goulburn River, Murray River and Lake Kramen. Moreover, the co-ordinated watering actions meant that carbon, nutrients, native plant seeds and native fish eggs and larvae were directly transported from upstream to downstream sites and from the river channel to the floodplain.

The VEWH holds Victorian environmental entitlements for water recovered under interstate projects and agreements — Living Murray and RMIF entitlements — and these require coordinated decision-making about where they are used. The primary objective of Living Murray entitlements is to support Murray icon sites, which include the Barmah Forest, Gunbower Forest, Hattah Lakes and the Lindsay–Mulcra–Wallpolla islands in Victoria. RMIF also support environmental objectives along the Murray system in Victoria, NSW and SA. Recommendations for the coordinated use of Living Murray allocation and RMIF are made by the Southern Connected Basin Environmental Watering Committee.

The VEWH partners with the Commonwealth Environmental Water Office to optimise the benefits of water for the environment held by the Commonwealth Environmental Water Holder (CEWH) and delivered in Victoria. Delivery of the Living Murray's and Commonwealth's environmental Water Holdings, to meet Victorian environmental watering objectives, is included in relevant system sections in the following pages of this document.

Water for the environment delivered through northern Victorian waterways can often be reused to achieve further environmental benefits downstream. If return flows are not reused at Victorian environmental sites, VEWH, Living Murray and CEWH return flows continue to flow across the border to SA where they will be used to provide environmental benefits along the Murray River and in the Coorong, Lower Lakes and Murray Mouth area.

The VEWH may order, or authorise waterway managers to order, Living Murray and Commonwealth environmental water for environmental outcomes at downstream (non-Victorian) sites. The VEWH may also order water for delivery in the Murray system to non-Victorian sites under river operating rules that help improve environmental outcomes while maintaining the reliability of entitlements for all water users. In previous years, this has included deliveries to the Murray from the lower Darling, orders for delivery from Lake Victoria and orders for delivery to the Murray River.



Seasonal outlook 2020–21

Rainfall across the northern region in 2019–20 was below the long-term average for the third consecutive year, and total annual rainfall in parts of the Mallee was among the lowest on record. Despite the overall dry conditions, there were some wetter months. Rain in July and August 2019 produced small natural flow events in the Ovens River, which flowed into the Murray above Barmah Forest, and in the Loddon River. Rainfall in April and May 2020 caused minor flooding in the Ovens, Kiewa and Broken catchments. Spring and early summer were dry and water for the environment was used to deliver the required water regime in the region's regulated rivers during these months, particularly spring freshes in the Campaspe, Goulburn, Loddon and Murray rivers.

Operational demands in the lower Murray through summer resulted in inter-valley transfers (IVTs) being delivered from the Goulburn River, Campaspe River and lower Broken Creek. High IVTs during summer continued to compromise some of the environmental outcomes, particularly in the lower Goulburn River, as they reduce bank vegetation and increase the risk of erosion and bank failure. An interim operating limit on IVTs of up to 50 GL per month was applied by the Minister for Water to minimise the environmental risk to the lower Goulburn River in 2019–20. The intention of the limit was to reduce the effect on bank vegetation and minimise erosion, while still meeting downstream demands. Initial monitoring data indicated that vegetation was again impacted, with the effect on erosion still being assessed. Small, disconnected waterways (such as upper Broken Creek) had little to no flow over summer, except for environmental flows which were used to avoid loss of critical habitat.

The climate outlook from June to August 2020 indicates average to above-average temperatures and higher-than-median rainfall is likely for northern Victoria. The wetting-up of catchments and inflows into major storages during this time will be important to support early season allocations and water availability in 2020–21. Wetter conditions and higher streamflows may result in unregulated flows throughout winter. Longer-term outlooks have a lower level of confidence, but as at May 2020 climate models were predicting a negative Indian ocean dipole event in winter/spring 2020, which increases the likelihood of above-average rainfall during this time.

The allocation outlook for 2020–21 provided by the Northern Victorian Resource Manager (NVRM) on 15 May 2020 indicated low opening allocations are likely across all systems. Carryover of water into 2020–21 will be important to meet early season environmental demands, and possibly most 2020–21 demand if winter/spring is dry to extremely dry. Smaller systems (such as the Campaspe and Broken) are forecast to receive small (if any) increases in allocation during 2020–21 under the extreme dry[1] and dry scenarios, whereas the Goulburn, Loddon and Murray systems are more likely to get closer to a moderate allocation of around 50 percent high-reliability water shares in all but an extreme dry scenario. Under average to wet scenarios, allocations may increase more quickly in the smaller systems in response to increased inflows — a boom-or-bust type of response — when compared to the Goulburn/Loddon and Murray systems, which tend to have more gradual increases as they are larger systems. It may be difficult to commit significant volumes of environmental water to enhance unregulated events in the Goulburn and Murray rivers if these events occur before environmental allocations increase. The NVRM has not provided an outlook for low-reliability entitlements, but for planning purposes the VEWH has assumed allocation against low-reliability entitlements during 2020–21, unless significant rain provides inflows that are more than expected under an average scenario or in line with a wet scenario.

Under a dry scenario, environmental flows are expected to focus on protecting and maintaining habitat for native plants and animals to avoid decline or loss. Examples include watering wetlands (such as Horseshoe Lagoon on the Goulburn River) to maintain vegetation and provide refuge for waterbirds and to maintain low flow in the Campaspe River and other rivers to protect water-dependent species including native fish and platypus. If conditions and allocations improve, water for the environment may be used to deliver larger events to improve the health of environmental values that have experienced hot, dry conditions over the last two years. Under average to wet scenarios, larger floodplain watering events at icon sites along the Murray are planned, as is the watering of additional wetlands across the region. These larger-scale watering events will increase the quality and quantity of wetland habitat for waterbirds, frogs and turtles, support waterbird breeding events and transfer carbon from the floodplain to the rivers to increase the productivity of food webs and provide food for fish and other aquatic animals. Increased flows in creeks and rivers will aim to increase the abundance of waterbugs, enhance the breeding and recruitment of native fish and improve fringing bank vegetation.

[1] Goulburn-Murray Water's resource outlooks refer to the driest outlook as 'extreme dry'. In the seasonal watering plan, the driest planning scenario is usually called 'drought'.

5.2 Victorian Murray system

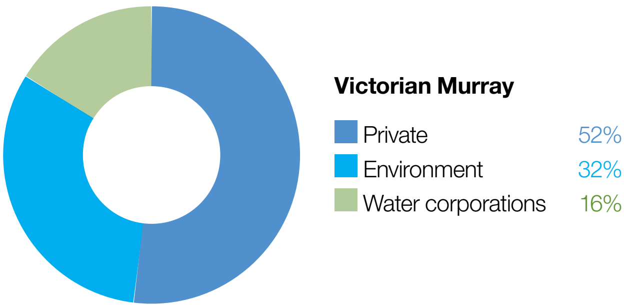
Waterway managers – Goulburn Broken, Mallee and North Central catchment management authorities

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

Environmental water holders – Victorian Environmental Water Holder (including the Living Murray program), Commonwealth Environmental Water Holder

Did you know...?

Early results indicate huge numbers of native fish have been saved, thanks to Australia's first irrigation diversion channel screens at Cohuna. No Murray cod larvae were detected drifting into the irrigation channel during the peak larval drift period, which means potentially thousands of Murray cod could remain in the creek system where they can better survive and thrive! Before the screens were installed, up to 160 cod larvae were lost to the channel a day.



Proportion of water entitlements in the Murray basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Gunbower Creek, by North Central CMA
Above: Intermediate egret on Barmah Lake, by Keith Ward

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 recognised Ramsar-listed sites due to the significance of their wetland types and the abundance and range of waterbird species that use them. Many other wetlands in the system are either nationally or regionally significant.

Water for the environment can be supplied to the Victorian Murray system from a range of sources. These include entitlements held by the VEWH, which includes those held on behalf of the Living Murray program and the Commonwealth Environmental Water Holder; reuse of return flows; and in some instances, use of operational water en route. The source of the water used for individual watering actions and the ability to deliver all watering actions will depend on water availability, water commitments by other environmental water holders and operational requirements. As a result, the following Victorian Murray system sections do not specify the expected availability of water for the environment.

5.2.1 Barmah Forest

System overview

The Barmah-Millewa Forest covers 66,000 ha and spans the New South Wales (NSW)–Victoria border between Tocumwal, Deniliquin and Echuca (Figure 5.2.1). It is listed under the (Ramsar) Convention on Wetlands of International Importance (the Ramsar Convention), the Australian Directory of Important Wetlands and is one of six Living Murray icon sites. The forest's Victorian components are the Barmah National Park and part of the River Murray Reserve, covering 28,500 ha of forest and wetlands that support a vast range of significant plant and animal species.

The wetlands throughout the forest continue to provide a constant source of nutritional foods and significant fibres for the Yorta Yorta People. It is also evident that the resources in the landscape were utilized to manufacture canoes, shields and carrying devices.

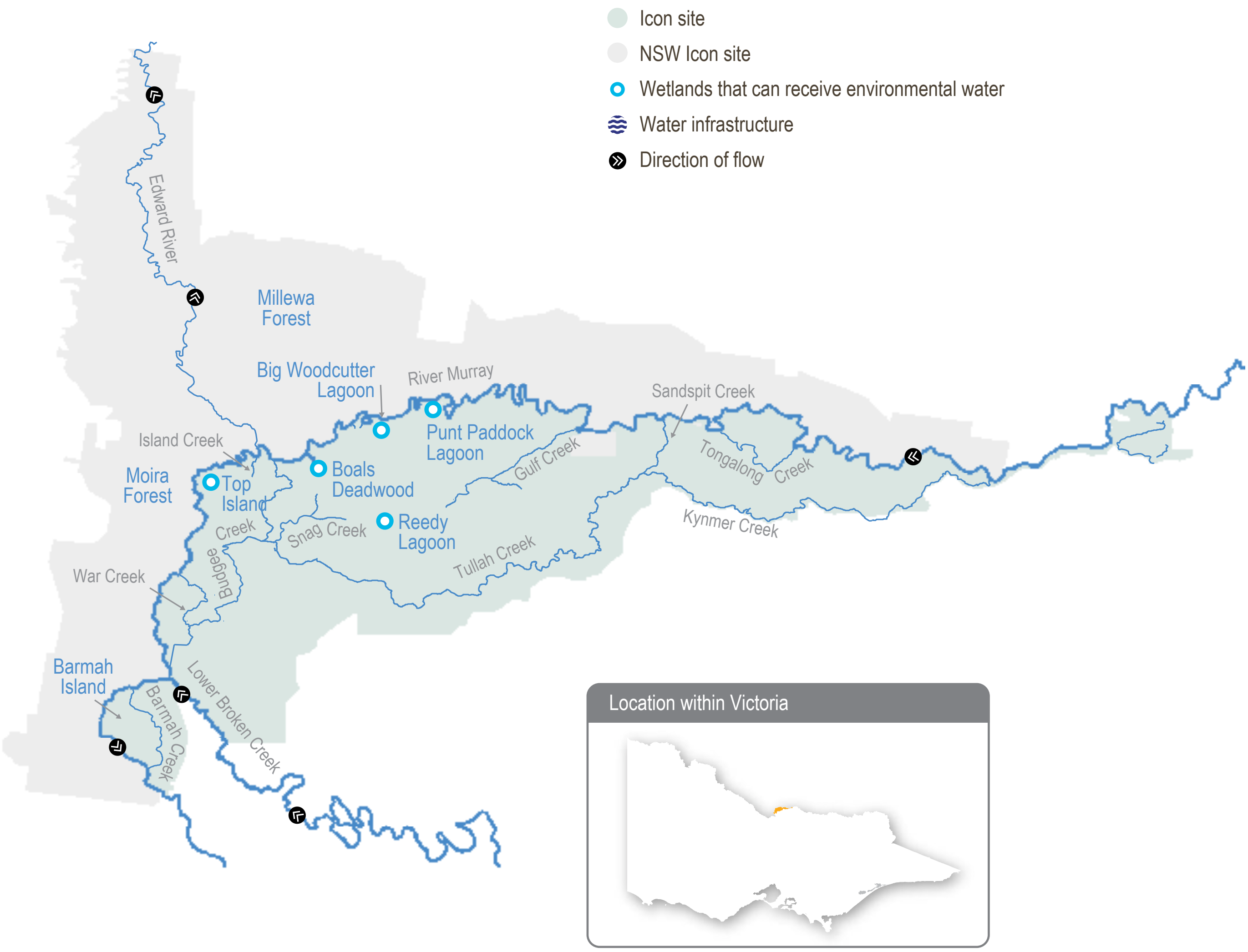
Flooding in the Barmah-Millewa Forest depends on flows in the Murray River. A natural narrowing of the river (known as the Barmah choke) restricts flow and causes overbank flooding when flows below Yarrawonga Weir exceed the channel's capacity. This restriction influences both the operation of Yarrawonga Weir and the upper limit of environmental flows that can be delivered to the forests.

Prior to river regulation for water supply, flooding would have regularly occurred with high flows from rainfall in winter and spring – helping to shape a rich and productive forest environment. Today, flooding in the forest is also influenced by system operation for water supply for users downstream in the Murray River, which can cause damage to the forest and banks of the river depending on the timing and volume of the flows.

The delivery of irrigation water during summer/autumn is managed to minimise unseasonal flooding of the forest. Regulators along the banks of the Murray River that control flow between the river and the forest remain closed during summer and autumn to restrict flow through low-lying flood runners. The delivery of water to Barmah Forest is also limited by a flow constraint below Yarrawonga Weir to minimise impacts to adjacent farming operations in NSW. The current constraint limits releases to a maximum of 18,000 ML per day between July and September (with potentially-affected landholder support) and to 15,000 ML per day for the rest of the year. To overcome this constraint, most environmental flows are shared between Barmah and Millewa forests to deliver water to low-lying wetlands in each forest at least every second year. It is currently not possible to achieve the desired flood depth and duration for floodplain marsh vegetation in both forests at the same time without larger natural flooding.

Water management at Barmah–Millewa Forest seeks to build on natural flow and the delivery of consumptive and operational water en route to optimise environmental outcomes when possible. As Barmah-Millewa Forest is located towards the upper reaches of the regulated portion of the Murray River, water for the environment that passes through the forest can often be used at sites further downstream as part of multi-site watering events.

Figure 5.2.1 Barmah Forest



Environmental values

The Barmah-Millewa Forest is the largest river red gum forest in Australia and the most intact freshwater floodplain system along the Murray River. 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. Barmah Forest is known to support 74 plant and animal species protected under state and national legislation.

Environmental watering objectives in the Barmah Forest

	Enable carbon and nutrient cycling between the floodplain and river through connectivity
	Maintain or increase habitat for native fish and increase their population
	Maintain or increase habitat available for frogs
	Maintain or increase habitat available for turtles including the broad-shelled turtle
	Enhance the health of river red gum communities and aquatic vegetation in the wetlands and watercourses and on the floodplain Promote the growth of floodplain marsh vegetation communities, with a particular focus on increasing the extent of Moira grass
	Provide feeding and nesting habitat for the successful recruitment of colonial nesting waterbirds
	Provide early-season flushing of the lower floodplain to reduce the risk of low-oxygen events in summer

Traditional Owner cultural values and uses

"We are the First People of this place. We were here even before the Murray River flowed through Barmah." — Uncle Des Morgan, Yorta Yorta Elder (Joint Management Plan for Barmah National Park, 2020).

Yorta Yorta are joint managers of Barmah National Park under a Traditional Owner Land Management Agreement with the State of Victoria. Goulburn Broken CMA worked with Yorta Yorta Nation Aboriginal Corporation during the environmental water planning process to source their feedback about planned watering actions. Yorta Yorta Traditional Owners have been involved in the development of longer-term management plans that have informed these watering actions.

Examples of Yorta Yorta cultural values and uses in Barmah Forest that are supported through environmental flow delivery include:

- maintaining drought refuges, which protects turtles that are an important totemic species for the Yorta Yorta community
- watering to support floodplain marsh vegetation, which includes important food and medicinal plants such as sneezeweed and basket sedge

Yorta Yorta Nation Aboriginal Corporation contribute to Barmah Forest environmental watering planning, monitoring and management through employment as part of the Living Murray Program Indigenous Partnerships Program. This contribution is acknowledged in Table 5.2.1 with an icon.

	Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.1, Goulburn Broken CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing)
- riverside recreation and amenity (such as camping and birdwatching)
- community events and tourism (such as providing access for boat tours)
- socio-economic benefits (such as apiarists and irrigation diverters).

Recent conditions

The 2019–20 year was characterised by extremely dry conditions throughout spring, although two small natural flow events originating from the Ovens and Kiewa rivers caused low-level flooding in the forest in mid- and late winter. Carryover in the Murray system from 2018–19 was essential to enable watering early in the year; Victorian Murray allocations increased slowly as a result of the dry conditions during 2019–20.

Forest regulators were opened in July 2019 to allow a natural connection between the Murray River and the waterways in Barmah Forest. Flow increased above the channel's capacity in August 2019 as a result of rainfall in upstream catchments. That event was followed by the delivery of the 'southern spring flow' — a planned environmental flow event for the Murray River between Lake Hume and the sea — which wetted low-lying parts of the Barmah Forest floodplain through September and October 2019. Environmental flows reduced in late October, and forest regulators were closed at the end of October 2019. Most floodplain habitats within the forest dried during summer and autumn. The main exception was a small section of the forest that re-flooded in January 2020 as a result of vandalism to a forest regulator.

Watering actions for Barmah Forest were mostly delivered as planned in 2019–20. Maintaining winter/spring connection between the river and the forest enabled carbon and nutrient exchange and improved food resources and habitat for fish, frogs, turtles and waterbirds. The low-level flooding supported wetland plant growth, but it ended too soon to stimulate some species to flower, due to insufficient water availability. A potential watering action that aimed to support colonial nesting waterbird breeding was not delivered, because significant natural breeding was not observed. Drying throughout the forest in summer/autumn is important to maintain plant diversity and wetland productivity.

A prolonged, low-level, spring watering event in 2020–21 is desirable to allow more floodplain vegetation to flower, set seed and recruit. Waterbird breeding in Barmah Forest was at the lowest level in a decade in 2019–20 as a result of dry conditions. Providing flows to support a successful waterbird breeding event will be a priority in 2020–21. If conditions remain very dry, water for the environment will be mainly used to maintain critical drought refuges (such as waterholes in creek beds).

Scope of environmental watering

Table 5.2.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

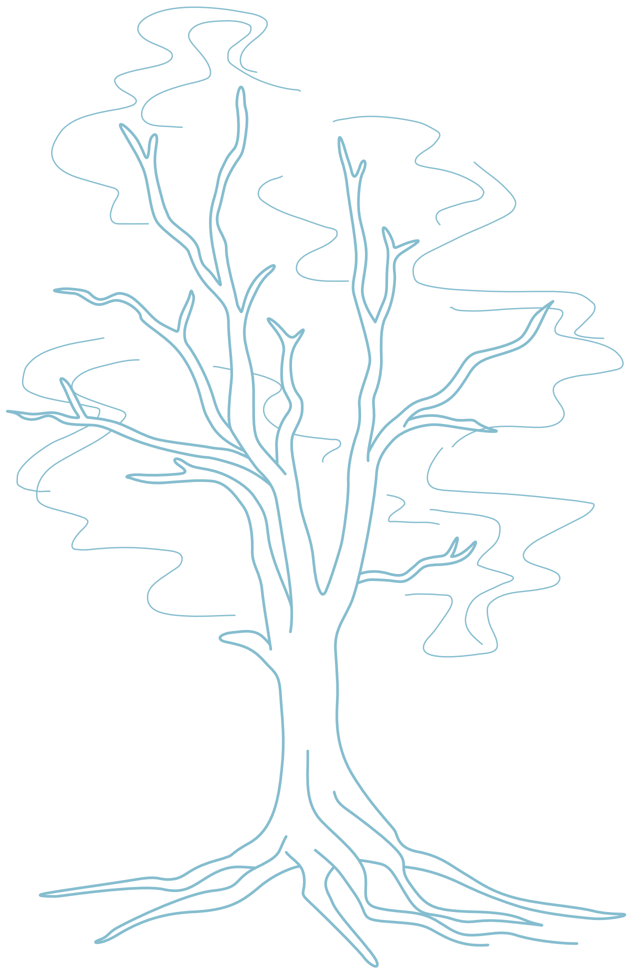


Table 5.2.1 Potential environmental watering actions and objectives for the Barmah Forest

Potential environmental watering action	Functional watering objectives	Environmental objectives
Winter/spring low flow to various waterways in Barmah Forest (variable flow rates and duration during July to December)	• Provide flow in forest waterways to maintain habitat for native fish and turtles • Facilitate the movement of native fish between floodplain waterways and the river • Remove accumulated organic matter from waterways to cycle carbon to the river system and minimise the risk of hypoxic blackwater	
Spring/summer freshes in the Murray River channel (one to three freshes that increase flow by at least 500 ML/day and maintain it for eight days during October to December)	• Trigger spawning of native fish species, primarily golden and silver perch	
Spring/summer/autumn freshes to Gulf and Boals creeks (100 ML/day for three to five days as required during November to April)	• Maintain critical drought-refuge areas in Barmah Forest to provide habitat for native fish and turtles • Flush drought-refuge pools to maintain water quality	
Spring/summer/autumn low flow to floodplain waterways including Sandspit, Gulf, Big Woodcutter, Boals, Island and Punt Paddock Lagoon (200 ML/day for 30 to 60 days during November to April)	• Provide flows to replenish refuge areas and maintain water quality • Provide flows to replenish permanent waterways, to maintain fish and turtle populations • Maintain connectivity to the river • Remove accumulated organic matter, cycle carbon to the river system and minimise the risk of hypoxic blackwater	
Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands (200–400 ML/day for four and a half months during September to February)	• Provide a cue to initiate and/or maintain waterbird breeding • Maintain wetting duration and depth for growth of wetland vegetation	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Spring wetting of floodplain marshes (variable flow rates of 9,500–18,000 ML/day below Yarrawonga Weir for three months during September to December)	• Wet open plains for sufficient duration to allow the growth of floodplain marsh vegetation • Provide water to forest wetlands and low-lying floodplain areas to create foraging opportunities for waterbirds and increase available habitat for turtles, frogs and small-bodied native fish	
Autumn/winter low flow in the Murray River (1,800–4,000 ML/day downstream of Yarrawonga during May to June)	• Increase water depth in the Murray River channel to provide habitat for large-bodied native fish in the Murray River and unregulated anabranches in Barmah–Millewa Forest	

Scenario planning

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

The ecological objectives at Barmah-Millewa Forest require sustained flows in the Murray River that peak in spring. Flow control structures are used to direct water from the Murray River channel into the forest and facilitate the later return of most of that water back to the river for use further downstream.

Demands for water for the environment in Barmah Forest vary significantly in response to natural conditions. Variable winter/spring low flow and spring/summer freshes are required under all scenarios. The variable winter/spring low flow is required to maintain habitat and movement opportunities for aquatic animals (such as native fish) and is achieved by keeping the regulating structures open and allowing water to move in and out of the forest in response to normal flow changes in the Murray River. The spring/summer freshes are achieved by providing changes in the flow rate in the Murray River below Yarrawonga Weir.

Under drought and dry conditions, potential environmental watering actions will primarily aim to maintain water levels and water quality in refuge habitats to sustain fish and turtle populations. Actions to achieve these objectives require relatively small volumes of water to be directed into the forest. These actions are unlikely to return much water to the Murray River for downstream use.

Under the average or wet scenarios, the focus shifts to building resilience in the system by increasing the ecological response to natural flood events. Specific actions under the average or wet scenarios 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 maintain the health of the trees. These actions require large volumes of water to be directed into the forest, with environmental water provided as a directed release from Hume Reservoir and managed via forest regulators. Most of the water used for these actions is eventually returned to the Murray River through the natural shedding action of the floodplain. Targeted wetland watering may occur under various scenarios to support the breeding of colonial nesting waterbirds and other flood-dependent birds via the diversion of water through specific regulators.

Spring wetting of floodplain marshes is not considered a high priority in 2020–21 under the dry and drought scenarios, but it would provide environmental benefit and may be delivered under certain circumstances. For example, if above-channel-capacity operational transfers from Hume Reservoir are delivered through Barmah Forest, then the watering action could be achieved by delivering a relatively small volume of environmental flow on top of or following the operational delivery. A multi-site environmental watering objective supporting whole-of-River-Murray and/or downstream environmental objectives during winter and spring may also deliver flows through Barmah Forest, and these could be supplemented to optimise environmental outcomes in Barmah Forest. The volume of water for the environment required to achieve the floodplain marsh flow objectives under the dry or drought scenarios depends on demands for operational water or environmental multi-site events, and it is therefore not estimated in Table 5.2.2 below.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flow periods unlikely • Flows in the Murray River will remain within channel all year	• Some small unregulated flow in late winter/spring • Low chance of overbank flows in late winter/spring	• Likely chance of small-to-medium unregulated flow in winter/spring • Likely chance of overbank flows in winter/spring	• High probability of moderate-to-large unregulated flow in winter/spring • Expected large overbank flows
Potential environmental watering – tier 1 (high priorities)[1]	• Winter/spring low flow • Spring/summer freshes • Spring/summer/ autumn freshes to Gulf and Boals creeks	• Winter/spring low flow • Spring/summer freshes • Spring/summer/ autumn low flow • Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands	• Winter/spring low flow • Spring/summer freshes • Spring/summer/ autumn low flow • Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands • Spring wetting of floodplain marshes • Autumn/winter low flow	• Winter/spring low flow • Spring/summer freshes • Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands • Spring wetting of floodplain marshes • Autumn/winter low flow
Potential environmental watering – tier 2 (additional priorities)	• Spring wetting of floodplain marshes	• Spring wetting of floodplain marshes		
Possible volume of environmental water required to achieve objectives[2]	• 8,500 ML (tier 1)	• 51,500 ML (tier 1)	• 566,000 ML (tier 1)	• 570,000 ML (tier 1)

[1] Tier 1 potential environmental watering at Barmah Forest is not classified as tier 1a or 1b because the water available for use is shared across various systems, and it is not possible to reliably determine the supply specifically available for Barmah Forest.

[2] The possible volumes of water for the environment required in Barmah Forest are estimates and highly variable, depending on factors such as seasonal conditions and the contributions of operational and/or unregulated flows. Much of the environmental water delivered to Barmah Forest is returned to the River Murray — around 80 percent in the dry to wet scenarios — and can be re-used at downstream environmental watering sites.

5.2.2 Gunbower Creek and Forest

System overview

Gunbower Forest is a large, flood-dependent forest situated on the Murray River floodplain in northern Victoria between Torrumbarry and Koondrook (Figure 5.2.2).

Covering 19,450 ha, it is bounded by the Murray River to the north and Gunbower Creek to the south. It is an internationally significant site under the Ramsar Convention and forms part of the Living Murray Gunbower-Koondrook-Perricoota forests icon site. River regulation and water extraction from the Murray River and Gunbower Creek has reduced the frequency, duration and magnitude of flood events in Gunbower Forest. This has affected the extent and condition of floodplain habitats and the health of plant and animal communities (such as river red gum and black box communities, native fish, birds, platypus, frogs and turtles) that depend on those habitats.

Gunbower Creek is natural creek that has been modified to supply irrigation water from the Murray River to the Torrumbarry Irrigation Area. There are twelve lagoons, largely located in the upper reaches of the creek system, that are permanently or seasonally connected to Gunbower Creek. Water for the environment is used in Gunbower Creek to improve habitat for native fish, especially Murray cod.

The Living Murray environmental works program in the middle and lower forest was completed in 2013. The works allow up to 4,500 ha of the wetlands and floodplain to be watered with considerably less water than would be required if the watering infrastructure was not in place. The works enable efficient watering through Gunbower Creek and the forest to maintain wetland and floodplain condition and provide connectivity between the creek, forest floodplain and the Murray River. Frequent connections between the river and floodplain habitats allow biota to move between habitats and support critical ecosystem functions (such as carbon exchange).

Environmental values

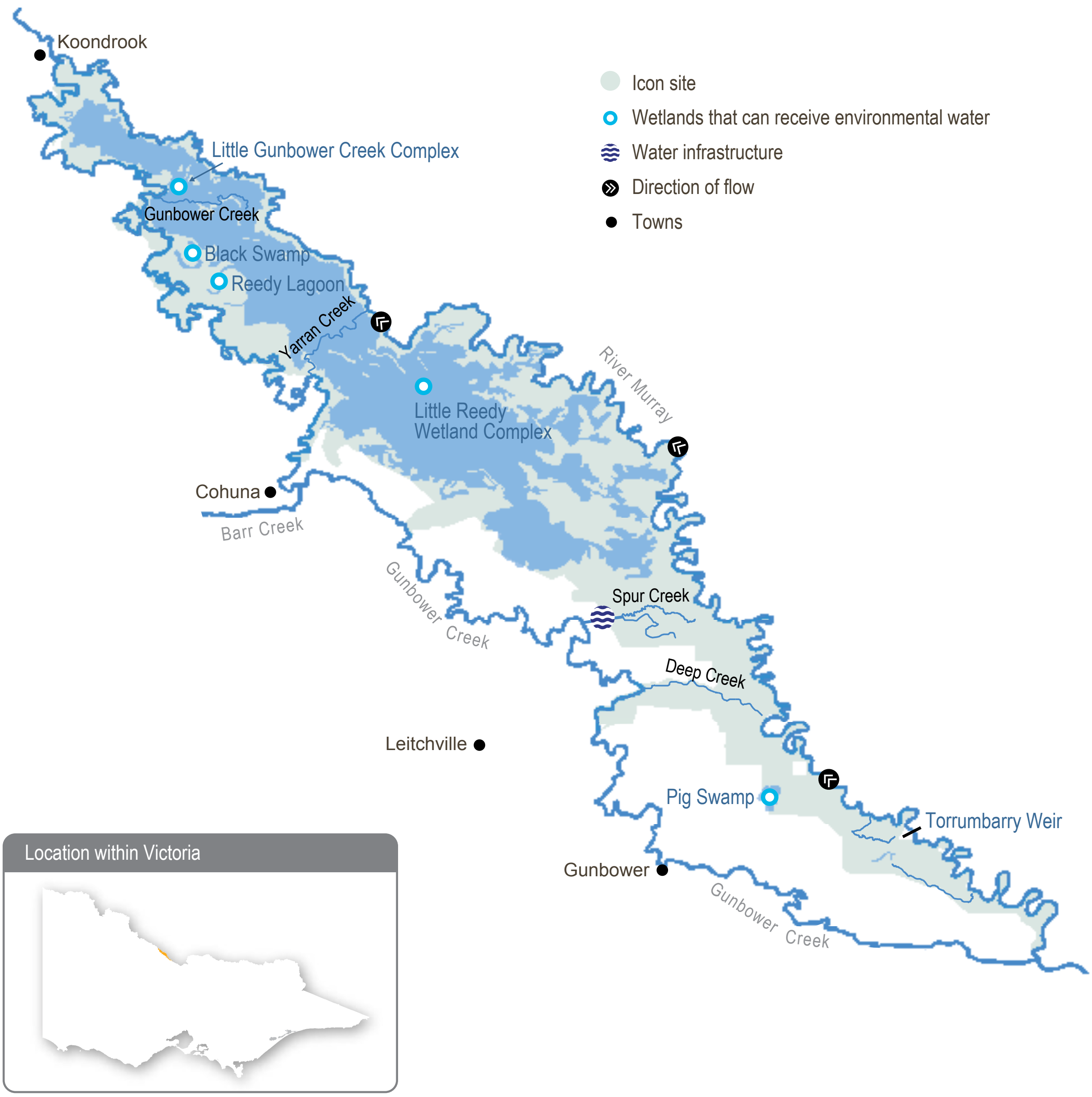
Gunbower Forest contains many important environmental values. It includes rare and diverse wetland habitats and large areas of remnant vegetation communities (such as river red gum forest and woodlands). It is also home to vulnerable and endangered plants and animals including river swamp wallaby-grass, wavy marshwort, Murray-Darling rainbowfish, eastern great and intermediate egrets. It also supports internationally recognised migratory waterbird species.

Gunbower Creek provides important habitat for native fish (such as Murray cod, golden perch and freshwater catfish). It is a valuable refuge for native fish, and it provides a source of fish to recolonise surrounding waterways.

Environmental watering objectives in Gunbower Creek and Forest

Provide feeding, breeding and refuge habitat for small-bodied native fish (such as Murray-Darling rainbow fish) in forest wetlands Maintain and improve populations of large-bodied native fish (such as Murray cod) in Gunbower Creek
Provide suitable feeding, breeding and refuge habitat for frogs
Provide suitable feeding, breeding and refuge habitat for turtles
Support carbon and nutrient cycles in the forest and wetlands and periodically deliver carbon and nutrients from the forest to adjacent waterways to support food webs
Maintain and improve the health and increase the abundance of native vegetation in permanent and semi-permanent wetlands Improve the health of river red gums, black box and grey box communities
Provide feeding, breeding and refuge habitat for waterbirds including colonial nesting species (such as egrets, cormorants and herons)
Maintain and improve water quality in Gunbower Creek

Figure 5.2.2 Gunbower Creek and Forest



Traditional Owner cultural values and uses

At Gunbower Island there are two Traditional Owner groups which recognise the forest as their traditional Country. The mid and lower area of Gunbower Forest is recognised as the traditional Country of the Barapa Barapa people, and the upper Gunbower Forest is recognised as the traditional Country of the Yorta Yorta people. North Central CMA seeks engagement and input from both groups when undertaking annual environmental water planning and throughout the year as part of the Living Murray Indigenous Partnerships Program.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.2.5 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

Barapa Barapa custodians have clearly expressed their aspirations for an active role in the management of land and water, to fulfil custodianship obligations and contribute to improvements in the health of Country.

Barapa Barapa Traditional Owners have been working in partnership with the North Central CMA to deliver the Water for Country project in Gunbower Forest since 2015. The Water for Country project builds on the work of the previous Barapa Barapa Cultural Heritage Mapping of Lower Gunbower Forest project, delivered in 2013–14 to map a catalogue of cultural heritage assets in the forest. The Water for Country project aims to investigate how Traditional Owners' cultural and spiritual values may be better represented in water management. In 2018, the Water for Country group has evolved to also include Wamba Wamba Traditional Owners and continues to have a focus on Gunbower Forest.

