Seasonal Watering Plan 2021-22

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.

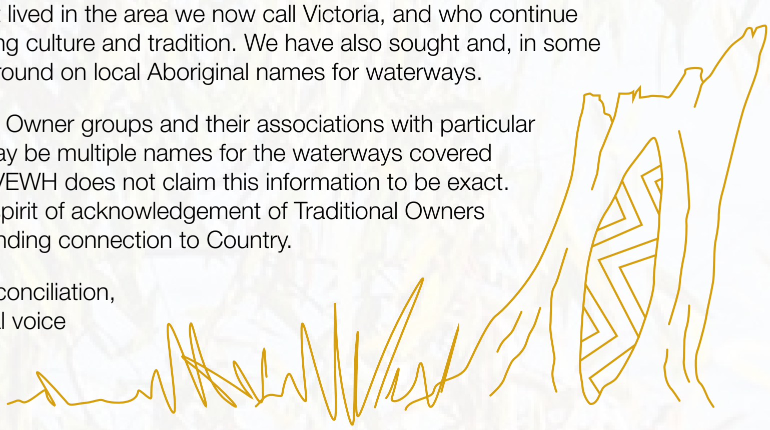
We acknowledge Aboriginal people as Australia's first peoples and as Traditional Owners and custodians of the land and water on which we rely. We recognise the intrinsic connection of Traditional Owners to Country, and we value their ongoing contribution to managing Victoria's landscapes. We also recognise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

There is a meaningful intersection between the aims of the environmental watering program – healthy waterways, healthy communities – and the deep and enduring obligations Traditional Owners have to Country and community. We acknowledge the ongoing contribution that Aboriginal people are making to planning and managing water for the environment, including that outlined in the system sections of this seasonal watering plan. We also recognise that this contribution is largely through frameworks and processes that have not been determined by Traditional Owners, and contribution does not imply endorsement of those frameworks and processes. More can be done to increase Traditional Owners' contributions and enable progress towards self-determination within and beyond the environmental watering program. The VEWH will continue to play its role to support and enable this where it can.

Over millennia, Aboriginal people have shaped, managed and cared for the land and waterways that sustain them. There have been very different clan and Nation boundaries to those that exist today. 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.



Cover: Fishing at Merbein Common, by David Sickerdick provided by Mallee CMA
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.

Waterbirds at Hattah Lakes, by Mallee CMA

Foreword

I am pleased to introduce the Victorian Environmental Water Holder's (VEWH's) *Seasonal Watering Plan 2021-22*, which outlines the scope of why, where and when water for the environment may be delivered over the next 12 months.

Over the past 12 months, we've seen an enormous change to the way we work as we continue to manage the impact of COVID-19. Most of us have had to quickly adapt to working remotely and interacting virtually, rather than face-to-face. Despite these challenges, the VEWH and our valued program partners — waterway managers, Traditional Owners, storage managers, land managers, environmental water holders, scientists and communities — have continued to work closely together to achieve a comprehensive seasonal watering plan that aims to deliver the best possible outcomes for our environment.

Our planning for the upcoming watering season comes on the back of last year's La Niña weather pattern which provided much-needed rainfall in the Gippsland, central and northern regions of Victoria, resulting in good inflows to many reservoirs, some minor reservoir spills and unregulated flows in several river systems. In western Victoria, La Niña had less effect; water storages remained low and there was a heavy reliance on the available allocations of water for the environment to provide flows in the Wimmera and Glenelg systems.

This year, available carryover and forecast inflows in the Gippsland and central regions put us in a good position to deliver planned environmental watering actions to consolidate and build on the environmental outcomes observed in 2020-21. In northern Victoria, many floodplain systems not inundated since 2016-17 will need water for the environment, and we will work with our program partners to supply these large floodplain water demands, particularly in the mid-Murray River system. In western Victoria, we will need a significant boost in allocations of water for the environment during winter/spring to support the delivery of many watering actions. If water availability remains low, we will focus on delivering minimum flows to protect aquatic ecosystems.

Evidence over the past 10-15 years combined with climate change forecasts indicates that water for the environment will be increasingly required to support river and wetland health. Climate modelling also indicates there will be more extreme events (such as droughts and floods), with a continued seasonal shift in rainfall meaning less rain in the cooler months.

The need for flexibility and a seasonally adaptive approach continues to be important as the effects of climate change create uncertain seasonal conditions.

Our water planning is underpinned by scientific understanding and local knowledge from across Victoria which, together with river and wetland studies, informs our decisions about where to best deliver water for ecological benefits as well as helps optimise shared benefits including cultural benefits for Traditional Owners through healthy Country and recreation and tourism benefits.

A great example of the way water for the environment can support cultural values is at Guttrum Forest, where environmental flows have been planned in conjunction with the Barapa Barapa and Wemba Wamba peoples. Traditional Owners provide valuable information about what the wetland used to look like and what values it previously supported. Working together will ensure their cultural heritage is protected during watering events and 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 ability to tap into local knowledge is a vital element of our planning, and I thank Victoria's catchment management authorities and Melbourne Water who have consulted with their local communities when developing the watering proposals for the plan.

The past year has also seen a renewed appreciation of the shared benefits that water for the environment can provide to the many Victorians who use their waterways for recreation, rest and relaxation. Healthy waterways are important for community health, and protecting our waterways and the plants and animals that rely on them provides benefits for all Victorians now and in the future. For example, this coming year in the western region, we're supporting community events and tourism by planning coordinated flows to improve Wimmera River conditions for fishing competitions at Dimboola, Jeparit and Horsham. You'll find many more examples of actions that support social and recreational outcomes throughout the systems sections of the seasonal watering plan.

Thank you to all who contributed to the plan and to those of you who will work towards its delivery over the next year.

Chris Chesterfield
Chairperson, Victorian Environmental Water Holder

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Section 5 : Northern region

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Wimmera River Jeparit, by David Fletcher

Section 1

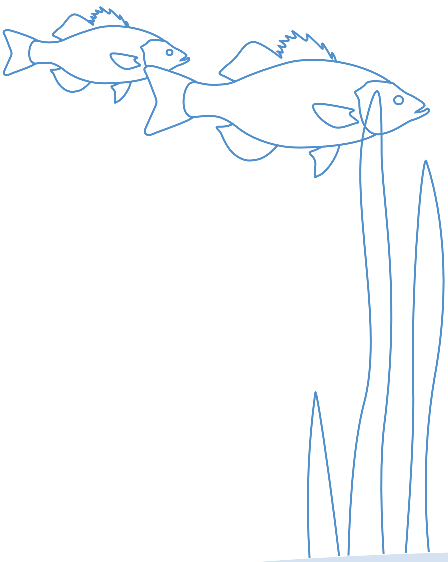
Introduction

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 2021-22.

In this section...



1.1.1 Why do we need an environmental watering program?

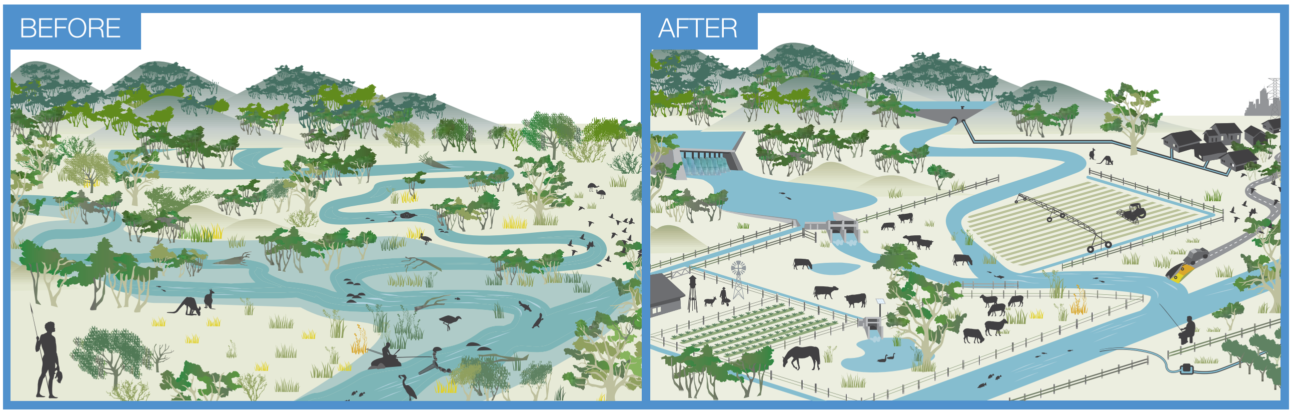
Many of Victoria's rivers and wetlands have been significantly modified, compared to how they were during the tens of thousands of years that Traditional Owners managed them. Water now flows differently through the landscape: it is captured in dams and weirs and diverted by infrastructure — pipelines, 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 storages, reservoirs, 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, wetlands and floodplains 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 our waterways.

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, increased river flow in autumn provides a signal for Australian grayling 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 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, connects habitats and improves water quality.

By improving the health of rivers, wetlands and floodplains, environmental watering provides many direct benefits to the community: it can enhance places that people visit to relax, play and connect with nature, increase populations of fish species popular with anglers, sustain healthy Country and totem species for Aboriginal communities and improve the quality of water available to irrigators. Or the benefits can be opportunistic: for example, the delivery of an environmental flow can be timed so kayakers and other recreational users of a river know about the flow and can take advantage of it.

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

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

The environmental watering program is part of the Victorian waterway management program that is overseen by the Minister for Water through the Department of Environment, Land, Water and Planning (DELWP). The Victorian Environmental Water Holder (VEWH) is an independent statutory authority responsible for holding and managing Victoria's environmental water entitlements.

Many public authorities — referred to as program partners — collaborate to deliver the environmental watering program. 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.

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 works with the Commonwealth Environmental Water Office, the Murray-Darling Basin Authority (MDBA) and the New South Wales and South Australian governments to prioritise and coordinate how and where water for the environment is used to maintain and improve 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 Owners' perspectives to the program.

Scientists provide 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 data to inform management decisions about some rivers.

1.1.5 How are Traditional Owners engaged in the environmental watering program?

There is an intersection between the aims of the environmental watering program — healthy waterways and healthy communities — and the deep and enduring obligations Traditional Owners have to Country and their communities.

In many regions of Victoria, Traditional Owners and their representatives have strong relationships with local waterway managers, who are working to embed the involvement of Traditional Owners and their objectives, values, uses and knowledge in the management of environmental flows. Their work is explained in the regional overviews and system sections in this seasonal watering plan.

However, more can be done to increase the contribution of Traditional Owners and provide opportunities for self-determination within and beyond the environmental watering program. The VEWH and its program partners will continue to identify and act on these opportunities.

1.1.6 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 achieve environmental outcomes from the delivery of all water (see section 1.4)
- 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 of publication of this seasonal watering plan 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.

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

Integrated catchment management is a holistic way of managing land, water and biodiversity from the top to the bottom of catchments. The environmental watering program is a key element of integrated catchment management in Victoria.

The main Victorian policy documents that influence the VEWH's work are the 2013 *Improving Our Waterways: Victorian Waterway Management Strategy*, the 2016 *Water for Victoria Water Plan* and the sustainable water strategies for the central, northern, Gippsland and western regions. Regional waterway strategies identify priority waterways, which have been determined in consultation with local communities, and they also 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. Actions in *Water for Victoria* aim to 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, streamside land management, sustainable agriculture, sustainable land use planning and development, integrated urban water management and other waterway management activities (such as providing for fish passage and improving in-stream 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.

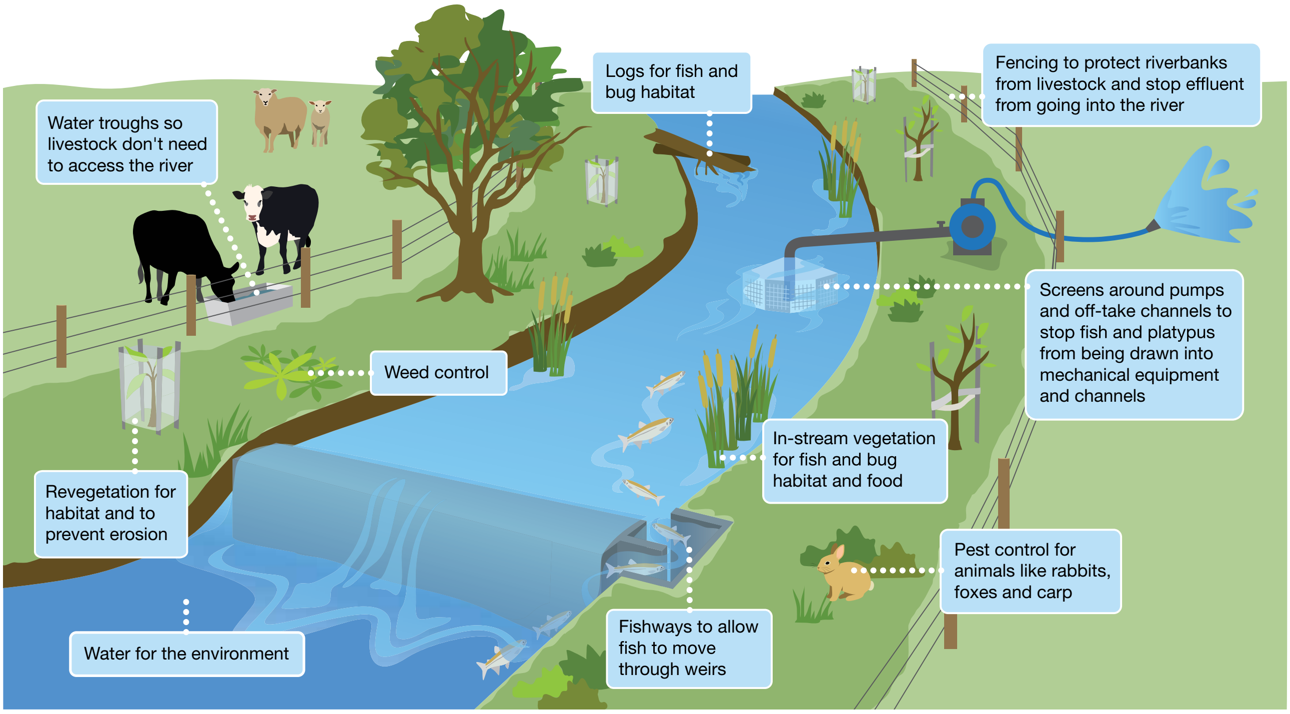
Victoria's environmental watering program is integral to the success of the following three strategies and plans.

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 are leading 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 *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 Example of complementary waterway management activities



1.1.8 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 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 (see Figure 1.1.3).

Some effects of climate change are already apparent. The *Long-term Water Resource Assessment for Southern Victoria* shows that long-term water availability for the environment has declined by 4-28% in southern basins over the last 10-15 years (see Figure 1.1.4). Reduced rainfall over this period has resulted in less frequent spills from reservoirs and lower rates of catchment run-off to waterways below reservoirs.