Barapa Barapa Traditional Owners identified a range of opportunities for 2020–21 watering to support cultural values (Table 5.2.3).

Table 5.2.3 Barapa Barapa cultural values and uses at Gunbower Forest

Values/uses	Considerations
Cultural values, cultural practices	Water in wetlands and on the floodplain from environmental watering and natural flooding supports culturally important plants throughout Gunbower Forest and allows the continuation of cultural practices including harvesting of food, medicine and weaving plants.
Cultural values	Providing drought refuge and maintaining areas with healthy habitat is a high priority for Barapa Barapa Traditional Owners. In a dry forest, they feel it was important to ensure that water is delivered to healthy areas, such as Reedy Lagoon, which elicit a good vegetation response and can support wetland and forest fauna.
Cultural values, cultural practices	Barapa Barapa Traditional Owners recognise the value of resources that occur on the drawdown after inundation of the forest floodplain, providing food for animals, and cultural plants such as old man weed. Providing this resource is considered particularly important in a dry forest.
Cultural values, cultural practices	Having a diversity of habitat and vegetation responses is a priority for Barapa Barapa Traditional Owners, particularly in a dry year. They highlighted the importance of having a diversity of drought refuge, with a range of water depths, which creates a more diverse vegetation response and results in a range of resources becoming available over a longer timeframe.
Cultural values	Barapa Barapa Traditional Owners value having water in natural creeks and billabongs off main wetlands, which were likely to have traditionally been canoe mooring sites. Evidence of this in the forest can be seen near Long Lagoon by numerous earth mounds and a large canoe tree on the edge of a large floodrunner.
Cultural practices	Barapa Barapa Traditional Owners have aspirations to reintroduce traditional fish traps into natural creeks within Gunbower Forest. The flood-runners around the Little Gunbower Creek Complex have been identified as potential trial sites.
Cultural heritage	Barapa Barapa Traditional Owners have noted that areas of black box and river red gum both have cultural heritage values, however the changed watering regime since regulation and changing climate is causing the encroachment of black box into areas previously dominated by river red gum. Barapa Barapa Traditional Owners expressed the desire to preserve the tree community that was historically present.

The Barapa Barapa Water for Country project has led to the creation of the Barapa Barapa Cultural Watering Objectives Framework, which is a guiding document to ensure cultural priorities and outcomes are considered and incorporated in environmental water planning and management. The framework considers cultural objectives matched with hydrological considerations, indicators and measures for monitoring success (Table 5.2.4). These objectives are considered in conjunction with the environmental and functional watering objectives for the potential watering actions in Table 5.2.5.

Planning for environmental watering in 2020–21 included discussion of vegetation monitoring results, forest condition and potential watering requirements with a field ecologist and a field visit to review the previous year's cultural objectives and outcomes and discuss potential new objectives.

Applying the framework during seasonal watering proposal engagement with Barapa Barapa Traditional Owners will ensure that environmental watering activities incorporate Barapa Barapa Traditional Owners' cultural aspirations and that water managers are culturally informed when delivering environmental water.

All potential watering actions in Table 5.2.5 provide the opportunity to support Barapa Barapa cultural values and objectives, but achievement will be guided by climatic conditions.

Table 5.2.4 Barapa Barapa cultural objectives for environmental watering in Gunbower Forest 2020–21 (from the Barapa Barapa Cultural Watering Objectives Framework)

Cultural objective	Hydrological aim	Indicator	Measure
Promote and maintain healthy and abundant native fish communities in Gunbower Creek and Gunbower Forest	Presence of water in wetlands before spring to support fish spawning events	Presence of native fish spawning Native fish populations show a range of ages	Fish surveys, larval sampling
	Presence of water in deep wetlands, so that fish can survive for longer	Presence of native fish following watering event	Fish surveys
Promote the natural flow of water	Water flows via natural flow paths to culturally important sites	Presence of water at culturally significant sites (e.g. fish ponds)	Photo points, site surveys
	Presence of healthy looking and smelling forest	Presence of healthy canopies and good ground cover on the forest floodplain	Plant surveys
Promote and maintain healthy cultural plants and resources	Presence of water in small wetlands and depressions to provide resources across the forest, particularly in dry years	Presence of food and fibre resources distributed across the forest	Cultural harvests, plant surveys, seed collection
	Presence of water in wetlands which are healthy	A diverse range of plants, animals and insects living in harmony	Results of monitoring activities (e.g. macroinvertebrate surveys, flora and fauna surveys)
Promote healthy waterbird populations	Presence of water in wetlands that support waterbird breeding	Presence of waterbird breeding	Waterbird surveys, spring–summer surveys for eggs

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.5, North Central CMA considered how environmental flows could support values and uses including:

- riverside recreation and amenity (such as birdwatching, duck hunting and photography)
- community events and tourism (such as park visitation)
- socio-economic benefits (such as timber harvesting and education).

Recent conditions

Gunbower Forest and surrounding areas have had below-average rainfall and above-average temperatures for the last three years.

In 2019–20, no natural inflows entered the Gunbower Forest from the Murray River, but a managed spring high-flow event in the Murray River provided an opportunity to deliver water through Yarran Creek to facilitate fish movement between Gunbower Creek and the Murray River. Water for the environment was used in winter 2019 to fill or top-up wetlands in Reedy Lagoon and the Little Gunbower wetland complex within Gunbower Forest. In the absence of a natural flood, selected wetlands within these complexes are planned to be allowed to draw down in 2020 to reduce carp numbers, before potential top-ups in autumn 2021.

Water for the environment was also delivered to Gunbower Creek in 2019–20 to maintain habitat for native fish during winter (when irrigation flows cease) and to improve the quality of nursery habitats for native fish (especially Murray cod) during spring and summer. Annual fish surveys in Gunbower Creek have detected successful breeding and survival of Murray cod each year that water for the environment has been delivered, and the surveys are showing improved abundance and age structure within the resident Murray cod population over time.

Golden perch do not appear to breed successfully in Gunbower Creek, and there are major barriers that limit exchanges with populations in the Murray River and other connected systems. Planned works to build a fishway at Koondrook Weir in winter 2021 aim to improve connectivity between the Murray River and Gunbower Creek. This will allow large-scale fish movement to support natural recruitment within Gunbower Creek and to allow Murray cod and other species that currently breed in Gunbower Creek to disperse and contribute to broader regional populations.

Scope of environmental watering

Table 5.2.5 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

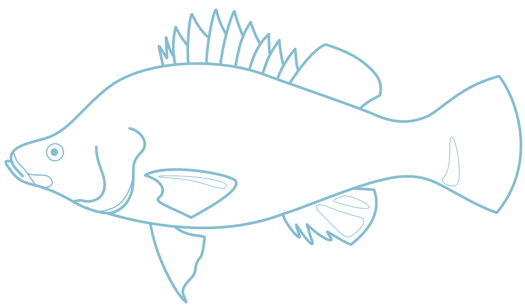


Table 5.2.5 Potential environmental watering actions and objectives for Gunbower Creek and Forest

Potential environmental watering action	Functional watering objectives	Environmental objectives
Gunbower Forest		
Reedy Lagoon (fill and provide top-ups in winter/ spring 2020)	• Maintain water depth and extent to support the growth and recruitment of wetland plants • Maintain water depth to provide feeding and refuge habitat for waterbirds, turtles and frogs • Maintain depth and water quality to provide habitat for small-bodied native fish including Murray-Darling rainbowfish	
Black Swamp (partial fill and provide top-ups in winter/ spring 2020)	• Increase and maintain water depth and extent to support the growth and recruitment of wetland plants • Provide feeding and refuge habitat for waterbirds, turtles and frogs • Maintain depth and water quality to provide habitat for small-bodied native fish	
Trigger-based top-up permanent and semi-permanent wetlands (variable flow rates during spring/summer as required in response to bird breeding event)	• Maintain a waterbird breeding event • Maintain the wetland vegetation to provide habitat for colonial nesting and flow-dependent waterbirds	
Reedy Lagoon (top-up in autumn/winter 2021)	• Maintain water depth to support wetland plants to grow • Maintain feeding and refuge habitat for waterbirds, small-bodied native fish, turtles and frogs	
Black Swamp (top-up in autumn/winter 2021)	• Maintain water depth to support wetland plants to grow • Maintain feeding and refuge habitat for waterbirds, small-bodied native fish, turtles and frogs	
Winter/spring fresh in Yarran Creek (variable flow rates and duration based on water levels in Gunbower Forest and flows in the Murray River and Gunbower Creek)	• Provide connectivity between Gunbower Creek and Murray River through the Yarran Creek and Shillinglaws regulators, to increase flowing habitat for the lateral movement of native fish, turtles, carbon and nutrients • Provide migration and spawning opportunities for native fish	

Table 5.2.5 Potential environmental watering actions and objectives for Gunbower Creek and Forest *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Little Gunbower wetland complex (fill in autumn/ winter 2021)	• Increase water depth and extent to trigger wetland plants to germinate in late winter and early spring • Provide feeding and refuge habitat for waterbirds, turtles and frogs • Provide habitat for small-bodied native fish	
Little Reedy wetland complex (including Green Swamp, Corduroy Swamp and Little Reedy Lagoon) (fill in autumn/winter 2021)	• Increase water depth and extent to trigger wetland plants to germinate in late winter and early spring • Provide feeding and refuge habitat for waterbirds, turtles and frogs • Provide habitat for small-bodied native fish	
Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates to maintain an appropriate wetted extent during winter/spring)	• Wet river red gum, black box and grey box communities • Provide access to breeding habitat and food resources for native fish (such as Murray cod) • Provide refuge habitat for frogs, turtles and waterbirds including colonial nesting species	
Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates during autumn/winter 2021)	• Wet river red gum, black box and grey box communities • Provide access to breeding habitat and food resources for native fish (such as Murray cod) • Provide refuge habitat for frogs, turtles and waterbirds including colonial nesting species	
Gunbower Creek		
Autumn/winter low flow (above 200 ML/day during May to August)	• Maintain habitat and food resources for native fish (such as Murray cod) during the non-irrigation season	
Spring/summer/autumn low flow (targeting a gradual increase, stable flow period and decrease in flows ranging between 300-500 ML/day during August to May)[1]	• Maintain breeding habitat and food resources for native fish (such as Murray cod) • Provide cues for the migration and spawning of native fish • Dilute low-oxygen water exiting Gunbower Forest below Koondrook Weir if required	
Autumn/winter fresh (500 ML/day for one to four weeks during May to August)	• Deliver in response to high flow in Murray River and low oxygen water draining off Gunbower Forest during the non-irrigation season to protect water quality and allow fish to move between Murray River and Gunbower Creek	

[1] Flows may be delivered at the upper end of the range — 500 ML per day — at any time between August 2020 and May 2021 in response to unregulated flow in the Murray River or to mitigate the potential impacts of low-oxygen water exiting the Gunbower Forest below Koondrook weir.

Scenario planning

Table 5.2.6 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The highest-priority potential watering actions under all conditions in 2020–21 are to fill and provide top-ups to Reedy Lagoon and Black Swamp in winter/spring 2020. These are permanent wetlands, and water is needed to support the growth and recruitment of wetland plants as well as provide feeding and breeding habitat for small-bodied native fish, frogs, turtles and waterbirds. If a waterbird breeding event commences in any wetland, top-ups may be needed to maintain water depth and habitats through spring and summer until juvenile waterbirds have fledged. Additional top-ups may be delivered to Reedy Lagoon and Black Swamp in autumn/winter 2021 if dry conditions are expected in 2021–22, to provide refuge over winter for water-dependent animals including waterbirds. Providing the prescribed low flow to Gunbower Creek in all seasons is also a high priority under all scenarios, to maintain and improve populations of native fish.

Under the dry, average and wet scenarios, the environmental watering priorities will be to maintain and improve the condition of semi-permanent and permanent wetlands across the forest and support local populations of waterbirds, frogs, small-bodied fish and turtles. Delivering top-ups and fills to selected wetlands within the Little Gunbower and Little Reedy wetland complexes in autumn/winter 2021 will provide habitat for waterbirds and other water-dependent animals during the cooler months and prime the wetlands for a spring productivity boost. If flow in the Murray River exceeds 15,000 ML per day for more than two weeks in winter/spring, a fresh may be delivered in Yarran Creek to allow carbon, fish, turtles and seed propagules to move between Gunbower Creek, Gunbower Forest and the Murray River. Delivering water for the environment to the Gunbower Forest floodplain in autumn/winter 2021 is a high priority under the dry, average and wet scenarios, to maintain and improve the health of river red gums and provide waterbird and native fish habitat.

Under average and wet conditions, natural flow from the Murray River may wet parts of the Gunbower Forest floodplain in winter/spring 2020. Water for the environment may be used to extend natural flooding events in selected river red gum areas, to maintain and improve tree health.

If significant volumes of water for the environment are delivered to Gunbower Forest via the Hipwell Road Regulator, it may not be possible to deliver the full range of flows to increase the large-bodied fish population in Gunbower Creek. If so, flow in Gunbower Creek will be managed to maintain habitat for the existing native fish population. Low flow may be increased to the upper end of the recommended range — 500 ML per day — to dilute low-oxygen floodwater that drains from the floodplain below Koondrook Weir following a natural or delivered floodplain watering event.

Water for the environment may also be used to temporarily increase flow in Gunbower Creek to the upper end of the recommended flow range — 500 ML per day— in response to higher flows in the Murray River that occur at important times for fish breeding or movement. These high Murray River flows are expected to mainly occur under a wet scenario.

There is a possibility that Goulburn-Murray Water will require Gunbower Creek to be shut down during winter/spring 2021 to allow for the construction of fishways at Koondrook Weir and Cohuna Weir outside the irrigation season. If these works proceed as planned, water will be delivered at a low rate to maintain some pool habitats for resident fish populations, but higher flows to the creek and deliveries to Gunbower Forest via the Hipwell Road Regulator will not be possible. Any potential watering actions that are cancelled as a result of those works will likely become a very high priority to deliver in 2021–22.

A minimum volume of 21,000 ML is planned to be carried over into 2021–22. The carryover volume will provide certainty of supply for low flow in Gunbower Creek during the non-irrigation season to maintain flowing habitat and support top-ups of permanent wetlands in lower Gunbower Forest. Extra water may need to be carried over to support any Gunbower Forest floodplain watering actions that commence in autumn or June 2021.

Table 5.2.6 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	• No natural inflows into Gunbower Forest	• Minor natural inflows into Gunbower Forest may occur in winter/spring	• Overbank flows are likely in winter/spring
Potential environmental watering – tier 1 (high priorities)[1]				
Gunbower Forest	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter)	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter) • Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex • Gunbower Forest floodplain, floodrunners and wetlands	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter) • Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex • Extend natural flooding by wetting Gunbower Forest floodplain, floodrunners and wetlands • Gunbower Forest floodplain, floodrunners and wetlands	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter) • Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex • Extend natural flooding by wetting Gunbower Forest floodplain, floodrunners and wetlands
Gunbower Creek	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/autumn low flow	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/autumn low flow	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/autumn low flow	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/autumn low flow
Potential environment watering – tier 2 (additional priorities)				
Gunbower Forest	• Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex	• n/a	• n/a	• Gunbower Forest floodplain, floodrunners and wetlands
Gunbower Creek	• n/a	• n/a	• n/a	• Gunbower Creek autumn/winter fresh
Possible volume of environmental water required to achieve objectives[2,3]	• 21,500 ML (tier 1) • 7,500 ML (tier 2)	• 50,000 ML (tier 1)	• 51,500 ML (tier 1)	• 36,500 ML (tier 1) • 31,000 ML (tier 2)
Priority carryover requirements	• 21,000 ML to 56,000 ML[4]			

[1] Tier 1 potential environmental watering at Gunbower Creek and Gunbower Forest is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for Gunbower Creek and Gunbower Forest.

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

[3] These estimates take account of the use of operational water en route to achieve watering action targets (except for discrete wetland watering actions), with water for the environment being required to underwrite the associated losses in Gunbower Creek and Gunbower Forest.

[4] Carryover volumes take into account that wetting of Gunbower Forest floodplain, floodrunners and wetlands has started in autumn/winter 2021 and will require sufficient volumes of carryover to complete the watering action in winter/spring 2021. If no floodplain watering action commences in autumn/winter 2021, this volume is subject to change.

5.2.3 Central Murray wetlands

System overview

The central Murray wetlands are located on the lower Loddon River and Murray River floodplains. The wetland system includes Round Lake, Lake Cullen, Lake Elizabeth, Lake Murphy, Johnson Swamp, Hird Swamp, Richardson's Lagoon, McDonalds Swamp, Third Reedy Lake, the Wirra-Lo wetland complex and Guttrum and Benwell state forests.

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 flow paths and are rarely filled by natural floods. They rely on water for the environment to maintain their ecological character and health.

Ten of the central Murray wetlands can receive water for the environment from permanent infrastructure: Lake Cullen, Hird Swamp, Johnson Swamp, Round Lake, McDonalds Swamp, Lake Elizabeth, Lake Murphy, Richardson's Lagoon, Third Reedy Lake and the Wirra-Lo wetland complex. Temporary pumps may be used to deliver water for the environment from the Murray River to some semi-permanent wetlands in the Guttrum and Benwell forests.

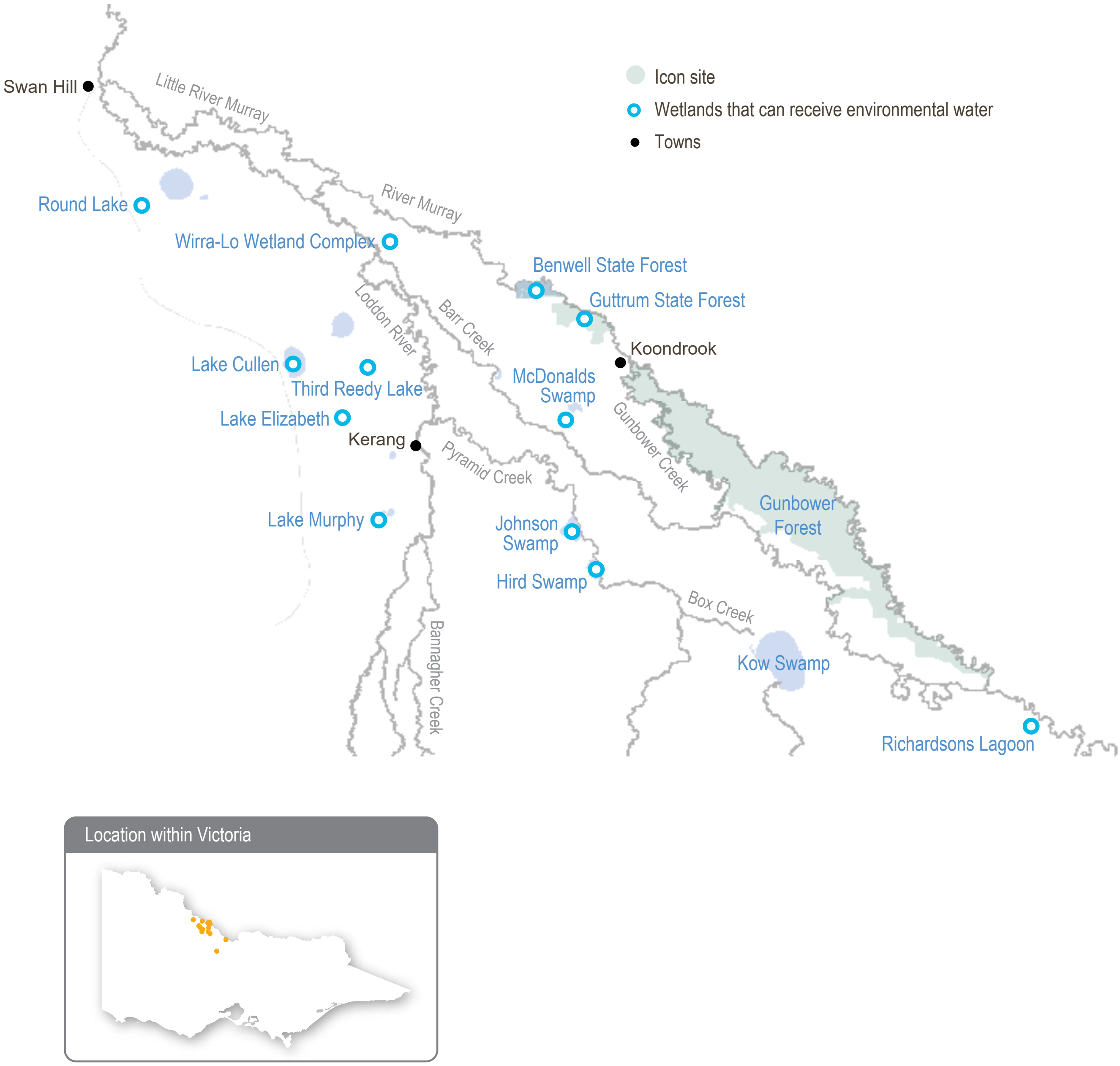
Environmental values

The wetlands in the Central Murray system support numerous listed threatened species ranging from vulnerable to critically endangered including the Australasian bittern, Murray hardyhead, Australian painted snipe, growling grass frog and the southern purple spotted gudgeon, which was presumed extinct in Victoria until it was found at Third Reedy Lake in spring 2019. When the wetlands receive environmental water, they can attract prolific birdlife and provide feeding and breeding habitat for many threatened and endangered bird species (including the eastern great egret and white-bellied sea eagle) listed under legislation and international agreements. Lake Cullen, Hird Swamp and Johnson Swamp are internationally recognised under the Ramsar Convention, while the other wetlands in the Central Murray system have bioregional significance.

Environmental watering objectives in the central Murray wetlands

Maintain and improve populations of listed threatened species including critically endangered Murray hardyhead and southern purple spotted gudgeon Maintain or increase populations of common small-bodied native fish (such as carp gudgeon and flatheaded gudgeon)
Maintain and improve populations of endangered growling grass frog Maintain populations of common native frogs (such as barking marsh frog, Peron's tree frog and spotted grass frog)
Maintain populations of native turtle species (such as Murray River turtle and the common long necked turtle)
Restore and maintain the health of streamside trees (such as river red gum and black box) Restore and maintain mudflat vegetation communities (such as tall marsh, herblands, rushes and sedges) Restore and maintain native aquatic vegetation species (such as tassel, milfoil and pondweed) Reduce the extent and density of invasive plant species Support a mosaic of wetland plant communities across the region
Provide resting, feeding and breeding habitat for a variety of waterbird feeding guilds including threatened species (such as Australasian bittern, little bittern and brolga)
Provide carbon and nutrients to Pyramid Creek to boost the riverine food web

Figure 5.2.3 The Central Murray wetlands system



Traditional Owner cultural values and uses

The wetlands and surrounding land in the central Murray region are rich in cultural heritage, with sites and artefacts of cultural practices present throughout the landscape. The rivers and floodplains are valued as food and fibre sources and contain many sites of significance such as camp sites and meeting places. Environmental watering supports values such as native fish, waterbirds and turtles, and promotes the growth of culturally important plants that provide food, medicine and weaving materials. The presence of water itself can be a cultural value, as well as the quality of the water, as healthy water promotes a healthy Country.

Barapa Barapa, Wamba Wemba and Yorta Yorta Traditional Owners have contributed to environmental water planning for wetlands important to them in the central Murray region in 2020-21. Focus areas include:

- Barapa Barapa and Wamba Wemba Traditional Owners have highlighted maintaining or improving the health of wetland vegetation as a key priority across the wetlands. Watering activities in Guttrum Forest will again be a particular focus for Barapa Barapa and Wamba Wemba Traditional Owners in 2020–21 (as described below)
- North Central CMA and Barapa Barapa Traditional Owners have collaborated to deliver the DELWP-funded Decision-Support Tool project, which is guiding vegetation works at McDonalds Swamp, and Lake Leaghur and Lake Yando (sites within the Boort wetlands, see section 5.7.2). This has allowed them to align watering actions in these wetlands with the watering requirements of the revegetation and enabled monitoring to be completed by Barapa Barapa
- North Central CMA and Yorta Yorta Nation Aboriginal Corporation have considered watering priorities for 2020–21, with a particular focus on Richardsons Lagoon. The Yorta Yorta Traditional Owners are supportive of the current drying phase in the lagoon, and its objectives of aerating sediment, reducing carp and providing a boost to productivity when water returns.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.2.8 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

Barapa Barapa and Wamba Wemba input to watering actions for Guttrum Forest in 2020–21

The proposed delivery of water for the environment to Guttrum Forest during 2020–21 has been planned in conjunction with the Barapa Barapa and Wamba Wemba peoples, for whom the wetlands and surrounding forest are places of high cultural significance. The Traditional Owners have been an important part of Guttrum Forest planning and management from the outset and were directly involved in the delivery of environmental flows to Reed Bed Swamp in 2019–20.

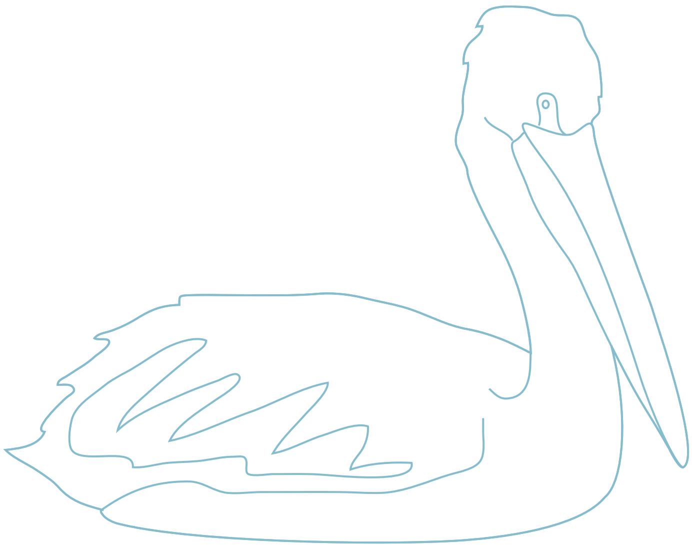
Barapa Barapa and Wamba Wemba collaborate with waterway managers to ensure that during watering events their cultural heritage is protected and that the hydrological needs of important cultural values (such as food and medicinal plant species, scar trees and ring trees) are supported through the timing and duration of planned watering actions to the forest.

The Traditional Owners advised that filling Guttrum Forest in winter 2020 and a top-up in spring would be appropriate timing to support large old trees and bird breeding. Additional watering in autumn/winter 2021 was recommended to prime the wetland for fills in the 2021–22 water year, to increase the duration of wetting.

Table 5.2.7 outlines the values and uses considered in the planning and management of watering at Guttrum Forest in 2020–21.

Table 5.2.7 Barapa Barapa and Wamba Wemba cultural values and uses at Guttrum Forest

Value/use	Considerations
Food, fibre and medicinal plants	A winter fill followed by a spring top-up will ensure that the duration of wetting will be long enough to support aquatic vegetation during its optimal growth period. Allowing the wetland to dry before summer will also promote cultural plants on the mudflats in these areas.
Cultural heritage	Watering of Reed Bed Swamp supports fringing large old trees including a couple of ring trees and scar trees. The condition of these trees was seen to improve following the 2019 watering: for example, there was new growth.
Spiritual wellbeing	The improvement in condition of the wetland and the presence of water and moisture contributed to a sense of spiritual wellbeing.
Sharing cultural knowledge	The Traditional Owners provide support and advice about what ecological values to target: that is, they provide information about what the wetland used to look like and what values it previously supported. Traditional Owners were also present during the set-up of infrastructure and were able to provide advice about avoiding impacts to their cultural heritage.
Employment opportunities	Traditional Owners want to become more involved in the management of their Country through increased employment opportunities (such as ecological and cultural monitoring). This occurred as part of the 2019 watering of Reed Bed Swamp.
Cultural landscape	Maintaining the open-water habitat and mudflats underneath that will disappear if the river red gum saplings that germinated in the 2016 floods are not removed. This is important for maintaining the cultural landscape and access to food and medicinal resources.



Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.8, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as kayaking, canoeing, fishing, swimming and water sports)
- riverside recreation and amenity (such as walking, running, cycling, camping, birdwatching and duck hunting)
- community events and tourism (such as visitation during the hunting and fishing seasons, Breakfast with the Birds events (North Central CMA), supporting Aboriginal cultural heritage and history-based tours)
- socio-economic benefits (such as ecosystem services like groundwater recharge, flood mitigation, nutrient treatment and carbon storage).

Recent conditions

The central Murray area had below-average rainfall and above-average temperatures throughout most of 2019–20. Rainfall in spring 2019 was well below the long-term average and as a result, storage inflows for the year were also much lower than average. Water for the environment was delivered to seven central Murray wetlands in 2019–20 in line with planning under a dry scenario.

Round Lake and Lake Elizabeth received environmental water during 2019–20 to maintain salinity within the target range for endangered Murray hardyhead. Lake Cullen, which has held water since the natural floods in 2016, was topped up in spring 2019 to support the growth and recruitment of submerged and emergent aquatic plants and provide feeding and roosting habitat for waterbirds.

Wirra-Lo wetland complex received environmental water during the spring and summer 2019–20 that primarily targeted growling grass frogs and wetland vegetation communities. Wetting and drying regimes are being staggered across the eight wetlands within the Wirra-lo wetland complex based on their ecological condition and site-specific watering needs, including to support revegetation projects and the feeding and breeding habitat of various species (such as the growling grass frog and Australasian bittern).

Water for the environment was delivered to Reed Bed Swamp and Little Reed Bed Swamp in Guttrum Forest for the first time in spring 2019. The watering action aimed to reduce the recent encroachment of river red gum saplings across the bed of the wetland and provide feeding and breeding habitat for waterbirds and frogs. Many of the large old fringing river red gums showed improved tree canopy with new growth after the watering event.

Johnson Swamp was filled in spring 2019 to provide food and breeding habitat for waterbirds, especially Australasian bittern. Subsequent monitoring detected Australasian bittern breeding calls as well as large numbers of small-bodied native fish, waterbugs, frogs and eastern long-neck turtles. A spring fresh in Pyramid Creek was partly diverted through Johnson Swamp to help export nutrients, carbon and waterbugs from the wetland into the creek to increase the productivity of riverine food webs.

After completing its drying cycle, McDonalds Swamp received a partial fill in autumn 2020. The watering aimed to promote the growth of planted and naturally recruited river red gums, support early plant germination and promote winter feeding conditions for waterbirds and frogs, and prime the wetland for a spring fill.

Water for the environment was delivered to Third Reedy Lake for the first time in 2019–20. Goulburn-Murray Water used to manage Third Reedy Lake as a water storage, but it is no longer needed for that purpose and the long-term plan for the site is to restore a more natural wetting and drying regime to support a range of environmental values. Ecological surveys conducted as part of the de-commissioning work recorded several southern purple spotted gudgeon at the site. The species was thought to be extinct in Victoria, and water for the environment is currently being used to maintain the population at Third Reedy Lake while long-term management plans for the site and the species are being developed.

Scope of environmental watering

Table 5.2.8 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.2.8 Potential environmental watering actions and objectives for the central Murray wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Round Lake (top-up as required)	• Maintain salinity within 25,000–60,000 EC (may go up to 80,000 EC) to support suitable habitat and breeding conditions for Murray hardyhead and growing conditions of submerged aquatic plants	
Lake Elizabeth (top-up as required)	• Maintain salinity within 25,000–60,000 EC (may go up to 80,000 EC) to support suitable habitat and breeding conditions for Murray hardyhead, and growing conditions of submerged aquatic plants • Provide permanent water as habitat for waterbirds	
Wirra-Lo wetland complex – Brolga Swamp (fill in spring and top up as required)	• Promote growth and maintenance of submerged and emergent aquatic vegetation • Provide feeding and breeding habitats for growling grass frog and other frog species • Provide open water and foraging habitats for shallow wading waterbirds and mudflat specialists to feed and breed • Provide refuge and recruitment sites for freshwater turtles	
Wirra-Lo wetland complex – Red Gum Swamp (fill in spring and top up as required)	• Promote the growth and maintenance of existing red gum trees • Provide feeding and breeding habitats for growling grass frog and other frog species • Provide recruitment sites for freshwater turtles • Provide resting, feeding and breeding habitat to support waterbirds	
Wirra-Lo wetland complex – Bunyip Swamp East and Bunyip Swamp West (top up in spring, and further top-up as required)	• Support the growth of recently established reed beds to create nesting habitat for Australasian bittern	
Third Reedy Lake – (top up as required)	• Maintain water level above 74.0m AHD (Australian Height Datum) to support critical habitat and breeding for the southern purple spotted gudgeon	
McDonalds Swamp (fill in late winter/spring, and top up as required)	• Promote the growth of planted and naturally recruited river red gums, native semi-aquatic and aquatic plants, which provide high-quality habitat for waterbirds to feed and breed • Maintain feeding conditions for waterbirds if significant waterbird breeding occurs	
Hird Swamp (west) (fill in spring and top up as required)	• Promote the growth and establishment of wetland plant communities to provide high quality habitat for waterbirds, reptiles and frogs to feed and breed • Maintain food for nesting waterbirds if significant breeding occurs	
Hird Swamp (west) (through-flow to Pyramid Creek in spring/summer)	• Deliver carbon-rich water to Pyramid Creek to increase the productivity of riverine food webs	

Table 5.2.8 Potential environmental watering actions and objectives for the central Murray wetlands *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Guttrum Forest (partial fill in winter 2020, with top-ups in spring/summer if required to support waterbird breeding)	• Wet existing adult river red gums to support growth and drown river red gum saplings to maintain open-water habitat • Promote the growth and re-establishment of aquatic and tall marsh vegetation • Maintain depth of wetland to support frogs and waterbird feeding and breeding	
Richardsons Lagoon (fill in winter/spring, top up as required)	• Promote the growth of aquatic macrophytes, reeds and rushes, which in turn would support aquatic biota • Wet the higher floodplain environment to maintain eucalypt floodplain woodland and create habitats for waterbirds, reptiles and frogs and associated wetland animals to feed and breed • Increase food resources (e.g. waterbugs and zooplankton) for waterbirds and other wetland animals	
Guttrum Forest (partial fill in autumn/winter 2021)	• Increase water depth and extent to trigger wetland plants to germinate in late winter and early spring • Provide feeding and refuge habitat for waterbirds and frogs	

Scenario planning

Table 5.2.9 outlines the potential environmental watering and expected water use under a range of planning scenarios.

There are seven high-priority (tier 1) wetlands that are planned to receive environmental water releases under all scenarios during 2020–21. Watering at four of these wetlands aims to maintain critical habitat for rare or threatened species: Round Lake (Murray hardyhead), Lake Elizabeth (Murray hardyhead), Third Reedy Lake (southern purple spotted gudgeon) and Wirra-Lo wetland complex (growling grass frog). Watering at McDonalds Swamp, Hird Swamp and Guttrum Forest is needed to support North Central CMA's strategy of providing a mosaic of wetland habitat types and ecosystem services across the central Murray region over multiple years. The planned watering actions at these seven sites are expected to use between 17,700 ML and 18,300 ML, depending on weather conditions. Watering at Richardson's Lagoon is also a high priority under the average and wet scenarios, as water availability will allow the optimum watering regime to be met.

The environmental values at Richardsons Lagoon will benefit from watering in winter/spring 2020, but it is considered a lower priority as its minimum watering regime will allow for the site to remain dry between events for up to two years. A flow through Hird Swamp from Pyramid Creek has been identified as a tier 2 watering action under all scenarios, but it may be elevated to a high-priority action if a spring high flow occurs in Pyramid Creek when Hird Swamp is already full. This is very similar to the flow delivered through Johnson Swamp in 2019–20, and it would enhance the environmental benefit of the planned winter/spring fill at Hird Swamp by transporting carbon and waterbugs from the wetland to Pyramid Creek, where it can increase food for native fish. Potential watering actions for Pyramid Creek in 2020–21 are described in section 5.7.1. Partially filling Guttrum Forest in autumn/winter 2021 has also been identified as a tier 2 watering action under all scenarios. This watering action aims to prime the wetland ahead of a larger fill in winter/spring 2021, and it will only be delivered if the winter/spring event is likely to proceed and there is sufficient water available at the time.

There are no plans to deliver water for the environment to Johnson Swamp, Lake Cullen and Lake Murphy in 2020–21. If there are no natural floods, these wetlands will be allowed to draw down to oxygenate the soil, control invasive aquatic weeds and support the growth of lake-bed herbland vegetation communities that rely on periodic drying phases to develop and reproduce.

Priority carryover requirements have primarily been calculated based on the estimated volume required to support Murray hardhead sites, Guttrum Forest, Wirra-Lo wetland complex and the southern purple-spotted gudgeon in 2021–22.

Table 5.2.9 Potential environmental watering for the central Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment runoff and natural flow into the wetland are unlikely	• Some catchment run-off and natural flow into the wetlands are possible, particularly in winter/spring	• Low to moderate catchment run-off and natural flow into the wetlands are likely, particularly in winter/spring	• Catchment run-off and natural flow into the wetlands is likely with potential widespread flooding in some wetlands, particularly winter/spring
Potential environmental watering – tier 1 (high priorities)[1,2]	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020)	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020)	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020) • Richardsons Lagoon	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020) • Richardsons Lagoon
Potential environmental watering – tier 2 (additional priorities)[2]	• Richardsons Lagoon • Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)	• Richardsons Lagoon • Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)	• Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)	• Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)
Possible volume of environmental water required to achieve objectives[3]	• 17,700 ML (tier 1) • 3,700 ML (tier 2)	• 18,500 ML (tier 1) • 3,700 ML (tier 2)	• 21,700 ML (tier 1) • 500 ML (tier 2)	• 21,500 ML (tier 1) • 500 ML (tier 2)
Priority carryover requirements	• Up to 14,000 ML			

[1] Tier 1 potential environmental watering for the central Murray wetlands is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the central Murray wetlands.

[2] Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios.

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

5.2.4 Hattah Lakes

System overview

The Hattah-Kulkyne National Park is situated in north-west Victoria adjacent to the Murray River (Figure 5.2.4). The national park contains a complex of more than 20 semi-permanent freshwater lakes known collectively as the Hattah Lakes.

The ecology of the Hattah Lakes and surrounding floodplain is strongly influenced by flooding regimes of the Murray River. The system fills when there is high flow in the Murray River, and some lakes hold water for several years after floods recede. Regulation of the Murray River has significantly reduced the frequency and duration of small- to medium-sized natural floods in the Hattah Lakes system. Over time, this has degraded vegetation communities and reduced the diversity and abundance of animals that use the vegetation and wetlands for habitat and food.

The Hattah Lakes complex can be broadly divided into the southern Hattah Lakes, which contains permanent to semi-permanent wetlands, and the higher-elevation northern Hattah Lakes, which are mostly ephemeral wetlands.

The Messenger, Oateys and Cantala regulators allow water to flow between the Murray River and Hattah Lakes. When flows in the Murray River are about 26,000 ML per day, water begins to flow through Messengers regulator into Chalka Creek and through to the Hattah Lakes complex. A permanent pump station has also been constructed that can deliver up to 1,000 ML per day to Hattah Lakes through Chalka Creek. The regulators and pump station are used in combination with several small constructed levees to restore a beneficial pattern of flooding to the lakes.

Lake Kramen in the south east of Hattah-Kulkyne National Park is disconnected from the main Hattah Lakes complex. The Hattah Lakes pump station can deliver up to 145 ML per day to Lake Kramen to restore flooding regimes.

Environmental values

Hattah Lakes is home to a diverse range of flood-dependent vegetation that changes with the topography of the landscape. Vegetation types range from wetland communities in lower-lying areas that require almost annual flooding to lignum and black box communities situated higher on the floodplain that only need flooding once every four to five years (on average).

A combination of natural flooding and the delivery of environmental flows since 2010 has improved tree canopy health and recruitment of black box and river red gum communities throughout the Hattah Lakes. Woodland birds, including the endangered regent parrot, have benefited from the improved tree health.

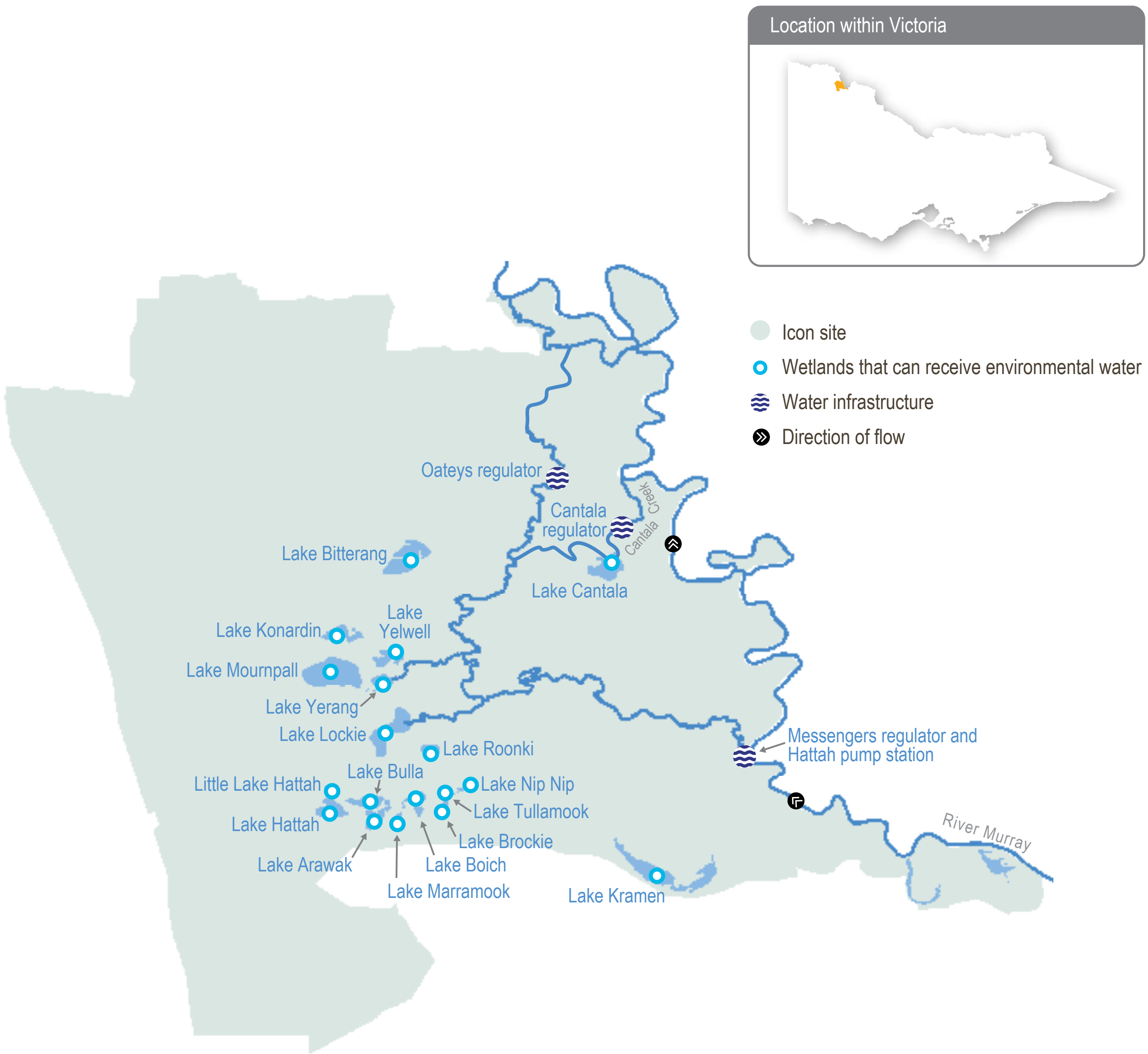
Hattah Lakes provides important waterbird breeding sites in an arid landscape. A total of 34 species of waterbirds are known to breed at the lakes when conditions are suitable. Another six species of waterbirds breed in the surrounding floodplain. Wetland drought-refuge sites are limited in the region, making Hattah Lakes critically important for waterbirds and terrestrial animals.

The Hattah Lakes support native fish species such golden perch and endangered freshwater catfish, which can move between the lakes and the Murray River when flows are suitable. Fish can also persist in permanent wetlands in the Hattah Lakes during dry years.

Environmental watering objectives in the Hattah Lakes

	Increase the native fish populations
	Restore and maintain a mosaic of healthy wetland and floodplain plant communities
	Provide feeding and nesting habitat for the successful recruitment of waterbirds and woodland birds

Figure 5.2.4 The Hattah Lakes system



Traditional Owner cultural values and uses

The Hattah Lakes system is part of a highly sensitive region for Aboriginal cultural heritage values and contains considerable evidence of past Aboriginal occupation. More than 1,000 Indigenous archaeological sites at the Hattah Lakes are registered with Aboriginal Victoria.

The local Aboriginal community maintains strong connections to the land and its resources such as native species used for food and medicine.

Mallee CMA and members of Tati Tati, Latje Latje, Gilby Corporation and Munutunga discussed a range of options for how environmental flows can be delivered at Hattah Lakes in 2020–2021. Elders spoke of the importance of drying cycles for wetlands and the abundance of the culturally significant old man weed that is flourishing on the drying lake beds. They also warned of not leaving the system dry too long and provided advice on the method of mimicking natural inundation when water does return. Their recommendations for watering actions have shaped environmental water planning for 2020–21.

Social, economic and recreational values and uses

In planning the potential watering actions in Table 5.2.10, Mallee CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, kayaking and fishing)
- riverside recreation and amenity (such as camping, photography, birdwatching and bushwalking)
- community events and tourism (such as 'Junior Ranger' school holiday programs including bushwalking, birdwatching and bug hunting, school education programs, citizen science projects (microbats), tours involving kayaking, mountain bike riding, camping, fishing and swimming)
- socio-economic benefits (such as beekeeping).

Recent conditions

Weather observations at the nearest weather station to Hattah Lakes in Ouyen indicate there was below-average rainfall and above-average temperatures in the area during 2019–20. The average maximum temperature at Ouyen during 2019–20 was less than the previous year, but long-term data indicates that temperatures have increased over the previous 10 years. Rainfall totals were substantially below average for the year. Overbank flows from the Murray River affect the ecology of the Hattah Lakes floodplain more than local weather conditions, but the trend of increasing temperature and decreasing rainfall is harmful to plant and animal communities between floods.

2019–20 was dry across the entire Murray River valley and the major upstream tributaries that contribute flows to the mid-Murray river system. There were no spills from major upstream storages and the magnitude of operational flows and environmental flows that were released was well below the threshold for inflows to Hattah Lakes.

Decisions about environmental watering interventions at Hattah Lakes during 2019–20 focussed on the need to water Lake Kramen — a disconnected wetland at the fringes of the system — and the need to dry the main southern Hattah Lakes.

At Lake Kramen, observations of tree health indicated that environmental watering was necessary during spring 2019 to avoid a permanent decline of vegetation condition, therefore environmental water was released as planned to Lake Kramen during August to October 2019.

Water for the environment delivered the last flood in the southern Hattah Lakes wetland complex in 2017. The wetlands have been allowed to draw down since then, and the last wetlands to hold water dried in February 2020. The moisture remaining in the lake-bed soils and local rainfall is supporting the growth and recruitment of specialised lake-bed native vegetation.

If there is no natural wetting before autumn 2021, the lake-bed vegetation in the southern Hattah Lakes will have likely completed its life cycle and will die off, due to reduced soil moisture. Water for the environment may be used in autumn/winter 2021 to refill these wetlands and restart the important wetting and drying cycle. Lake Kramen is expected to gradually draw down over several years. The planned timing of future environmental watering at Lake Kramen will be determined by the condition of the fringing vegetation.

Scope of environmental watering

Table 5.2.10 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.2.10 Potential environmental watering actions and objectives for the Hattah Lakes

Potential environmental watering action[1]	Functional watering objectives	Environmental objectives
Southern Hattah Lakes (fill of selected wetlands during autumn/winter 2021)	• Stimulate the growth and improve the condition of river red gums • Provide refuge and feeding habitat for waterbirds • Stimulate the growth of aquatic vegetation in wetlands that are currently dry	
Hattah Lakes (floodplain inundation up to 45.0 m AHD at any time if there is a natural flood)	• Wet river red gums and black box on the floodplain to stimulate growth and improve the condition of mature trees • Provide suitable soil conditions for the germination of black box trees on the floodplain and support the growth of trees that germinated in the flows provided in 2017 • Provide suitable conditions to support waterbird and woodland bird breeding and feeding • Provide connections to allow native fish to move between Hattah Lakes and the Murray River • Provide spawning and recruitment habitat for small-bodied native fish and nursery habitat for large-bodied native fish (such as golden perch)	

[1] The Hattah Lakes pump station may also be operated at any time of year for annual maintenance requirements.

Scenario planning

Table 5.2.11 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Environmental watering is planned under all scenarios during 2020–21. The magnitude, extent and duration of environmental watering will increase through the spectrum of dry, average and wet scenarios.

In the absence of a natural flood, the highest-priority potential watering action will be to fill up selected wetlands in the southern Hattah Lakes in autumn/winter 2021. Under drought and dry scenarios, water for the environment should target the lowest-lying wetlands: Lakes Bulla, Hattah, Little Hattah, Lockie, Yewell and Yerang. Watering these wetlands would create a mosaic of wetland habitats within the southern Hattah Lakes that are at different stages of their wetting and drying cycle and provide significant refuge for waterbirds and terrestrial fauna in a generally dry landscape.

Under an average scenario, potentially significant local rainfall and higher flows in the Murray River may provide an environmental cue to wet more wetlands. This would provide benefits for a larger area of native vegetation, increase the total amount of available habitat for waterbirds and provide the first opportunity in several years to grow waterbird populations.

If the potential watering actions planned for autumn/winter under the dry and average scenarios begin and cannot be completed by 30 June 2021, it will be necessary to continue watering into the 2021–22 water year.

In a wet scenario, natural flow is expected to wet Hattah Lakes, and environmental water may be used to extend the duration and extent of wetting to ensure parts of the floodplain that rely on natural floods are watered. Little or no environmental watering may be needed to supplement a large flood, but if there is only moderate natural flooding, the Hattah pumps may be used to enhance environmental outcomes.

The tier 2 watering actions that are identified would target extra wetlands and the floodplain to broaden the area watered and increase the overall environmental benefits. The tier 2 watering actions could be delivered if circumstances allow, but they can likely be deferred without significant environmental harm.

Table 5.2.11 Potential environmental watering for the Hattah Lakes under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Low flow year-round in the Murray River and no natural inflows to Hattah Lakes; substantial wetland drying will occur	• Rare high-flow events in the Murray River and no natural inflows to Hattah Lakes; substantial wetland drying will occur	• Short periods of high flow, most likely in late winter/spring, providing minor natural inflows to Hattah Lakes	• Lengthy periods of high flow with major spills from storages resulting in widespread wetting of Hattah Lakes and floodplain
Potential environmental watering – tier 1 (high priorities)[1]	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bulla, Hattah, Little Hattah, Lockie, Yewell and Yerang	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bulla, Hattah, Little Hattah, Lockie, Yewell and Yerang	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bulla, Hattah, Little Hattah, Lockie, Yewell, Yerang, Arawak, Boich, Brockie, Konardin, Marramook, Mournpall, Nip Nip and Tullamook	• Hattah Lakes (floodplain inundation up to 45.0 m AHD)
Potential environmental watering – tier 2 (additional priorities)		• Autumn/winter fill of southern Hattah Lakes, targeting lakes Arawak, Boich, Brockie, Konardin, Marramook, Mournpall, Nip Nip and Tullamook	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bitterang and Cantala	
Possible volume of environmental water required to achieve objectives[2]	• Up to 12,000 ML (tier 1)	• 12,000 ML (tier 1) • 18,000 ML (tier 2)	• 30,000 ML (tier 1) • 30,000 ML (tier 2)	• Up to 125,000 ML (tier 1)[3]

[1] Tier 1 potential environmental watering at Hattah Lakes is not classified as tier 1a or 1b, because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for Hattah Lakes.

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

[3] In a wet scenario, it is expected that natural floods will meet most of the required watering actions, with environmental water making up shortfalls as needed.

5.2.5 Lower Murray wetlands

System overview

The lower Murray wetlands are dispersed across the Murray River floodplain between Swan Hill and the South Australian border. The system includes a myriad of interconnected creeks, wetlands and floodplains that are ecologically important and reflect the natural character and attributes of the floodplain. While the number of wetlands across the lower Murray region are in their hundreds, about 54 of these have received water for the environment to date.

Regulation and diversion of Murray River flows have substantially reduced the frequency and duration of the high river flows that would naturally water the lower Murray wetlands. This change to the water regime has been exacerbated by climate change and has reduced the variety and condition of environmental values associated with billabongs and other floodplain habitats.

Water for the environment can be delivered to some wetlands in the region through direct pumping from the Murray River and/or use of irrigation supply infrastructure. Most wetlands that receive environmental flows can be managed independently of each other.

Some wetlands within the lower Murray region can receive water through weir pool manipulation and regulator operation, for improved environmental outcomes. However, because they do not receive held environmental water, they are not specified under this plan. Details of the environmental objectives associated with those wetlands can be found in the Mallee CMA's *Seasonal Watering Proposal for the Lower Murray Wetlands 2020–21*.

Environmental values

The lower Murray wetlands are comprised of multiple wetlands, creeks and billabongs. Depending on their location in the landscape, interactions with groundwater and their management history, the wetlands may be permanent or temporary, freshwater or saline. Differences in water regime and water quality between the wetlands provide a range of habitats for plants and animals. For example, permanent, saline wetlands (such as Koorlong Lake) provide vital habitat for the endangered Murray hardyhead fish. Ephemeral wetlands support different ecological processes in their wet and dry phases. During the wet phase, they provide short-term boom periods when river red gum trees and wetland plants grow, spread and provide habitat for aquatic animals (such as waterbugs, birds, frogs and in some cases fish). During the dry phase, sediments are exposed to the air (which is important for carbon and nutrient cycles), and terrestrial plants grow and complete life cycles.

Environmental watering objectives in the lower Murray wetlands

	Maintain and/or increase populations of native fish in permanent wetlands
	Maintain and/or grow populations of native frogs including the endangered growling grass frog
	Increase the diversity, extent and abundance of wetland plants Improve the condition of river red gums, black box and lignum
	Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial nesting species (such as egrets)

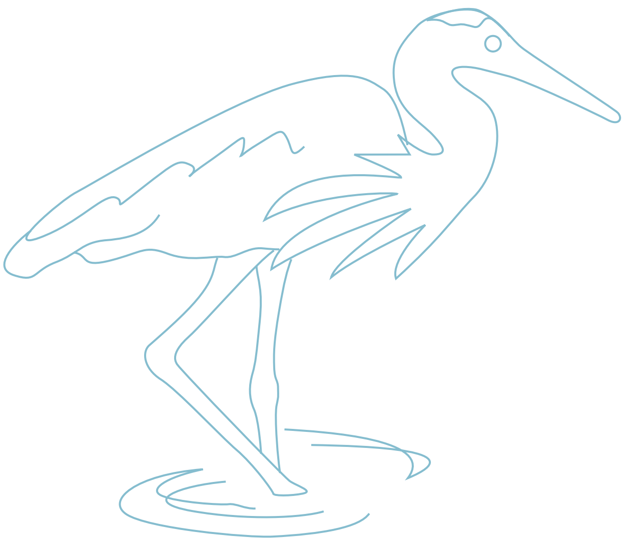
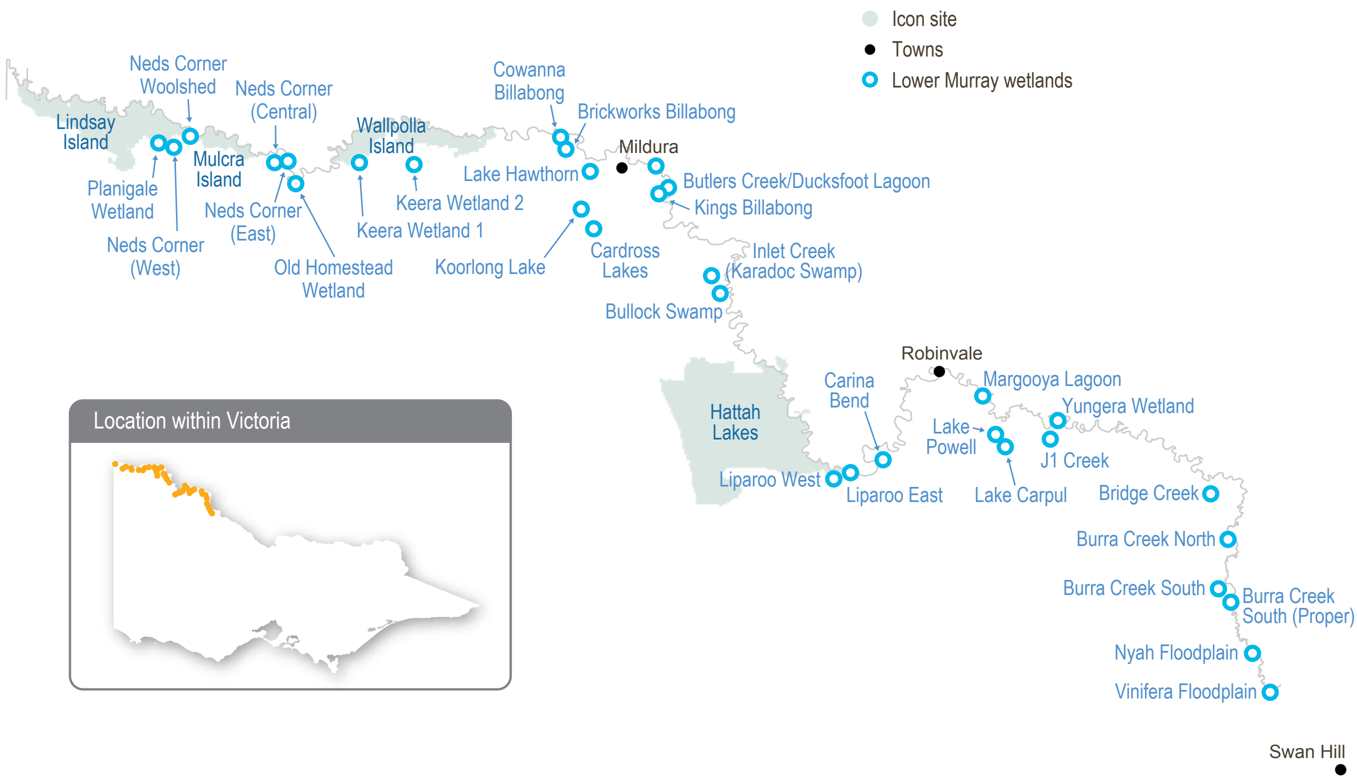


Figure 5.2.5 The lower Murray wetlands



Traditional Owner cultural values and uses

Watering of the lower Murray wetlands supports values such as traditional food sources and medicines, important species and provides opportunities for teaching, learning and storytelling.

Mallee CMA has met with the First People of Millewa-Mallee Aboriginal Corporation (representing Latji Latji, Ngintait, Nyeri Nyeri and Wergaia Traditional Owners), and representatives from Tati Tati, Weki Weki, Wadi Wadi, Gilby Corporation and Munutunga Elders. Discussions covered a range of options for how environmental flows can be delivered in 2020–2021 and what the traditional ecological needs were in the current climate. Elders participated in planning and prioritisation processes on Country important to them and relationships with the Mallee CMA were strengthened. The values, knowledge and concerns raised through these discussions have supported Mallee CMA's planning for wetland watering across the lower Murray region.Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.2.12 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

Robertson Creek is an area of high cultural significance that is being degraded as vegetation dies from lack of water and wind erodes the landscape. The First People of the Millewa Mallee Aboriginal Corporation are undertaking a program of restoration and protection work at the site. To complement the protection and restoration objectives, environmental water is planned to be delivered under all scenarios except drought, to improve the canopy cover of black box trees and to regenerate understory vegetation along Robertson Creek. In turn, the improved vegetation health will provide wind protection to the landscape alongside Robertson Creek.

Margooya Floodplain Wetland is a new site to be incorporated in the lower Murray wetlands environmental watering program in 2020-21. It is a small wetland to the north-east of Margooya Lagoon and the area is known to be of significant Indigenous cultural value. The main lagoon can receive water using existing infrastructure, but the surrounding floodplain is showing signs of drought stress. Mallee CMA has worked closely with the local Aboriginal community to identify potential watering actions to preserve and enhance cultural values at the site, including availability of traditional foods and medicines and preservation of an ecosystem and landscape used for ceremonies and featuring in song lines.

Social, economic and recreational values and uses

In planning the potential watering actions in Table 5.2.12, Mallee CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing, swimming and yabbying)
- riverside recreation and amenity (such as bushwalking, photography, running, yoga, geocaching, camping, birdwatching and four-wheel driving)
- community events and tourism (such as Parks Victoria's 'Junior Ranger' school holiday programs including bushwalking, birdwatching and bug hunting, citizen science projects (frogs and bats), community education and engagement programs, and tourists visiting the wetlands)
- socio-economic benefits (such as local businesses).

Recent conditions

The lower Murray region had below-average rainfall and above-average temperatures throughout 2019–20. Rainfall in some areas was the lowest recorded across two consecutive years. Flow in the Murray River was not sufficient to connect any wetlands on the lower Murray floodplain, and there was very limited run-off from local catchments.

In 2019–20, environmental water was delivered to 10 lower Murray wetlands that were identified as a high priority for environmental watering under a dry scenario. Most deliveries were in spring to maintain native vegetation, provide refuges for fish and waterbirds and maintain key ecosystem functions. Top-ups were provided to Lake Hawthorn, Brickworks Billabong and Koorlong Lake during summer and autumn to protect habitat for endangered Murray hardyhead.

During 2019–20, the Mallee CMA monitored water levels at wetlands that it had identified as important refuge habitats for native fish and frogs. Continued surveillance of refuge habitats will be a high priority in 2020–21.

Scope of environmental watering

Table 5.2.12 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.2.12 Potential environmental watering actions and objectives for the lower Murray wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Brickworks Billabong (fill in spring, with top-ups over summer/autumn as required)	• Fill in spring to 34.0 m AHD (Australian Height Datum) to wet and grow ruppia to provide nursery habitat for Murray hardyhead, and provide high levels of aquatic productivity • Allow natural recession of a maximum 1 m in late summer/autumn (to 33.0 m AHD) to provide shallow-water habitat and expose the mudflats to support foraging and resting of small waders	
Lake Hawthorn (top up in spring/summer/autumn as required)	• Fill the wetland to 33.3 m AHD to encourage the germination and growth of ruppia to provide nursery habitat for Murray hardyhead and visitation by shorebirds • Maintain water levels within a 30 cm range to provide resources for shorebirds and to maintain the Murray hardyhead population	
Koorlong Lake (top up in spring/summer/autumn as required)	• Fill the wetland to 38.0 m AHD in spring to support the growth of ruppia to provide nursery habitat for Murray hardyhead and provide high levels of aquatic productivity • Maintain water levels within a 30 cm range to provide resources for shorebirds and to maintain the Murray hardyhead population	
Margooya Floodplain Wetland (fill in autumn)	• Wet the floodplain to improve the health of the river red gum	
Robertson Creek (fill in spring)	• Fill the creek to wet the vegetation on the creek bed, banks and terraces to maintain the health and persistence of fringing black box and lignum communities	
Neds Corner Woolshed (through-flow in spring)	• Slow through-flow to allow seepage and fill deeper holes, to maintain the health of the fringing red gum vegetation communities and water-dependent species	
Bidgee lagoons (fill in spring)	• Fill the wetlands to maintain the health of river red gum communities, promote emergent vegetation communities and provide habitat for waterbirds	
Robertson Wetland (west) (partial fill in spring)	• Partially fill the wetland to promote the growth of cane grass and lignum and provide habitat for waterbirds	
Fishers lagoons (fill in spring)	• Fill the wetland to maintain the health of fringing river red gum communities	
Burra Creek South proper (fill in spring)	• Fill the creek line to maintain the fringing river red gum communities	
Lake Powell (fill in spring)	• Fill the lake to maintain the river red gum communities • Improve nesting habitat for waterbirds in flooded trees bordering the lake	
Lake Carpul (fill in spring)	• Fill the lakes to maintain the river red gum communities • Improve nesting habitat for waterbirds in flooded trees bordering the lake	

Scenario planning

Table 5.2.13 outlines the potential environmental watering and expected water use under a range of planning scenarios.

In the event of ongoing dry conditions, a modest watering program is proposed for the 2020–21 year. The highest priority under all scenarios is to ensure water and salinity levels at Brickworks Billabong, Lake Hawthorn and Koorlong Lake are suitable to protect the endangered Murray hardyhead. Lake Hawthorn and Koorlong Lake will likely require managed environmental water deliveries under all scenarios, but natural floods are likely to meet the required watering regime at Brickworks Billabong under a wet scenario. Maintaining varying levels of permanent water at these sites also provides shallow-water habitat for wading, feeding and loafing by small wading bird species and migratory birds.

Under dry and average scenarios, additional priority sites include Robertson Creek, Neds Corner Woolshed Creek, Margooya Floodplain Wetland and the Bidgee lagoons (see the additional information below). The target water levels and volumes delivered to these sites may vary under each scenario depending on the available water, local rainfall and assessed environmental conditions. The rationale for watering these sites in 2020–21 is described below.

Robertson Creek contains black box woodland and shrubby understory communities, which are currently in poor condition and considered to have a low resilience to ongoing drought. Watering at this site aims to improve the condition of these vegetation communities and help protect nearby areas of cultural significance.

Watering at Neds Corner Woolshed Creek in 2019–20 had a very positive effect on native plants and animals at the site. Follow-up watering in 2020–21 will help improve the condition of the low herb communities at the wetland base and the large old river red gums, and it will build their resilience.

Under dry and average scenarios, environmental water may be pumped from the Murray River into the Margooya floodplain wetland in autumn 2021 to improve the health of river red gum that haven't been wetted since the 2016 floods. This watering will support Aboriginal cultural objectives at the site.

The Bidgee lagoons support two water-dependent ecological vegetation classes (floodplain grassy wetland and riverine chenopod woodland) that are classified as endangered in the Murray Fans bioregion. The lagoons have received water four times in the last 10 years, but the duration of these natural events was relatively short and did not deliver the environmental benefit expected of longer-duration events. Vegetation in some parts of the lagoons is in moderate condition, but vegetation in other areas is in poor condition. Targeted environmental watering is planned under dry and average scenarios in 2020–21 to improve the condition of vegetation communities across the whole site.

Under a wet scenario, many wetlands across the lower Murray floodplain are likely to be watered by natural floods and local rainfall. The only high-priority sites that are likely to require environmental water to meet their recommended watering regime under wet conditions are Lake Hawthorn, Koorlong Lake, Robertson Creek and Burra Creek South proper.

Burra Creek South proper has received water only twice in the last 10 years, with environmental water delivered in 2013–14 and 2014–15; and it did not receive any flood water in 2016. The site contains lignum, red gum and black box communities and was last observed in 2018 as being in moderate condition. However, due to persistent dry conditions after 2016, the site is at risk of deterioration. A fill in spring would improve vegetation condition and provide habitat for waterbirds and waterbugs.

If more water is available under average or wet conditions, it may be used to improve the condition of other sites on the lower Murray floodplain considered a lower priority. Under average conditions, extra water may be used at Robertson Wetland and Fishers lagoons. Under wet conditions, extra water may be used at Lake Powell and Lake Carpul. Watering these sites in 2020–21 if the opportunity arises will reduce the need to water them in the next one to two years if dry conditions return.