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 significantly improves environmental outcomes.

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 other systems through the development of a *Central and Gippsland Sustainable Water Strategy*. All water recovered for the environment through these commitments will be managed by the VEWH and its partners to improve the health of the environment 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 have developed guidelines 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 in 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.

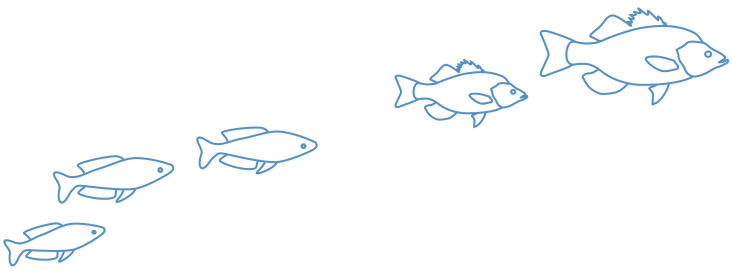
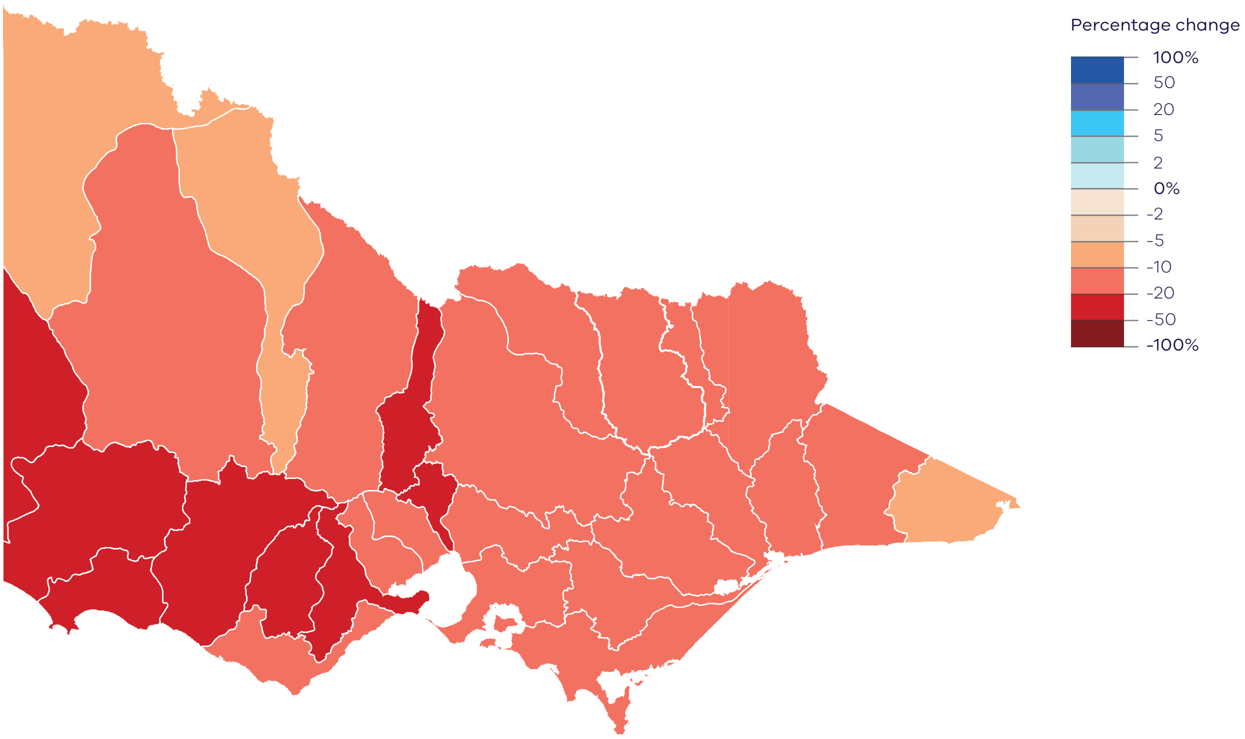
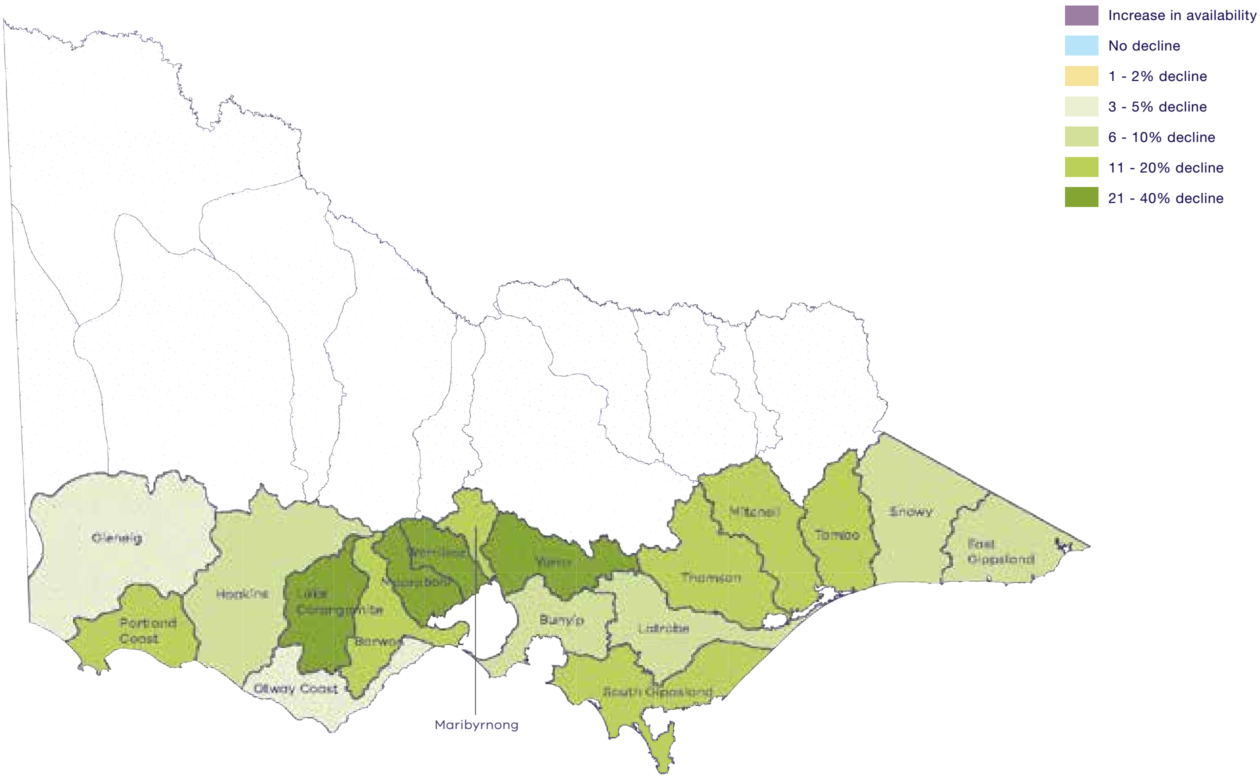


Figure 1.1.3 Projected changes in run-off in 2065, medium climate change scenario



Source: Water for Victoria

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



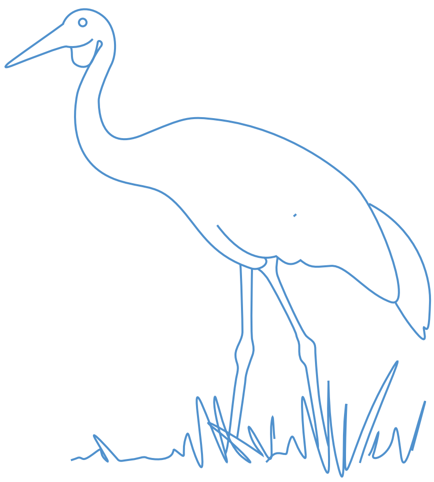
Source: Long-term Water Resource Assessment for Southern Victoria

1.1.9 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 streamside 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 two 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's (CEWH's) Environmental Flow Monitoring Evaluation and Research (Flow-MER) program combines targeted research into the relationship between water regimes and vegetation, fish, waterbirds and food webs with long-term monitoring at seven selected areas throughout the Murray-Darling Basin. The Flow-MER program is monitoring the responses of fish, vegetation, macroinvertebrate, stream metabolism and bank erosion to environmental flows in the lower Goulburn River, which is the only area in Victoria the program is monitoring.

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 the Living Murray program icon sites between 2006-07 and 2019-20. 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, the Living Murray program icon sites, 2006-07 to 2019-20

	Barmah-Millewa Forest	Gunbower Forest	Koondrook-Perricoota Forest	Hattah Lakes	Lindsay, Mulcra and Wallpolla islands	Chowilla floodplain	Lower Lakes, Coorong and Murray Mouth
2019-20	B	B	D	A	B	C	C
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

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

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

There is more information about the program on the VEWH's 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's 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...

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 2021-22 plan and any variations are valid for this water year — 1 July 2021 to 30 June 2022 — 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 (ranging from drought to wet) and associated water availability scenarios that may unfold during the year. This scenario planning provides a guide for the VEWH and waterway managers throughout the year when it comes to deciding what environmental flows to deliver. 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 and associated 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.

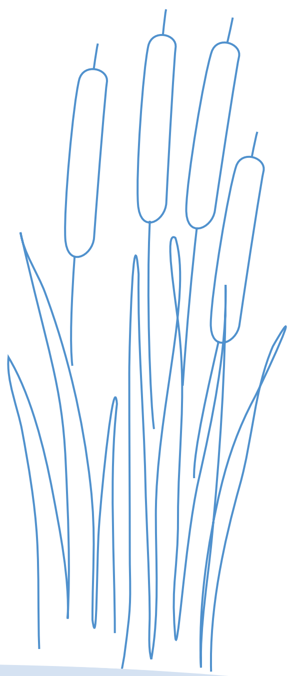


Figure 1.2.1 Victorian environmental watering program planning framework

Key - Responsibilities
- Waterway managers
- VEWH
- Expert advisors

Regional waterway strategies

- Identify priority river reaches and wetlands and values in each of Victoria's 10 catchment management regions
- Are developed every eight years in consultation with local communities

Guides priorities for ↓

Environmental water management plans

- Provide long-term environmental objectives, desired flow regimes and management arrangements
- Are developed progressively for each system or site that is identified as a long-term priority for environmental watering
- Are updated as required with new information
- Assume current water-recovery commitments and targets

← Informs

Expert advice

- Environmental flow studies: expert analysis of flow components required to support environmental values and objectives
- Outcomes from monitoring programs (such as VEFMAP)
- Traditional cultural and ecological knowledge
- Academic and consultant expertise

Forms basis of ↓

Seasonal watering proposals

- Describe regional priorities for environmental water use in the coming year under various planning scenarios
- Are developed annually

← Informs

Community engagement

- Environmental water advisory groups, Traditional Owners, community groups, recreational users, irrigators, environment groups and other relevant stakeholders

↓

Seasonal watering plan (this document)

- Describes statewide potential environmental watering in the coming year under various planning scenarios
- Is developed annually
- Consolidates the seasonal watering proposals the VEWH accepts
- Can be varied at any time, with the same consultative requirements as for the plan's initial development

→ Decisions communicated through

Seasonal watering statements and watering authorisations

- Communicate decisions about watering activities to be undertaken as water availability scenarios occur throughout the year
- Authorise waterway managers to undertake watering
- Can be released at any time during the year
- 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.

The regional overviews in sections 2 to 5 include a summary of the engagement activities waterway managers undertook when developing seasonal watering proposals.

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 enable the flexibility to adapt to changing conditions, the Act allows the VEWH to vary any section of the seasonal watering plan 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.

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. Significant changes to the timing, magnitude or duration of a planned watering action must be approved by the VEWH Commission via a formal variation.

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 may be required 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 harm 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…

1.3.1 How are watering decisions made throughout the year?

1.3.2 When does the Victorian Environmental Water Holder commit and authorise the use of water for the environment?

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

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

1.3.5 How are economic, recreational, social and Aboriginal cultural values and uses considered in environmental watering decisions?

1.3.6 How are risks managed?

1.3.7 How are environmental watering emergencies managed?

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 or costs 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?

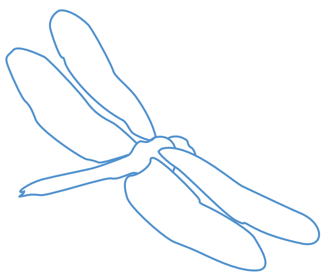
As the season unfolds, many of the uncertainties associated with seasonal conditions, water availability and operational context become clearer, and this clarity informs decisions about what environmental flows should proceed. Many on-ground factors do not become clear until very close to the anticipated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

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?

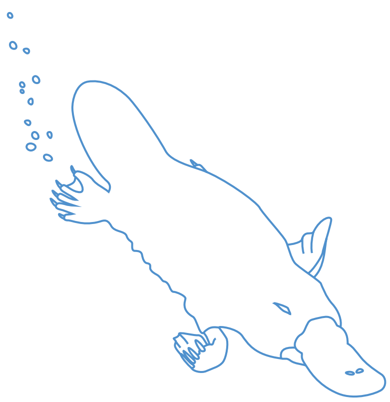
The VEWH aims to commit as much water as is sensibly possible, as early as possible, to provide waterway managers with certainty to proceed with the planned environmental watering actions.

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 associated costs are acceptable.

Where 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 1.1.3 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.



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 formally authorises the use of that water through seasonal watering statements. When water in Victorian accounts held by the CEWH and the Living Murray program is needed for delivery to non-Victorian sites, the VEWH enables the water use through a watering authorisation. Watering authorisations generally include the same conditions and requirements as seasonal watering statements, but the water must be ordered and delivered by the VEWH instead of a waterway manager.

Can environmental water holders and waterway managers change their plans after a seasonal watering statement or watering authorisation has been issued?

The VEWH may withdraw a seasonal watering statement or watering authorisation at any point during the year, in consultation with relevant environmental water holders and 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 available water for the environment (and funding) is used, carried over or traded, to maximise benefits 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 environmental water requirements of particular sites (the demand) and the availability of water for the environment (the supply).

A deficit in supply might arise because of:

- large, high-value demands for water for the environment
- low water availability.

To avoid a deficit, the VEWH may look to use tools such as carryover and trade (as explained in subsection 1.4.2). Where a deficit is unavoidable, the VEWH in collaboration with waterway managers and other water holders if relevant must prioritise environmental watering actions.

Prioritisation decisions are informed by factors including such as likely environmental outcomes, the previous watering history in a specific river or wetland, environmental and public risks, seasonal conditions and the delivery of cultural and recreational benefits. Potential watering actions might be prioritised within a site, between sites and/or over multiple years. Trade-offs may also be made between delivering watering actions and selling water allocation to fund complementary works and measures or to improve knowledge and capability that will result in better environmental outcomes.