Table 5.2.13 Potential environmental watering for the lower Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural flow in the Murray River year-round and wetlands rely on delivery of water for the environment; very low rainfall year-round and extremely hot and dry conditions in summer/autumn causes substantial wetland drying	• Short periods of high flow in the Murray River are possible, however overbank flows to wetlands are unlikely; low rainfall and very warm summer/autumn	• Sustained periods of high flow in the Murray River in late winter and early spring may wet some low-lying wetlands but most wetlands will rely on delivery of water for the environment • Local rainfall may be high and provide run-off to some wetlands	• Lengthy periods of high flow and floods with major spills from storages, resulting in widespread wetting of the floodplain and most wetlands • Some reliance on water for the environment to achieve target water levels • Local rainfall may be high and will provide run-off to most wetlands
Potential environmental watering – tier 1 (high priorities)[1,2]	• Brickworks Billabong • Lake Hawthorn • Koorlong Lake	• Brickworks Billabong • Lake Hawthorn • Koorlong Lake • Margooya floodplain wetland • Robertson Creek • Neds Corner Woolshed Creek • Bidgee lagoons	• Brickworks Billabong • Lake Hawthorn • Koorlong Lake • Margooya Floodplain Wetland • Robertson Creek • Neds Corner Woolshed Creek • Bidgee lagoons	• Lake Hawthorn • Koorlong Lake • Robertson Creek • Burra Creek South proper
Potential environmental watering – tier 2 (additional priorities)	• n/a	• n/a	• Robertson Wetland (west) • Fishers lagoons	• Lake Powell • Lake Carpul
Possible volume of environmental water required to achieve objectives[3]	• 1,970 ML (tier 1)	• 3,555 ML (tier 1)	• 3,835 ML (tier 1) • 710 ML (tier 2)	• 2,200 ML (tier 1) • 6,200 ML (tier 2)

1 Tier 1 potential environmental watering at the lower Murray wetlands is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the lower Murray wetlands.

2 Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios.

3 Environmental water requirements for tier 2 actions are additional to tier 1 requirements

5.2.6 Lindsay, Mulcra and Wallpolla islands

System overview

Lindsay, Mulcra and Wallpolla islands cover over 26,100 ha of Victorian floodplain in the Murray-Sunset National Park, as Figure 5.2.5 shows. They form part of the Chowilla Floodplain and Lindsay-Wallpolla islands icon site that straddles the Victoria–SA border in the mid-Murray River system.

The Lindsay, Mulcra and Wallpolla islands floodplain is characterised by a network of permanent waterways, small creeks and wetlands. The Lindsay River, Potterwalkagee Creek and Wallpolla Creek form the southern boundaries of the site and create large floodplain islands with the Murray River to the north.

In their natural state, these waterways and wetlands would regularly flow and fill in response to high water levels in the Murray River. Large floods still occur, but major storages in the upper reaches of the Murray River system have reduced the frequency of small- to moderate-sized floods.

Flows in the mid-Murray River system are regulated through a series of weir pools, generally referred to as locks. Water levels in the weir pools are managed primarily to provide safe navigation and adequate water levels for off-stream diversion via pumps. In recent years, the water level of weir pools 7 and 8 has also been managed to achieve ecological benefits in the Murray River channel, for example by lowering pool levels to increase the velocity of flowing water, which can support drift of golden and silver perch larvae when conditions are suitable for breeding.

Weir pool levels have a big effect on flows in Mullaroo Creek, the Lindsay River and Potterwalkagee Creek. When water levels in locks 7 and 8 are raised above the full supply level, flows to Potterwalkagee Creek increase and Lindsay River starts flowing. When weir pools are lowered, flows to both the Lindsay River and Potterwalkagee Creek cease. Mullaroo Creek is less-affected by weir pool levels and flows are controlled through the Mullaroo Creek regulator which connects the creek and the Murray River. Moderate lowering of the lock 7 weir pool level has little effect on Mullaroo Creek but lowering to or beyond 0.5 m below full supply level makes it difficult to deliver the recommended minimum flow of 600 ML per day that is required to maintain fast-flowing habitat for native fish, especially Murray Cod.

Fluctuation of weir pool levels is a major consideration for jurisdictions managing flows in the Murray River and the anabranch waterways of Lindsay, Mulcra and Wallpolla islands. Environmental objectives and associated water regimes for the Murray River sometimes conflict with those for the Lindsay, Mulcra and Wallpolla anabranch systems. Responsible agencies in Victoria and NSW and the Murray-Darling Basin Authority collaboratively plan how to manage weir pools and flows effectively.

Environmental values

The Lindsay, Mulcra and Wallpolla islands represent three separate anabranch systems including streams, billabongs, large wetlands and swamps. When flooded, waterways and wetlands within these systems provide habitat for native fish, frogs, turtles and waterbirds. Terrestrial animals (such as woodland birds) also benefit from improved productivity and food resources when the system floods. Large floodplain wetlands (such as Lake Wallawalla) can retain water for several years after receiving inflows; they provide important refuge for wetland-dependent species and support terrestrial animals (such as small mammals and reptiles).

Mullaroo Creek and the Lindsay River support one of the most-significant populations of Murray cod in the lower Murray River. These waterways provide fast-flowing habitat that Murray cod favour, and contrast with the mostly slow-flowing and still habitats created by the nearby Murray River weir pools. Fish in Mullaroo Creek and Lindsay River breed and produce juveniles that colonise other parts of the Murray system. Waterways and wetlands throughout the icon site support several other fish species including freshwater catfish, golden perch, silver perch, Murray-Darling rainbowfish and unspecked hardyhead.

The reduced frequency and duration of floods in the Murray River has degraded the water-dependent vegetation communities throughout the Lindsay, Mulcra and Wallpolla island system, which has in turn reduced the diversity and abundance of animals that rely on healthy vegetation for habitat.

Environmental watering objectives for Lindsay, Mulcra and Wallpolla islands

	Restore nutrient and carbon cycling between floodplains, floodplain wetlands and waterways to increase ecosystem productivity
	Increase the abundance, diversity and distribution of native fish
	Support frog populations
	Support waterbug populations
	Support turtle populations
	Increase the abundance and diversity of wetland vegetation
	Increase the waterbird population by providing feeding and breeding habitat in floodplain wetlands

Traditional Owner cultural values and uses

Mallee CMA has met on Country with Traditional Owners of Lindsay, Mulcra and Wallpolla islands and the First People of the Millewa-Mallee Aboriginal Corporation (representing Latji Latji, Ngintait, Nyeri Nyeri and Wergaia Traditional Owners) to discuss watering requirements for their Country. After much discussion, Elders' key focus was to support Country to recover from the ravages of drought. Their recommendations for watering actions have shaped the environmental water planning for 2020–21.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.14, Mallee CMA has also considered how environmental flows could support other values and uses such as:

- water-based recreation (such as kayaking, fishing and swimming)
- riverside recreation and amenity (such as walking, camping, birdwatching and relaxing with friends and family)
- community events and tourism (such as school education programs, commercial tours and citizen science projects)
- socio-economic benefits (such as apiarists, local businesses such as accommodation and shops).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.2.14 with an icon.

	Watering planned to support angling activities

Native recreational fish species that are stocked into recently wetted wetlands can undergo rapid growth and achieve high survival rates. In March 2019, the Victorian Fisheries Authority conducted a trial in partnership with First People of the Millewa-Mallee Aboriginal Corporation and Mallee CMA that released 120,000 juvenile golden perch and silver perch to Wallpolla Horseshoe Lagoon.

In order to protect the juvenile perch, water will be delivered to the lagoon as a series of top-ups as required in spring and autumn, as part of the regular environmental water deliveries to support the naturally occurring environmental values of the site (such as fish and aquatic vegetation).

The stocked native fish are expected to benefit from environmental watering at Wallpolla Horseshoe Lagoon without compromising the primary watering objectives for the site. Once the fish have grown to a suitable size, they will be released into the Murray River to contribute to the regional populations and provide opportunities for anglers.

Recent conditions

Weather observations at Lake Victoria — the nearest weather station to Lindsay, Mulcra and Wallpolla islands — indicate there was below-average rainfall and above-average temperatures in the region during 2019–20. The average maximum temperature at Lake Victoria during 2019–20 was less than in the previous year, but long-term data indicates that temperatures have increased over the previous 10 years. Monthly rainfall totals were substantially below average for the year.

The 2019–20 year was mostly dry in the entire Murray River valley and major upstream tributaries (such as the Goulburn and Murrumbidgee rivers). There were no spills from major upstream storages, and the magnitudes of operational flows and environmental flows that were released in the Murray system were well below the threshold required to provide flows to wetlands and floodplains at Lindsay, Mulcra and Wallpolla islands. Summer floods in northern New South Wales (NSW) and Queensland provided flow in the Darling River and in April 2020 the Darling River provided substantial flow to the Murray River for the first time in more than two years. This inflow was well below the magnitude needed to wet Lindsay, Mulcra and Wallpolla islands.

All of the high-priority potential watering actions were delivered during 2019–20. These included year-round flows to maintain fish habitat in Mullaroo Creek and spring high flows in Mullaroo Creek, Potterwalkagee Creek and the upper reaches of the Lindsay River to help native fish disperse, spawn and recruit. Water for the environment was also pumped to wetlands and creeks on Wallpolla Island in spring and autumn, to improve vegetation condition and provide habitat for waterbirds and fish.

Scope of environmental watering

Table 5.2.14 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

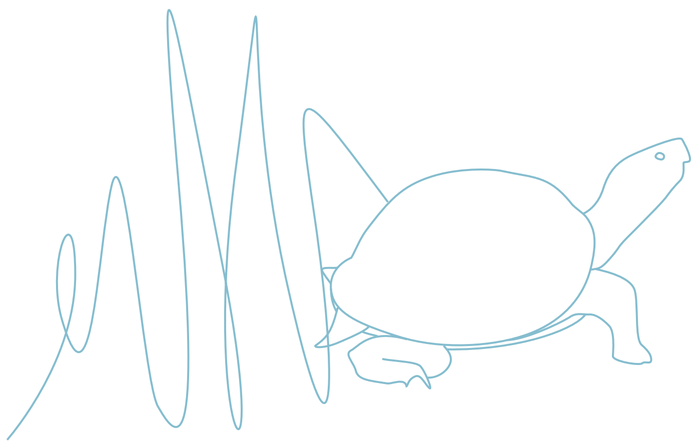


Table 5.2.14 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Lindsay Island – Mullaroo Creek		
Year-round low flow (minimum of 600 ML/day)	• Maintain fast-flowing habitat for native fish (such as Murray cod, silver perch and golden perch) • Maintain habitat for aquatic vegetation and maintain soil moisture to maintain the condition of streamside vegetation	
Spring fresh (one fresh of up to 1,000-1,400 ML/day for three months during September to November)	• Cue fish movement and spawning and improve recruitment opportunities for native fish	
Lindsay Island – Lindsay River		
Spring/summer fresh (one fresh of 65-200 ML/day via the northern regulator and one fresh of 20-200 ML/day via the southern regulator for a maximum of four months during September to December)	• Provide temporary flowing water to reconnect pools and support dispersal, spawning and recruitment opportunities for native fish • Wet the substrate and debris (snags) close to the bank to promote the growth of biofilms, which provide a food source for animals higher in the food chain	
Autumn/winter fresh (one fresh of 130 ML/day via the northern regulator and 90 ML/day via the southern regulator for two months during May to June)	• Wet the substrate and debris (snags) close to the bank to promote the growth of biofilms, which provide a food source for animals higher in the food chain[1]	
Lindsay Island wetlands		
Websters Lagoon (complete fill in spring)	• Provide a connection between Websters Lagoon and the Murray River to allow the exchange of carbon, nutrients and fish between the wetland and the river • Provide conditions for lake bed herbaceous plants and semi-aquatic plants in the littoral zone to grow in the drying phase after watering • Provide variable water levels in the littoral zone to provide feeding habitat for shorebirds • Provide open-water habitat as refuge and feeding and breeding habitat for waterbirds	
Scotties Billabong (complete fill in spring)	• Provide shallow-water habitat to provide foraging and breeding opportunities for frogs • Stimulate the growth of streamside and instream vegetation • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	
Wetland 33 (complete fill in spring)	• Fill to the wetland fringe to increase growth of shrubs and lignum on the wetland fringe • Provide shallow-water habitat and open-water habitat to create foraging opportunities for waterbirds, frogs and turtles • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	
Lindsay-Mullaroo connector (complete fill in spring)	• Provide a temporary connection to the Lindsay River to allow the exchange of nutrient, carbon and plant propagules • Provide conditions for lake bed herbaceous plants and semi-aquatic plants to grow in the littoral zone in the drying phase after watering • Stimulate the growth of severely stressed streamside vegetation	

Table 5.2.14 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands *(continued)*

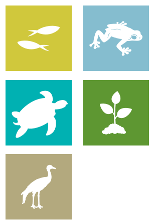
Potential environmental watering action	Functional watering objectives	Environmental objectives
Crankhandle (complete fill in spring)	• Provide shallow-water habitat to provide foraging and breeding opportunities for frogs • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering • Fill to the wetland fringe to increase the growth of shrubs and lignum on the wetland fringe	
Lake Wallawalla (partial fill in autumn/winter)	• Provide shallow-water habitat, open-water habitat and shoreline habitat to create foraging opportunities for waterbirds, frogs and turtles • Break the dormancy of yabbies so they emerge from burrows, feed and reproduce • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	
Mulcra Island – Potterwalkagee Creek		
Winter/spring fresh (one fresh of 90-475 ML/day via the Stoney Crossing regulator and 440 ML/day via the upper Potterwalkagee Creek regulator for a maximum of five months during September to November)	• Provide temporary flowing water to reconnect pools and support dispersal, spawning and recruitment opportunities for native fish • Wet the substrate and debris (snags) close to the bank to promote the growth of biofilms, which provide a food source for animals higher in the food chain • Maintain soil moisture to maintain the condition of streamside vegetation	
Mulcra Island – wetlands		
Mulcra Horseshoe (complete fill in spring)	• Provide shallow-water habitat and open-water habitat to create foraging and breeding opportunities for waterbirds, frogs and turtles • Provide a connection to the Murray River to support dispersal, spawning and recruitment opportunities for native fish • Stimulate the growth of emergent, aquatic and streamside vegetation • Provide a connection to the Murray River to allow the exchange of carbon, nutrients between the floodplain and the river	
Mulcra Island floodplain (floodplain inundation in spring)	• Stimulate the growth of emergent, aquatic and streamside vegetation • Provide shallow-water habitat and open-water habitat to create foraging and breeding opportunities for waterbirds, frogs and turtles • Support fish spawning events and provide temporary habitat for juvenile fish	
Snake Lagoon (complete fill on spring)	• Stimulate growth of emergent, aquatic and streamside vegetation • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	

Table 5.2.14 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Wallpolla Island		
Wallpolla Horseshoe Lagoon (partial or complete fill in spring/autumn)	• Wet/drown river red gum saplings in the bed of Wallpolla Horseshoe to limit their coverage • Provide suitable breeding conditions for waterbirds • Provide shallow-water habitat and open-water habitat to create foraging and breeding opportunities for waterbirds, frogs and turtles • Provide the conditions for lake bed herbaceous plants and semi-aquatic plants to grow in the littoral zone during the drying phase after watering • Provide nursery habitat for naturally occurring fish populations and juvenile golden perch and silver perch stocked by Victorian Fisheries Authority to increase growth rates before fish are released to the Murray River	
Finnigans Creek (low flow in spring) Sandy Creek (low flow in winter/spring) Wallpolla Creek East (low flow in winter/spring)	• Provide connections between Wallpolla East, Sandy Creek and Finnigans Creek to allow nutrient exchange, increased wetland productivity and the dispersal of plant propagules • Provide variable water levels in the littoral zone to improve wetland productivity and promote the growth of native aquatic and fringing plants • Provide variable water levels in the littoral zone to provide feeding habitat for shorebirds • Provide open-water habitat to create foraging opportunities for waterbirds	

[1] The autumn fresh in the Lindsay River also has an operational objective of providing water that can be efficiently delivered to Lake Wallawalla via pumping.

Scenario planning

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

There are two categories of planned environmental watering opportunities for Lindsay, Mulcra and Wallpolla islands in 2020–21:

- environmental watering of anabranch waterways (Mullaroo Creek, Lindsay River and Potterwalkagee Creek) and floodplain wetlands in coordination with operation of weir pools
- a program of small-scale pumping to deliver water to individual wetlands at Lindsay and Wallpolla islands.

Of the waterways and floodplain wetlands connected to the weir pools, the only sites proposed to receive environmental water under all planning scenarios are Mullaroo Creek and Websters Lagoon. Even under drought conditions, it is essential to provide flows to Mullaroo Creek to maintain flowing water habitat for large-bodied native fish. Websters Lagoon can be efficiently managed via a regulator to provide an annual wet-dry cycle under all scenarios. Under an average scenario, environmental water may be delivered to Lindsay River and Potterwalkagee Creek in spring, when locks 7 and 8 will be at suitable levels. These locks are expected to be lowered during summer/autumn under an average scenario and all year under a drought or dry scenario, which will prevent flow into Lindsay River and Potterwalkagee Creek. No environmental watering is planned for these systems under a wet scenario, because natural flows and floods are likely to meet all ecological watering requirements.

Water for the environment may be pumped to up to nine high-priority wetlands and ephemeral creek lines across Lindsay and Wallpolla Islands in 2020–21. Water will need to be pumped directly into Wallpolla Horseshoe under drought, dry and average scenarios, but it is expected to fill naturally under a wet scenario. Other wetlands on Lindsay and Wallpolla islands are likely to need active watering under dry and average scenarios. Most of these wetlands will likely be watered in spring 2020, but pumping at Lake Wallawalla is planned to commence in autumn 2021 under average and wet scenarios and continue through to late spring 2021. All sites are expected to receive natural inflows under a wet scenario; but if only minor-to-moderate flooding occurs, pumping may still be required to reach target water levels in Lake Wallawalla and Wallpolla Creek East.

Additional environmental watering priorities (tier 2) have been identified for Lindsay and Mulcra islands wetlands and floodplain under dry and average scenarios. The tier 2 priorities identified are critical to achieving environmental objectives at the site in the long term and could be delivered in 2020–21 if circumstances allow, but they could be deferred without significant environmental harm.

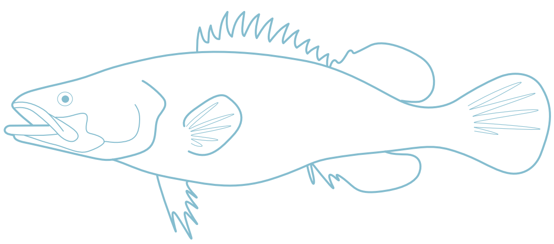


Table 5.2.15 Potential environmental watering for Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet[1]
Expected conditions	• Year-round low flow in the Murray River and no natural floodplain wetting. Weir pools will be drawn down below full supply level year-round. Substantial wetland drying will occur.	• Rare high-flow events in the Murray River and no natural floodplain wetting. Weir pools will be drawn down below full supply level year-round. Substantial wetland drying will occur.	• Short periods of high flow, most likely in late winter/spring, providing minor wetting of the floodplain. Weir pool levels raised in winter/spring and drawn down in summer/autumn.	• Long periods of high flow, with major spills from storages resulting in widespread wetting of the floodplain and wetting of most wetlands. Weirs would be removed to allow the passage of natural flows.
Lindsay Island				
Lindsay Island potential environmental watering – tier 1 (high priorities)[2]	• Year-round low flow (Mullaroo Creek) • One spring fresh (Mullaroo Creek) • Websters Lagoon (complete fill)	• Year-round low flow (Mullaroo Creek) • One spring fresh (Mullaroo Creek) • Websters Lagoon (complete fill) • Scotties Billabong (complete fill) • Wetland 33 (complete fill) • Lindsay-Mullaroo connector (complete fill) • Crankhandle (complete fill)	• Year-round low flow (Mullaroo Creek) • One spring fresh (Mullaroo Creek) • One spring fresh (Lindsay River) • One autumn/winter fresh (Lindsay River) • Websters Lagoon (complete fill) • Scotties Billabong (complete fill) • Wetland 33 (complete fill) • Lindsay-Mullaroo connector (complete fill) • Crankhandle (complete fill) • Lake Wallawalla (partial fill)	• One autumn/winter fresh (Lindsay River) • Lake Wallawalla (partial fill)
Possible volume of water for the environment required to achieve objectives[3]	• < 950 ML	• 950 ML	• Up to 6,250 ML	• Up to 4,000 ML

Table 5.2.15 Potential environmental watering for Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios *(continued)*

<table>
<tr><th>Planning scenario</th><th>Drought</th><th>Dry</th><th>Average</th><th>Wet[1]</th></tr>
<tr><td colspan="5">Mulcra Island</td></tr>
<tr><td>Potterwalkagee Creek potential environmental watering – tier 1 (high priorities)[2]</td><td colspan="2">• N/A</td><td>• One spring fresh (Potterwalkagee Creek)</td><td>• N/A</td></tr>
<tr><td>Potterwalkagee Creek potential environmental watering – tier 2 (additional priorities)</td><td colspan="2">• N/A</td><td>• Mulcra Horseshoe (complete fill)
• Mulcra Island floodplain inundation
• Snake Lagoon (complete fill)</td><td>• N/A</td></tr>
<tr><td>Possible volume of water for the environment required to achieve objectives[4,5]</td><td colspan="2">• 0 ML</td><td>• Up to 3,000 ML (tier 1)
• Up to 3,000 ML (tier 2)</td><td>• 0 ML</td></tr>
<tr><td colspan="5">Wallpolla Island</td></tr>
<tr><td>Wallpolla Island wetlands potential environmental watering – tier 1 (high priorities)[2]</td><td>• Wallpolla Horseshoe Lagoon (partial fill)</td><td>• Wallpolla Horseshoe Lagoon (partial fill)
• Finnigans Creek
• Sandy Creek
• Wallpolla Creek East</td><td>• Wallpolla Horseshoe Lagoon (partial fill)
• Finnigans Creek
• Sandy Creek
• Wallpolla Creek East</td><td>• Wallpolla Creek East</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)</td><td>• 400 ML</td><td>• 4,900 ML</td><td>• 4,900 ML</td><td>• 1,000 ML</td></tr>
</table>

[1] Natural wetting of wetlands and the floodplain under a wet scenario achieves the environmental watering requirements of most sites, so few potential watering actions are planned under a wet scenario.

[2] Tier 1 potential environmental watering at Lindsay, Mulcra and Wallpolla islands are not classified as tier 1a or 1b, because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the Lindsay, Mulcra and Wallpolla islands.

[3] These estimates include environmental use for Mullaroo Creek, Lindsay River and the lock 7 weir pool. Environmental water used at these sites may be accounted for in Victoria and New South Wales.

[4] These estimates include environmental use for Potterwalkagee Creek, Mulcra Island and the lock 8 weir pool. Environmental water used at these sites may be accounted for in Victoria and New South Wales.

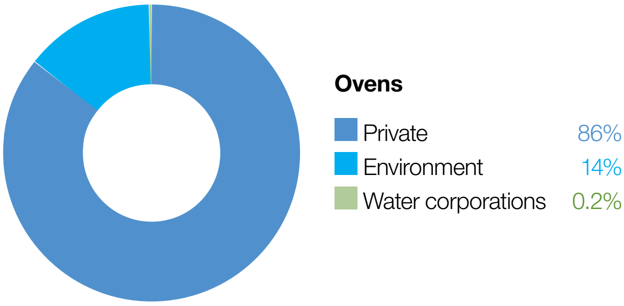
[5] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

5.3 Ovens system

Waterway manager – North East Catchment Management Authority
Storage manager – Goulburn-Murray Water
Environmental water holder – Commonwealth Environmental Water Holder

Did you know...?

In June 2019 and March 2020, 39 ML of water owned by Taungurung Land and Waters Council was delivered as an environmental flow down the King River. The flows have contributed to healing Country by providing a boost to the health and productivity of the waterway.



Proportion of water entitlements in the Ovens basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Buffalo River, by Natalie Ord courtesy of North East CMA
Above: Catfish release at Mullinmur Wetland, by Manifeasto Photography

System overview

The Ovens River rises in the steep, forested mountains of the Great Dividing Range near Mount Hotham and flows about 150 km to join the Murray River in the backwaters of Lake Mulwala. The system contains two small water storages: Lake Buffalo on the Buffalo River and Lake William Hovell on the King River. The regulated reaches of the Ovens system include the Buffalo and King rivers below these storages and the Ovens River from its confluence with the Buffalo River to the Murray River.

As its storages are quite small and spill regularly, the Ovens system maintains a large proportion of its natural flow regime, particularly in winter/spring. However, the storages and licensed water extractions throughout the system can restrict flow during low flow periods, and parts of the system can become quite flow stressed during summer and autumn.

The Ovens River flows into Lake Mulwala on the Murray River, the largest weir pool on the Murray regulated system. Ovens River flows contribute to the reliability and variability of flows in the Murray River and support many downstream uses including irrigation, urban supply and watering of iconic floodplain sites (such as Barmah Forest).

Water for the environment is held in Lake Buffalo and in Lake William Hovell and can be released when the storages are not spilling. Five reaches in the Ovens system can benefit from releases of water for the environment. While all are important, there is a relatively small volume (123 ML) of water available, and it is insufficient to meet most of the environmental flow objectives. The available water is used selectively to deliver the greatest possible environmental benefit. Water for the environment is most commonly used in the Ovens system to deliver critical flow events in reaches immediately below the two main storages, or it is used in conjunction with operational water releases to influence flow in the lower Ovens River. It is also used to fill and top up Mullinmur Wetland in Wangaratta.

Environmental values

The diverse aquatic habitat and abundant food resources associated with the Ovens system support a wide range of native fish species including Murray cod, trout cod, golden perch and unspecked hardyhead. The Buffalo River provides valuable habitat for large-bodied fish species during part of their breeding cycle, while trout cod have a large range within the system and are found as far up the King River as Whitfield. A project to recover trout cod populations in the Ovens system has been successful, and efforts to reintroduce Macquarie perch are continuing.

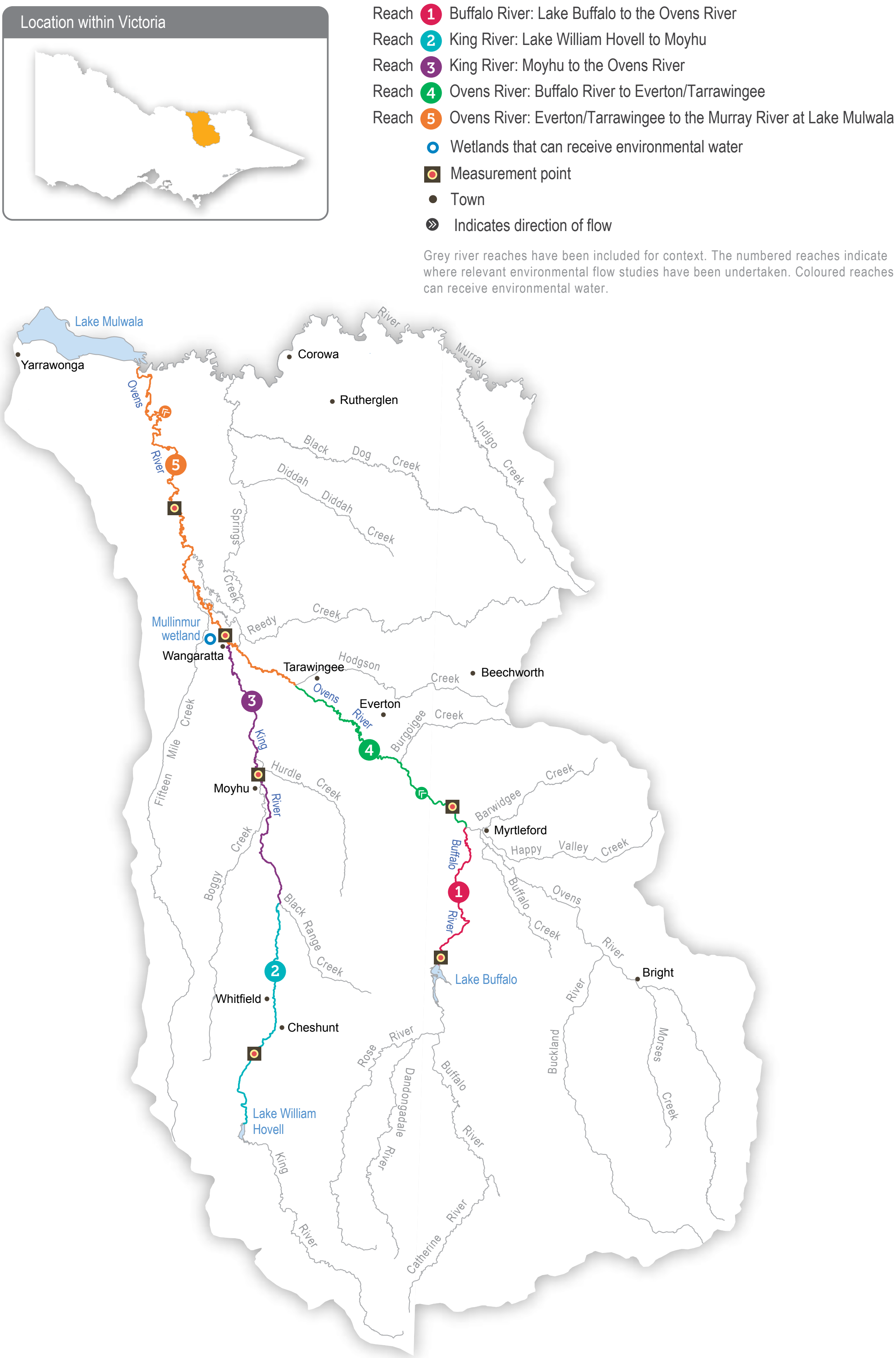
Frogs (such as the giant banjo frog and growling grass frog) are abundant in the lower reaches and associated wetlands of the Ovens River and in the King River above Cheshunt. The lower Ovens wetland complex contains over 1,800 wetlands, is listed as nationally significant and is home to a variety of waterbirds including egrets, herons, cormorants and bitterns. The streamside zones of river channels throughout the Ovens system support some of Victoria's healthiest river red gum forests and woodlands, while the wetlands support a variety of aquatic and semi-aquatic vegetation communities.

Water for the environment was delivered to Mullinmur Wetland at Wangaratta for the first time in 2019–20. This site has been the focus of several environmental improvement projects in recent years. Specific management actions include carp removal, a revegetation program and a project that started in December 2019 to determine whether the wetland can support a sustainable brood stock population of native freshwater catfish. The Arthur Rylah Institute translocated 60 freshwater catfish into Mullinmur Wetland in December 2019, and ongoing monitoring throughout 2020–21 will assess the viability of the population.

Environmental watering objectives in the Ovens System

- Maintain the size and distribution of native fish populations
- Maintain the form of the riverbank and channel and ensure river bed surfaces are in suitable condition to support all stream life
- Maintain the condition and extent of wetland vegetation communities
- Maintain an adequate abundance and diversity of waterbugs, to support river food webs and associated ecosystem processes
- Maintain water quality for all river life

Figure 5.3.1 The Ovens system



Traditional Owner cultural values and uses

North East CMA has consulted with Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation in environmental water planning for the Ovens system. The environmental and ecological objectives of the proposals were supported and align with the broad values of these Traditional Owner groups. Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in 5.3.1 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

Taungurung Land and Waters Council may consider using their water entitlement in the King River system to support environmental objectives as part of their goal of healing Country. Taungurung Land and Waters Council's 39 ML of allocation has been released from Lake William Hovell twice previously as an environmental flow in partnership with North East CMA, Goulburn-Murray Water and the VEWH to provide additional water to the King River and assist in healing Country. The flow provided a small variation within the water level to inundate new habitat for instream biota (fish and macroinvertebrates), allowing them to move more freely and find new sources of food.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.3.1, North East CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as boating and fishing)
- riverside recreation and amenity (such as camping)
- community events and tourism (such as providing a setting for community gatherings and sporting events, and citizen science projects)
- socio-economic benefits (such as businesses used by anglers).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.3.1 with an icon.

Watering planned to support angling activities

Environmental water will be used to top up Mullinmur Wetland over summer, support aquatic vegetation and support native catfish which were translocated to the wetland in 2019 from a drying lake in Barham, New South Wales. This will enable the site to be used as a catfish broodstock location for future reintroductions into the region.

The water will also support other benefits for the local community, as the site is managed by the Catholic Education Department with support from Wangaratta Landcare and Sustainability Incorporated. It is used as a community and environmental educational site for Galen Catholic College students, young people attending the Borinya Wangaratta Community Partnership and other members of the local community, demonstrating the important ecological functions that wetlands provide and how water for the environment is used to support ecological values.

Recent conditions

Hot, dry conditions prevailed throughout much of the Ovens River catchment in 2019–20, resulting in flows into Lake Buffalo and Lake William Hovel being well below the long-term average until rainfall began filling storages in March 2020. Water for the environment held in Lake Buffalo was used in conjunction with an operational bulk water transfer to deliver a small autumn fresh in the Buffalo River in early March. Small increases in river height were also observed in reach 4 of the Ovens River during this fresh. Water for the environment was delivered in conjunction with water held by the Taungurung Land and Waters Council from Lake William Hovell in late March, providing flow variability to reaches 3 and 4 of the King River.

Bushfires burnt large areas of the catchment above Lake Buffalo during summer, and subsequent heavy rainfall washed ash and other sediment into upstream tributaries, causing poor water quality on occasions in the Buffalo and Ovens rivers. Natural events, operational deliveries and the use of water for the environment helped flush deposited ash and sediments and improve water quality.

Water for the environment was delivered to Mullinmur Wetland at Wangaratta for the first time in December 2019, to prepare habitat for translocated freshwater catfish. A second top-up was delivered in February 2020, to maintain water levels to support the growth and recruitment of aquatic vegetation and sustain the translocated fish.

Scope of environmental watering

Table 5.3.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.3.1 Potential environmental watering actions and objectives for the Ovens system

Potential environmental watering action	Functional watering objectives	Environmental objectives
Autumn fresh (one fresh of greater than 430 ML/day for three days in reaches 1 and 4, and greater than 130-260 ML/day in reach 5 during March to April)	• Provide flow cues to stimulate the movement of native fish • Maintain connectivity between pools for fish movement • Mix pools to improve the water quality • Provide small variations in river levels and velocity, to flush sediment from hard substrates and maintain waterbug habitat • Scour biofilm from the river bed	
Summer/autumn low-flow variability (greater than 80 ML/day for one to two days during February to March in reaches 1, 2 and 3)	• Maintain connectivity between pools for fish movement and water quality • Provide small variations in river levels to move sediment and maintain waterbug habitat	
Mullinmur Wetland (top-up during November to February)	• Maintain the water level to support the growth and recruitment of aquatic vegetation • Maintain habitat for freshwater catfish	

Scenario planning

Table 5.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

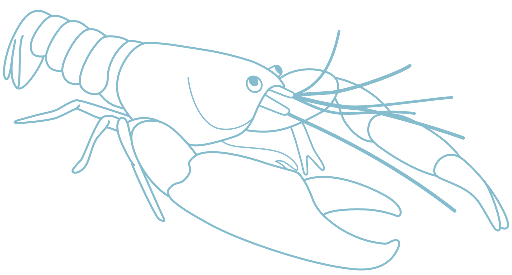
The weather and inflows into storages have a large effect on how water for the environment is likely to be used in the Ovens system. Under dry and average conditions, water for the environment may be used to provide low flow variability and avoid cease-to-flow events in the river reaches immediately below the storages. Under average conditions, water for the environment may also be used in conjunction with operational water bulk transfers from Lake Buffalo to deliver larger freshes and achieve environmental outcomes over a much greater length of river. Planned watering actions under a drought scenario remain the same as those under a dry scenario, however access to entitlements may be restricted if rights to environmental water are qualified.

Watering Mullinmur Wetland is a high priority under dry and average scenarios. No potential watering actions have been identified for the Ovens system under a wet scenario because the environmental flow requirements are likely to be achieved naturally through storage spills and unregulated tributary inflows.

Table 5.3.2 Potential environmental watering for the Ovens system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Possible winter/early spring natural flow • Highly likely low summer/autumn flows • No bulk water release	• Possible winter/early spring natural flow • Highly likely low summer/autumn flows • Bulk water release unlikely	• High winter/spring natural flow • Possible summer/autumn low flow • Bulk water release likely	• High natural flow throughout most of the year • Bulk water release likely • All flow objectives achieved naturally
Expected availability of water for the environment[1]	• 123 ML			
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flow variability • Mullinmur Wetland top-up	• Summer/autumn low flow variability • Mullinmur Wetland top-up	• Autumn fresh • Summer/autumn low flow variability • Mullinmur Wetland top-up	• None required
Possible volume of environmental water required to achieve objectives	• 0–123 ML	• 123 ML	• 123 ML	• 0 ML

[1] Access to entitlements may be restricted if rights to environmental water are qualified under a drought scenario.

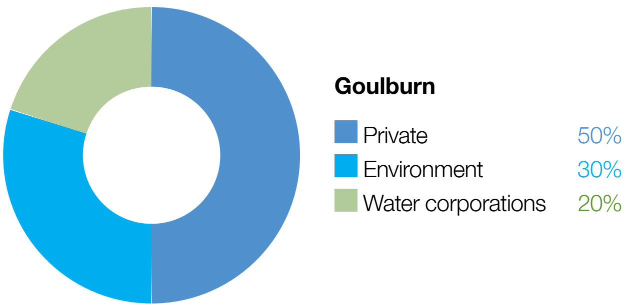


5.4 Goulburn system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder (including the Living Murray program), Commonwealth Environmental Water Holder



Proportion of water entitlements in the Goulburn basin held by private users, water corporations or environmental water holders at 30 June 2019.

Did you know...?

Taungurung people know the Goulburn River as *Waring*, and have a special connection to it and its tributaries.

The waters of Waring have a special connection with Taungurung, including its tributaries such as the Broken River, Hughes Creek, Seven Creeks, Yea River, Acheron River, King Parrot Creek, Rubicon River, Jamieson River, and the Howqua and Delatite rivers. Taungurung's involvement is crucial to incorporate their traditional ecological knowledge into water management in the region.

Horseshoe Lagoon is a culturally significant site for Taungurung women. Water for the environment was delivered to the site, outside Seymour, for the first time in July 2019. Celebrating the delivery Taungurung water knowledge group Baan Ganalina (Guardians of Water), Goulburn Broken CMA, local landholders and partners came together to mark the significant occasion. Horseshoe Lagoon is one of the many Goulburn River associated wetlands which are highly significant for Taungurung.

Top: Goulburn River, by Goulburn Broken CMA
Above: Checking in-stream vegetation in the Goulburn River, by Goulburn Broken CMA

The Goulburn system includes the Goulburn River and Goulburn wetlands.

5.4.1 Goulburn River

System overview

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 Murray River east of Echuca. It is an iconic heritage river because of its environmental, Aboriginal cultural heritage and recreational values.

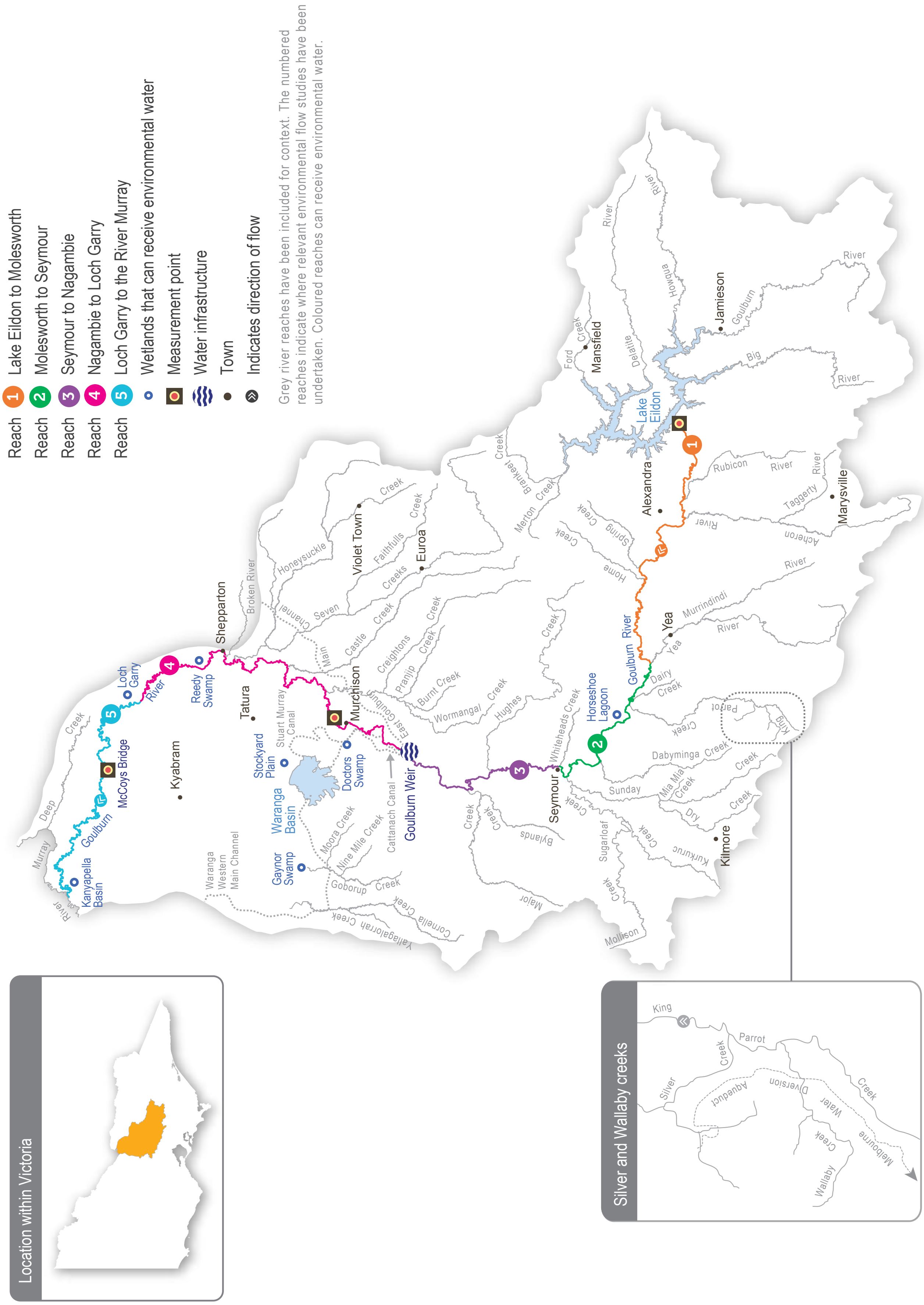
There are several environmental water holders in the Goulburn system. The Commonwealth Environmental Water Holder (CEWH) holds the largest volume and use of Commonwealth environmental water is critical to achieving outcomes in the Goulburn River, as well as priority environmental sites further downstream. Water for the environment held on behalf of the Living Murray program may assist in meeting objectives in the Goulburn system en route to icon sites in the Murray system (see subsection 1.4.2). Water held by the VEWH in the Goulburn system is primarily used to meet environmental objectives in the Goulburn River and the Goulburn wetlands, but can also be used to support ecological objectives at downstream sites along the Murray River and in SA.

The construction and operation of Lake Eildon and Goulburn Weir have significantly altered the natural flow regime of the Goulburn River. Water harvesting during wet periods, and releases to meet irrigation and other consumptive demands during dry periods, means that flow below these structures is typically low in winter/spring and high in summer/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 and filling many of the natural wetlands and billabongs. Several tributaries including the Acheron and Yea rivers and the Broken River below Lake Eildon add some flow variation on top of the Goulburn River's regulated flow regime. Large floods that cause the Goulburn River's storages to fill and spill are also important for the overall flow regime and its associated environmental values.

The priority environmental flow reaches in the Goulburn River are downstream of Goulburn Weir (reaches 4 and 5), which are collectively referred to as the lower Goulburn River. The mid-Goulburn River extends from Lake Eildon to Goulburn Weir (reaches 1 to 3). From early spring to late autumn, large volumes of water are delivered from Lake Eildon to Goulburn Weir to supply the irrigation system. During that period, flow in the mid-Goulburn River is usually well above the recommended environmental flow targets. Deliveries of water for the environment have the most benefit in the mid-Goulburn River (especially in reach 1 immediately downstream of Lake Eildon) outside the irrigation season, when flow is much lower than natural.

Environmental flow targets can sometimes be met by the coordinated delivery of operational water being transferred from Lake Eildon to the Murray River. These transfers are known as inter-valley transfers (IVTs). These transfers occur during the irrigation season between spring and autumn, and they may meet environmental flow objectives without the need to release water for the environment. In recent years, operational transfers in the Goulburn River have significantly exceeded the environmental flow recommendations for summer and early autumn and have damaged bank vegetation and eroded the riverbanks. Interim operating rules have been put in place to help minimise this damage, and a review of the Goulburn to Murray trade rule is currently underway.

Figure 5.4.1 The Goulburn system



Environmental values

The Goulburn River and its tributaries support a range of native fish species including golden perch, silver perch, Murray cod, trout cod, Macquarie perch and freshwater catfish. Aquatic vegetation, scour holes and woody debris within the channel provide high-quality habitat for adult and juvenile fish. River red gums are a dominant feature of the streamside zone along the length of the Goulburn River. These trees shade the river and provide habitat for many species including the squirrel glider. Leaves that fall from the river red gums provide carbon that supports riverine food webs, and dead trees that fall into the river provide a surface for biofilms and macroinvertebrates and habitat for fish. Birds (such as egrets, herons and cormorants) use trees along the river to roost and feed, while frogs benefit from shallowly- wetted vegetation at the edge of the river channel and in adjacent wetlands.

The Goulburn River system is an important conservation area for threatened species. Several wetlands in the Goulburn catchment are formally recognised for their conservation significance. Tributaries of the mid-Goulburn River between Lake Eildon and Goulburn Weir host some of the last remaining Macquarie perch populations in the Murray-Darling Basin, while freshwater catfish can be found in lagoons connected to reach 3 of the Goulburn River. Monitoring over recent years shows that environmental flows in the lower Goulburn River trigger golden perch and silver perch to spawn. However, further monitoring is required to determine how these spawning events contribute to populations locally and in the wider southern basin. Self-sustaining populations of Murray cod have been confirmed, and trout cod have been spawning and extending their range in the lower Goulburn River.

Environmental watering objectives in the Goulburn River

- Protect and boost populations of native fish
- Maintain the form of the riverbank and channel including maintaining a high diversity of river bed surfaces to support all stream life
- Provide sufficient rates of carbon and nutrient production and processing to support native fish and waterbug communities
- 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
- Maintain abundant and diverse waterbug communities, to support riverine food webs
- Minimise the risk of hypoxic blackwater

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with the Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the Goulburn River. The environmental and ecological objectives of the proposals were supported and align with the broad values of these Traditional Owner groups.

Yorta Yorta Nation Aboriginal Corporation raised concerns about the cultural damage IVTs are having on the lower Goulburn River and the Barmah Choke in addition to the ecological damage being caused. Environmental flow deliveries and system planning in the Goulburn River aim to mitigate some of these impacts. Taungurung Land and Waters Council also shared these concerns, and strongly supports the implementation of a new operational rule for IVTs and the Victorian Government's review of the trade rule to avoid further damage of the ecological and cultural values of the river.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.4.1, Goulburn Broken CMA considered how environmental flows could support values and uses such as:

- water-based recreation (such as boating and fishing)
- riverside recreation and amenity (such as walking, camping and other outdoor activities)
- socio-economic benefits (such as irrigation diverters and water supply for settlements on the Goulburn River).

The Goulburn River provides numerous recreational and economic benefits. Using water for the environment to provide fish passage and habitat and delivering freshes to encourage fish migration and spawning enhances native fish populations for recreational benefit. Following community feedback, the timing of a targeted environmental flow in November/December is planned to reduce impacts on river access, benefiting anglers and local businesses. This flow will be identified in Table 5.4.1 with an icon.

Watering planned to support angling activities

The delivery of the spring/summer fresh provides a cue for golden perch to spawn, and it is timed to minimise impacts on regional communities and businesses during the annual Murray cod opening weekend — the first weekend in December — while still ensuring the environmental objectives of the fresh can be achieved.

Recent conditions

Conditions in the Goulburn catchment in 2019–20 were very similar to those in 2018–19, with below-average rainfall in winter/spring. Temperatures throughout most of the year were above the long-term average, particularly in summer, leading to high evaporation rates from storages. Heavy rainfall in autumn helped replenish storages and resulted in a series of natural flows being passed at Goulburn Weir. Despite below-average inflows to Goulburn system storages in 2019–20, sufficient water was available for the environment through carryover and new allocation to meet high-priority flow requirements throughout the year.

Little natural flow occurred below Goulburn Weir in winter, and water for the environment was used to deliver a winter fresh in July 2019. This was followed by variable low flow that aimed to pass mid-Goulburn tributary inflows to the lower Goulburn River below Goulburn Weir. Conditions remained dry in spring, with a spring fresh delivered from September to October 2019 to support native fish and to trigger the germination of bank vegetation. IVTs started after the spring fresh, and no environmental water was delivered between mid-November 2019 and mid-March 2020. IVTs were delivered as a series of pulses (to reduce the effect on bank vegetation), but flows were consistently above the recommended environmental limit in summer/autumn. Although high IVT flows likely compromised some of the lower bank vegetation outcomes that were achieved by the spring fresh, wetting of the middle-to-upper bank during the spring fresh facilitated the growth and seed development of existing vegetation, provided carbon and nutrient cycling benefits and maintained habitat for waterbug communities. Higher rainfall in autumn delivered several natural flow events in the lower Goulburn River. Water for the environment was used to slow operational recessions after spills at Goulburn Weir, to minimise the risk of erosion and bank slumping.

Water for the environment delivered in the Goulburn River is reused at downstream sites along the Murray River, after a deduction for losses. In 2019–20, environmental flows that passed through the Goulburn River were subsequently used to support native fish objectives in Gunbower Creek, wet wetlands in the Gunbower and Guttrum forests and the Hattah Lakes system, and support ecological objectives in SA. Water for the environment that is delivered from the Goulburn system makes a significant contribution to environmental objectives further downstream, which helps to achieve environmental outcomes at the Murray-Darling Basin scale.

Scope of environmental watering

Table 5.4.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.4.1 Potential environmental watering actions and objectives for the Goulburn River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Year-round low flow (500-830 ML/day in reach 4 and 540-940 ML/day in reach 5)	• Provide slow, shallow habitat required for the recruitment of larvae/juvenile fish and habitat for adult small-bodied fish • Provide deep-water habitat for large-bodied fish • Submerge snags to provide habitat for fish and waterbugs and a substrate for biofilms to grow • Maintain habitat for aquatic vegetation and water the root zone of low-bank vegetation • Vary flow within a specified range to encourage planktonic production (for food), disrupt biofilms and maintain water quality	
Winter/spring fresh (one to two freshes of more than 6,600 ML for 14 days during July to October in reaches 4 and 5)	• Improve macroinvertebrate habitat by improving water quality and by increasing the wetted perimeter • Provide carbon (e.g. leaf litter) to the channel • Wet bench habitats to encourage plant germination • Remove terrestrial vegetation and trigger the recruitment of native bank vegetation	
Provide slower recession to unregulated flows or releases from Goulburn Weir (3,000 ML/day and below in summer/autumn and from 6,000 ML/day in winter/spring) in reaches 4 and 5	• Minimise the risk of bank erosion associated with rapid drying • Minimise the risk of hypoxic blackwater after natural events	
Spring/autumn/winter low flow (400 ML/day during July to September and April to June in reach 1)	• Wet and maintain riffles to provide habitat for biofilms and waterbugs • Scour fine sediment from the gravel bed and riffle substrate • Maintain the wetted perimeter of the channel and habitat for aquatic vegetation • Maintain existing beds of in-channel vegetation • Maintain habitat for small-bodied native fish	
Winter fresh (up to 15,000 ML/day with more than 14 days above 6,600 ML/day in June/July 2021, reaches 4 and 5)	• Improve macroinvertebrate habitat by improving water quality and by increasing the wetted perimeter • Provide carbon (e.g. leaf litter) to the channel • Wet bench habitats to encourage plant germination • Remove terrestrial vegetation and trigger the recruitment of native bank vegetation	
Flows should not exceed 1,000 ML/day for five to six weeks after a spring fresh (in late spring/summer) in reaches 4 and 5	• Allow newly grown littoral emergent and semi-aquatic plants to become established and persist • Provide habitat for small-bodied fish and macroinvertebrates	
One spring/summer fresh (greater than 6,600 ML for one day between November and December in reaches 4 and 5)	• Provide a cue for golden and silver perch to spawn	

Table 5.4.1 Potential environmental watering actions and objectives for the Goulburn River *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Autumn fresh (one fresh up to 6,000 ML/day for two days between March and April in reaches 4 and 5)	• Encourage the germination of new seed on the lower banks and benches • Improve water quality by reducing turbidity and mixing stratified water • Flush fine sediment from hard substrates to allow new biofilm growth and to improve food and habitat for macroinvertebrates	
Flows should not exceed 1,000 ML/day (for more than 20 consecutive days, with a minimum of seven days between pulses in summer/autumn in reaches 4 and 5)	• Maintain for more than one season a littoral fringe of emergent or semi-aquatic plants • Provide slow-flowing littoral habitat for small-bodied fish and macroinvertebrates	

Scenario planning

Table 5.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

In 2020–21, the focus of water for the environment in the lower Goulburn River will be on vegetation recovery to improve the condition of the lower banks that have been damaged by high IVTs in summer/autumn in recent years and to help offset the impact of future IVTs. Under all scenarios, providing year-round low flow is the highest priority under all scenarios. This flow provides habitat for fish and macroinvertebrates and helps the vegetation to recover. Goulburn-Murray Water generally diverts a proportion of natural high flow from Goulburn Weir into the Waranga Basin. These operational transfers cause flow rates in the lower Goulburn River to drop rapidly after a natural high-flow event. Water for the environment is used when required to slow the recession of natural spills at Goulburn Weir, to reduce the risk of bank slumping and provide a more natural flow pattern for native fish. The highest environmental watering priority in reach 1 will be to maintain minimum low flow outside the irrigation season, to maintain habitat for small-bodied native fish, aquatic vegetation and waterbugs.

Delivering a winter/spring fresh followed by five to six weeks of low flow is a high priority in 2020 under dry and average scenarios, to aid vegetation recovery. These flows are expected to occur naturally under a wet scenario and are planned under a drought scenario as an additional priority.

A focus this year will be on timing environmental water deliveries alongside unregulated events and tributary inflows. Ongoing monitoring suggests that unregulated inflows carry more plant seed, nutrients and sediments that are beneficial to the lower Goulburn River.

A winter fresh is included under average and wet scenarios to enhance environmental objectives that cannot normally be achieved under drier scenarios. A spring/summer fresh will also be considered under average and wet scenarios to cue golden perch spawning, but this watering action will not be delivered if it is likely to impact the recovery of bank vegetation. If summer low flow targets are met (that is, if IVTs are not too high), an autumn fresh may be delivered in March or April 2021 to maintain bank vegetation and allow new seeds to germinate.

Carrying over water to meet minimum low flow objectives in July 2021 to September 2022 is an important consideration under drought, dry and average scenarios.

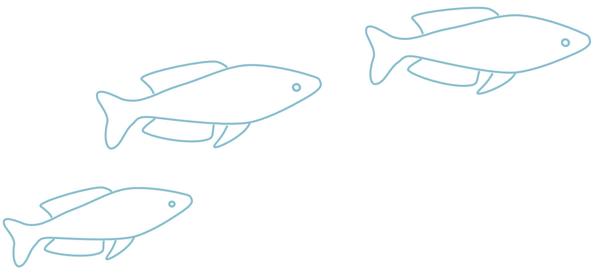


Table 5.4.2 Potential environmental watering for the Goulburn River under a range of planning scenarios

Planning scenario	Drought	Dry	Below average	Average	Wet
Expected river conditions	• No natural flow • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide some low flow for half a month from winter/mid-spring and is likely to provide small, short winter/spring freshes • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide some low flow for a few months from winter/mid-spring and is likely to provide small winter/spring freshes • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide low flow for most of the year and is likely to provide the winter/spring freshes • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide low flow and multiple overbank flow events in winter/spring
	• Normal minimum passing flows at reach 5 of 400 ML/day during July to October and 350 ML/day during November to June				
Expected availability of water for the environment[1]	• 154,000 ML	• 265,000 ML	• 386,000 ML	• 461,000 ML	
Potential environmental watering – tier 1a (high priorities)[2]	• Year-round low flow • Recession flow management • Spring/autumn/winter low flow (reach 1)	• Year- round low flow • Winter/spring fresh (partial) • Recession flow management • Spring/autumn / winter low flow (reach 1)	• Year-round low flow • Winter/spring fresh • Recession flow management • Spring/autumn/winter low flow (reach 1) • Extend natural flow events	• Year-round low flow • Winter/spring fresh • Recession flow management • Spring/autumn/winter low flow (reach 1) • Winter fresh 2021 • Spring/summer fresh • Extend natural flow events	• Year-round low flow • Recession flow management • Spring/autumn/winter low flow (reach 1) • Winter fresh 2021 (partial) • Spring/summer fresh • Extend natural flow events
Potential environmental watering – tier 1b (high priorities with shortfall)	• Winter/spring fresh (partial)	• Winter/spring fresh • Winter fresh 2021 (full) • Spring/summer fresh	• Winter fresh 2021 (full) • Spring/summer fresh	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring fresh	• N/A	• N/A	• Autumn fresh (partial)	• Autumn fresh (partial)
Possible volume of environmental water required to achieve objectives[3]	• 120,000 ML (tier 1) • 107,000 ML (tier 1b) • 28,000 ML (tier 2)	• 234,000 ML (tier 1) • 188,000 ML (tier 1b)	• 366,000 ML (tier 1) • 175,000 ML (tier 1b)	• 388,000 ML (tier 1) • 47,000 ML (tier 2)	• 316,000 ML (tier 1) • 47,000 ML (tier 2)
Priority carryover requirements	• 23,000 ML	• 23,000 ML	• 23,000 ML	• 0 ML	• 0 ML

[1] When trading opportunities are available, additional water for the environment allocations from the Murray River can be transferred in to meet Goulburn demand.
[2] Low-flow periods following a spring fresh or between summer/autumn pulses are considered tier 1a priorities under all planning scenarios.
[3] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

5.4.2 Goulburn wetlands

System overview

Within the Goulburn Broken catchment, there are about 2,000 natural wetlands identified, but only five (Reedy Swamp, Gaynor Swamp, Doctors Swamp, Horseshoe Lagoon and Loch Garry) have received water for the environment through VEWH or CEWH entitlements. Several other small wetlands in the Goulburn catchment have been watered under a separate arrangement through the Murray-Darling Wetlands Working Group.

Gaynor Swamp, Reedy Swamp, Loch Garry, Doctors Swamp and Kanyapella Basin wetlands can receive water for the environment through irrigation supply infrastructure. The volume of water that can be delivered to each wetland depends on the physical capacity of the infrastructure and the seasonal allocation. Water for the environment can be delivered from the Goulburn River to Horseshoe Lagoon via a temporary pump.

Environmental values

Many natural wetlands across the Goulburn catchment including Reedy Swamp, Loch Garry, Gaynor Swamp, Kanyapella Basin and Doctors Swamp are formally recognised for their conservation significance. The Goulburn wetlands support a variety of plant communities ranging from river red gum swamps 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, nesting site for colonial waterbirds and stopover feeding site for migratory birds (such as sharp-tailed sandpiper and marsh sandpiper).

Doctors Swamp is considered one of the most intact red gum swamps in Victoria, supporting over 80 wetland plant species.

Gaynor Swamp is a cane grass wetland situated on paleosaline soils: soils formed from historic oceans. The wetland supports thousands of waterbirds including brolga and intermediate egrets when wet. Gaynor Swamp has a higher salt concentration than other wetlands in the region and it attracts a different suite of feeding waterbirds as it draws down. One of the most significant species that feeds on exposed mudflats at Gaynor Swamp is the red-necked avocet.

Loch Garry incorporates an old channel of the Goulburn River that provides deep, open-water habitat. The channel is surrounded by shallow, vegetated wetland depressions, red gum forest and sand ridges. It is an important site for waterbird feeding and roosting, and it is a drought refuge for eastern great egrets, musk ducks, nankeen night herons and royal spoonbills.

Kanyapella Basin is a shallow freshwater marsh that provides habitat for numerous plant and animal species including the threatened intermediate egret. Historically, it has been a popular breeding site for ibis, heron and cormorants.

Horseshoe Lagoon, a former channel of the Goulburn River, comprises vegetation mainly of tall marsh, floodway pond herbland and floodplain streamside woodland.

Environmental watering objectives in the Goulburn wetlands

	Maintain or increase the diversity and abundance of frog species
	Maintain turtle populations
	Increase the diversity and cover of native wetland plant species consistent with ecological vegetation class[1] benchmarks Reduce the cover and diversity of exotic plants Maintain populations of rigid water milfoil, slender water milfoil and river swamp wallaby-grass
	Provide breeding habitat for waterbirds Provide feeding and roosting habitat for waterbirds

[1] Ecological vegetation classes are the standard units for classifying vegetation types in Victoria. They are described through a combination of floristics, lifeforms and ecological characteristics and through a presumed association to particular environmental attributes. Each ecological vegetation class includes a collection of floristic communities (which is a lower level in the classification) that occurs across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.

Traditional Owner cultural values and uses

Goulburn Broken CMA sought input from Yorta Yorta Nation Aboriginal Corporation and Taungurung Land and Waters Council during the development of environmental watering plans for the Goulburn wetlands. Both groups have indicated that they support the watering action priorities planned for the year ahead and will continue to work with the CMA to implement these actions while exploring further opportunities to support their cultural values.

Waterway managers are seeking opportunities to support increased participation of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.4.3 with an icon.

Watering planned and/or delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses

Yorta Yorta Nation Aboriginal Corporation has been involved in planning for environmental watering at Kanyapella Basin and Loch Garry, including participating in the development of environmental water management plans for the sites. Kanyapella Basin, Loch Garry and the surrounding catchment have a long history of Traditional Owner occupation by the Yorta Yorta Peoples. Kanyapella Basin particularly plays an important role in Yorta Yorta cultural and spiritual heritage. Kanyapella Basin may be partially filled in winter or spring 2020, supporting cultural values such as knowledge sharing and food and medicinal plants. Loch Garry watering is planned for autumn 2021.

Taungurung Land and Waters Council and Goulburn Broken CMA are planning to repeat the environmental watering of Horseshoe Lagoon in winter 2020, following the first delivery of environmental water to the site in winter 2019. This was celebrated by the Taungurung women as it is a significant site and the best example of working together to protect cultural values and towards healing Country. The Taungurung water knowledge group, *Baan Ganalina*, have worked closely with Goulburn Broken CMA, the VEWH and other partners to bring water back to the lagoon to restore habitats and see the birds and other animals return to the site. Taungurung Land and Waters Council also participated in the development of the Environmental Water Management Plan for the site in 2019.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.4.3, Goulburn Broken CMA considered how environmental flows could support values and uses including recreation and amenity (such as walking, photography and birdwatching).

Recent conditions

The Goulburn catchment has observed persistent dry conditions over the past few years, with 2019–20 no exception. Annual rainfall was well below average for the region for most of the year, except for a very wet autumn with above-average rainfall, which provided suitable conditions to enable watering actions and also provided natural inflows as supplements. Temperatures throughout most of the year were above the long-term average. The drier conditions resulted in increased evaporation rates for storages and wetlands alike, but water availability was good due to carryover and 80 percent allocation to high-reliability water shares in the Goulburn system.

Environmental water was delivered to Horseshoe Lagoon for the first time in winter 2019, to partially fill the wetland before drying over summer. The wetland vegetation responded well to the watering with both the rare river swamp wallaby grass and veiled fringe sedge detected during monitoring; waterbirds and turtles were also observed at the lagoon.

The timing of a planned autumn 2020 fill of Reedy Swamp was moved to spring 2019 to build on a rainfall event that partially filled the wetland. The wetland provided a much-needed refuge in the region over a very dry summer, with waterbird and woodland bird species recorded including glossy ibis, Australasian shoveler, Latham's snipe, freckled duck and the first record of crimson chats at the site.

Autumn 2020 saw two wetland watering events delivered, assisted by the above-average rainfall observed in late April/ early May. The river-red-gum-dominated Doctors Swamp was filled in May 2020. The first environmental watering of Loch Garry was trialled and achieved a partial fill.

As always, planned watering actions were adaptively managed in 2019–20. The changed timing of delivery to Reedy Swamp optimised environmental outcomes and drought refuge by responding to natural conditions in spring, while the first trial delivery to Loch Garry delivered around half of the planned volume due to a slower delivery rate than expected. Gaynor Swamp was not actively watered in 2019–20 to allow it to dry, to reduce exotic vegetation cover at the site. Now the dry phase has been completed, a spring watering in 2020–21 is planned.

Scope of environmental watering

Table 5.4.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.4.3 Potential environmental watering actions and objectives for the Goulburn wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Doctors Swamp (top up or fill in spring)	• Promote vegetation growth • Provide feeding and roosting habitat for waterbirds	
Gaynor Swamp (partial fill in spring)	• Promote vegetation growth, particularly southern cane grass • Provide breeding and feeding habitat for waterbirds, in particular for brolga	
Horseshoe Lagoon (fill in winter)	• Maintain wetland vegetation communities by supporting growth and recruitment • Promote the growth of river swamp wallaby grass • Provide habitat for turtle and frog populations	
Kanyapella Basin (partial fill in spring)	• Promote different vegetation communities to establish	
Loch Garry (partial fill in autumn)	• Promote the growth and germination of native wetland vegetation communities, particularly wetland fringes • Provide feeding and breeding habitat for waterbirds	
Reedy Swamp (fill in autumn)	• Reduce the growth of exotic plants • Maintain native wetland vegetation • Provide a refuge and feeding and breeding habitat for waterbirds	

Scenario planning

Table 5.4.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Doctors Swamp and Gaynor Swamp are identified as high-priority watering sites in 2020–21 under all scenarios, because their drying regimes are reaching their maximum duration. Gaynor Swamp will also provide feeding and breeding habitat for threatened waterbirds (such as brolga). Horseshoe Lagoon is a high priority, because it requires follow-up watering to maintain vegetation condition.

Reedy Swamp and Loch Garry have also been identified for watering under all scenarios and Kanyapella basin under dry and average scenarios. These watering actions aim to improve environmental values at these sites, but if delivery to these wetlands cannot occur in 2020–21, no detrimental impact is expected on their environmental values in the upcoming year. Reedy Swamp is in good condition and is currently in a drying phase. An autumn watering in 2021 will aim to ensure it does not exceed its maximum dry period, and it will provide variability in the watering regime for native vegetation.

Loch Garry and Kanyapella Basin act as flood retardation basins, and watering in autumn 2020 occurred at Loch Garry as an initial trial, to observe the ecological response and help determine future management actions. Loch Garry is now planned to remain dry for the recommended duration, which will enable it to potentially be re-watered in autumn 2021 to observe the response of the ecological values of the site to a follow up watering.

It is a priority to carry over water, to allow 2021–22 top-ups to tier 1 wetlands planned to be watered in 2020–21.

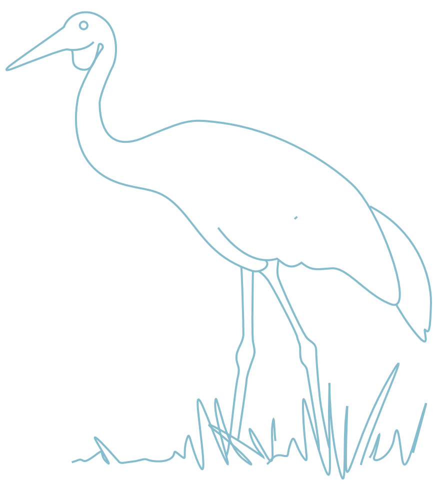
Table 5.4.4 Potential environmental watering for the Goulburn wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment runoff and natural flow into the wetlands are highly unlikely	• Catchment runoff and natural flow into the wetlands are unlikely	• Some catchment runoff and natural flow into some of the wetlands are likely, particularly in winter/spring	• Catchment runoff and natural flow into the wetlands may significantly contribute to water levels in the wetlands, particularly during winter/spring
Potential environmental watering – tier 1 (high priorities)[1,2]	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp
Potential environmental watering – tier 2 (additional priorities)[2]	• Reedy Swamp • Loch Garry	• Reedy Swamp • Loch Garry • Kanyapella Basin	• Reedy Swamp • Loch Garry • Kanyapella Basin	• Reedy Swamp • Loch Garry
Possible volume of environmental water required to achieve objectives[3]	• 1,700 ML (tier 1) • 1,600 ML (tier 2)	• 1,700 ML (tier 1) • 2,100 ML (tier 2)	• 1,500 ML (tier 1) • 2,100 ML (tier 2)	• 700 ML (tier 1) • 1,600 ML (tier 2)
Priority carryover requirements	• Up to 350 ML			

[1] Tier 1 potential environmental watering for the Goulburn wetlands is not classified as tier 1a or 1b, because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the Goulburn wetlands.