In deciding to prioritise one environmental watering action or site over another, or to prioritise a water sale over delivery, 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 governments' 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 to pay the costs of water delivery and/or storage
- 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, land managers and communities (including Traditional Owners, recreational user groups, environmental groups 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.

The advice of storage managers is important to understand the feasibility of delivering a watering action at a particular time, given potential 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 generally prioritise sites (for watering and other river health activities) that have high economic, environmental, social and Aboriginal cultural 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 under a range of climatic conditions

Planning scenario	Drought	Dry	Average	Wet
Expected conditions	No or negligible contributions from unregulated flows; waterways may stop flowing at times, more likely in 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 the 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 and/or magnitude of flow peaks to freshen water quality in deep refuge 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 economic, recreational, social and Aboriginal cultural values and uses considered in environmental watering decisions?

By improving the health of rivers, wetlands and floodplains, environmental watering provides many direct benefits to the community: it can enhance places that people visit to relax, play and connect with nature, increase populations of fish species popular with anglers, sustain healthy Country and totem species for Aboriginal communities and improve the quality of water available to irrigators. Or the benefits can be opportunistic: for example, the delivery of an environmental flow can be timed so kayakers and other recreational users of a river know about the flow and can take advantage of it.

Waterway managers work with communities to identify the cultural, economic, recreational, social and Aboriginal cultural values and uses of waterways and to consider them in regional catchment strategies, regional waterway strategies, environmental water management plans and seasonal watering proposals. Where possible, opportunities to support these values and uses are incorporated into watering decisions, provided they do not compromise environmental outcomes.

The community values and uses considered during planning for environmental flows in 2021-22 are summarised in each system section (sections 2 to 5). Specific watering actions planned to align with a social or recreational objective or to be delivered in partnership with Traditional Owners to support Aboriginal cultural values and uses are identified by the icons in Figure 1.3.3.

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.

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

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)

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 inter-agency 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 that 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 if water levels drop at a refuge habitat or breeding site 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 2021-22.

In this section...

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 12 April 2021, 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 12 April 2021)

System	Entitlement	Volume (ML)	Class of entitlement
Gippsland region			
Latrobe	Blue Rock Environmental Entitlement 2013	18,737[1]	Share of inflow
	Latrobe River Environmental Entitlement 2011	n/a[2]	Unregulated
Thomson	Bulk Entitlement (Thomson River – Environment) Order 2005[3]	10,000 8,000[1]	High reliability Share of inflow
Macalister	Macalister River Environmental Entitlement 2010	12,461 6,230	High reliability Low reliability
Central region			
Yarra	Yarra Environmental Entitlement 2006[3]	17,000 55	High reliability Unregulated
Tarago	Tarago and Bunyip Rivers Environmental Entitlement 2009	3,000[1]	Share of inflow
Werribee	Werribee River Environmental Entitlement 2011[3]	n/a[1]	Share of inflow
	Water shares	734 361	High reliability Low reliability
Moorabool	Moorabool River Environmental Entitlement 2010[3]	7,086[1]	Share of inflow
Barwon	Barwon River Environmental Entitlement 2011	n/a[2]	Unregulated
	Upper Barwon River Environmental Entitlement 2018	2,000[1]	Share of inflows
Western region			
Glenelg and Wimmera	Wimmera and Glenelg Rivers Environmental Entitlement 2010[3,4]	40,560 1,000	High reliability Lower reliability

System	Entitlement	Volume (ML)	Class of entitlement
Northern region			
Victorian Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	45,267 8,523 49,000	High reliability Low reliability Unregulated
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah-Millewa Forest Environmental Water Allocation	50,000 25,000	High reliability Low reliability
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	9,589 101,850 34,300	High reliability Low reliability Unregulated
	Environmental Entitlement (River Murray – NVIRP Stage 1) 2012	1,223[5]	High reliability
	Bulk Entitlement (River Murray – Snowy Environmental Reserve) Conversion Order 2004	29,794	High reliability
	Water shares – Snowy Environmental Reserve	14,671 6,423	High reliability Low reliability
	Water shares – the Living Murray program	12,267	High reliability
Goulburn	Goulburn River Environmental Entitlement 2010	26,555 5,792	High reliability Low reliability
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625 156,980	High reliability Low reliability
	Environmental Entitlement (Goulburn System – Northern Victoria Irrigation Renewal Project (NVIRP) Stage 1) 2012	1,682[5]	High reliability
	Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004	30,252 8,156	High reliability Low reliability
	Water Shares – Snowy River Environmental Reserve	8,321 17,852	High reliability Low reliability
	Water shares – the Living Murray program	5,559	High reliability
	Silver and Wallaby Creeks Environmental Entitlement 2006	n/a	Passing flow only
Broken	Water Shares	90 19	High reliability Low reliability
Campaspe	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126 5,048	High reliability Low reliability
	Campaspe River Environmental Entitlement 2013	20,652 2,966	High reliability Low reliability
Loddon	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005[3,4]	10,970 2,024	High reliability Low reliability
	Environmental Entitlement (Birch Creek – Bullarook System) 2009[3,4]	100	n/a[6]
	Water Shares – Snowy River Environmental Reserve	470	High reliability

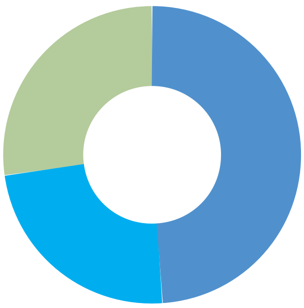
Further detail about the Water Holdings can be obtained from the Victorian Water Register (www.waterregister.vic.gov.au).

1 Water is accumulated continuously according to a share of inflows to these entitlements (i.e. the Blue Rock 9.45%, Thomson 3.9%, Tarago 10.3%, Werribee 10.0%, Moorabool 11.9% and upper Barwon River 3.8%). This volume represents the maximum that can be stored at any time, except for Werribee because the VEWH entitlement does not include a storage share in the Werribee system. The actual volume available in any year varies according to inflows.
2 Water available under these entitlements is dependent upon suitable river heights rather than a permitted volume.
3 The entitlement includes passing flows in addition to a volumetric entitlement.
4 The entitlement includes unregulated water in addition to a volumetric entitlement.
5 This entitlement volume is the mitigation water savings from GMW Connections Project Stage 1, as verified in the latest audit.
6 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. Water entitlement proportions for individual systems are presented in sections 2 to 5 of this seasonal watering plan where possible.

The proportions in Figure 1.4.1 are based on the total volume of surface water entitlements recorded in the Victorian Water Register at 30 June 2020. 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. 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 2020



Where possible, the proportion of water entitlements held by each user group is shown in each system section in the seasonal watering plan. 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.

Water donations

The VEWH may receive water donations from individuals, community groups and other organisations. This water can 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 may 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 28 February 2021

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	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 CMAs 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?

The VEWH and other environmental water holders use various tools (such as carryover, trade and the ability to use return flows or coordinate with other water deliveries) to meet required environmental demands as efficiently as possible. However, where the demand for environmental water exceeds the available supply, the VEWH (in collaboration with waterway managers and other water holders where relevant) must prioritise environmental watering actions.

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 environmental benefits. 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 may partly or wholly meet an environmental objective
- **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.

Return flows

In some systems, water for the environment delivered through upstream sites can be used again downstream.

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. Moreover, re-using water at multiple sites helps to support important ecological processes (such as transporting nutrients, plants and animals between waterways).

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. There is no financial consideration associated with administrative water transfers, except for administrative fees that a water corporation may charge.

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 nine out of the 10 years 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 critical environmental demands 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.

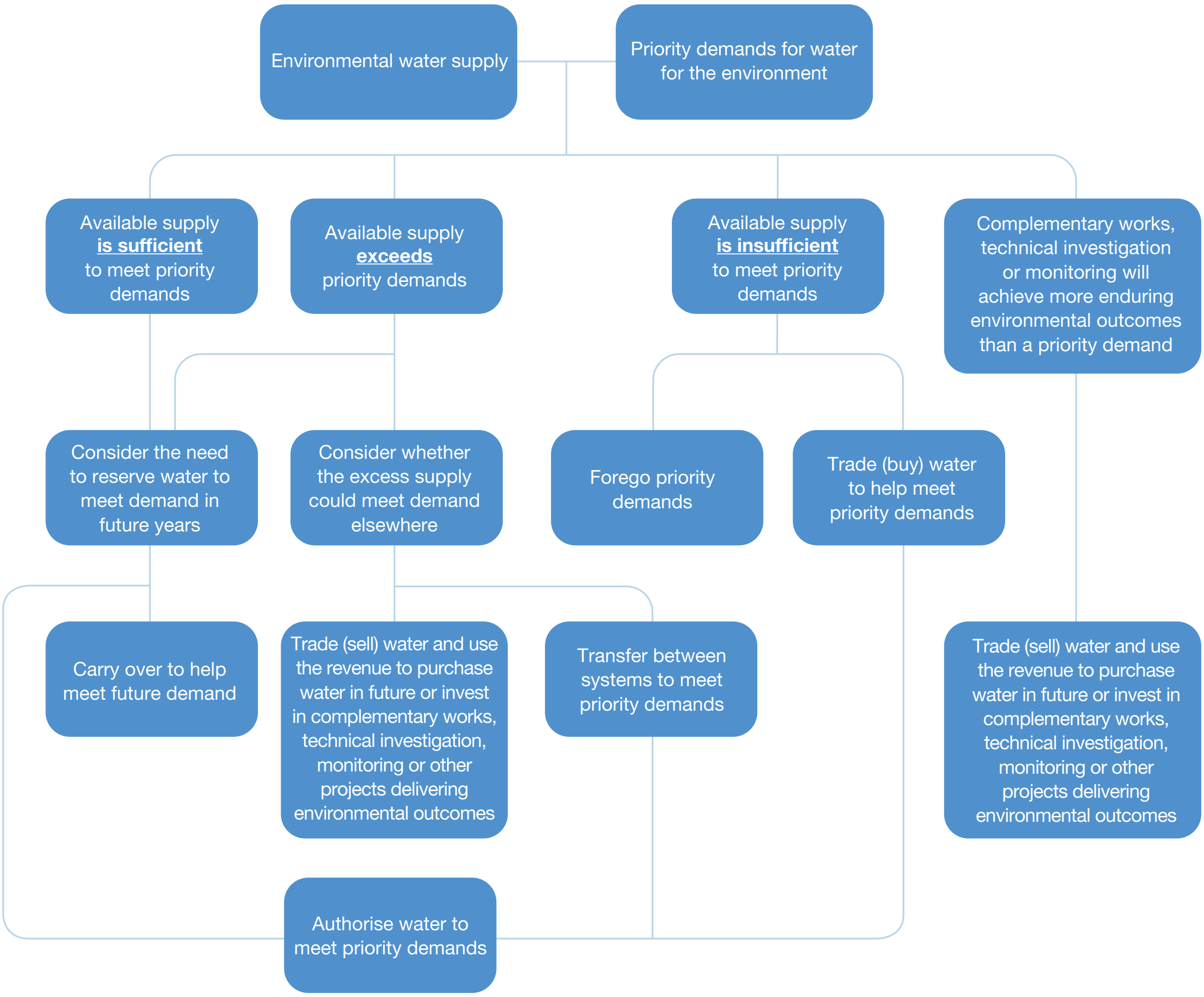
There may be occasions when the VEWH decides to sell water to invest in complementary works, measures, technical studies or other priorities, rather than use it or carry it over. This may occur if projects are shown to optimise environmental watering outcomes for an enduring benefit, beyond what could 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, if applicable, of the one or more waterway managers, storage managers and/or 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 have been considered as part of the planning for environmental flows, including opportunities to support these values provided environmental outcomes are not compromised
- **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 2021-22, their expected watering effects (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective they support. Achievement of each environmental objective relies on one or more potential environmental watering actions and their expected watering effects. Figure 1.5.2 is an example of this table
- **scenario planning**, which indicates in 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. The text accompanying the table describes the rationale or need for the proposed combination of potential environmental watering actions under each scenario. For example, the table 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, and the text will explain why those flows are important. The climate scenarios considered in most cases are drought, dry, average and wet but occasionally more or fewer scenarios are used. Section 1.3.4 explains how seasonal conditions are considered in planning. Figure 1.5.3 is an example of the scenario planning table.

Figure 1.5.1 Example environmental objectives table

Environmental objectives in the Macalister system

Increase the distribution, recruitment and abundance of native fish
Improve native emergent (non-woody) and fringing (woody) vegetation in the streamside zone
Increase the abundance and number of functional groups of waterbugs
Increase the abundance of platypus and rakali (water rats)

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.

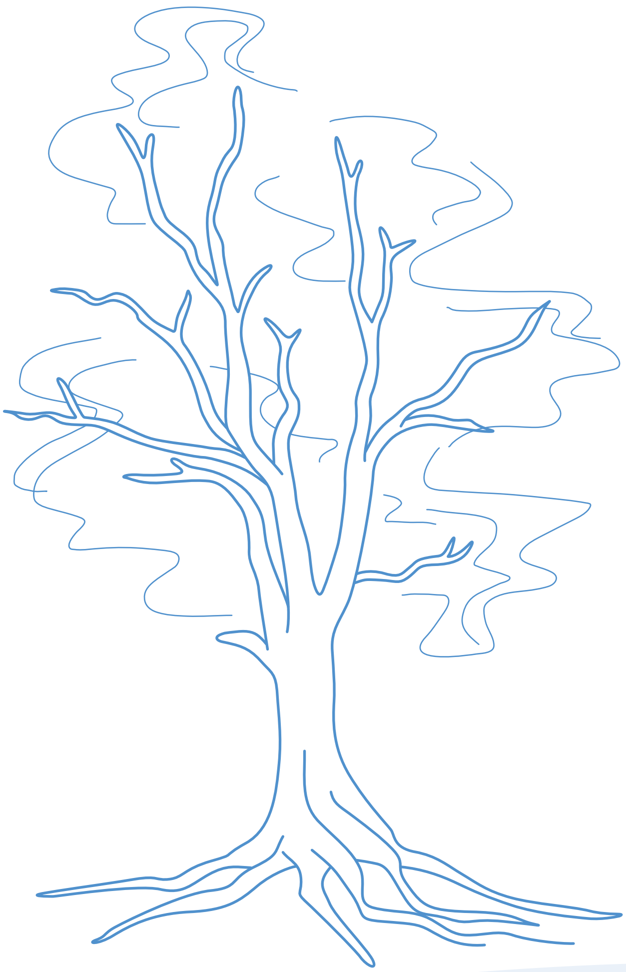
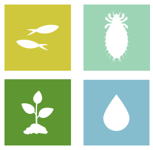


Figure 1.5.2 Example potential environmental watering actions and objectives table

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 1.3.2 explains how seasonal watering statements and watering authorisations 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	Expected watering effects	Environmental objectives
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.

An **expected watering effect** is the physical chemical, biological or behavioural effect expected from a potential watering action. Each potential watering action will have one or more expected watering effects.