[2] Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios

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

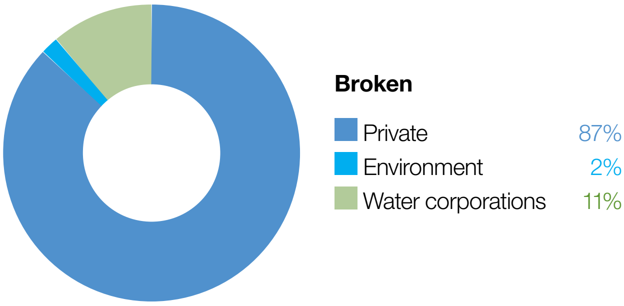


5.5 Broken system

Waterway manager – Goulburn Broken Catchment Management Authority
Storage manager – Goulburn-Murray Water
Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

Did you know...?

Native fish populations continue to increase in the Broken River. Autumn 2019 fish surveys by the Victorian Environmental Flows Monitoring and Assessment Program showed that Murray cod, Murray-Darling rainbowfish and golden perch numbers are all up from last year! A variety of sizes of Murray cod were recorded, suggesting strong recruitment, survival and growth. That's great news for anglers!



Proportion of water entitlements in the Broken basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Broken River, by Goulburn Broken CMA
Above: Magpie geese at Black Swamp, by Goulburn Broken CMA

The Broken system includes the Broken River, upper Broken Creek, lower Broken Creek and the Broken wetlands.

5.5.1 Broken River and upper Broken Creek

System overview

The Broken River is a tributary of the Goulburn River, rising in the Wellington-Tolmie highlands and flowing north-west to Benalla and then west for a total distance of 190 km before it joins the Goulburn River near Shepparton. Lake Nillahcootie is the main storage on the Broken River. It is about 36 km upstream of Benalla and harvests water from the river to support stock and domestic supply and irrigated agriculture. The main tributaries of the Broken River are Hollands Creek, Ryans Creek and Lima East Creek.

Lake Nillahcootie has a storage capacity that is about half the mean annual flow of its upstream catchment, so it fills in most years. The operation of Lake Nillahcootie has modified the river's natural flow pattern: winter/spring flow is less than natural because a large proportion of inflow is harvested, while summer/autumn flow is higher than natural because water is released to meet downstream irrigation demands. These impacts are most pronounced in the reach between Lake Nillahcootie and Hollands Creek. Below Hollands Creek, the river retains a more natural flow pattern, due to flows from unregulated tributaries. The catchment has been extensively cleared for agriculture including dryland farming (such as livestock grazing and cereal cropping) and irrigated agriculture (such as dairy, fruit and livestock).

Water is released from Lake Nillahcootie to meet downstream demand and minimum flow requirements specified under the bulk entitlement for the Broken River system. Releases from storage may be less than 30 ML per day as tributary inflows immediately below the storage (such as from Back Creek) can supply much of minimum-flow requirements specified in the bulk entitlement.

Upper Broken Creek is defined as the 89-km stretch of creek from the Broken River (at Caseys Weir) to the confluence with Boosey Creek near Katamatite. Upper Broken Creek flows across a flat, riverine plain and has naturally low runoff from its local catchment. It receives flood flows from the Broken River, although the frequency of these floods has been reduced by earthworks and road construction.

Upper Broken Creek has been regulated for more than a century. Before 2007, water was diverted into upper Broken Creek at Casey's Weir to meet local demand, but recent water savings projects have reduced the demand on the creek. There is now low flow throughout the year between Caseys Weir and Waggarandall Weir. Flow below Waggarandall Weir is mainly influenced by rainfall and catchment runoff. These changes have reduced the amount of permanent aquatic habitat.

Delivery of water for the environment to the Broken River is primarily constrained by the availability of water. Usually, the available volume of water for the environment is insufficient to provide all recommended flows. Deliveries of water for the environment to upper Broken Creek are also restricted by channel capacity and by the need to avoid flooding low-lying adjacent land.

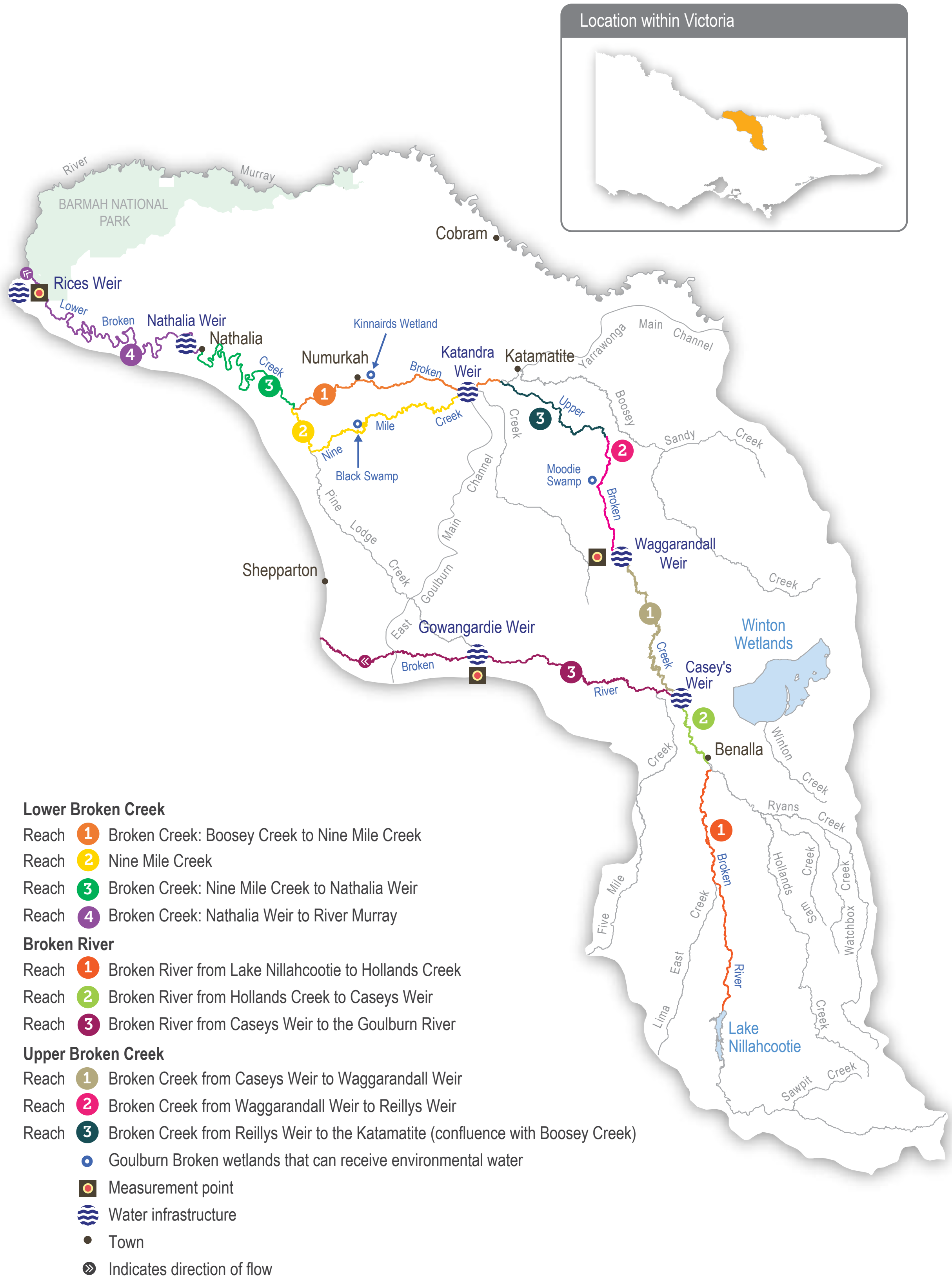
Environmental values

The Broken River retains one of the best examples of healthy in-stream vegetation in a lowland river in the region. A range of native submerged and emergent plant species including eelgrass, common reed and water ribbons populate the bed and margins of the river. These plants provide habitat for a range of animals including small- and large-bodied native fish species. Murray cod, Macquarie perch, golden perch, silver perch, river blackfish, mountain galaxias and Murray-Darling rainbowfish all occur in the Broken River. The river also supports a large platypus population.

The upper Broken Creek area is dominated by unique box streamside vegetation and remnant plains grassy woodland. It supports numerous threatened species including brolga, Australasian bittern, buloke and rigid water milfoil. Much of the high-quality native vegetation in the region is set aside as a natural features reserve. Upper Broken Creek supports a variety of native fish species including carp gudgeon, Murray cod, golden perch and Murray-Darling rainbowfish, as well as platypus and common long-necked turtle.

Both the Broken River and upper Broken Creek are listed in the Directory of Important Wetlands in Australia.

Figure 5.5.1 The Broken 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.

Environmental watering objectives in the Broken River and upper Broken Creek

Increase native fish populations
Maintain platypus populations
Maintain in-stream vegetation
Support a wide range and high biomass of waterbugs, to break down dead organic matter and support the river's food web
Maintain water quality

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with the Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the Goulburn River. The Traditional Owners confirmed that the environmental and ecological objectives of the environmental watering align with their Land and Water Management Plans, and the CMA is continuing to work with both groups to identify how environmental water management can support cultural values.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.5.1, Goulburn Broken CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing)
- riverside recreation and amenity (such as camping, birdwatching, picnicking and duck hunting)
- community events
- socio-economic benefits (such as supporting birds that control invasive species and providing green space and water in a dry landscape over summer).

Recent conditions

Below-average rainfall and above-average temperatures in the Broken River and upper Broken Creek in 2019–20 resulted in low inflows to the river and creek, low allocation of entitlements and low water availability for environmental flows.

In the Broken River, flow between Lake Nillahcootie and Casey's Weir in reaches 1 and 2 was very different to that below Casey's Weir in reach 3. The reaches between Lake Nillahcootie and Casey's Weir have minimal tributary inflows and flow in these reaches is predominantly shaped by operational releases from Lake Nillahcootie for entitlement demands downstream. Reaches 1 and 2 had a stable, low-magnitude flow from July to November 2019 and then higher-magnitude flow and slightly more variability from December 2019 onwards. In comparison, the flow pattern in reach 3 is mainly shaped by unregulated tributary inflows. There were several natural freshes in this reach between July and October 2019, and stable, low-magnitude flow from November till April 2020. There were some natural freshes in the Broken River in autumn 2020.

Upper Broken Creek has no significant tributaries and its flow is primarily influenced by operational releases, catchment runoff and environmental flows. Upper Broken Creek had low flow from July to December 2019 and then slightly higher and more variable flow from January 2020 onwards. Water for the environment was predominantly used to meet targets for summer/autumn low flow, which had been generally met by operational flows in previous years. This meant flows from operational releases were lower in upper Broken Creek in 2019–20 than in previous years.

Scope of environmental watering

Table 5.5.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.5.1 Potential environmental watering actions and objectives for the upper Broken Creek and Broken River

Potential environmental watering action[1]	Functional watering objectives	Environmental objectives
Upper Broken Creek		
Summer/autumn fresh (one fresh of 10-100 ML/day for 10 days during December to May as needed)	• Maintain water quality, particularly oxygen levels, in refuge pools	
Summer/autumn low flow (one to five ML/day during December to May)	• Maintain pool and riffle habitat for native fish populations and waterbugs • Maintain access to habitat and food resources for platypus • Maintain habitat for in-stream vegetation	
Winter/spring low flow (five to 10 ML/day during June to November)	• Maintain pool and riffle habitat for native fish populations and waterbugs • Maintain access to habitat and food resources for platypus • Maintain habitat for in-stream vegetation	
Broken River		
Year-round low flow (five to 15 ML/day)	• Maintain riffles, slackwater and pools to provide diverse hydraulic habitat for native fish, aquatic plants, platypus and waterbugs • Maintain habitat for in-stream and fringing vegetation, and prevent terrestrial vegetation colonising the stream bed	
Summer/autumn freshes (400–500 ML/day for two to eight days during December to May)	• Scour sediments around large wood, and turn over bed sediments to replenish biofilms and increase productivity • Provide flow cues to stimulate native fish to breed and migrate • Provide flow to maintain in-stream and fringing aquatic vegetation • Maintain longitudinal connectivity for native fish passage	

[1] Watering actions are listed in priority order and upper Broken Creek watering actions are higher priority than Broken River watering actions.

Scenario planning

Table 5.5.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. It is expected that there will be no water available for environmental flows in the Broken River and upper Broken Creek under drought and dry scenarios. It is likely under those scenarios that there will be zero to low natural flow resulting in zero allocations of entitlements.

There are two sets of watering actions: one for upper Broken Creek and another for the Broken River. Delivering flow to upper Broken Creek is a higher priority, because upper Broken Creek tends to have no inflows from tributaries and is mostly dependent on flows from operational deliveries. The potential watering actions for upper Broken Creek require less water than the potential watering actions for Broken River, and any environmental flows delivered to upper Broken Creek will pass through reaches 1 and 2 of the Broken River, where they will provide some environmental benefit.

In 2020–21, the highest priority in upper Broken Creek is to deliver a summer/autumn fresh (a tier 1a watering action under average and wet scenarios, and a tier 1b watering action under drought and dry scenarios), if required to maintain water quality. The fresh is likely to be able to be partially delivered under average and wet conditions with water for the environment. There is unlikely to be sufficient water available to deliver the fresh under drought or dry conditions. If water does become available under drought or dry conditions, the priority will be to deliver a summer/autumn fresh first, then the summer/autumn low flow to maintain critical aquatic habitat. Additional environmental deliveries for low flow and freshes are not expected to be needed under wet conditions, because flow requirements will be met by natural events.

It is expected that there will not be sufficient water available to provide any potential watering actions in the Broken River: that is, no tier 1a actions are identified. If additional water becomes available under drought and dry conditions after watering actions for upper Broken Creek have been met, the priority will be to deliver year-round low flow in the Broken River to maintain critical aquatic habitat. If further water is available, it will be used to deliver summer/autumn freshes, with dry and average conditions, to maintain habitat for macrophytes and native fish.

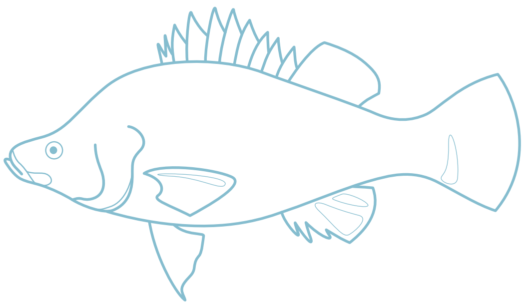


Table 5.5.2 Potential environmental watering for the upper Broken Creek and Broken River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated winter/spring flow in Broken River • No natural flow in upper Broken Creek • Low and cease-to-flow events possible throughout the year in all reaches • No back trade opportunities	• Low natural flow and odd freshes in Broken River • No natural flow in upper Broken Creek • Low and cease-to-flow events possible throughout the year in all reaches • No back trade opportunities	• High winter/spring flow in the Broken River • Some unregulated winter/spring flow in upper Broken Creek • Up to 1,500 ML back trade opportunity in Broken River in summer/autumn	• Winter/spring floods in the Broken River • Winter/spring freshes in upper Broken Creek • Up to 1,500 ML back trade opportunity available in Broken River in summer/autumn
Expected availability of water for the environment	• 0 ML	• 0 ML	• 647 ML	• 647 ML
Upper Broken Creek				
Potential environmental watering – tier 1a (high priorities)	• N/A	• N/A	• One summer/autumn fresh (partial, if required)	• One summer/autumn fresh (partial, if required)
Potential environmental watering – tier 1b (high priorities with shortfall)	• One summer/autumn fresh • Summer/autumn low flow • Winter/spring low flow	• One summer/autumn fresh • Summer/autumn low flow • Winter/spring low flow	• One summer/autumn fresh (remaining volume) • Summer/autumn low flow (remaining volume) • Winter/spring low flow	• One summer/autumn fresh (remaining volume)
Potential environmental watering – tier 2 (additional priorities)	• N/A	• N/A	• N/A	• N/A
Broken River				
Potential environmental watering – tier 1a (high priorities)	• N/A	• N/A	• N/A	• N/A
Potential environmental watering – tier 1b (high priorities with shortfall)	• Year-round low flow	• Year-round low flow	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A	• Summer/autumn fresh	• Summer/autumn fresh	• N/A
Possible volume of environmental water required to achieve objectives[1]	• 0 ML (tier 1a) • 5,510 ML (tier 1b)	• 0 ML (tier 1a) • 3,550 ML (tier 1b) • 5,800 ML (tier 2)	• 1,000 ML (tier 1a) • 2,010 ML (tier 1b) • 5,800 ML (tier 2)	• 1,000 ML (tier 1a)

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

5.5.2 Lower Broken Creek

System overview

The lower Broken Creek system includes the section of Broken Creek that flows from the confluence of Boosey Creek near Katamatite to the Murray River; and Nine Mile Creek, which is an anabranch of lower Broken Creek that flows from the East Goulburn Main Channel to below Numurkah.

Lower Broken and Nine Mile creeks have been regulated for over a century. Before regulation, the creeks would have had most of their flow in winter/spring and contracted to isolated pools or dried out during summer/autumn. The adjacent floodplain would have also flooded regularly. The creeks now have numerous weirs that maintain a relatively constant flow from mid-August until mid-May to support irrigated agriculture. 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 Murray River as it dried. Both creeks now provide year-round habitat for native fish, and fish passage structures allow fish to move between weir pools. Water for the environment is used to support these permanent fish habitats, by providing flows to trigger fish movement and support fish passage, control water quality and flush azolla as necessary.

Lower Broken Creek is operated separately to upper Broken Creek and the Broken River, because regulated water is delivered to lower Broken Creek from the Goulburn and Murray systems via the irrigation channel network, unlike upper Broken Creek and Broken River which are both supplied from Lake Nillahcootie on the upper Broken River.

Water for the environment can be provided to lower Broken Creek from the Goulburn system through the East Goulburn Main Channel and from the Murray system through the Yarrawonga Main Channel. Water is released into lower Broken Creek from several irrigation regulators along the length of lower Broken Creek. The main priority for environmental watering in the lower Broken Creek system is to maintain minimum flows throughout the year. Particular attention is given to reaches 1 and 2 during the non-irrigation season, when flow can stop. The next priority is to deliver freshes in winter/spring to trigger fish movement and spawning, maintain water quality and manage azolla blooms in reaches 3 and 4. The measurement point for environmental flows in lower Broken Creek is at Rices Weir.

Some of the environmental flow targets for lower Broken Creek are partly or wholly met by operational water releases — IVTs (from the Goulburn to the Murray) or choke bypass flows (when bypassing the Barmah choke in the Murray) — that are delivered to meet downstream demands. These operational deliveries mainly occur during peak irrigation demand between spring and autumn. Water for the environment may be used to supplement these operational releases and to deliver recommended flow components that are not met by the operational releases.

Environmental values

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. Sections of lower Broken and Nine Mile creeks have been reserved as state park and natural feature reserves. The associated floodplain and wetland habitats support box-dominated grassy woodland communities and numerous species of state and national conservation significance including river swamp wallaby grass and the Australasian bittern.

Environmental watering objectives in lower Broken Creek

Protect and increase native fish populations including the threatened Murray cod, golden perch and silver perch
Protect platypus populations, particularly outside the irrigation season Protect rakali (water rat) populations, particularly outside the irrigation season
Protect turtle populations, particularly outside the irrigation season
Avoid the excessive build-up of azolla Maintain the cover and condition of native in-stream and littoral vegetation communities
Maintain the diversity and abundance of waterbug populations
Maintain oxygen levels suitable for aquatic animals

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the lower Broken Creek. The environmental and ecological objectives of the proposals were supported and align with the broad values of caring for Country. Goulburn Broken CMA and Yorta Yorta Nation Aboriginal Corporation will explore further opportunities to deliver environmental water to support Yorta Yorta cultural values throughout the year.

Yorta Yorta Nation Aboriginal Corporation raised concerns about the cultural damage water transfers are having on the lower Goulburn River and the Barmah Choke in addition to the ecological damage being caused. Using the lower Broken and Nine Mile Creeks for delivery of water (either environmental or consumptive) to the lower Murray River as a bypass mechanism may help reduce the risk of erosion on the Barmah Choke and lower Goulburn River and thus help to protect culturally significant values.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.5.3, Goulburn Broken CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing and kayaking)
- riverside recreation and amenity (such as game hunting)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and water quality including preventing algal and azolla blooms).

Recent conditions

The Goulburn Broken region had below-average rainfall and above-average temperatures for most of 2019–20. Rainfall at Numurkah during the first half of 2019–20 was just over half of the long-term average for this period, resulting in low inflows to the local catchment. Water for the environment from the Goulburn and Murray system portfolios was used in combination with operational water to meet flow targets throughout the year.

Flow in lower Broken Creek was lower than planned during winter 2019–20, due to maintenance works on the Yarrawonga Main Channel and the East Goulburn Main Channel. Consequently, fish ladders were closed in July 2019 to hold water in the system to maintain fish habitat. Some water was delivered to the creek from secondary outfall irrigation channels, but flow in reaches 3 and 4 dropped to 15 ML per day on occasions, which is well below the recommended minimum winter target of 40 ML per day.

The flow increased to 250 ML per day at the start of the irrigation season in August 2019, and the rapid increase likely cued some fish movement through the system. IVTs from the Goulburn system and Murray choke bypass flows increased flow in lower Broken Creek to 500 ML per day in late October 2019, which likely cued further fish movement and spawning and flushed azolla. The average flow at Rice's Weir remained around 410 ML per day through summer and early autumn as operational water transfers to the Murray continued. Water for the environment was delivered in conjunction with operational deliveries from late March 2020 to maintain a flow of about 200 ML per day until the end of the irrigation season.

There is limited ecological monitoring in lower Broken Creek, but members of the Broken Environmental Water Advisory Group have reported a marked improvement in water quality since targeted environmental water deliveries started in 2010–11. The delivery of minimum low flow during the off-irrigation season provided winter foraging habitat and instream refuge areas, especially important for young-of-year fish, platypus, rakali (water rats) and turtles.

Scope of environmental watering

Table 5.5.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.5.3 Potential environmental watering actions and objectives for lower Broken Creek

Potential environmental watering action	Functional watering objectives	Environmental objectives
Year-round low flow (40-200 ML/day in reaches 3 and 4 and 40-100 ML/day in reaches 1 and 2)[1]	• Provide native fish with passage through fish ladders • Provide suitable foraging habitat for platypus and rakali (water rats), and support the movement of juveniles of both species • Provide habitat for turtles including protection from exposure to cold in winter • Provide flowing-water habitat and avoid winter drying of weir pools for fish, vegetation, waterbugs, platypus and turtles • Limit suspended sediment and maintain suitable oxygen concentration	
Winter/spring/summer/autumn high flow (200-250 ML/day in reaches 3 and 4 and 100-150 ML/day in reaches 1 and 2 during July to May)	• Provide habitat for fish and support fish movement, spawning and recruitment • Flush and mobilise azolla and maintain oxygen levels in summer	
Winter/spring freshes (up to three freshes of 450 ML/day during July to September)	• Flush and mobilise azolla, if it blooms • Trigger fish migration and movement	

[1] Intended to be delivered year-round, subject to supply constraints. Constraints may mean these flows cannot be delivered in the non-irrigation season between mid-May and mid-August.

Scenario planning

Table 5.5.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Due to regulation of lower Broken and Nine Mile creeks, which creates highly modified and relatively uniform conditions, environmental flow recommendations are relatively constant from year to year and independent of annual conditions.

During 2020–21, environmental flows in 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/or by natural flow. Therefore, water for the environment will only be used to make up shortfalls. During the irrigation season, water for the environment will be mainly used to deliver high flow and freshes, because irrigation demand and the associated operational water flows are likely to meet many of the environmental low flow requirements. Outside of the irrigation season, maintaining low flow above 40 ML per day in all reaches is the primary focus to ensure ecological objectives are met.

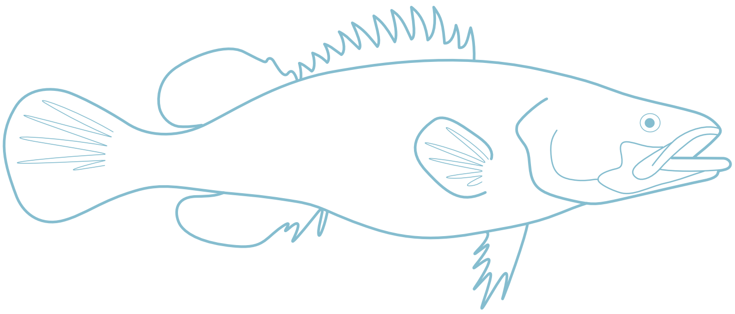
The potential environmental watering actions in Table 5.5.4 are all considered to be high priorities and are expected to meet the environmental requirements of the system. No tier 2 potential watering actions have been identified for 2020–21. Critical carryover requirements under all scenarios in 2020–21 ensure a minimum low flow and a small fresh can be delivered in 2021–22.

In addition to the deliveries of water for the environment explained in this seasonal watering plan, downstream environmental or operational demands may result in higher flows being delivered in lower Broken Creek in 2020–21. Higher flows through the lower Broken Creek system generally provide positive environmental outcomes.

Table 5.5.4 Potential environmental watering for lower Broken Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows in winter • No unregulated flows throughout the irrigation season (mid-August to May) • No diversion of unregulated Murray River flow available	• Some unregulated flows in winter • No unregulated flows throughout the irrigation season (mid-August to May) • No diversion of unregulated Murray River flow available	• Unregulated flows in winter/spring • No unregulated flows during October to May (except for an occasional unregulated fresh in spring) • Diversion of unregulated Murray River flow available during mid-August to October	• Unregulated flows in winter/spring • No unregulated flows during November to May • Diversion of unregulated Murray River flow available during mid-August to November
Potential environmental watering – tier 1 (high priorities)[1]	• Year-round low flow • Winter/spring/summer/autumn high flow • Winter/spring freshes			
Possible volume of environmental water required to achieve objectives	• 44,800 ML	• 45,680 ML	• 55,650 ML	• 43,150 ML
Priority carryover requirements	• 5,000 ML			

[1] Tier 1 potential environmental watering for lower Broken Creek is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for lower Broken Creek



5.5.3 Broken wetlands

System overview

Of some 2,000 natural wetlands in the Goulburn Broken area, only three in the Broken catchment have infrastructure that allow them to receive environmental water: Black Swamp, Kinnairds Wetland and Moodie Swamp. Kinnairds Wetland and Black Swamp are red gum swamps near Numurkah. Moodie Swamp is a cane grass wetland adjacent to upper Broken Creek at Waggarandall that provides excellent breeding habitat for brolga.

The water regimes of these wetlands are influenced by their position in the landscape. The development and operation of the Shepparton and Murray Valley irrigation districts have changed the natural flow paths and the timing, frequency, volume and duration of natural flooding to these and other wetlands in the region. Existing irrigation system infrastructure enables water for the environment to be delivered to the three nominated wetlands, but under existing agreements, irrigation deliveries have priority within the channel system. This limits the volume of water that can be delivered to the wetlands.

Environmental values

Moodie Swamp, Kinnairds Wetland and Black Swamp support a high diversity of vegetation communities ranging from river red gum to cane grass dominated. 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 of high conservation significance (such as eastern great egret, Latham's snipe, white-bellied sea eagle, Australasian bittern, brolga, royal spoonbill, yellow-billed spoonbill, Australasian shoveler and glossy ibis). Many of these species are listed in international agreements and conventions.

Environmental watering objectives in the Broken wetlands

	Increase and improve the growth of native wetland plant species consistent with the ecological vegetation class[1] benchmarks Reduce the cover and diversity of exotic plant species Maintain populations of rigid water milfoil and slender water milfoil
	Provide breeding habitat for waterbirds Provide feeding and roosting habitat for waterbirds

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with the Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the Broken wetlands. Yorta Yorta confirmed support for the environmental watering actions proposed and will continue to collaborate with Goulburn Broken CMA to identify opportunities for environmental water management to support Yorta Yorta cultural values.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.5.5, Goulburn Broken CMA considered how environmental flows could support values and uses including riverside recreation and amenity (such as walking, photography and birdwatching).

[1] Ecological vegetation classes are the standard unit for classifying vegetation types in Victoria. They are described through a combination of floristics, lifeforms and ecological characteristics and through a presumed association to particular environmental attributes. Each ecological vegetation class includes a collection of floristic communities (which is a lower level in the classification) that occurs across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.

Recent conditions

The Broken River catchment continued to experience dry conditions in 2019–20 on the back of two previous dry years, receiving below-average rainfall and experiencing above-average temperatures, particularly in spring/summer. Water availability in the Broken system for Moodie Swamp was very low, with high-reliability allocations only reaching two percent. Supply was better in the Murray system, enabling planned deliveries to Black Swamp and Kinnairds Wetland – which are supplied from the Murray system via the Murray valley irrigation area — to occur.

All Broken wetlands remained dry through winter, spring and summer. Environmental water was delivered to fill both Black Swamp and Kinnairds Wetland in autumn 2020, to provide feeding and breeding habitat for a variety of waterbirds and frogs and to stimulate the growth of wetland vegetation including the listed river swamp wallaby grass at Black Swamp and rigid and slender water milfoil at Kinnairds Wetland.

A planned delivery to Moodie Swamp in autumn 2020 was postponed due to the lack of supply and the preference to maintain flow and water quality in upper Broken Creek. Moodie Swamp did however receive some natural catchment runoff as a result of above-average rainfall in April/early May 2020 that provided minimal wetting of the fringing vegetation.

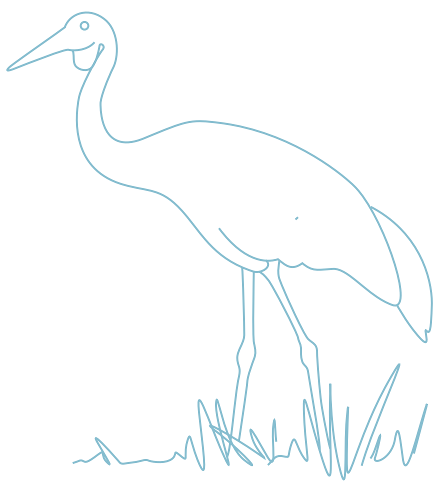
The postponement of the Moodie Swamp watering event in 2019–20 will extend the drying phase for this wetland to 31 months as of autumn 2021: the recommended drying phase is 6–9 months. Therefore, watering Moodie Swamp becomes more critical in 2020–21, to maintain threatened aquatic vegetation.

Scope of environmental watering

Table 5.5.5 describes the potential environmental watering action in 2020–21, its functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.5.5 Potential environmental watering action and objectives for the Broken wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Moodie Swamp (top up in spring as required, fill in autumn)	• Promote cane grass growth • Promote germination and growth of rigid water milfoil • Provide habitat for brolga nesting	



Scenario planning

Table 5.5.6 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Moodie Swamp has been identified as a high priority in all planning scenarios, as it remained dry throughout 2018–19 and 2019–20. If natural inflows occur over winter-spring 2020, a top-up in spring 2020 may be delivered to encourage and maintain any waterbird breeding. If the swamp remains dry, a fill in autumn 2021 is planned to promote the germination and growth of rigid water milfoil, as well as the growth of cane grass that brolga rely on for nesting. Both Black Swamp and Kinnairds Wetland received water in autumn 2020 and will enter a drying phase in 2020–21.

Low water availability in the Broken system under dry or drought conditions in 2020–21 may mean delivery to Moodie Swamp does not occur. Under average to wetter scenarios, water is likely to be available for delivery, and some natural inflow is likely under a wet scenario.

It is considered a priority to carry over water to allow 2021–22 top-ups to tier 1 wetlands planned to be watered in 2020–21.

Table 5.5.6 Potential environmental watering for the Broken wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment runoff and natural flow into the wetlands are highly unlikely	• Catchment runoff and natural flow into the wetlands is unlikely	• Some catchment runoff and natural flow into some of the wetlands is likely, particularly in winter/spring	• Catchment runoff and natural flow into the wetlands may significantly contribute to water levels in the wetlands, particularly during winter/spring
Potential environmental watering – tier 1 (high priorities)	• Moodie Swamp			
Possible volume of environmental water required to achieve objectives[1]	• 1,000 ML (tier 1)			
Priority carryover requirements	• Up to 350 ML			

[1] Moodie Swamp is supplied from the Broken system. There is insufficient supply available to meet potential environmental watering requirements for Moodie Swamp under all scenarios.

5.6 Campaspe system

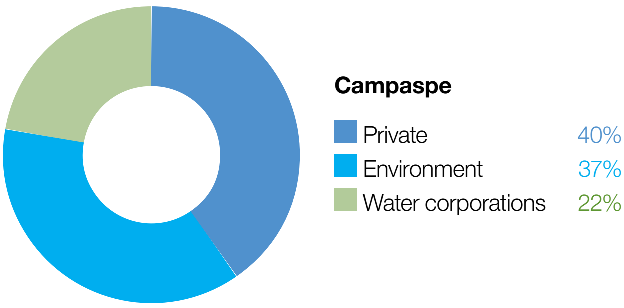
Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder (including the Living Murray program), Commonwealth Environmental Water Holder

Did you know...?

The Arthur Rylah Institute and citizen scientists have been collecting otoliths — fish ear bones — from fish in the Campaspe River. Rather than catching extra fish, anglers have helped by extracting the fish ear bones from the fish they keep for eating. Length and data comparisons indicate that golden perch have higher growth rates in the Campaspe, compared to other northern Victorian rivers. It is likely this is a result of healthy and abundant waterbug populations in the river, a key objective of environmental flows.



Proportion of water entitlements in the Campapse basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Campaspe River, by North Central CMA
Above: Campaspe vegetation, by North Central CMA

The Campaspe system includes the Campaspe River and the Coliban River.