Figure 1.5.3 Example scenario planning table

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Passing flows reduced	• Possible spills from storages in spring, minor flood levels may occur • Passing flows may be reduced	• Regular spills from storages in spring, minor to moderate flood levels may occur	• Large and frequent spills from storages, moderate to major flood levels may occur
Predicted supply of water for the environment	• 1,000 ML	• 1,500 ML	• 6,000 ML	• 8,000 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Summer/autumn low flow • Summer fresh (one fresh)	• Summer/autumn low flow • Summer/Autumn low flow (one fresh)	• Winter/spring low flow • Winter spring fresh (two freshes) • Winter/spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn fresh (three freshes)	• Winter/spring low flow • Winter spring fresh (four freshes) • Winter/spring high flow (two high flows) • Summer/autumn low flow • Summer/autumn fresh
	Tier 1b (supply deficit)			
	• Winter spring low flow • Summer/autumn fresh (one fresh)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn fresh (two freshes)	• Winter/spring fresh (two freshes) • Spring high flow (one high flow)	• Winter/spring high flows (two high flows) • Autumn high flow (one high flow)
Potential environmental watering – tier 2 (additional priorities)	• N/A	• N/A	• Autumn high flow (one high flow)	• N/A
Possible volume of water for the environment required to achieve objectives	• 800 ML (tier 1a) • 2,000 ML (tier 1b)	• 1,300 ML (tier 1a) • 2,500 ML (tier 1b)	• 4,200 ML (tier 1a) • 2,000 ML (tier 1b) • 1,200 ML (tier 2)	• 6,200 ML (tier 1a) • 1,200 ML (tier 1b)
Priority carryover requirements	• 200 to 1,800 ML			

Predicted volume of water for the environment that will be available over the entire year.

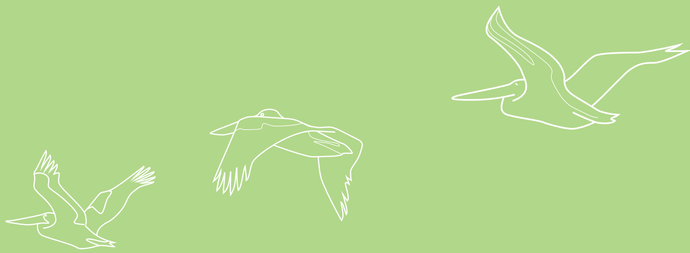
Potential watering actions that are required this year given current environmental conditions and the planned environmental watering strategies under each planning scenario.

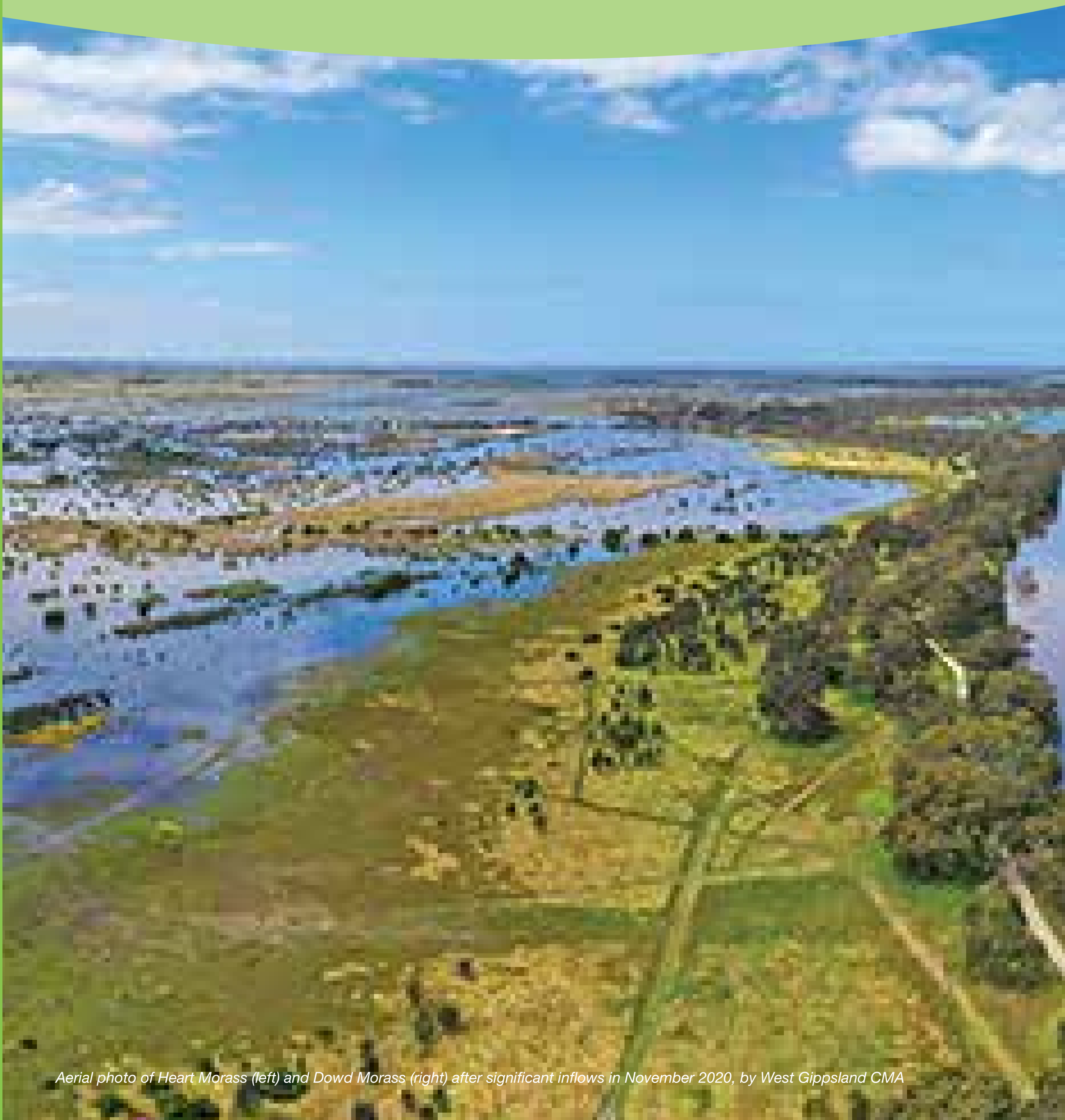
The subset of tier 1 watering actions that the waterway manager proposes to deliver with predicted supply under each planning scenario.

The remaining tier 1 watering actions that the waterway manager does not expect to be able to deliver if predicted supply is exhausted on tier 1a actions.

Potential watering actions that are generally not required every year to achieve intended environmental objectives but are needed on occasion to meet long-term condition outcomes. At the time of seasonal watering plan development, tier 2 potential watering actions are not considered necessary to deliver in the current year under specific planning scenarios, but are likely to be needed in coming years and may be delivered in the current year if environmental conditions change or to take advantage of operational circumstances.

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 the volume of water available and carryover are made before the beginning of the water year and are based on best available information. They are estimates only, and the VEWH and its program partners revise the estimates continually throughout the year.

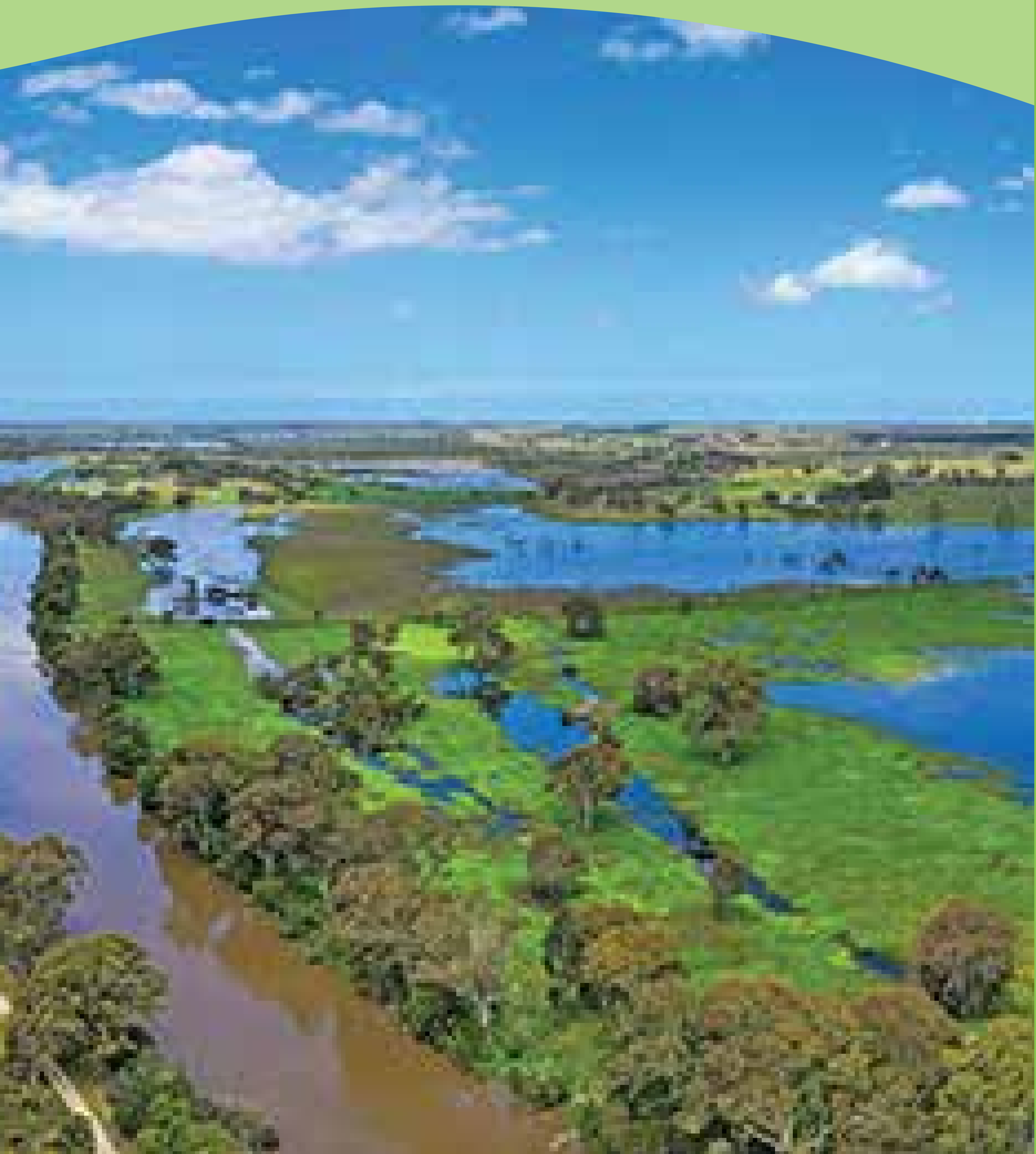




Aerial photo of Heart Morass (left) and Dowd Morass (right) after significant inflows in November 2020, by West Gippsland CMA

Section 2

Gippsland region



Snowy system
Thomson, Macalister & Latrobe systems

2.1 Gippsland region overview

In the Gippsland region, *Durt-Yowan* (Latrobe River), lower Latrobe wetlands, *Carran Carran* (Thomson River), Heyfield wetlands and *Wirn wirndook Yeerung* (Macalister River) can receive water from the VEWH's environmental entitlements. The Snowy River also receives environmental flows, but these are managed by the New South Wales 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.

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 *Durt-Yowan* (Latrobe River), *Carran Carran* (Thomson River), *Wirn wirndook Yeerung* (Macalister River), the Snowy River and the lower Latrobe wetlands covered by this section of the seasonal watering plan.

The State of Victoria has 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 VEWH and its program partners also 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 how community benefits from environmental flows can be provided while optimising environmental priorities for the year ahead. Aboriginal cultural, social and recreational values and uses are considered for each system in the following system sections.

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]

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 *Durt-Yowan* (Latrobe River), lower Latrobe wetlands, Thomson (which includes the Heyfield wetlands) 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 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 West Gippsland 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 the potential interaction of proposed watering with other activities on the waterway. For example, in the Gippsland region, Parks Victoria is more involved in the planning for and management of water for the environment for the lower Latrobe wetlands than for the other Gippsland 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 Catchment Management Authority in developing seasonal watering proposals for the Latrobe, lower Latrobe wetlands, Thomson and Macalister systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

Community groups and environment groups	**IAP2 level: Inform** • Greening Australia • Latrobe Valley Field Naturalist Club Inc. • Native Fish Australia	**IAP2 level: Inform** • Greening Australia • Latrobe Valley Field Naturalist Club Inc. • Native Fish Australia	**IAP2 level: Involve** • Cowwarr Landcare Group • Heyfield Wetlands Committee of Management • Waterwatch volunteers **IAP2 level: Inform** • Birdlife Australia	**IAP2 level: Involve** • Environment Victoria • Maffra and Districts Landcare Network • Native Fish Australia

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

	Latrobe system	Lower Latrobe wetlands	Thomson system	Macalister system
Government agencies	**IAP2 level: Collaborate** • Parks Victoria • Southern Rural Water	**IAP2 level: Collaborate** • Parks Victoria	**IAP2 level: Collaborate** • Melbourne Water • Southern Rural Water	**IAP2 level: Collaborate** • Southern Rural Water
	IAP2 level: Consult • Gippsland Water	**IAP2 level: Consult** • Gippsland Water	**IAP2 level: Involve** • Gippsland Water • Department of Environment, Land, Water and Planning	**IAP2 level: Involve** • Gippsland Water
	IAP2 level: Inform • Department of Environment, Land, Water and Planning • East Gippsland CMA	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • East Gippsland CMA		
Landholders/ farmers	**IAP2 level: Inform** • Individual landholders	**IAP2 level: Collaborate** • Field & 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 Cruises	**IAP2 level: Inform** • Port of Sale Heritage Cruises		
Recreational users	**IAP2 level: Inform** • Field & Game Australia • VRFish	**IAP2 level: Collaborate** • Field & 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)	**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 New South Wales 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 some Aboriginal, local community and environmental interests, alongside New South Wales and Victorian government agencies. East Gippsland CMA is a member of the Snowy Advisory Committee, and the VEWH is an observer.

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, 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 catchment management authority (CMA) on-ground works programs that are likely to support environmental watering outcomes in the Gippsland region include:

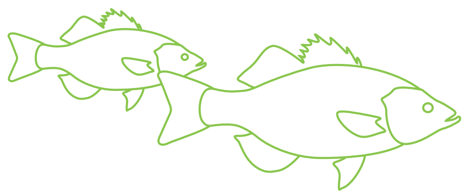
- works to protect and enhance stream banks along priority reaches of rivers and their tributaries including fencing to exclude stock, revegetation of riverbanks, willow removal and erosion control
- work with farmers along *Carran Carran* (Thomson River) and *Wirn wirndook Yeerung* (Macalister River) 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 *Carran Carran* (Thomson River) 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 *Durt-Yowan* (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 in remote parts of the Snowy River catchment, which led to 200 km of the river now being willow-free. Surveys and ongoing control of willows in areas that were burnt by the 2019-20 bushfires will be a particular focus over the next five years.