5.6.1 Campaspe River

System overview

Natural inflows in the upper Campaspe River catchment are harvested into Lake Eppalock, which is located near the townships of Axedale and Heathcote. The main tributaries of the Campaspe River are the Coliban River, McIvor and Pipers creeks above Lake Eppalock and Mount Pleasant, Forest and Axe creeks below Lake Eppalock. Below Lake Eppalock, the major in-stream structure is the Campaspe Weir, which was built to divert water to the Campaspe Irrigation District. It is no longer used for water diversion but is a barrier to fish migration. Higher flows usually spill over the weir. The Campaspe Siphon, just below Rochester, is part of the Waranga Western Channel, which carries water from the Goulburn system to western Victoria. Water can be released from the Waranga Western Channel into the lower reaches of the Campaspe River, but the siphon is another barrier to fish migration when there is low-to-moderate flow.

The flow below Lake Eppalock is largely influenced by releases from storage and the operation of the Campaspe Weir and the Campaspe Siphon. The Campaspe's major tributary (the Coliban River) flows through the three Coliban Water storages (the Upper Coliban, Lauriston and Malmsbury reservoirs) before reaching Lake Eppalock. Water for the environment is held and released from Lake Eppalock, with some limited ability to regulate flow further downstream at the Campaspe Weir.

Water for the environment is released from Lake Eppalock to support aquatic plants and animals in and along the river. It can be supplemented by water for the environment delivered via the Waranga Western Channel at the Campaspe Siphon, which provides important flexibility to meeting reach 4 demands. Water for the environment is primarily used to improve the magnitude and variability of flows during the winter/spring. Primary flow measurement points are at Barnadown (reach 2) and below the Campaspe Siphon (reach 4).

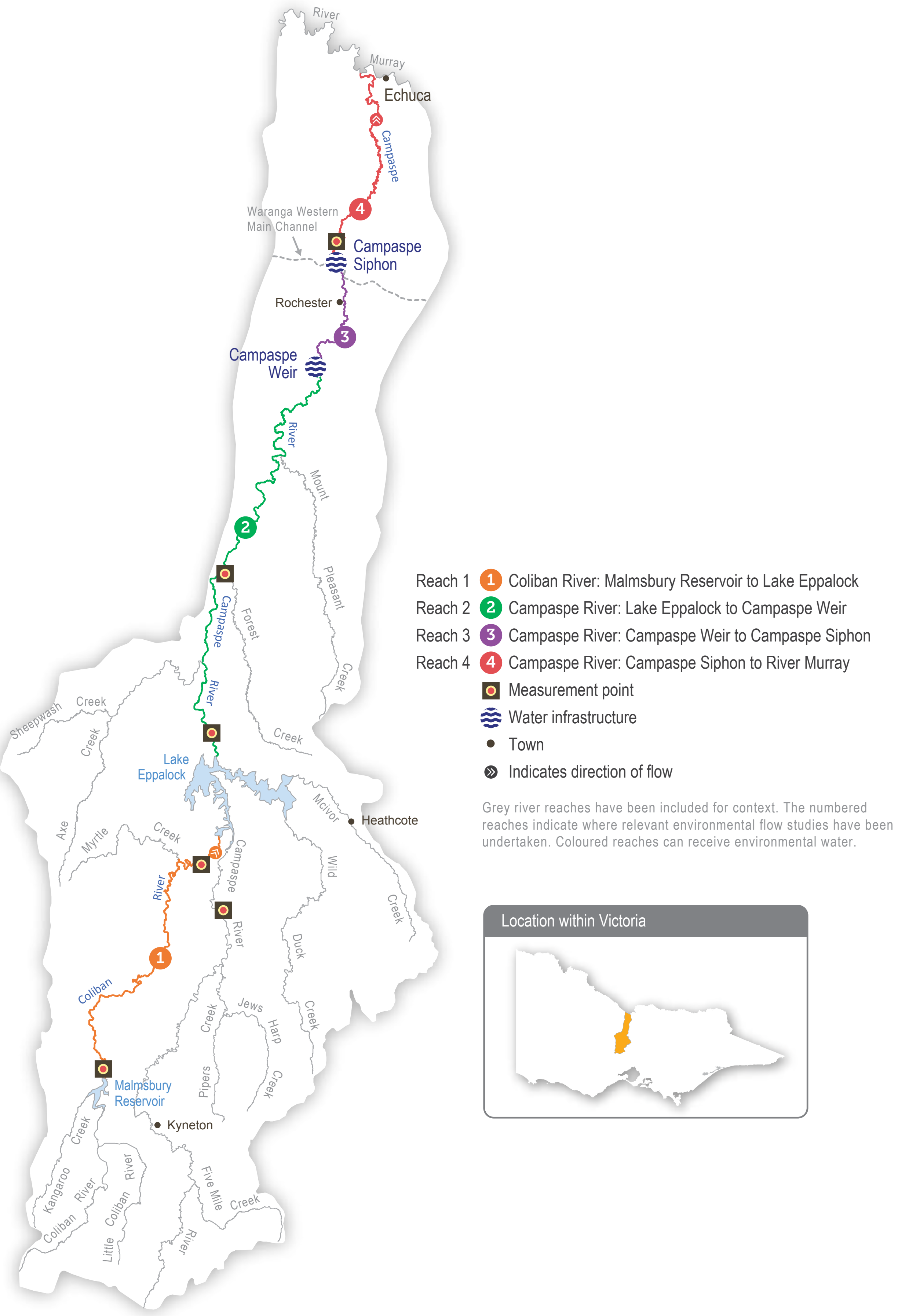
Goulburn-Murray Water transfers operational water from Lake Eppalock or through Waranga Western Channel to customers in the Murray River and to downstream storages (such as Lake Victoria). These IVTs usually occur in summer/autumn and, depending on the rate of delivery, can either support or compromise environmental watering objectives. High IVT flows delivered at a time when the Campaspe River would naturally have a low flow 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. Sustained high IVT flows in summer can also drown streamside vegetation. Storage managers and the CMA have been working cooperatively to enhance the positive effects and limit the negative effects of IVTs on native plants and animals in the Campaspe River. For example, IVTs are sometimes delivered in a pattern that meets summer low flow and fresh requirements, thereby reducing demand on the environmental entitlement. IVTs have also been released in a pattern to support native fish migration from the Murray River into reach 4 of the Campaspe River, without affecting delivery to downstream users.

Environmental values

The Campaspe River below Lake Eppalock provides important habitat for several native fish species including Murray cod, silver perch, golden perch, Murray-Darling rainbowfish and flat-headed gudgeon. Murray-Darling rainbowfish were presumed lost from the system during the Millennium drought, but since 2011, they have been recorded at many sites on the Campaspe River and are now abundant below Elmore. Environmental flows help native fish migrate and disperse throughout the Campaspe system.

Platypus, rakali (water rats), turtles and frogs are also present along the length of the Campaspe River. The streamside vegetation zone is narrow and dominated by large, mature river red gum trees that support wildlife (such as the swift parrot and squirrel glider).

Figure 5.6.1 The Campaspe system



Environmental watering objectives in the Campaspe River

	Provide habitat to help protect and increase populations of native fish Facilitate recolonisation by native fish species that have been presumed lost
	Maintain the resident platypus population by providing places to rest, breed and feed, as well as opportunities for juveniles to disperse
	Maintain adult river red gums and provide opportunities for successful recruitment Maintain the extent and increase the diversity of streamside vegetation Increase the extent of in-stream aquatic plants
	Increase waterbug productivity
	Maintain water quality in deep pools and prevent stratification in summer Reduce the risk of hypoxic blackwater events in summer

Traditional Owner cultural values and uses

In planning for environmental flows in the Campaspe River, North Central CMA has worked with Dja Dja Wurrung Clans Aboriginal Corporation, Taungurung Land and Waters Council and Yorta Yorta Nations Aboriginal Corporation to consider:

- valuable ways in collaboratively working together to understand how environmental values and cultural values align
- Taungurung's Baan Ganalina Advisory Group's and Dja Dja Wurrung's Kapa Gatjin Advisory Group's recently completed Aboriginal Water Assessment.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.6.1, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, kayaking and fishing)
- riverside recreation and amenity (such as birdwatching, camping, cycling, duck hunting, picnicking and walking)
- community events and tourism (such as regional visitation)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and wellbeing).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.6.1 with an icon.

	Watering planned to support peaks in visitation (e.g. camping or other public activities on long weekends or school holidays)

There are many places along the Campaspe where visitors can camp. Aysons Reserve is a very popular camping site near Elmore, and it draws hundreds of campers during the summer school holiday period. Where possible, delivery of summer freshes will be timed to improve river conditions for campers and for water-related activities during peak visitation periods (such as the January long weekend).

Recent conditions

The Campaspe River catchment had below-average rainfall and above-average temperatures throughout most of 2019–20. January 2020 was the only month to record above-average rainfall. The 2019–20 season opened with 26 percent allocation of high-reliability water shares and a declared low risk of spill, which meant environmental water that was carried over from 2018–19 was available for use. Allocations against environmental entitlements in the Campaspe system steadily increased throughout 2019–20 and by April 2020 had reached 80 percent.

A combination of natural inflows, environmental flows, passing flows, operational flows and IVTs met or exceeded most of the dry-scenario watering actions that were planned for the Campaspe in 2019–20. The main deviations from the planned flow regime included a three-day cease-to-flow event in July 2019 to allow maintenance works at the Eppalock outlet tower and some periods of high IVTs between mid-October 2019 and mid-February 2020 that increased low flow by 20 ML per day above the recommended threshold. The IVT in 2019–20 was considered as low risk to the Campaspe River's health compared to previous years when IVTs were around three to four times higher than the recommended flow. Past monitoring of IVTs had indicated an impact to native fish recruitment and riverside native vegetation.

Scope of environmental watering

Table 5.6.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.6.1 Potential environmental watering actions and objectives for the Campaspe River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (10–50 ML/day during December to May)	• Maintain slackwater habitats for zooplankton and nursery habitats for native fish • Maintain the water quality and depth in deep pools in summer for native fish and platypus • Allow platypus to safely move between pools while foraging and ensure adequate food for lactating females	
Year-round fresh (five to 200 ML/day for one to 14 days, as needed)	• A fresh may be required when dissolved oxygen levels are below 5 mg/L, air temperatures are above 28°, there are high water temperatures and/or low river flows to improve water quality along the river pools and de-stratify pools in reach 4, ensuring adequate oxygen to support aquatic animals (such as native fish and platypus)	
Reduced[1] winter/spring low flow (20–40 ML/day during June to November)	• Increase longitudinal connectivity to allow native fish to access new habitats • Facilitate the long-distance movement of male platypus, especially in the August/October breeding season. Provide foraging opportunities across a wide range of habitats for females to develop fat reserves before breeding. • Maintain water quality by preventing pools stratifying	
Winter/spring freshes (two freshes of 1,100–1,600 ML/day for two to five days during June to November)	• Flush accumulated leaf litter from banks and low benches to reduce the risk of blackwater events during high river flow in summer • Maintain soil moisture for established river red gum and woody shrubs (such as bottlebrush and tea tree) • Maintain connectivity to allow native fish movement and access new habitats • Encourage females platypus to select a nesting burrow higher up the bank to reduce risk of high flow later in the year flooding the burrow when juveniles are present	
Winter/spring low flow (40–200 ML/day during June to November)	• Increase longitudinal connectivity to allow native fish to access new habitats • Facilitate long distance movement by male platypus especially in the August/October breeding season • Provide foraging opportunities across a wide range of habitats for female platypus to develop fat reserves before breeding • Maintain water quality by preventing pools stratifying • Reduce terrestrial plants colonising the lower sections of the riverbank and low benches in the channel • Maintain soil moisture in the riverbank to water established river red gums and woody shrubs • Help establish littoral vegetation	
Summer/autumn freshes (one to three freshes 100–200 ML/day for two to three days during December to May)	• Increase longitudinal connectivity to allow native fish to access new habitats • Wet submerged wood and flush fine silt and old biofilms to promote new biofilm growth and increase waterbug productivity for native fish and platypus • Facilitate the downstream dispersal of juvenile platypus in April/May to colonise other habitat areas	

[1] Winter low flow of 20-40 ML/day is below the environmental flow recommendation of a minimum of 50 ML/day due to low water availability in the drought-dry scenario

Scenario planning

Table 5.6.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

For 2020–21, the highest-priority environmental flows are low flow in summer/autumn and winter/spring and delivering a year-round fresh (if needed) under all conditions (see tier 1a actions in Table 5.6.2).

Low flow in summer/autumn is critical for maintaining the river at a level that flushes high-salinity water from pools and maintains oxygen concentrations at a level that can support native fish and waterbugs. Under drought and dry conditions, the amount of water available for the environment is not likely to be sufficient to deliver the recommended winter/spring low flow watering action, and therefore a reduced magnitude low flow is proposed to ensure continuous flow is maintained year-round. The reduced magnitude winter/spring low flow will maintain riffle and pool habitats and water quality in all reaches but may not achieve objectives for streamside vegetation or allow fish and platypus to move freely throughout each reach. Delivering the full winter/spring low flow is a high priority under wet and average scenarios.

The other potential watering actions under average and wet scenarios are summer/autumn freshes and winter/spring freshes. Year-round freshes are a potential watering action as well; when there are low oxygen levels in the river, these will help improve water quality and help de-stratify pools in reach 4, to support aquatic animals.

Any additional water available under the drought or dry scenarios should be used to increase the magnitude of winter/spring low flow (tier 1b). Winter/spring freshes have been identified as tier 2 priorities under the drought and dry scenarios, and an additional winter/spring fresh is identified as a tier 2 watering action under the average scenario. These freshes will improve the condition of environmental values in the Campaspe River, but if there is insufficient water to deliver these freshes, that will not be to the detriment of the system's environmental values in 2020–21. Carryover into 2021–22 is not a priority this year, because sufficient allocation from a very high-reliability entitlement is expected to be available on 1 July 2020 to meet minimum critical demands.

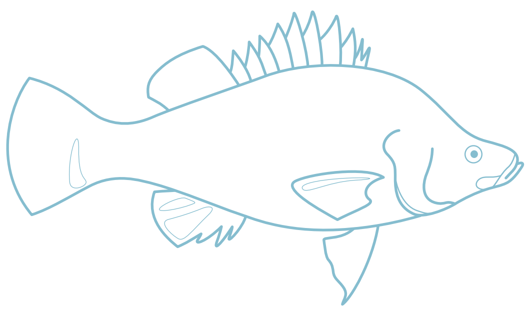


Table 5.6.2 Potential environmental watering for the Campaspe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Little or no natural flow • No passing flows in winter • Operational water deliveries	• Some natural flow • Increased passing flows • Operational water deliveries	• Some natural flow • Increased passing flows	• Some natural flow • Increased passing flows • Spills from storage
Expected availability of water for the environment	• 9,700 ML		• 20,300 ML	• 35,400 ML
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flow • Reduced winter/spring low flow • Year-round fresh (if needed)		• Summer/autumn low flow • One winter/spring fresh • Winter/spring low flow • One to three Summer/autumn freshes • Year-round fresh (if needed)	• Summer/autumn low flow • One to two winter/spring freshes • Winter/spring low flow • One to three Summer/autumn freshes • Year-round fresh (if needed)
Potential environmental watering – tier 1b (high priorities with shortfall)	• Increased magnitude winter/spring low flow		• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• One winter/spring fresh		• Additional winter/spring fresh	• N/A
Possible volume of environmental water required to achieve objectives[1]	• 9,700 ML (tier 1a) • 3,200 ML (tier 1b) • 4,100 ML (tier 2)		• 18,200 ML (tier 1a) • 4,100 ML (tier 2)	• 27,700 ML (tier 1a)

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

5.6.2 Coliban River

System overview

The Coliban River is the major tributary of the Campaspe River, and it flows into Lake Eppalock. It is highly regulated with three storages harvesting water primarily for urban use.

Flow in the Coliban River below Malmsbury Reservoir is regulated by the operation of the Malmsbury, Lauriston and Upper Coliban storages. An important distinction between the Coliban River and other regulated Victorian systems is the lack of irrigation demand. Therefore, flow in the river is influenced by the passing flow entitlement, which depends on catchment inflows and major flood events in the catchment.

Reach 1 of the Coliban River below Malmsbury Reservoir to Lake Eppalock can benefit from environmental watering. The VEWH does not have any environmental entitlements in the Coliban system, but passing flows can be managed — for example, they can be accumulated and released when most needed — to help mitigate some risks associated with critically low summer/autumn flow including low oxygen levels. 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 2020–21.

Environmental values

The Coliban River provides important habitat for platypus, rakali (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 stream bank shrubland vegetation and woodland containing river red gum, callistemon, woolly tea-tree and inland wirilda, which provide habitat for terrestrial animals.

Environmental watering objectives in the Coliban River

Increase the abundance and diversity of small-bodied native fish
Increase platypus communities by providing opportunities for successful breeding and dispersal
Increase the cover and diversity of aquatic plants Increase the cover and diversity of fringing vegetation, while limiting encroachment into the middle of the channel Maintain adult streamside woody vegetation and facilitate recruitment
Maintain an adequate diversity and biomass of waterbugs, to break down dead organic matter and support the river's food chain
Improve water quality and maintain healthy levels of oxygen in pools

Traditional Owner cultural values and uses

In planning for environmental flows in the Coliban River, Dja Dja Wurrung Clans Aboriginal Corporation and North Central CMA have considered how environmental water management assists with preservation of historical and contemporary cultural values including promoting a sense of place and spiritual connection.

The Dja Dja Wurrung Country Plan describes their aspirations around the management of rivers and waterways and articulates Dja Dja Wurrung peoples' support for the reinstatement of environmental flows as an overall objective for the management of water on Country. The North Central CMA and Dja Dja Wurrung Clans Aboriginal Corporation continue to work towards increased engagement on planning and delivery of environmental watering activities, including identifying opportunities for Dja Dja Wurrung involvement.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.6.3, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing)
- riverside recreation and amenity (such as birdwatching, camping, cycling and walking)
- community events and tourism (such as visitation)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, community wellbeing and benefits to the local economy from visitors).

Recent conditions

Rainfall in the Coliban River catchment was below the long-term average for every month during 2019–20, except in November and January. Daily maximum temperatures were generally above average, and December 2019 was exceptionally hot. Carryover from the previous year, along with some unregulated inflows in the Coliban River from July to September 2019, facilitated the accumulation of passing flows.

The flow varied along the length of the Coliban River throughout 2019–20. The Coliban River began contracting above Lake Eppalock towards Malmsbury Reservoir from October 2019 onwards, as the flow dried up along the river. Inflows from unregulated tributaries delivered several natural freshes to the whole system between July and September 2019. Passing flows that were accumulated in winter/spring were used to maintain low flow between Malmsbury Reservoir and Lake Eppalock throughout summer/autumn. Accumulated passing flows were also used to deliver a fresh to improve water quality for aquatic biota in this section of the river in March 2020.

In 2019–20, the priority pulsed low flow in summer and autumn for maintaining water quality was not required, as there was enough water to maintain a reduced summer/autumn low flow in the upper sections of the river. However, the water available was insufficient to maintain full connectivity of the river to Lake Eppalock, and the lower reaches contracted to a series of pools in summer.

Scope of environmental watering

Table 5.6.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.6.3 Potential environmental watering actions and objectives for the Coliban River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Pulsed summer/autumn low flow (five to 15 ML/day for one to 14 days during December to May)	• Maintain water quality including oxygen levels • Maintain refuge habitat for aquatic animals, including fish and platypus	
Summer/autumn low flow (one to 10 ML/day during December to May)	• Maintain aquatic habitat that support waterbugs, native fish, platypus and fringing vegetation • Maintain water quality including oxygen levels	

Summer/autumn freshes (one to two freshes of 25-160 ML/day for one to three days during December to May)	• Maintain the water depth through rifle-run habitats of five to 20 cm for a 25-50 ML/day event to maintain water quality and habitat for waterbugs
	• Maintain water depth through rifle-run habitats of 45–55 cm for a 160 ML/day event to:
	  • increase water depth to facilitate fish and platypus movement
	  • clean sediment and biofilms from river substrates
	  • wet benches and low banks to promote the growth and recruitment of fringing vegetation	

Scenario planning

Table 5.6.4 outlines the potential environmental watering and expected water use under a range of planning scenarios. Watering actions have only been considered for drought to average scenarios, because the storage is likely to spill under wet conditions, and therefore it will not be possible to accumulate passing flows to deliver environmental flows.

Low flow in summer/autumn is the highest-priority potential watering action across all (drought to average) scenarios, to support aquatic habitats for fish, platypus and waterbugs, and to support aquatic and fringing vegetation in the river. It should be possible to maintain continuous low flow targets under dry and average conditions, but less water will be available under drought conditions, so it may only be possible to deliver pulsed low flow to maintain refuge habitats

Under dry and average conditions, accumulated passing flows are planned to be used to deliver summer/autumn freshes to support vegetation recruitment, maintain aquatic habitats and clean river substrates. The number of freshes delivered will depend on the available water and observed conditions in the river.

If more water is available under drought conditions, it is planned to be set aside to support critical watering actions in 2021–22 and/or used to increase the magnitude or duration of low flow if conditions in the river deteriorate. Additional water will go to delivering tier 2 priorities which are freshes in summer/autumn (across all scenarios) and in winter/spring (in the drought scenario).

The carryover priority is to bank passing flows in the river for 2021–22 watering actions (700 ML).

Table 5.6.4 Potential environmental watering for the Coliban River under a range of planning scenarios

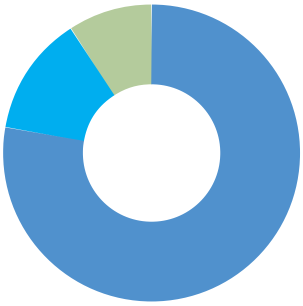
Planning scenario	Drought	Dry	Average
Expected river conditions	• Little or no natural flow	• Some natural flow	• Some natural flow
Expected availability of water for the environment	• Little passing flow accumulated for use in other times of the season • Reliant on carryover from 2019–20 year	• Increase in passing flows, with minimal risk of storage spills • Maximum accumulation of passing flows • Withheld flows for use at other times in the season	• Moderate to high passing flows but reduced ability to accumulate flows due to possible storage spills
Potential environmental watering – tier 1a (high priorities)	• Pulsed summer/autumn low flow • Summer/autumn low flow (reduced magnitude)	• Summer/autumn low flow (reduced magnitude) • One to two summer/ autumn freshes	• Summer/autumn low flow (reduced magnitude) • One to two summer/ autumn freshes
Potential environmental watering – tier 1b (high priorities with shortfall)	• Set aside 2021–22 carryover • Increased magnitude of summer/autumn low flow	• Increased magnitude of summer/autumn low flow	• Increased magnitude of summer/autumn low flow
Potential environmental watering – tier 2 (additional priorities)	• Two winter/spring freshes • Two summer/autumn freshes	• Increased magnitude of two summer/autumn freshes	• Increased magnitude of two summer/autumn freshes
Possible volume of environmental water required to achieve objectives	• 1,200 ML (tier 1a) • Tier 1b and 2 – dependent on water resources and river conditions	• 1,600 ML (tier 1a) • Tier 1b and 2 – dependent on water resources and river conditions	• 2,500 ML (tier 1a) • Tier 1b and 2 – dependent on water resources and river conditions
Priority carryover requirements	• Accumulate passing flows for 2021–22 (700 ML)		

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

Did you know...?

Lake Boort is a highly significant area for Dja Dja Wurrung. The floodplain not only contains some of the highest densities of scarred trees in the world but numerous cooking mounds and other remainders of past productivity. The connection continues through to this day and is embedded in the plants, animals, *Gatjin* (water), *Wi* (fire) and *Djandak* (land).



Loddon

Private	78%
Environment	13%
Water corporations	9%

Proportion of water entitlements in the Loddon basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: 12 Mile Creek in the lower Loddon catchment, by Kathryn Roosje, VEWH
Above: Loddon system vegetation, by North Central CMA

The Loddon system includes the Loddon River (including Tullaroop, Serpentine and Pyramid creeks), the Boort wetlands and Birchs Creek.

5.7.1 Loddon River system (including Tullaroop, Serpentine and Pyramid creeks)

System overview

The Loddon River flows from the Great Dividing Range in the south to the Murray River in the north. Tullaroop Creek is the main tributary in the upper Loddon River system. The middle section of the Loddon River is characterised by many distributary streams and anabranches that carry water away from the river onto the floodplain. The lower Loddon River is joined by Pyramid Creek at Kerang, at which point the Loddon becomes part of the Murray River floodplain.

Two main storages are located on the Loddon River: Cairn Curran and Tullaroop reservoirs, with Lake Laanecoorie used to regulate water from the main storages to the Loddon River. Below Laanecoorie Reservoir, the flow is regulated by the operation of the Bridgewater, Serpentine, Loddon and Kerang weirs.

Water for the environment 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 with the Loddon River at Loddon Weir. Water is provided to Pyramid Creek through releases from Kow Swamp, which receives water diverted from the Murray River at Torrumbarry Weir. Water is diverted from the Loddon River to Serpentine Creek and to the Loddon Valley Irrigation Area to supply agriculture.

The highly regulated nature of the Loddon system provides both challenges and opportunities for effective management of water for the environment. The ability to manipulate the timing of releases at multiple locations provides opportunities to accomplish environmental outcomes at discrete locations. However, coordinating environmental flows and consumptive flows is difficult through the irrigation season, especially when irrigation demand is high or flow in the river is highly variable. This can lead to constraints in the timing and delivery of water for the environment or higher-than-recommended flows above Loddon Weir. The structures used for managing irrigation water form barriers in the waterway, restricting continuity and the ability to achieve outcomes for native fish and possibly platypus.

Environmental values

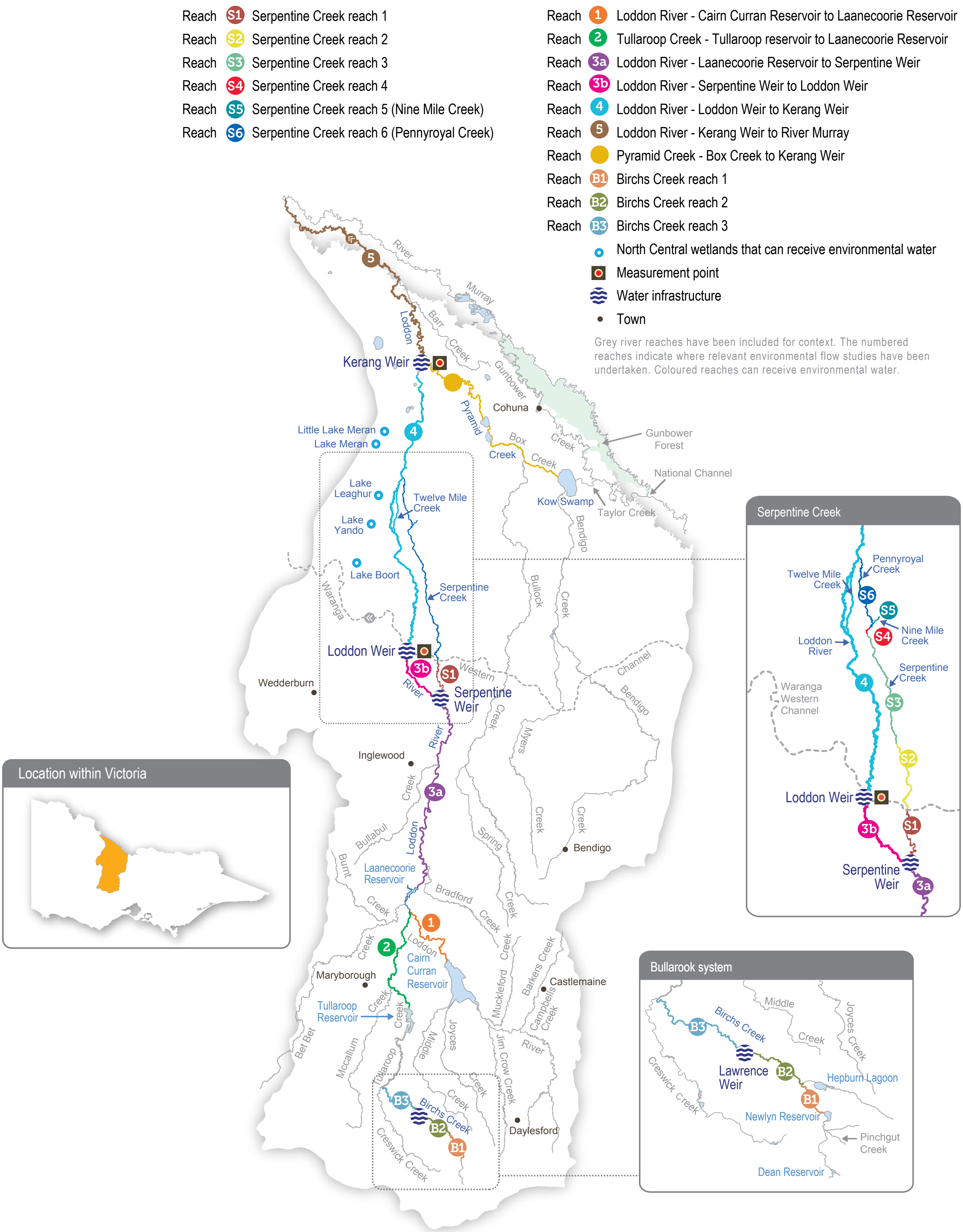
The Loddon River system supports platypus, rakali (water rats) and several species of native fish. Streamside vegetation varies in condition depending on the recent water regime, the extent of clearing and historic and current land management practices. Those areas remaining relatively intact support a variety of woodland birds and other native animals. Important plant species across the system include cane grass, tangled lignum, black box and river red gum.

Although fish populations in the Loddon system are affected by the many barriers caused by weirs and reservoirs, a large range of species are still found through the catchment. Native fish are most abundant and diverse in the upper catchment. River blackfish are found in Serpentine Creek and rare Murray-Darling rainbow fish are found in the middle and lower sections of the Loddon River.

The highest-priority reach for environmental watering is from Loddon Weir to Kerang Weir. The reach does not carry irrigation water, and it relies heavily on environmental flows to maintain its environmental condition. Environmental flows to this reach aim to improve the condition of streamside vegetation, maintain water quality and increase the abundance and diversity of native fish. Environmental flows are delivered to the upper Loddon River, Tullaroop Creek and Serpentine Creek to maintain or increase populations of river blackfish and platypus.

Pyramid Creek and the lower Loddon River support large-bodied fish (such as golden perch, Murray cod and silver perch) and are important corridors for fish migration between the Loddon and Murray systems. Engineering works to provide fish passage at the Chute, Box Creek regulator, Kerang Weir, Fish Point Weir and Little Murray Weir on the Little Murray River in recent years have been important in reopening these migration routes. The Arthur Rylah Institute has monitored fish movement and populations in Pyramid Creek and the lower Loddon River since 2017, and results have indicated that the combined Loddon-Pyramid flow is stimulating native fish movement through the fishways.

Figure 5.7.1 The Loddon system



Environmental watering objectives in the Loddon River system

Increase populations of small and large-bodied native fish Provide habitat for fish to feed and breed and opportunities for movement between habitats
Enhance the channel form and features including deep pools and benches Maintain the condition of suitable substrate, to maintain ecosystem processes Engage floodrunners, distributary channels, anabranches and backwaters
Increase the population and recruitment of resident platypus Maintain a stable rakali (water rat) population in the long term
Maintain the streamside and floodplain vegetation Maintain and increase the extent of in-stream vegetation
Maintain/increase the diversity and productivity of waterbugs, including biofilms and waterbug functional feeding groups, to drive productive and dynamic food webs
Maintain water quality, to support aquatic animals and minimise the risk of blackwater events

Traditional Owner cultural values and uses

In planning for environmental flows in the Loddon River, Dja Dja Wurrung, Barapa Barapa and Wamba Wemba and North Central CMA have considered how environmental flows in the Loddon system can be managed to support their respective values and uses.

The Dja Dja Wurrung Traditional Owners have expressed an interest in seeing a return of species to the river that were, within peoples' living memory, more abundant. This includes species such as platypus, turtles and yabbies. Restoring a natural flow regime and improving water quality are overall cultural aspirations of the Dja Dja Wurrung for management of waterways.

The Barapa Barapa and Wamba Wemba are the Traditional Owners in the northern part of the Loddon catchment, and artefacts of cultural practices are present throughout the Loddon and Pyramid system and its floodplain. The river and floodplain are valued as food and fibre sources and sites of cultural significance such as scar trees, camp sites, meeting places and other important sites.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.7.1, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing, kayaking, water skiing and swimming)
- riverside recreation and amenity (such as camping, cycling, picnicking and walking)
- community events and tourism (such as local visitation)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.7.1 with an icon.

Watering planned to support water sports activities (e.g. skiing competitions)

If possible, North Central CMA will work with Goulburn-Murray Water to manage the delivery of low flow over summer/autumn, which supports optimum conditions for annual water-skiing competitions on the Loddon River at Bridgewater.

Recent conditions

The mid-Loddon catchment had above-average rainfall in July 2019, but the middle and upper Loddon catchments were significantly drier than average during spring and for the first half of summer. Rainfall throughout the Loddon catchment was above average during late summer/autumn 2020, but that did not significantly affect storage levels. Seasonal determinations did not reach 100 percent in the Loddon or Goulburn systems during 2019–20, but carryover, used of allocated water and environmental water transferred into the Loddon system from entitlements in the Goulburn system ensured that enough water was available to deliver all required environmental flows.

Rainfall in the Bet Bet Creek catchment caused spills at Laanecoorie Reservoir and Loddon Weir during July and August 2019, which provided a series of natural freshes and minor overbank flows in the Loddon River below Loddon Weir during early winter. Following the winter spills, flow in the Loddon system returned to the usual regulated conditions for the remainder of the year. Flow in the Loddon River above Loddon Weir, Serpentine Creek and Pyramid Creek exceeded the recommended environmental flow rates at various times during summer/autumn, due to consumptive water deliveries.

The planned environmental watering regime for reach 4 of the Loddon River under dry and average scenarios was entirely achieved in 2019–20. Following the winter high flow, the priority for the year was to continue year-round low flow in the Loddon River and provide summer-autumn freshes to protect water quality and refuge habitat in the Loddon River and Serpentine Creek. Carryover and water transferred into the system made it possible to deliver a spring fresh, combining water from the Loddon River and Pyramid Creek during November 2019.