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 2021-22 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 New South Wales Department of Planning, Industry and Environment works with the Bureau of Meteorology, East Gippsland CMA, New South Wales State Emergency Service 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 2021-22

Following relatively dry years in 2018-19 and 2019-20, average rainfall and temperature conditions were observed throughout west Gippsland during most of 2020-21. Below-average rainfall was recorded for the region in July, but a large-scale La Niña event brought average-to-above-average rainfall in the second half of 2020 and January 2021. The *Durt-Yowan* (Latrobe), *Carran Carran* (Thomson) and *Wirn wirndook Yeerung* (Macalister) rivers had relatively high flow throughout winter and spring, and minor flooding occurred in the lower reaches of *Durt-Yowan* (Latrobe River). All of the lower Latrobe wetlands included in the environmental watering program — Sale Common, Dowd Morass and Heart Morass — filled during 2020-21, and Lake Wellington was the freshest it has been — that is, it has the lowest salinity levels — since 2012.

East Gippsland had below-average rainfall in early winter, and much of the catchment was still suffering from dry conditions in 2019-20 and the bushfires that burnt vast areas of the catchment in December 2019 and January 2020. Rainfall increased significantly in July, and the second half of winter 2020 and autumn 2021 were wetter than average. A large rain event across eastern Australia in March 2021 caused minor flooding in some east Gippsland rivers.

The Bureau of Meteorology climate outlook suggests that warmer-than-average temperatures and average to slightly above-average rainfall may occur in the Gippsland region in early 2021-22. Such climatic conditions would likely result in increased inflows to storages in west Gippsland that hold Victorian entitlements to water for the environment, and it may lead to high flow or overbank flows in some systems. The El Niño–Southern Oscillation outlook has been downgraded to inactive, and it is not anticipated to be a significant influencer of the climate in early 2021-22.

Water for the environment for the Latrobe, Thomson and Macalister systems is held in Blue Rock Reservoir, Thomson Reservoir and Lake Glenmaggie respectively. High carryover into 2021-22 is expected in all three west Gippsland river systems because natural events helped meet many of the planned environmental watering actions in 2020-21. The supply of water for the environment going into 2021-22 is likely to be higher than in recent years, which should enable high-priority watering actions to be delivered in winter and spring, without compromising the ability to meet critical demands later in the year.

Allocations across the west Gippsland systems are largely influenced by storage inflows during winter and spring, and so by late spring 2021 waterway managers will be able to determine which potential watering actions they can deliver in summer and autumn. If climatic conditions remain close to the long-term average or become wetter, available water will likely be used to deliver larger-magnitude, longer-duration watering actions to consolidate and build on the environmental outcomes observed in 2020-21. Specific watering actions under these scenarios will aim to have another successful recruitment event for native migratory fish in the Latrobe, Thomson and Macalister systems, enhance recovery of aquatic animal and vegetation communities that were affected by previous dry periods and promote longer-term resilience in the systems. Achieving these flow outcomes may involve timing releases of water for the environment to extend the duration of natural freshes or managed spill releases (where they do not cause impacts to third parties) to optimise outcomes from these events.

If 2021-22 sees a return to drier conditions, the planned flows will likely be delivered at the lower end of their recommended magnitude and duration. There is expected to be sufficient supply to still meet most of the high-priority watering actions planned for dry and drought climate scenarios in 2021-22. Under a drought scenario, environmental watering will focus on protecting high-value assets (such as critical flows for threatened migratory fish, especially species that would normally rely on habitats that were burnt in east Gippsland) and setting aside sufficient reserves to deliver early-season watering priorities in 2022-23.

Environmental watering in the lower Latrobe wetlands in 2021-22 will aim to fill all three wetlands at least partially, given the wetlands experienced several years of dry conditions before 2020-21. It will be preferable to fill the wetlands under average and wet conditions.

The environmental Water Holdings in west Gippsland are not sufficient to meet all the priority flows identified in environmental flow studies, which are ultimately needed to significantly improve the condition of *Durt-Yowan* (Latrobe River), *Carran Carran* (Thomson River) and *Wirn wirndook Yeerung* (Macalister River). Policy actions to increase the supply of water for the environment are being considered through the *Central and Gippsland Region Sustainable Water Strategy* process, which is due to be completed in 2022-23. In the interim, the VEWH and its program partners may consider alternative supply options (such as transfers or trades) to help boost supply for specific watering actions. 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.

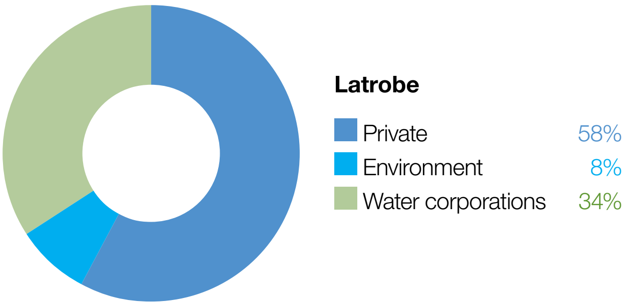
The water year for the Snowy system starts in May and finishes in April the following year, which differs from how water is managed in the other Gippsland systems. The total volume for release and daily release targets for the Snowy River from May 2021 to April 2022 were endorsed by the Snowy Advisory Committee in February 2021, 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



Proportion of water entitlements in the Latrobe basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

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 *Durt-Yowan* (Latrobe River).

Did you know...?

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

Top: Durt-Yowan (Latrobe River), by West Gippsland CMA
Above: Spoonbill at Dowd Morass, by David Stork

The Latrobe system includes *Durt-Yowan* (Latrobe River) and lower Latrobe wetlands: Sale Common, Heart Morass and Dowd Morass.

2.2.1 Latrobe River

System overview

Durt-Yowan (Latrobe River) originates on the Baw Baw Plateau and passes through relatively flat to undulating plains, which have been largely cleared for agriculture, before flowing into Lake Wellington (the westernmost point of the Gippsland Lakes) (Figure 2.2.1). Notable tributaries include the Tanjil River, Narracan Creek, Morwell River, Tyers River, Traralgon Creek and *Carran Carran* (Thomson River).

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

Options to deliver water for the environment to *Durt-Yowan* (Latrobe River) via the Tyers River may be investigated in 2021-22. These options include a physical transfer of water from Blue Rock Reservoir to Moondarra Reservoir via existing infrastructure operated by Gippsland Water or a temporary administrative transfer arrangement. Delivering water via the Tyers River would increase the proportion of the Latrobe catchment that could receive water for the environment without compromising outcomes in the main target reaches of *Durt-Yowan* (Latrobe River). If adopted, these options are expected to benefit native in-stream and streamside vegetation and non-migratory fish within the Tyers River.

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

Environmental values

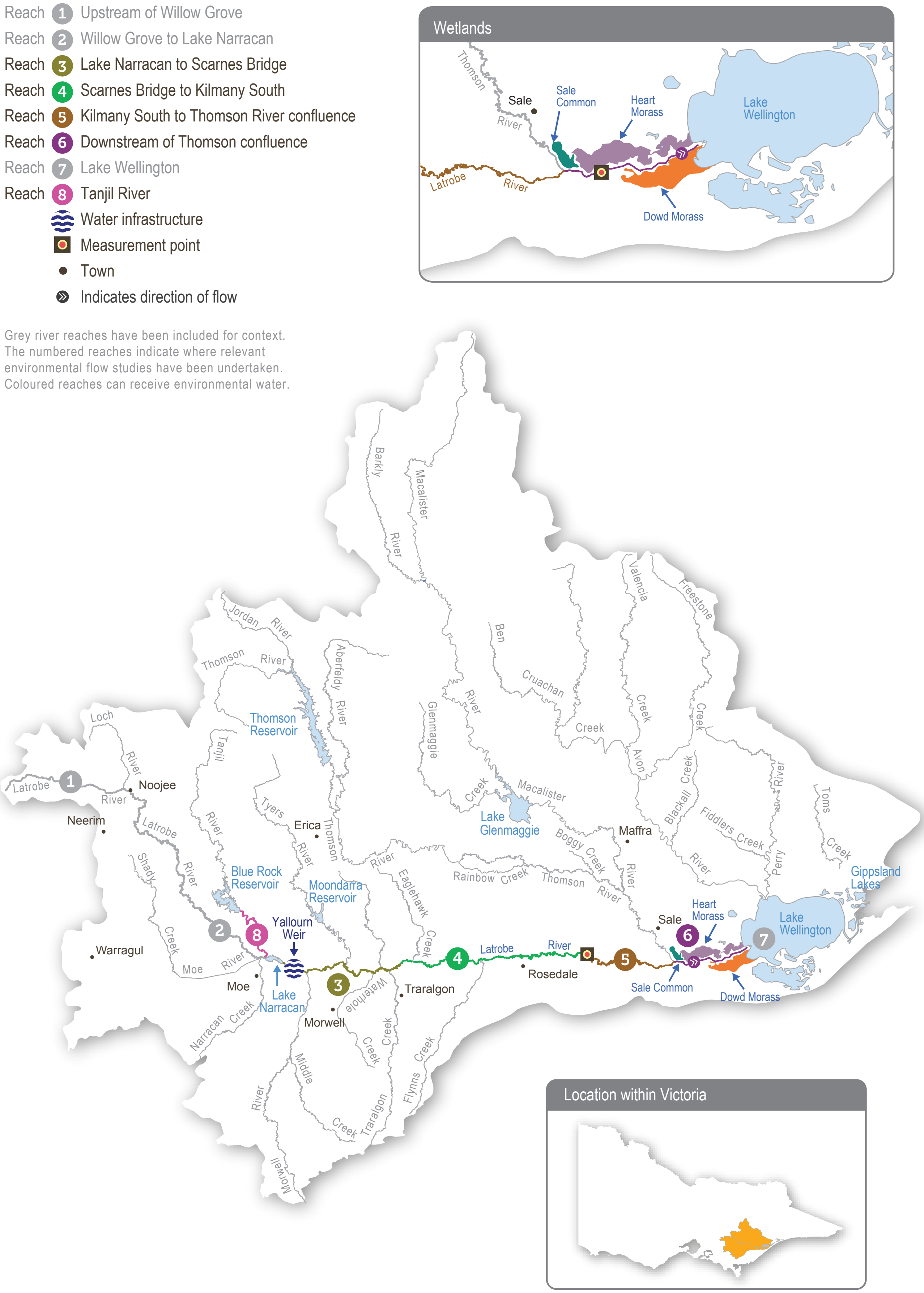
The upper reaches of *Durt-Yowan* (Latrobe River) flow through state forest and are relatively intact and ecologically healthy. It contains continuous stands of river red gums and intact streamside vegetation, and it supports native animals including barred galaxias, river blackfish, Gippsland spiny crayfish and nankeen night herons.

Durt-Yowan (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 is found in all but the most modified sections of *Durt-Yowan* (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. *Durt-Yowan* (Latrobe River) supports several native estuarine and freshwater fish including black bream, Australian bass, Australian grayling and short- and long-finned eel. The river also provides habitat and supports feeding and breeding conditions for platypus, rakali (water rats) and freshwater turtles.

Durt-Yowan (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.

Figure 2.2.1 The Latrobe system



Environmental watering objectives in *Durt-Yowan* (Latrobe River)

Maintain or increase native fish (migratory, resident and estuary) populations
Maintain or increase in-stream geomorphic diversity
Maintain or improve the extent of platypus and rakali (water rats) populations
Maintain the abundance of freshwater turtle populations
Improve the condition and increase the 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 reaches of *Durt-Yowan* (Latrobe River) and its estuary

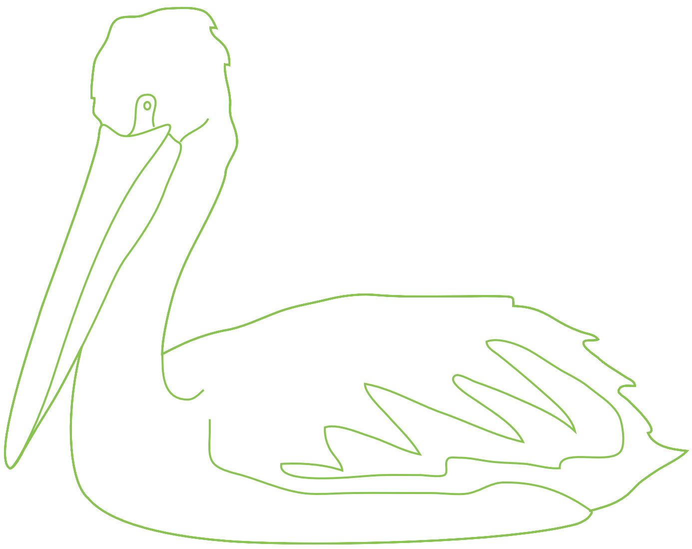
Traditional Owner cultural values and uses

The Gunaikurnai have had a continued connection to Gunaikurnai Country for thousands of years, including with the waterways in the Latrobe 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.

GLaWAC is working in partnership with West Gippsland CMA to determine how cultural values and uses can be considered in planning for water for the environment. For the Latrobe system, this includes:

- undertaking Aboriginal Waterways Assessments, to examine cultural values and uses, and incorporating the findings of assessments into the *Latrobe Environmental Water Requirements Investigation*
- identifying primary objectives under the modified water regime
- expressing preliminary outcomes: watering actions that recognise and promote:
    - healthy Country
    - the importance of the Latrobe river system to the Gunaikurnai songline of pelican and musk duck and their water quality and habitat requirements
    - waterways as meeting places
    - preliminary accommodation of the water quality and management requirements of species with cultural values and uses.



GLaWAC is sharing with the West Gippsland CMA its knowledge of 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 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 2.2.1, West Gippsland CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing and water skiing)
- riverside recreation and amenity (such as hunting)
- socio-economic benefits (such as commercial fishing; diversion for domestic, irrigation and stock use; 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 the following icon.

Recreational benefits from water for the environment in *Durt-Yowan* (Latrobe River)

Watering planned to support water sports activities (e.g. water skiing)

West Gippsland CMA coordinates with the Lake Narracan Ski Club to plan the timing of releases of water for the environment so that they do not affect water levels in the lake during water skiing events held between January and March.

Recent conditions

Climatic conditions in the Latrobe catchment in 2020-21 were close to the long-term average, and some periods of above-average rainfall were observed. High levels of flow were sustained in *Durt-Yowan* (Latrobe River) for most of the year, and several minor floods occurred in winter and spring in the lower reach and estuary. Due to high inflows and little need for environmental flows in 2019-20, the full volume under the environmental entitlement was available at the start of the water year, and it was sustained for the rest of 2020-21 due to low demand.