Monitoring stations continuously monitor temperature and oxygen in reach 4 of the Loddon River. Low oxygen and high water temperatures have occurred in the Loddon River under low flow conditions in previous years, but environmental flows and relatively cool conditions throughout the second half of summer/autumn prevented poor water quality during 2019–20. Environmental water will continue to be used in future, to reduce the risk of dangerously low levels of oxygen.

Scope of environmental watering

Table 5.7.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

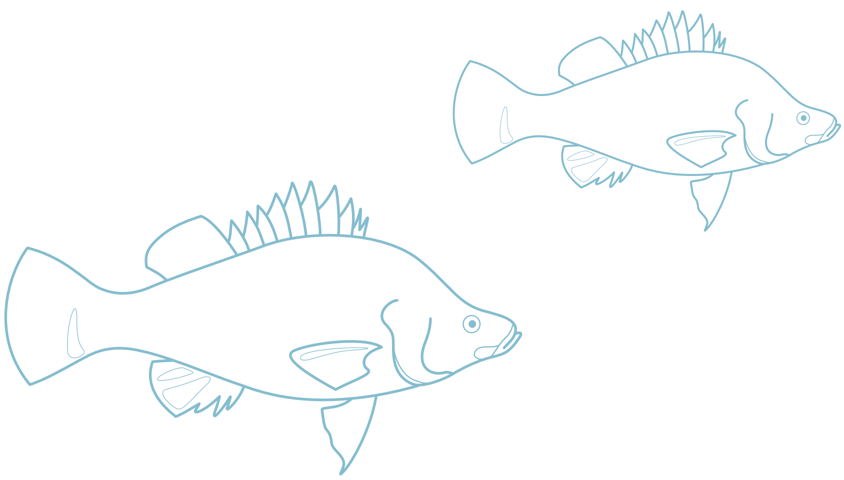


Table 5.7.1 Potential environmental watering actions and objectives for the Loddon River system

Potential environmental watering action	Functional watering objectives	Environmental objectives
Loddon River (targeting reach 4)		
Summer/autumn fresh (one to three freshes of 50–100 ML/day for three to four days during December to May)[1]	• Flush fine sediment from hard surfaces • Increase the water level, to promote the growth of fringing emergent macrophytes • Increase connectivity to promote the local movement of fish and platypus including juvenile dispersal in autumn • Freshen water quality and re-oxygenate pools	
Winter/spring high flow (one high flow of 450–750 ML/day for six to 10 days during August to November)[2]	• Scour accumulated sediment from pools and scour biofilms • Flush accumulated organic matter from the bank and benches, to increase productivity and reduce the risk of a hypoxic blackwater event in summer • Increase the wetted area, to promote the recruitment and growth of streamside and emergent vegetation • Stimulate native fish movement and breeding	
Summer/autumn low flow (25–50 ML/day during December to May)[3]	• Maintain an adequate depth in pools for aquatic plants and to provide habitat for waterbugs, fish and rakali (water rats) • Provide continuous flow through the reach, to maintain water quality • Maintain connecting flows to support in-stream and fringing non-woody vegetation	
Winter/spring low flow (50[4]–100 ML/day during June to November)	• Increase the water depth for fish, platypus and rakali (water rats) dispersal and to provide foraging habitat • Prevent silt and fine sediment settling on submerged wood and other hard surfaces • Water the native fringing bank vegetation and prevent the growth of exotic terrestrial plants in the river channel	
Autumn high flow (one high flow of 400 ML/day for six to 10 days during March to May)	• Trigger and facilitate the upstream movement of golden perch, silver perch and Murray cod older than one year • Facilitate platypus dispersal	

Table 5.7.1 Potential environmental watering actions and objectives for the Loddon River system *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Serpentine Creek[5]		
Summer/autumn fresh (one to three freshes of 30–40 ML/day for one to three days during December to May)	• Maintain the channel form by inundating benches • Flush fine sediment and scour biofilms, to replenish the food supply • Transport organic matter that has accumulated in the channel • Provide flow variability to maintain the diversity of fringing vegetation • Wet exposed woody habitat for waterbugs and provide a sufficient depth of water and variability of flow to maintain microbial biofilms • Freshen water quality by diluting salt and oxygenating pools	
Winter/spring fresh (one fresh of 40–150 ML/day for two days during August to November)	• Maintain the channel form and scour pools • Provide connectivity for fish and waterbugs to access different habitat areas • Transport organic matter that has accumulated in the channel, to increase productivity and reduce the risk of a hypoxic blackwater event in summer • Provide a cue for adult platypus to construct burrows above the higher water level	
Summer/autumn low flow (10–20 ML/day during December to May)	• Provide flow variability to prevent notching of riverbanks • Provide connectivity between pools to allow the dispersal of small-to-medium-bodied native fish • Wet exposed roots, leaf packs and woody debris, to provide habitat for aquatic animals • Provide sufficient flow to maintain water quality by oxygenating pools • Maintain foraging habitat for platypus • Maintain the wetted area to support in-stream aquatic vegetation (such as water ribbons, eel weed and milfoil)	
Winter/spring low flow (20–30 ML/day during June to November)	• Maintain spawning habitat for native fish • Wet exposed roots, woody debris, emergent vegetation and leaf packs, to provide habitat for aquatic animals • Maintain water quality by preventing stagnation • Provide flow variability, to prevent notching of riverbanks and maintain diversity of fringing vegetation • Provide a sufficient depth of water and variability of flow to maintain microbial biofilms	

Table 5.7.1 Potential environmental watering actions and objectives for the Loddon River system *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Pyramid Creek and Loddon River (reach 5)		
Spring high flow (one high flow of 700 ML/day for 10 days during September to October)	• Trigger the migration, spawning and recruitment of native fish species including Murray cod • Maintain connectivity between habitats and improve water quality	
Autumn/winter low flow (90–200 ML/day during May to August)	• Maintain connectivity between pools and provide habitat for fish and waterbugs outside of the irrigation season • Improve water quality by reducing salinity levels • Enhance the wetted area to maintain and promote the growth of fringing emergent (non-woody) vegetation along the lower banks of the channel • Redistribute fine sediment on benches and bars	
Autumn high flow (up to one high flow of 700–900 ML/day for 10 days during March to May)	• Trigger the migration, spawning and recruitment of native fish species including Murray cod • Facilitate the upstream movement of golden perch, silver perch and Murray cod older than one year • Maintain connectivity between habitats and improve water quality • Facilitate platypus dispersal	

[1] The recommended magnitude and duration may be increased if needed to prevent a decline in oxygen levels.

[2] Due to the potential wetting of private land, environmental flows above 450 ML per day in reach 4 will not be provided without the agreement of landholders who could potentially be affected.

[3] Recommended magnitude may be increased if needed to prevent adverse declines in oxygen levels.

[4] Winter/spring low flow of 50 ML per day is below the passing flow magnitude and will result in the VEWH banking passing flows savings, for use in other potential watering actions.

[5] Flows in Serpentine Creek will be allowed to either return to the Loddon River or continue down Pennyroyal/Bannacher Creek or Nine Mile Creek with the agreement of landholders.

Scenario planning

Table 5.7.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Up to three summer/autumn freshes and continuous low flow are planned to be delivered in the Loddon River under all scenarios. These flows are critical for providing connectivity for aquatic animals and freshening water quality. A winter/spring high flow, timed to combine with increased flow in Pyramid Creek, is also planned to be delivered under all scenarios to trigger upstream movement of native fish from the Murray system for feeding and breeding.

Low flow is important for wetting bank vegetation and providing foraging habitat for aquatic animals. In the Loddon River, the magnitude of low flow is expected to vary between 25 to 100 ML per day, depending on conditions (and therefore changes in expected supply) and the time of year. During winter/spring, continuous low flow of 50 ML per day is planned under a drought scenario. This will result in the accumulation of passing flows (as passing flows increase to 77 ML per day in May to October), for use later in the season. Under dry conditions, passing flows are expected to meet the winter low flow requirement, whereas under average and wet conditions, low flow will likely be increased to 100 ML per day. During summer and autumn, continuous low flow is planned to be as low as 25 ML per day in a drought-dry year but may be increased to 50 ML per day if conditions are average to wet. Contingency has been factored in to supply volumes under drought and dry scenarios to temporarily increase summer/autumn low flow magnitudes or the duration of freshes if required, to prevent dangerously low oxygen declines if extended heatwaves are forecast. If more water is available, it is planned to be used to further increase the magnitude of planned freshes and low flow to better align with the environmental flow recommendations. Autumn high flow to cue and support fish movement is a lower priority under a drought scenario compared to dry, average and wet scenarios.

Freshes and low flow are priorities across all seasons for Serpentine Creek under all scenarios. Lower anticipated supply under drought and dry conditions will likely restrict the number of summer/autumn freshes that can be delivered and restrict low flow to the lower end of the recommended range. The full number of recommended freshes and higher-magnitude low flow should be delivered if more water becomes available under these scenarios.

In Pyramid Creek, the highest-priority action under all scenarios is to deliver a spring high flow, which is intended to be timed to meet the peak of the high flow in the Loddon River at Kerang Weir. Coordinating these events provides flow of a sufficient magnitude to trigger native fish to move upstream from the Murray River toward Kow Swamp and Gunbower Creek for spawning and recruitment. Pyramid Creek carries a large volume of consumptive water during the irrigation season, but the flow can drop significantly outside the irrigation season. Under all scenarios, water for the environment will likely be used to supplement flow in late autumn and winter, to maintain habitat for fish and other aquatic animals during this period. Autumn high flow should be delivered under average and wet conditions, if sufficient water is available.

Up to 6,500 ML is prioritised for carryover into 2021–22. This water will help meet winter/spring low flow in all waterways and the spring high flow in the Loddon River.

Table 5.7.2 Potential environmental watering for the Loddon River system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Negligible contributions from unregulated reaches and tributaries of the Loddon River, consumptive water deliveries in the irrigation season • Reduced passing flows in autumn/ winter likely	• Small inflows from unregulated reaches and tributaries of the Loddon River contributing to low flow, consumptive water deliveries in the irrigation season	• Natural flow will provide low flow and multiple freshes, most likely in winter/ spring • Consumptive water deliveries in the irrigation season • No spill likely	• Spills from Loddon system storages will provide extended-duration high flow and overbank flow most likely in late winter/spring
Expected availability of water for the environment[1]	• Up to 15,600 ML	• 17,700 ML	• 20,700 ML	• 20,700 ML
Loddon River (targeting reach 4)				
Potential environmental watering – tier 1a (high priorities)	• One to three summer/autumn freshes • One winter/spring high flow • Summer/autumn low flow • Winter/spring low flow at lower magnitude (accumulating passing flows savings)	• One to three summer/autumn freshes • One winter/spring high flow • Summer/autumn low flow	• One to three summer/autumn freshes • One winter/spring high flow • Summer/autumn low flow • Winter/spring low flow	
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn fresh delivered at upper magnitude • Winter low flow delivered at upper magnitude	• Winter low flow delivered at upper magnitude[2] • One autumn high flow	• One autumn high flow	
Potential environmental watering – tier 2 (additional priorities)	• One autumn high flow	• N/A		
Serpentine Creek				
Potential environmental watering – tier 1a (high priorities)	• One to three summer/autumn freshes • One winter/spring fresh • Summer/autumn low flow • Winter/spring low flow		• Three summer/autumn freshes • One winter/spring fresh • Summer/autumn low flow • Winter/spring low flow	
Potential environmental watering – tier 1b (high priorities with shortfall)	• Low flow delivered at upper magnitude • Winter/spring fresh delivered at upper magnitude		• N/A	

Table 5.7.2 Potential environmental watering for the Loddon River system under a range of planning scenarios *(continued)*

Pyramid Creek and Loddon River (reach 5)				
Potential environmental watering – tier 1a (high priorities)	• One spring high flow (coordinated with Loddon River high flow) • Autumn/winter low flow			
Potential environmental watering – tier 1b (high priorities with shortfall)	• N/A		• Autumn high flow	
Possible volume of environmental water required to achieve objectives[3]				
Loddon River (reach 4) and Serpentine Creek	• 11,300 ML (tier 1a) • 4,300 ML (tier 1b) • 4,100–6,800 ML (tier 2)	• 12,000–15,700 ML (tier 1a) • 6,800–13,600 ML (tier 1b)	• 24,500 ML (tier 1a)[4] • 4,100–6,800 ML (tier 1b)	
Pyramid Creek and Loddon River (reach 5)	• 4,000 ML (tier 1a)[5]		• 4,000 ML (tier 1a)[5] • 2,000 ML (tier 1b)[5]	
Priority carryover requirements	• 6,500 ML			

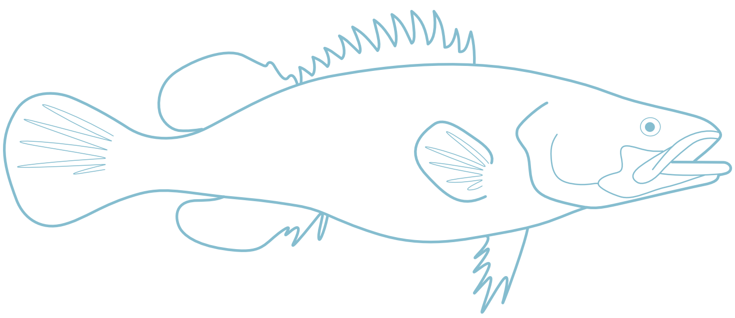
[1] Water holdings available for demands in the Loddon River system are also used to source demands in the Boort wetlands.

[2] Under a dry scenario, winter low flow is planned to otherwise be delivered at the passing flow rate (77 ML per day) for tier 1a.

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

[4] This tier 1a volume is the supply required to meet all potential watering actions with water for the environment. While it is higher than the expected availability of environmental water holdings, it is likely that some actions may be achieved with natural flows in the system reducing the actual volume required.

[5] Consumptive water en route to downstream sites is diverted through Pyramid Creek to meet these events, with the associated losses debited to the VEWH. A volume of 2,000 ML per event is required to underwrite these losses, however the actual use debited is likely to be less than this volume.



5.7.2 Boort wetlands

System overview

The Boort wetlands are on the floodplain west of the Loddon River, below Loddon Weir. They consist of temporary and permanent freshwater lakes and swamps: Lake Boort, Lake Leaghur, Lake Yando, Little Lake Meran and Lake Meran. Together, the Boort wetlands cover over 800 ha. There are numerous other wetlands in the district, but they are currently not managed with water for the environment.

The natural watering regimes of wetlands throughout the broader 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. Water is delivered to the Boort wetlands through Loddon Valley Irrigation Area infrastructure.

The availability of water for the environment for the Boort wetlands is closely linked to water available for the Loddon River system. The ability to deliver water for the environment to the wetlands is sometimes limited by channel capacity constraints. The VEWH and North Central CMA work with the storage manager (Goulburn-Murray Water) to best meet environmental objectives within capacity constraints.

Environmental values

The Boort wetlands provide habitat for a range of plant and animal species. 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.

Environmental watering objectives in the Boort wetlands

Increase the population of large and small-bodied fish species
Increase the diversity and population of native frogs including by enhancing breeding opportunities
Maintain the population of freshwater turtles, in particular Murray River turtles
Rehabilitate and increase the extent of emergent and aquatic vegetation (aquatic herblands, tall marsh), intermittent swampy woodland and riverine chenopod woodland Maintain the health and restore the distribution of river red gums and associated understorey species Maintain the extent and restore the health of black box vegetation
Support a high diversity of wetland birds by enhancing feeding and breeding conditions

Traditional Owner cultural values and uses

In planning for environmental flows in the Boort wetlands, North Central CMA has worked with Barapa Barapa and Wamba Wemba Traditional Owners and Dja Dja Wurrung Clans Aboriginal Corporation to identify opportunities to engage on environmental water planning and delivery now and in future.

The wetlands and surrounding land in the Boort region are rich in cultural heritage, with sites and artefacts of cultural practices present throughout the landscape. The rivers and floodplains are valued as food and fibre sources and contain many sites of significance such as camp sites and meeting places. Environmental watering supports values such as native fish, waterbirds and turtles, and promotes the growth of culturally-important plants that provide food, medicine and weaving materials. The presence of water itself can be a cultural value, as well as the quality of the water, as healthy water promotes a healthy Country.

A key priority for Barapa Barapa and Wamba Wemba Traditional Owners in the Boort and central Murray region wetlands is maintaining or improving the condition of wetland vegetation health. North Central CMA and Barapa Barapa Traditional Owners are collaborating to deliver the DELWP-funded Decision Support Tool (DST) project which focuses on McDonalds Swamp (central Murray wetlands, see section 5.2.3), Lake Leaghur and Lake Yando. The project involves the delivery of revegetation works and vegetation monitoring. Environmental watering decisions at these wetlands have been able to support the DST project by aligning watering actions with the watering requirements of the revegetation and enabling monitoring to be completed by Barapa Barapa.

The Dja Dja Wurrung Country Plan describes their aspirations around the management of rivers and waterways and articulates Dja Dja Wurrung peoples' support for the reinstatement of environmental flows as an overall objective for the management of water on Country. The North Central CMA and Dja Dja Wurrung Clans Aboriginal Corporation continue to work towards increased engagement on planning and delivery of environmental watering activities, including identifying opportunities for Dja Dja Wurrung involvement.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.7.3, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing and kayaking)
- riverside recreation and amenity (such as birdwatching, camping, duck hunting and walking)
- community events and tourism (such as supporting Aboriginal cultural heritage and history-based tours)
- socio-economic benefits (such as ecosystem services like groundwater recharge, flood mitigation, nutrient treatment and carbon storage).

Recent conditions

Rainfall across the Boort wetlands during 2019–20 was close to the long-term average, but there were no floods in the Loddon River catchment and therefore no significant inflows to the wetlands. The Boort wetlands last flooded in 2016, and since then water for the environment has been delivered to Lake Meran and Little Lake Meran, which, at the end of 2019–20, both continued to hold water. Lake Yando and Lake Leaghur are completely dry and are due for filling under their recommended watering regimes. Lake Boort is also dry and is preferred to remain dry in 2020–21 to maintain its optimal regime.

Water for the environment was used to top up water levels in Lake Meran between spring 2019 and autumn 2020 as recommended in the *Lake Meran Environmental Water Management Plan*, to maintain habitat for aquatic animals and promote the growth of fringing vegetation. A planned partial fill at Lake Yando did not proceed in 2019–20, due to delivery constraints and channel blockage when the water was needed. Consequently, a fill of Lake Yando will be a high priority in 2020–21, which will require the channel to be cleared before filling.

Scope of environmental watering

Table 5.7.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

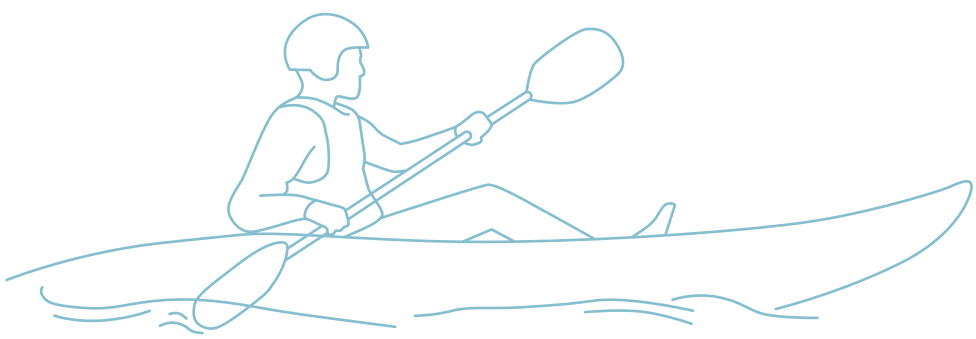
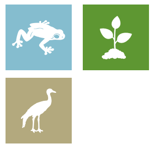
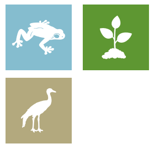


Table 5.7.3 Potential environmental watering actions and objectives for the Boort wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Lake Meran (top-ups as required to maintain water level between 77.30 and 77.80m AHD)	• Increase the water depth to maintain an appropriate water temperature for aquatic animals and provide a refuge for freshwater turtles, waterbirds and fish • Provide dry areas (above 77.8 m AHD) to promote the growth and increase the extent of herbland vegetation around the wetland fringe • Top-ups will most likely be required in late winter, spring and autumn, but may be delivered year-round to maintain minimum water depth requirements for aquatic animals	
Lake Meran (fill, if required in response to natural flooding)	• Provide moisture to maintain mature trees in the intermittent swampy woodland on the wetland fringe • Provide deep, open water to support the feeding of deep-water foraging waterbirds and support breeding of colonial nesting birds	
Lake Yando (fill in late winter/spring)	• Wet the wetland fringe to promote the germination and recruitment of river red gums and maintain the existing mature trees • Support the growth of aquatic and semi-aquatic plants • Provide habitat and food resources for aquatic animals • Grow zooplankton and waterbug communities to provide food for waterbirds and frogs	
Lake Leaghur (fill in winter/ spring)	• Wet the wetland fringe to promote the germination and recruitment of fringing vegetation (such as river red gums and cane grass) • Support the growth of aquatic and semi-aquatic plants • Provide habitat and food resources for aquatic animals • Grow zooplankton and waterbug communities to provide food for waterbirds and frogs	
Lake Yando and Lake Leaghur (top-ups as required, if significant waterbird breeding occurs)	• Maintain shallow-water habitat under tree canopies to ensure adequate food resources for nesting waterbirds and their chicks • Top-ups will most likely be required over late spring/summer but may be delivered at other times if required	

Scenario planning

Table 5.7.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Topping up Lake Meran to maintain the water level between 77.3 and 77.8 m AHD is a high priority under all scenarios, to manage the lake's salinity for aquatic animals and provide permanent refuge for fish and Murray River turtles. If under a wet scenario natural flows raise the water level in Lake Meran significantly above 77.8m AHD, water for the environment may be used to achieve a complete or near-complete fill for the remainder of 2020–21. Waterway managers will respond adaptively depending on the level of natural inflow, climatic forecasts and environmental conditions.

Lake Yando has been dry for over two years and filling it in 2020–21 is a priority under all scenarios, to support vegetation germination and growth.

A fill of Lake Leaghur is planned to be provided between late winter and spring under average and wet scenarios, to maintain the health of mature streamside vegetation and to promote seedling recruitment. Deliveries will be subject to planned channel infrastructure upgrades being completed before optimal filling times. While desirable under an optimal watering regime, this delivery is less of a priority compared to other sites under drought and dry scenarios, as one more year of drying is tolerable under its environmental management plan. However, if Lake Leaghur remains dry in 2020–21, filling the wetland in 2021–22 will become a high priority to meet minimum watering recommendations. Where applicable, additional top-ups may be provided to Lake Yando and Lake Leaghur to ensure adequate food resources for nesting waterbirds if significant waterbird breeding occurs.

Lake Boort is currently dry and is planned to be allowed to remain dry to prevent over-watering trees and to allow them to grow. Unless filled naturally, Little Lake Meran is planned to continue to be drawn down to a minimum level or to dry completely. This will provide an important dry period, to promote the growth of herbland plants and fringing vegetation.

Most wetlands are expected to fill naturally from large overland floods under a wet scenario.

Table 5.7.4 Potential environmental watering for the Boort wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural inflows to wetlands	• Minimal natural inflows to wetlands from local catchment runoff possible	• Periods of high flow combined with localised catchment contributions, which are expected to provide minor inflows to wetlands	• Extended durations of high flow and overbank flow from creeks and flood runners, which fill most wetlands
Potential environmental watering – tier 1[1] (high priorities)[2]	• Lake Meran (top-ups) • Lake Yando (fill) • Lake Yando (top up, if triggered)	• Lake Meran (top-ups) • Lake Yando (fill) • Lake Yando (top up, if triggered)	• Lake Meran (top-ups) • Lake Yando (fill) • Lake Leaghur (fill) • Lake Yando and Lake Leaghur (top up, if triggered)	• Lake Meran (top-ups) • Lake Meran (fill, if required) • Lake Yando (fill) • Lake Leaghur (fill) • Lake Yando and Lake Leaghur (top up, if triggered)
Potential environmental watering – tier 2 (additional priorities)[2]	• Lake Leaghur (fill) • Lake Leaghur (top up, if triggered)	• Lake Leaghur (fill) • Lake Leaghur (top up, if triggered)	• N/A	
Possible volume of environmental water required to achieve objectives[3]	• 3,400 ML (tier 1) • 2,000 ML (tier 2)	• 3,400 ML (tier 1) • 2,000 ML (tier 2)	• 5,400 ML (tier 1)	• 5,400–11,400 ML (tier 1)

1 Tier 1 potential environmental watering for the Boort wetlands is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the Boort wetlands

2 Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios.

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

5.7.3 Birchs Creek

System overview

Birchs Creek is a tributary of the Loddon River located in the southern-most part of the catchment. The creek rises in the ranges north-east of Ballarat and flows north-west through Newlyn and Smeaton before joining Tullaroop Creek near Clunes. The lower parts of the catchment are extensively cleared where the creek meanders through an incised basaltic valley. The creek contains a regionally significant platypus community and a vulnerable river blackfish population.

Birchs Creek is part of the broader Bullarook system which contains two small storages — Newlyn Reservoir and Hepburn Lagoon — which provide water for irrigation and urban supply. The storages fill and spill during winter or spring in years with average or above-average rainfall.

Birchs Creek receives tributary inflows from Rocky Lead, Langdons, Lawrence and Tourello creeks. Groundwater provides reliable baseflows to the downstream reaches of Birchs Creek in most years.

The VEWH is allocated 100 ML in Newlyn Reservoir on 1 December each year, provided that seasonal determinations in the Bullarook system are at least 20 percent. Any unused allocation from 1 December can be carried over until 30 November of the following water year, but if Newlyn Reservoir spills from 1 July to 30 November, the volume held in carryover is lost. Any water remaining on 30 November is forfeited. When seasonal determinations are below 20 percent, the VEWH does not receive an allocation, and the system's resources are shared equitably to protect critical human and environmental needs.

Environmental values

Birchs Creek supports threatened aquatic plants and its deep pools provide habitat for aquatic animals during dry periods. The creek contains native fish including regionally-significant populations of river blackfish and mountain galaxias as well as flat-headed gudgeon and Australian smelt. Recent monitoring indicates that platypus are present throughout the entire creek.

The removal of willows along the creek in 2018 has led to observed improvements in in-stream vegetation and the presence of small-bodied fish.

Environmental watering objectives in Birchs Creek

Increase the population and diversity of small to medium-bodied native fish including river blackfish, mountain galaxias, flat-headed gudgeon and Australian smelt Re-establish populations of small to medium-bodied native fish in reaches 1 and 2 of Birchs Creek
Maintain the breeding population of platypus and increase the number of individuals to improve the population's resilience to future droughts and floods Provide opportunities for platypus dispersal to Creswick and Tullaroop creeks
Maintain and improve the diversity and abundance of in-stream aquatic plants Maintain a diverse variety of fringing and streamside native vegetation communities
Increase the population of waterbugs and the diversity of functional groups to drive productive and dynamic food webs
Maintain water quality to support aquatic life and ecological processes

Traditional Owner cultural values and uses

In planning for environmental flows in Birchs Creek, Dja Dja Wurrung Clans Aboriginal Corporation and North Central CMA have identified the creek as a potential site for future projects.

The Dja Dja Wurrung Country Plan describes their aspirations around the management of rivers and waterways and articulates Dja Dja Wurrung peoples' support for the reinstatement of environmental flows as an overall objective for the management of water on Country. The North Central CMA and Dja Dja Wurrung Clans Aboriginal Corporation continue to work towards increased engagement on planning and delivery of environmental watering activities, including identifying opportunities for Dja Dja Wurrung involvement.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.7.5, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing)
- riverside recreation and amenity (such as improving amenity at key community spaces like Anderson's Mill)
- community events and tourism (such as education activities like school groups and River Detectives)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses).

Recent conditions

The Birchs Creek catchment experienced below-average rainfall and above-average temperatures throughout 2019–20. High rainfall in August 2019 caused Newlyn Reservoir to fill and spill, which meant the VEWH forfeited allocation that was carried over from 2018–19. Newlyn Reservoir is a very small water storage and modest inflows cause it to spill in most years. The VEWH received a full allocation of 100 ML in December 2019, and that water will be available for use until 30 November 2020 unless Newlyn Reservoir spills again.

The combination of spills from Newlyn Reservoir, tributary inflows, consumptive water orders and groundwater discharge met and at times exceeded the dry scenario environmental flow recommendations for Birchs Creek during 2019–20.

Scope of environmental watering

Table 5.7.5 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.7.5 Potential environmental watering actions and objectives for Birchs Creek

Potential environmental watering action	Functional watering objectives	Environmental objectives
Spring fresh (one fresh of 30 ML/day for three days during September to November)	• Maintain and support the growth of streamside vegetation by increasing soil moisture and depositing sediment on the bank and benches • Scour organic matter that has accumulated in the channel and cycle nutrients throughout the creek • Wet benches and smaller channels, to increase habitat and refuge for small fish • Freshen refuge pools and provide connectivity between pools for fish and platypus movement	
Autumn freshes (up to three freshes of 10 ML/day for three days during March to April)	• Increase the water depth, to maintain and support the growth of in-stream aquatic vegetation • Expand riffle/run areas to provide waterbug habitat • Top up pools to refresh water quality (particularly oxygen levels) and enhance connectivity between pools for fish and platypus movement	

Scenario planning

Table 5.7.6 outlines the potential environmental watering and expected water use under a range of planning scenarios.

In 2020–21, delivering a spring fresh is a priority under all scenarios, to bolster the condition of the creek in the lead-up to summer. The spring fresh is planned to be delivered under drought and dry conditions using water that the VEWH will carry over from 2019–20. Under average and wet conditions, it is more likely that these flows will occur naturally.

The forecast water resource outlook indicates that the VEWH will not receive allocation in the Bullarook system during 2020–2021 under drought conditions. Under such conditions, the storage manager, Goulburn-Murray Water, will consult with water entitlement holders in the system to manage available resources with consideration of critical human and environmental needs. Under dry, average and wet scenarios, full allocation is forecast. If available, allocated water is most likely to be used to deliver one to three autumn freshes between March and April 2021. If not required due to natural variation in the system meeting flow requirements, any unused water for the environment that was allocated on 1 December 2020 will likely be carried over to the 2021–22 water year, for use up to 30 November 2021.

Table 5.7.6 Potential environmental watering for Birchs Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Reservoir spill unlikely • Flows extremely low in winter/spring • Limited irrigation releases due to low allocations	• Reservoir spill possible • Low flow in winter/spring if no spills occur • Moderate irrigation releases	• Reservoir spills certain in winter/spring • Some natural flow through summer/autumn	
Expected availability of water for the environment	• 100 ML (carryover)	• 100–200 ML (carryover and allocation)	• 100 ML (allocation)[1]	
Potential environmental watering – tier 1a (high priorities)	• One spring fresh	• One spring fresh • One to three summer/autumn freshes	• One to three summer/autumn freshes	
Possible volume of environmental water required to achieve objectives	• 100 ML (tier 1a)	• 100–200 ML (tier 1a)	• 100 ML (tier 1a)	
Priority carryover requirements	• If the 100 ML allocation is received on 1 December 2020 and Birchs Creek is in good condition over summer/autumn, carry over 100 ML allocation into 2021–22 water year for use by 30 November 2021			

[1] Under an average or wet scenario, it is likely that Newlyn Reservoir will spill before 30 November 2020, losing the 100 ML carryover from December 2019.

Successful revegetation of water ribbon at Lake Murphy, by Damien Cook

Section 6

Further information

6.1 Acronyms and abbreviations

AHD – Australian Height Datum (also see Glossary entry)

BGLC – Barengi Gadjin Land Council Aboriginal Corporation

BLCAC – Bunurong Land Council Aboriginal Corporation

CEWH – Commonwealth Environmental Water Holder

CMA – Catchment management authority

DELWP – Department of Environment, Land, Water and Planning

EVC – Ecological Vegetation Class

FSL – Full supply level

GLaWAC – Gunaikurnai Land and Waters Aboriginal Corporation

GWMWater – Grampians Wimmera Mallee Water

IVT – Inter-valley transfer

MDBA – Murray-Darling Basin Authority

MDWWG – Murray Darling Wetlands Working Group

ML – Megalitre (also see glossary entry)

NVIRP – Northern Victoria Irrigation Renewal Project

NVRM – Northern Victoria Resource Manager

RMIF — River Murray Increased Flows

SAC – Snowy Advisory Committee

VEFMAP – Victorian Environmental Flows Monitoring Assessment Program

VEWH – Victorian Environmental Water Holder

WetMAP – Wetland Monitoring Assessment Program

WMPP – Wimmera-Mallee Pipeline Project

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 in 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 objectives – Measurable target outcomes sought for each environmental value in the system, to be achieved by ongoing implementation of one or more watering actions as well as complementary actions (such as controlling invasive species or installing fishways). Target outcomes may take years or several decades to achieve.

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.

Functional watering objective – The physical or biological effect that a particular watering action aims to achieve.

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 water for the environment which is stored in major reservoirs and used for potential 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 the most-suitable 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 the use of water for the environment 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 water for the environment entitlements consistently with the seasonal watering plan.

Shared benefits – The many cultural, economic, recreational, social and Traditional Owner 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 water for the environment a year for use at six iconic sites along the River Murray.

Tier 1a – High-priority potential environmental watering actions that could be achieved with the assumed supply of water.

Tier 1b – High-priority potential environmental watering actions that are unlikely to be achieved with the assumed supply of water and may require additional water to meet demands.

Tier 2 – Environmental watering actions identified as being necessary to support the environmental objectives, but which are not essential to deliver this year.

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 water for the environment 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 for the environment – Water available for environmental purposes including entitlements held by the VEWH, passing flows and unregulated flows.

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 2019-20*, please contact the VEWH.

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 CMA
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 CMA
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 CMA
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 CMA
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 CMA
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

Printed by FilmShot Graphics (June 2020)

ISSN: 2203-6539 (Print)

ISSN: 2203-6520 (Online)

Disclaimer

This publication may be of assistance to you but the VEWH and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

vewh.vic.gov.au

VICTORIAN ENVIRONMENTAL WATER HOLDER

VICTORIA State Government