Water for the environment was managed in line with an average climate scenario throughout 2020-21, and all planned watering actions were met or exceeded. Natural inflows provided several large flows that are needed to support key ecological and geomorphological processes and cannot be delivered through managed releases of water for the environment. This is the second year in a row where all deliverable flow components required for *Durt-Yowan* (Latrobe River) have been achieved, which has allowed some recovery in the system following dry years in 2017-18 and 2018-19.

Fish surveys conducted in *Durt-Yowan* (Latrobe River) in March 2021 detected many young-of-year tupong (indicating successful recent recruitment), 12 Australian bass and 25 percent fewer carp compared to 2015 survey results. Fish ecologists from the Arthur Rylah Institute for Environmental Research advised that maintaining minimum low-flow targets throughout 2021-22 will facilitate the upstream dispersal and increase the survival of new tupong recruits.

Scope of environmental watering

Table 2.2.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 2.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Durt-Yowan* (Latrobe River)

Potential environmental watering action	Expected watering effects	Environmental objectives
***Durt-Yowan* (Latrobe River) (targeting reach 5)**		
Winter/spring low flow (620 ML/day during July to November 2021 and June 2022)	• Wet benches to maintain habitat, support the growth of emergent macrophyte vegetation and limit encroachment of terrestrial 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, turtles, aquatic mammals and breeding substrate for river blackfish • Maintain longitudinal connectivity to allow movement/dispersal of native fish, turtles platypus and rakali (water rats)	
Summer/autumn low flow (250-380 ML/day during December to May)	• Maintain an adequate depth in pool habitat to support native fish, turtles, platypus and rakali (water rats) and submerged vegetation • Limit encroachment by terrestrial vegetation and support the growth of emergent macrophyte vegetation • Mix pools to maintain oxygen levels suitable for aquatic animals	
Summer/autumn river freshes (three to six freshes of 920 ML/day for one to five days during December to May)	Water-quality fresh (one-day duration): • freshen water quality in pools to support fish, waterbug and zooplankton communities • provide sufficient velocity to turn over and flush sediments (sands and silts) from pools and scour algae from hard surfaces Fish and vegetation fresh (three to five days duration) Objectives listed for the one-day fresh and additional objectives: • wet benches to support the growth of emergent macrophyte vegetation • clean fine sediment from stream bed substrates including river blackfish nesting habitats • provide longitudinal connectivity (including over benches for Australian grayling) for native fish, platypus and rakali (water rats)	
Summer/autumn estuary fresh(es) (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 three-to-five-day river fresh and additional objectives for the Latrobe River estuary: • upper estuary: fully flush with freshwater to support submerged vegetation, provide adequate 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 the lower Latrobe wetlands *Note: this event requires a contribution of 1,280 ML/day from Carran Carran (Thomson River) over the equivalent period to meet objectives*	

Scenario planning

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

Maintaining target low flows throughout the year to provide habitat and support vegetation growth, and delivering summer/autumn freshes to maintain water quality and provide specific opportunities for fish movement, are high priorities under all climate scenarios. These flows are necessary to consolidate environmental outcomes achieved on the back of wetter conditions in 2019-20 and 2020-21.

Most of the recommended flows are likely to be achieved through a combination of natural events, operational releases, passing flows and environmental deliveries under average and wet climate scenarios. The magnitude and duration of low flows and freshes will likely be lower under drought and dry climate scenarios, where the focus is maintaining current ecological values rather than improving them. However, there will be less natural inflow and lower operational releases under drought and dry climate scenarios, and there will not be enough water for the environment to deliver all of the required watering actions, even at the lower end of their recommended range.

Under drought and dry climate scenarios, the available water for the environment will be used to deliver summer/autumn low flows and a small number of summer/autumn freshes. Summer/autumn flows are prioritised, because critically low flow at this time of year can lead to poor water quality and reduce available habitat, which in turn will threaten populations of native fish, platypus and turtles.

It is unlikely that target summer/autumn low flows will be able to be maintained continuously from December to May under a drought scenario, and up to four freshes will likely be needed to prevent adverse water-quality events in reach 5, although it is likely there will only be sufficient supply to deliver three of these under a drought scenario. At least one of these freshes should have a longer duration — between three to five days — to provide an opportunity for fish movement and to water native vegetation on low channel benches. More freshes with larger magnitudes and longer durations will be delivered under dry, average and wet climate scenarios, which will extend benefits downstream of reach 5. Where inflow from the Thomson River estuary is of sufficient magnitude, some freshes will instead be delivered for up to 10 days, to achieve additional environmental objectives in the Latrobe River estuary.

There are no true carryover provisions in the Latrobe system; rather, the VEWH maintains an ongoing share of storage capacity in Blue Rock Reservoir. Under a drought scenario, it will be important to ensure a minimum of 2,500 ML is maintained in storage at the end of 2021-22 to help deliver critical watering actions in 2022-23. Under dry, average and wet scenarios in 2021-22, several of the demands are expected to be met with natural flows, and so it is expected that medium to large volumes will remain available in storage at the end of the water year. Therefore, there is no additional priority carryover requirement.

Table 2.2.2 Potential environmental watering for *Durt-Yowan* (Latrobe River) under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Passing flows reduced	• Possible spills from storages in spring, minor flood levels may occur • Passing flows may be reduced	• Regular spills from storages in spring, minor to moderate flood levels may occur	• Large and frequent spills from storages, moderate to major flood levels may occur
Predicted supply of water for the environment	• 18,700 ML	• 20,700 ML	• 25,700 ML	• 33,700 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Summer/autumn low flow (partial) • Summer/autumn river fresh (two at lower duration, one at mid-duration [four days])	• Summer/autumn low flow • Summer/autumn river fresh (four at lower duration and two at mid-duration [three days]) • Replace one mid-duration summer/autumn river fresh with an estuary fresh, if conditions allow	• Winter/spring low flow (partial) • Summer/autumn low flow • Summer/autumn river fresh (one at lower duration and three at mid-duration [four days]) • Replace all mid-duration summer/autumn river freshes with estuary freshes, if conditions allow	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn river fresh (one at lower duration and three at upper-duration [five days]) • Replace all mid-duration summer/autumn river freshes with estuary freshes, if conditions allow
	Tier 1b (supply deficit)			
	• Winter/spring low flow (partial) • Summer/autumn low flow (continuous) • Tier 1a mid-duration summer/autumn river fresh replaced with a summer/autumn estuary fresh (delivered for seven days) • One additional summer/autumn river fresh (at lower duration)	• Winter/spring low flow (partial) • One additional summer/autumn estuary fresh	• Winter/spring low flow (continuous)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 16,200 ML (tier 1a) • 28,300 ML (tier 1b) • 0 ML (tier 2)	• 14,400-20,400 ML (tier 1a) • 13,400 ML (tier 1b) • 0 ML (tier 2)	• 7,400-15,200 ML (tier 1a) • 12,000 ML (tier 1b) • 0 ML (tier 2)	• 8,600-15,200 ML (tier 1a) • 0 ML (tier 1b) • 0 ML (tier 2)
Priority carryover requirements	• 2,500 ML	• 0 ML		

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 *Durt-Yowan* (Latrobe River) between its confluence with *Carran Carran* (Thomson River), and they form part of the Gippsland Lakes system.

River regulation and water extraction from *Durt-Yowan* (Latrobe River), *Carran Carran* (Thomson River) and *Wirn wirndook Yeerung* (Macalister River) have 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 *Durt-Yowan* (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.

The 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.

Leading up to the *Seasonal Watering Plan 2021-22*, the focus on the lower Latrobe wetlands has included:

- incorporating the findings of the *Durt-Yowan* (Latrobe River) Aboriginal Waterways Assessment into the *Latrobe Environmental Water Requirements Investigation*, which will assist the CMA to consider cultural benefits in water for the environment planning and decision-making for the lower Latrobe wetlands
- on-Country discussions with GLaWAC and Gunaikurnai Elders and Community to examine cultural values and uses
- discussions about 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 about water quality and increasing salinity
- concerns about pest species including carp.

GLaWAC is sharing with the West Gippsland CMA its knowledge of 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 the Latrobe River 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 the health of native flora and fauna with cultural values and uses of significance to the Gunaikurnai.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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 2.2.3 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

GLaWAC and West Gippsland CMA are exploring opportunities to enhance environmental watering with Traditional Owner outcomes in the lower Latrobe wetlands. In 2021-22, this is planned to include a jointly managed Gunaikurnai environmental watering event in Dowd Morass. The overarching objective is to deliver water for the environment to the western end of the morass in a way that better aligns with the natural flow paths of *Durt-Yowan* (Latrobe River) and wetland, supporting enhanced environmental and cultural outcomes. The flow will be delivered at a time of cultural significance to Gunaikurnai people and be aligned with appropriate seasonal conditions (water quality and weather) to support healthy Country.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 2.2.3, 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 birdwatching, camping and duck hunting)
- socio-economic benefits (such as commercial eel and carp fishing).

Recent conditions

Climatic conditions in the Latrobe catchment in 2020-21 were close to the long-term average, with some periods of above-average rainfall observed. Several minor floods in the lower reaches of *Durt-Yowan* (Latrobe River) in winter and spring spilled into Dowd Morass. The VEWH's entitlement for the lower Latrobe wetlands is not limited in volume, and regulator gates may be opened opportunistically based on the water height in *Durt-Yowan* (Latrobe River) at Swing Bridge.

Environmental watering at the lower Latrobe wetlands was managed in line with an average climate scenario in 2020-21, and all planned watering actions were achieved. A combination of natural floods in winter and spring and managed inflows of water for the environment fully or partly filled Sale Common, Dowd Morass and Heart Morass in 2020-21. This watering followed two years of relatively dry conditions at all three wetlands, and it helped improve the condition of fringing wetland vegetation communities and provided feeding and breeding habitat for aquatic animals and waterbirds. Water for the environment was used to partly flush Heart Morass from October to January, to export accumulated salts and sulfates and transfer nutrients between the river and the wetland. Heart Morass and Dowd Morass began to draw down over the warmer months, and the regulator gates were opened as needed (and where water quality allowed) to prevent complete drying. Sale Common was actively managed to maintain water levels between a partial fill and full supply levels year-round. No trigger-based fills were required to prevent or respond to declines in water quality at any of the lower Latrobe wetlands in 2020-21.

Environmental watering in 2021-22 aims to build on the achievements of 2020-21, protecting high-priority environmental values, supporting key ecohydrological functions and providing refuge habitat in the event of drought. Fill events will be targeted at all wetlands to achieve these outcomes, where flow conditions and water quality in *Durt-Yowan* (Latrobe River) allow.

Scope of environmental watering

Table 2.2.3 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

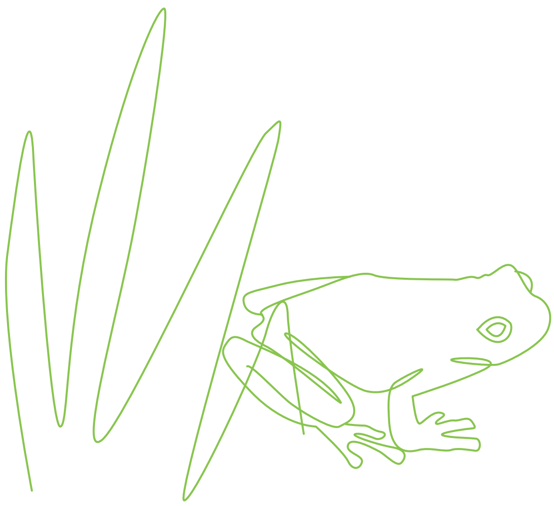


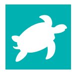
Table 2.2.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the lower Latrobe wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Sale Common		
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	
Partial fill (in July to August1 with top-ups as required to maintain water depth of at least 0.3 m Australian Height Datum [AHD] and surface coverage year-round)	• 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 • Discourage invasive plants, particularly the excessive spread of giant rush	
Fill (with top-ups as required during August to November, to maintain water depth of 0.4 to 0.5 m AHD for two months)	• 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 and turtle breeding by providing nesting habitat • Provide connectivity between the river and wetlands and increase habitat and feeding opportunities for frogs and turtles	
Trigger-based fill or top-up to 0.5m AHD (during December to January, if required to drown out invasive vegetation)	• Wet key habitats within the wetland for a sufficient duration to discourage invasive plants, particularly the excessive spread of giant rush	
Partial drawdown (during December to March)	• Oxygenate sediments to enable aquatic vegetation germination and recruitment • Provide water level fluctuations for emergent vegetation reproduction and expansion (particularly swamp scrub and tall marsh) • Break down organic matter and promote nutrient cycling • Expose mudflats and create shallows to facilitate waterbird foraging	
Dowd Morass		
Top-up (any time, following bird breeding event if required)	• Prolong wetting of reed beds to maintain habitat and food resources for waterbirds and protect chicks from predators, following an observed breeding event	
Fill to control salinity (anytime)	• 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[1] if electrical conductivity is rising and reaches 7,000 µS/cm	
Partial fill (with top-ups as required to maintain surface coverage during July to December and April to June[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	

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

Potential environmental watering action	Expected watering effects	Environmental objectives
Fill (with top-ups as required to maintain water depth of 0.6m AHD 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 the 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 and food resources for frogs and turtles • Reduce the impact of saltwater incursion from Lake Wellington	
Partial drawdown (during January to March)	• Oxygenate sediments to enable aquatic vegetation germination and recruitment • Provide water level fluctuations for emergent vegetation reproduction and expansion (particularly swamp scrub and tall marsh) • Break down organic matter and promote nutrient cycling • Expose mudflats and create shallows to facilitate waterbird foraging	
Heart Morass		
Top-up to permanently maintain water level above -0.3 m AHD (anytime)	• Minimise the risk of acid sulfate soils developing by keeping known high-risk areas wet • 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[3] 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 and food resources for waterbirds and protect chicks from predators, following an observed breeding event	
Fill and partial flushing flow (during July to November[4])	• Wet high-elevation banks and streamside zone to support vegetation growth, creating nesting and foraging habitat for waterbirds, and provide food resources for terrestrial birds • Provide connectivity between the river and wetlands and between wetlands, increasing available habitat and providing food resources for frogs and turtles • Export accumulated salts and sulfates and allow the import and export of nutrients, dissolved organic carbon and seed dispersal between *Durt-Yowan* (Latrobe River) and Heart Morass	

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

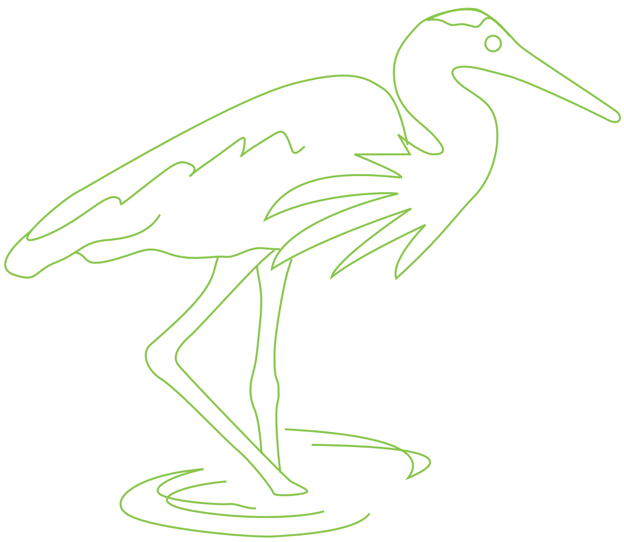
Potential environmental watering action	Expected watering effects	Environmental objectives
Partial fill (with top-ups as required to maintain a minimum water depth 0.3 m AHD during August to December[1] and April to June)	• Support the growth and flowering of semi-aquatic plants • Provide appropriate wetland fringing habitat for frogs and turtles • Provide conditions that support waterbug communities and food resources for frogs, turtles and waterbirds	   
Partial drawdown (during January to March)	• Oxygenate sediments to enable aquatic vegetation germination and recruitment • Provide water level fluctuations for emergent vegetation reproduction and expansion (particularly swamp scrub and tall marsh) • Break down organic matter and promote nutrient cycling • Expose mudflats and create shallows to facilitate waterbird foraging	 

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

2 This is the likely timing under a drought scenario. Note, under a dry, average or wet scenario a fill event may occur during this period, as detailed in Table 2.2.4.

3 If the salinity level in the Latrobe River exceeds 10,000 µS/cm, a top-up will not be provided.

4 If a partial flushing flow is not possible until the end of November, top-ups will be provided to maintain a fill with a minimum water depth of 0.5m AHD.



Scenario planning

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

The main priority for environmental watering at the lower Latrobe wetlands in 2021-22 is to fill each wetland as much as possible in winter/spring and prevent complete drying over summer and autumn. The proposed watering actions aim to consolidate environmental outcomes from 2020-21, further enhance recovery from extended drying in 2018-19 and 2019-20 and build ecosystem resilience ahead of future dry periods. The wetlands can only be filled when water levels and water quality in lower reaches of *Durt-Yowan* (Latrobe River) are suitable, and therefore the timing and extent of filling events will be heavily influenced by natural climatic conditions and flow in *Durt-Yowan* (Latrobe River). It is likely that only partial fills will be possible under a drought scenario, and natural overbank floods are likely at any time of year under a wet scenario. Trigger-based inflows to address a potential acid sulfate soil risk, support a natural waterbird breeding event or control invasive vegetation will be delivered when needed and possible, even if the timing of these actions compromise other planned filling or partial drawdown events. Specific watering plans for each wetland under different climate scenarios are described below.

Sale Common

The minimum aim for Sale Common is to partially fill the wetland in winter and provide top-ups as needed to maintain water levels above 0.3 m AHD throughout the year, which will wet about half of Sale Common. Maintaining at least a partial fill is considered ecologically important to support wetland plant communities (which experienced near-complete drying in 2018-19 and 2019-20) and provide habitat for frogs, turtles and waterbirds. This is likely to be the maximum water level achieved under a drought scenario.

Filling the wetland for at least two months from late winter or early spring is a high priority where possible to connect the wetland to *Durt-Yowan* (Latrobe River), stimulate recruitment of plant communities at the outer margins of the wetland and provide nesting habitat for breeding waterbirds. This is likely to be achieved under average and wet scenarios, and it may be achieved under a dry scenario if there is sufficient flow and water quality in *Durt-Yowan* (Latrobe River) at the required time.

Dowd Morass

The plan at Dowd Morass is to fill or partly fill the wetland in winter and spring, then allow a controlled partial drawdown in summer, with top-ups as needed during the drawdown phase and from April to June 2022 to prevent water levels from dropping too much. A partial fill will support some vegetation outcomes and help maintain habitat and food for waterbirds, frogs and turtles, but a complete fill will likely be needed to trigger waterbird breeding and improve vegetation communities at higher elevations. River conditions under a drought scenario will likely prevent a complete fill in winter and spring, and the planned partial drawdown in summer may not be achievable under a wet climate scenario due to local runoff and unregulated inflows from *Durt-Yowan* (Latrobe River).

Heart Morass

Acidity and salinisation represent a high risk to environmental values at Heart Morass, and maintaining water levels above -0.3 m AHD at all times is a high priority to avoid exposing potential acid sulfate soils. Flushing flows, whereby water for the environment is delivered at the upstream end of the wetland and released through a downstream regulator, are also a high priority to deliver where possible, to remove accumulated salt and sulphides. Maintaining water levels above -0.3 m AHD should be possible under all climate scenarios. Flushing flows will probably be provided naturally under a wet scenario and will be provided partially with water for the environment where possible under dry and average climate scenarios.

Water levels in *Durt-Yowan* (Latrobe River) under a drought scenario are not likely to be high enough to support a partial flushing event at Heart Morass. The preferred water regime under a drought scenario will be to partially fill the wetland from winter to early summer to support wetland plant communities and maintain habitat and food resources for frogs, turtles and waterbirds.

A partial draw down is recommended at Heart Morass over summer and autumn under drought to average climate scenarios, to expose shoreline habitat to increase the diversity of vegetation communities, allow nutrient cycling and provide foraging habitat for shorebirds. Significant drawdown is unlikely under a wet climate scenario.

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 and wetland conditions</td><td>• No natural inflow from Durt-Yowan (Latrobe River), and wetlands are likely to dry completely</td><td>• Minor natural inflow from Durt-Yowan (Latrobe River) in winter/spring; expect moderate to substantial drying in summer</td><td>• Moderate winter/ spring flow in Durt-Yowan (Latrobe River) likely to fill or partially fill the wetlands; expect minor drying in summer</td><td>• Major flow in Durt-Yowan (Latrobe River) in winter/ spring and possibly autumn/ winter likely to fill all wetlands with very little drying in summer</td></tr>
<tr><td colspan="5">Sale Common</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td>• Top-up (any time, following bird breeding)
• Partial fill (with top-ups as required)
• Partial drawdown (during December to March)</td><td colspan="3">• Top-up (any time, following bird breeding)
• Fill (with top-ups as required during August to November)
• Trigger-based fill or top-up to 0.5m AHD (during December to January, if required)
• Partial fill (with top-ups as required during December to June)</td></tr>
<tr><td colspan="5">Dowd Morass</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td>• Top-up (any time, following bird breeding)
• Fill (any time, to control salinity)
• Partial fill (with top-ups as required in August to December and April to June)
• Partial drawdown (during January to March)</td><td colspan="2">• Top-up (any time, following bird breeding)
• Fill (any time, to control salinity)
• Partial fill (with top-ups as required in July, December and April-June)
• Fill (with top-ups as required during August to November)
• Partial drawdown (during January to March)</td><td>• Top-up (any time, following bird breeding)
• Fill (any time, to control salinity)
• Partial fill (with top-ups as required in July and April to June)
• Fill (with top-ups as required during August to November)</td></tr>
<tr><td colspan="5">Heart Morass</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td>• Top-up (any time, to permanently maintain water level above -0.3m AHD)
• Top-up (any time, following bird breeding)
• Partial fill (with top-ups as required during August to December)
• Partial drawdown (during December to March)</td><td colspan="2">• Top-up (any time, to permanently maintain water level above -0.3m AHD)
• Top-up (any time, following bird breeding)
• Fill and partial flushing flow (during July to November)
• Partial fill (with top-ups as required during April to June)
• Partial drawdown (during December to March)</td><td>• Top-up (any time, to permanently maintain water level above -0.3m AHD)
• Top-up (any time, following bird breeding)
• Fill and partial flushing flow (during July to November)
• Partial fill (with top-ups as required during April to June)</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 *Durt-Yowan* (Latrobe River). Water can be diverted to the lower Latrobe wetlands at any time of the year when flows are above -0.7m AHD at *Durt-Yowan* (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: Carran Carran (Thomson River) at Coopers Creek, by West Gippsland CMA
Above: Heyfield wetlands vegetation, by West Gippsland CMA

System overview

Carran Carran (Thomson River) flows from the slopes of the Baw Baw Plateau to join *Durt-Yowan* (Latrobe River) south of Sale (Figure 2.3.1). The major tributaries of *Carran Carran* (Thomson River) are the Aberfeldy and Jordan rivers in the upper reaches and *Wirn wirndook Yeerung* (Macalister River) in the lowest reach. Most natural flow originates from the Aberfeldy River. Two major structures regulate flow on *Carran Carran* (Thomson River): Thomson Reservoir — the largest water supply storage for metropolitan Melbourne — and Cowwarr Weir — a regulating structure that supplies irrigation water to parts of the Macalister Irrigation District.

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

Water for the environment is held in the Thomson Reservoir and released into the river as required. Reach 3 of *Carran Carran* (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, *Carran Carran* (Thomson River) splits into the old *Carran Carran* (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 *Carran Carran* (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 *Carran Carran* (Thomson River) and the township of Heyfield. Due to the construction of levees and weirs along *Carran Carran* (Thomson River), river water rarely enters the wetlands; 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 wetland plant communities that have been planted as part of a comprehensive revegetation program in recent years.

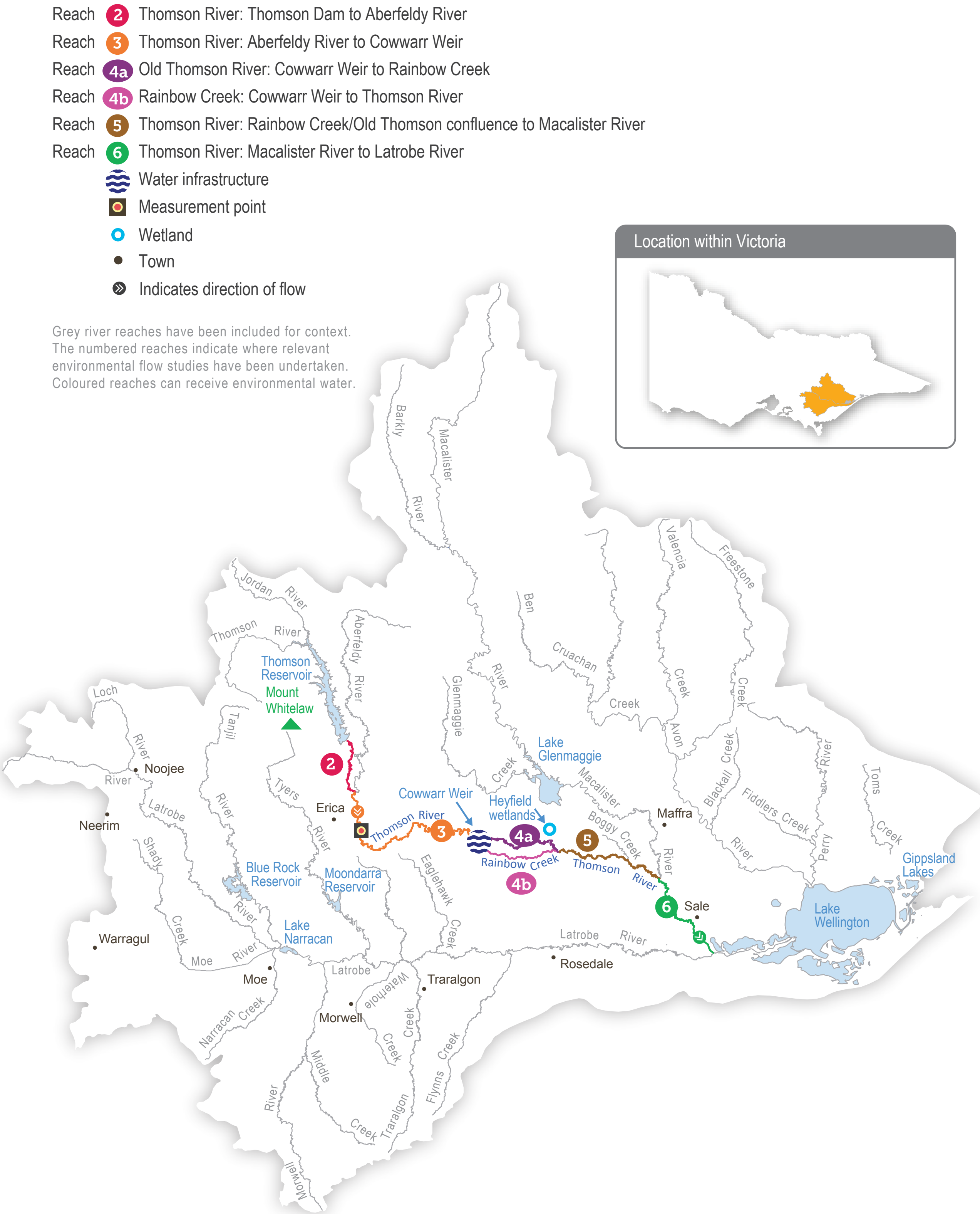
Environmental values

Carran Carran (Thomson River) supports native species of migratory fish that need to move between the sea and freshwater environments to complete their life cycles, including Australian grayling, tupong, short- and long-finned eel, Australian bass, and pouched and short-headed lamprey. 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 vary throughout 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. They provide habitat for aquatic and terrestrial animals including threatened migratory birds that prefer shallow, slow-moving waterbodies.

Figure 2.3.1 The Thomson system



Environmental watering objectives in the Thomson system

Restore populations of native fish, specifically Australian grayling Maintain/enhance the structure of native fish communities
Maintain the existing frog population and provide suitable habitat
Maintain or enhance the physical form of the channel to provide a variety of channel features and habitats for aquatic animals Maintain or enhance river function by maintaining substrate condition and enabling carbon cycling
Increase the abundance of platypus
Maintain and restore the structural diversity and appropriate distribution (zonation) of streamside vegetation along the riverbank and reduce terrestrial encroachment/invasion (*Carran Carran* [Thomson River]) Increase the recruitment and growth of native in-stream, fringing and streamside vegetation (*Carran Carran* [Thomson River]) Maintain the existing vegetation, promote the growth and establishment of semi-aquatic species (Heyfield wetlands) Enhance the resilience of semi-aquatic 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
Maintain and improve water quality in the Thomson River 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 system, into which *Carran Carran* (Thomson River) feeds. 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.

The 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.

This has included GLaWAC membership on the Steering Committee and Project Advisory Group for the 2020 review of the *Carran Carran* (Thomson River) FLOWS study. FLOWS studies provide guidance about the timing, watering duration and amount of water needed by native plants and animals and are therefore a critical input to the annual water for the environment planning process.

GLaWAC cultural water officers have also recently completed an Aboriginal Waterways Assessment on *Carran Carran*, and they are assessing how to document, protect and further the river's cultural values and uses. Traditionally, *Carran Carran* 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 is sharing with the West Gippsland CMA its knowledge of 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 the Latrobe River 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 birdwatching, camping, hiking and duck hunting)
- 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 businesses and helping to maintain bankside vegetation, preventing erosion and potential land loss.).

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 the following icons.

Recreational benefits from water for the environment in *Carran Carran* (Thomson River)

	Watering planned to support water sports activities (canoeing and kayaking)
	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 in *Carran Carran* (Thomson River) create ideal whitewater rafting conditions for kayakers and canoers. The timing of environmental flows may be adjusted to optimise opportunities to support these recreation activities, where it does not compromise environmental outcomes. For example, the spring fresh, which aims to cue the migration of Australian grayling and other native fish, 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 *Carran Carran* (Thomson River). Kayaking and rafting activities have inherent risks, and large environmental flows are ramped up and down over several days to avoid sudden changes in water levels that may affect river users. The West Gippsland CMA also provides notification of planned large releases of water for the environment to alert river users about potential increases in the water level and velocity.

Interested community members can register on the West Gippsland CMA website to receive notification of upcoming watering events.

Recent conditions

The *Carran Carran* (Thomson River) catchment had average to above-average rainfall throughout much of 2020-21. The majority of water for the environment for the Thomson system is allocated up-front at the start of the water year, with additional allocation throughout the year based on inflows to Thomson Reservoir. Consistent inflows occurred throughout winter and spring, boosting water availability and resulting in further allocations, which by the end of spring were 17 percent greater than at the same time in 2019-20. Water was released from Thomson Reservoir throughout the year to meet minimum passing flow requirements, irrigation demand and some environmental flow demands. Environmental flows in *Carran Carran* (Thomson River) were managed in line with average and wet climate scenarios — note that the potential watering actions for 2020-21 were the same under both scenarios — and most planned environmental flows in winter and early spring 2020 were met by natural flows.

Carran Carran (Thomson River) had several natural freshes in July and August including one event that peaked above 6,000 ML per day at Coopers Creek gauge. Water for the environment was used to deliver a spring fresh of 800 ML per day at Coopers Creek in late September/early October 2020 to support vegetation outcomes. A natural fresh that peaked at about 3,000 ML per day in late October/early November provided a natural trigger for fish to migrate upstream from marine/estuarine habitats. Over summer, operational and natural flows met low-flow requirements and partially met one summer/autumn fresh. Water for the environment was used to deliver a fresh in March 2021 to support vegetation growth and flush sediments, and to deliver two autumn freshes of 800 ML per day to trigger downstream fish migration. It was also used to maintain low flows through autumn 2021. No water for the environment was delivered to the Heyfield wetlands in 2020-21: significant rainfall across the catchment filled the wetlands in winter and water levels were maintained throughout spring, providing habitat for waterbirds, frogs and turtles.

All of the high priority (tier 1) planned environmental watering actions for *Carran Carran* (Thomson River) were met in 2020-21. Some tier 2 watering actions were also partially met, which contributed to environmental outcomes in the Thomson River estuary.

Environmental monitoring indicates improved environmental outcomes in the Thomson system and some recovery from drier conditions between 2017 and 2019. Fish surveys in February 2021 detected successful recruitment following spring freshes in 2020. Specific findings included the catch of 19 Australian grayling in the middle to lower reaches and the highest catch rate of tupong in the 17 years of surveying. Some tupong were also caught upstream of Horseshoe Bend, which indicates fish are using the recently constructed fishway to access habitat in the upper reaches of *Carran Carran* (Thomson River) and the Aberfeldy River. On a landscape scale, west Gippsland catchments may play an important role in providing habitat for coastal migratory fish populations, given many catchments in east Gippsland were affected by the 2019-20 bushfires. Environmental watering in 2021-22 will aim to maintain and where possible build on the environmental outcomes achieved in 2020-21. Scientists at the Arthur Rylah Institute have recommended maintaining low flows in 2021-22 to promote the upstream dispersal and survival of new tupong recruits.

Scope of environmental watering

Table 2.3.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 2.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Thomson system

***Carran Carran* (Thomson River) (targeting reach 3)**		

	• Maintain a minimum level of habitat and maintain water quality in pools and riffles for waterbugs and fish (when delivered at 125 ML/day). Habitat availability and condition is increased when delivered at higher magnitudes
	• Regulate the water temperature and wet large woody debris to provide food and shelter for waterbugs and fish
	• Maintain sufficient water depth to facilitate platypus and fish movement between localised habitats and increase foraging opportunities (further enhanced when delivered at higher magnitudes)
	• Wet low-lying benches (when delivered at higher magnitudes) to prevent encroachment by invasive plants and permit seed dispersal
	• Additional benefits to the Thomson River estuary (reach 6) are expected when provided at 350 ML/day magnitude:
	  • partially flush the upper water column, 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 system	

Spring fresh(es) (one to two freshes of 800-900 ML/day for five to seven days during September to November)
• Watering planned to support water sports activities
• Watering planned to support peaks in visitation
	• Trigger the migration of adult and juvenile native fish (in particular the upstream migration of juvenile Australian grayling and Australian bass from marine/estuarine habitats)
	• 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 and prevent pools from infilling
	• Scour substrates to remove accumulated fine sediment and biofilms to improve habitat and food for waterbugs
	• Additional benefits to Thomson River and its estuary (reach 6) are expected when provided at 900 ML/day magnitude:
	  • wet vegetation on higher benches
	  • partially flush the upper water column in the Thomson River 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 system	

Summer/autumn low flow (125 ML/day during December to April)	• Maintain habitat and water quality in pools and riffles for waterbugs and fish • Facilitate localised movement between habitat types for small-bodied native fish and platypus • Wet low-lying benches to prevent encroachment by invasive plants and enable vegetation zonation	

Table 2.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Thomson system *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives

Summer/autumn fresh(es) (one to two freshes of 230-350 ML/day for seven days during December to March)	• Wet aquatic and fringing vegetation to maintain its condition and support its growth
	• Provide velocity and depth diversity and prevent sediment smothering by fine sediments
	• When delivered in February-March (at 230 ML/day) the fresh also aligns with and supports native fish movement:
	  • trigger downstream migration of adult short- and long-finned eel and upstream movement of juvenile Australian bass
	  • increase the water depth over riffles to facilitate local movement between habitats for large-bodied native fish	

Autumn freshes (two freshes of 800 ML/day for five to seven days during April to May)	• Trigger the migration of adult and juvenile native fish, in particular:
	  • the downstream migration and spawning of adult Australian grayling (April)
	  • the downstream migration of adult tupong and upstream migration of adult and juvenile Australian bass (May)
	• Carry plant seeds and propagules from the upper catchment for deposition downstream and help maintain zonation of vegetation
	• Prevent infilling of pools by mobilising fine sediments and depositing them on existing bars and benches, to provide substrate for vegetation
	• Scour substrates to remove accumulated fine sediment	

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 as required to maintain water level (during September to December)	• Top up ponds before summer to maintain vegetation and enhance recruitment by triggering seed release • Maintain habitat for waterbirds and frogs (such as growling grass frogs and golden bell frogs)	
Partial drawdown (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.

It is important to deliver a mix of low flows and freshes throughout the year in *Carran Carran* (Thomson River), but the magnitude, duration and frequency of these events will generally be lower under drought and dry climate scenarios compared to average and wet scenarios. The reason for this is two-fold. First, there is unlikely to be enough water for the environment to deliver flows at the upper end of their recommended magnitude and duration under drier climate scenarios. Second, under drier climate scenarios the main environmental focus is maintaining key habitats and resources for existing plants and animals, whereas under wetter climate scenarios it will be important to deliver larger-magnitude events, to increase the recruitment of native plants and animals.

Under all climate scenarios, the highest-priority watering actions to be met with environmental flows in *Carran Carran* (Thomson River) are 800 ML per day autumn and spring (in October/November) freshes, which target migratory fish movement into or out of the system. These events are essential to cue the spawning and recruitment of the threatened Australian grayling population and other native migratory fish species. Where possible, the spring and autumn freshes may be timed to coincide with events or long weekends to provide additional recreational benefits for river users. Two autumn freshes will likely be delivered under all climate scenarios, but under a dry scenario, the duration may be reduced from seven to five days to conserve water. Freshes that last for five days are expected to trigger some fish migration, although total fish movement is likely to be less than for a seven-day fresh. Providing an additional 800-900 ML per day spring fresh in September is important under all scenarios to support vegetation outcomes, but there is unlikely to be enough water for the environment to actively deliver these events in drought to average climate scenarios. It will be important to deliver two summer/autumn freshes under all climate scenarios to clear fine silt and biofilms from in-stream habitat and facilitate the movement of native fish and platypus.

Delivery of low flows throughout the year is expected to change, depending on the climate scenario. A flow of 125 ML per day in reach 3 is the target magnitude in summer/autumn and is the minimum recommended flow during winter/spring, which is expected to be met under all climate scenarios by operational passing flows. Under drought and dry scenarios, the target flow rate may be increased up to 230 ML per day for brief periods in May and June, to provide greater fish and platypus passage throughout the reach. Under wetter climate scenarios, increasing the flow magnitude between 230 and 350 ML per day in July 2021 and again between May and June 2022 is preferred, as it results in additional benefits for fringing and streamside vegetation.

Under all climate scenarios, a minimum of 2,600 ML is prioritised for carryover into 2022-23, to meet critical early-season, low-flow requirements in *Carran Carran* (Thomson River).

The recommended water regime for Heyfield wetlands is the same under all climate scenarios because extensive revegetation at the site has occurred in recent years and wetlands filling is required to support the semi-aquatic and terrestrial fringing plants to establish and promote natural recruitment. Water for the environment will likely be needed to fill and top up the wetlands under drought and dry climate scenarios. Natural runoff is likely to meet some or all of the recommended watering actions at Heyfield wetlands under average and wet climate scenarios.

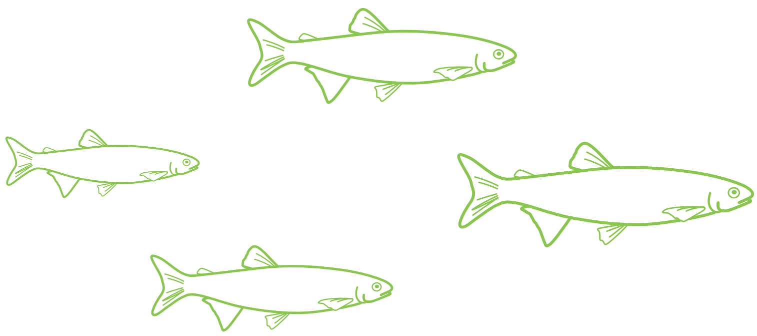


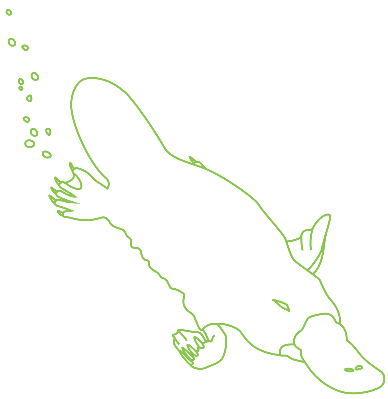
Table 2.3.2 Potential environmental watering for *Carran Carran* (Thomson River) under a range of planning scenarios

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 flow • Small volume of consumptive water released from storage	• Natural flow from Aberfeldy River and other tributaries contributes to low flow, freshes and sustained high flow • Minimal volume of consumptive water released from storage
Predicted supply of water for the environment	• 25,700-28,700 ML	• 28,700-31,700 ML	• 31,700-34,700 ML	• 33,700-37,700 ML
***Carran Carran* (Thomson River) (targeting reach 3)**				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Winter/spring low flow (125-230 ML/day between May and June 2022, and 125 ML/day at other times) • Spring fresh (one fresh, at lower duration and magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, one at upper, one at lower duration) • Autumn freshes (two freshes, one at lower duration [in May])	• Winter/spring/autumn low flow (at 230 ML/day in July 2021 and May to June 2022, and 125 ML/day at other times) • Spring fresh (one fresh, at longer duration but lower magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, one at upper, one at lower duration) • Autumn freshes (two freshes)	• Winter/spring/autumn low flow (at 350 ML/day in July 2021 and May to June 2022, and 125 ML/day at other times) • Spring fresh (one fresh, at longer duration but lower magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, one at upper, one at lower duration) • Autumn freshes (two freshes)	• Winter/spring low flow (at 350 ML/day in July 2021 and May to June 2022, and 125 ML/day at other times) • Spring freshes (two freshes, both at longer duration but one at lower magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, one at upper, one at lower duration) • Autumn freshes (two freshes)
	Tier 1b (supply deficit)			
	• Autumn/winter/spring low flow (in addition to tier 1a, increase magnitude to 350 ML/day during July to November) • Tier 1a spring fresh delivered at longer duration and one additional spring fresh at longer duration and upper magnitude	• Autumn/winter/spring low flow (at upper magnitude continuously) • One additional spring fresh, at longer duration and upper magnitude	• Autumn/winter/spring low flow, at upper magnitude continuously • One additional spring fresh, at longer duration and upper magnitude	• Autumn/winter/spring low flow, at upper magnitude continuously
Potential environmental watering – tier 2 (additional priorities)	• N/A			

Table 2.3.2 Potential environmental watering for *Carran Carran* (Thomson River) under a range of planning scenarios *(continued)*

	• Fill (in August) • Top-ups (two, in September-December) • Partial drawdown (in December to February)			
	• N/A			
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 22,000 ML (tier 1a) • 30,400 (tier 1b) • 0 ML (tier 2)	• 25,000 ML (tier 1a) • 30,400 ML (tier 1b) • 0 ML (tier 2)	• 34,500 ML (tier 1a) • 18,200 ML (tier 1b) • 0 ML (tier 2)	• 39,500 ML[1] (tier 1a) • 13,200 ML (tier 1b) • 0 ML (tier 2)
Priority carryover requirements	• 2,600 ML			

1 While the demand is in excess of available supply, it is expected that some of the events will be at least partially met with natural inflows under a wet scenario.



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...?

Wirn wirndook Yeerung (Macalister River) has been prioritised as a key fishery for the Native Fish Report Card Program, where monitoring will focus on Australian bass and Australian grayling. This four-year monitoring program is collecting long-term information about the condition of native recreational fisheries across the state. The program is a partnership between the Department of Environment, Land, Water and Planning, the Victorian Fisheries Authority and recreational fishing licence holders. The program started in 2017, collecting information on various indicators of fish population health including abundance, year-class distribution for specific fisheries and target recreational species and priority threatened species.

Top: Wirn wirndook Yeerung (Macalister River) at Lanigans Bridge, by West Gippsland CMA
Above: Short-finned eel, by Trevor Prescott

System overview

Wirn wirndook Yeerung (Macalister River) flows from Mt Howitt in the Alpine National Park and joins *Carran Carran* (Thomson River) south of Maffra (Figure 2.4.1). 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 *Wirn wirndook Yeerung* (Macalister River).

Lake Glenmaggie is the major water-harvesting storage regulating *Wirn wirndook Yeerung* (Macalister River). Maffra Weir is a small diversion weir located further downstream in Maffra.

Before the construction of Lake Glenmaggie, *Wirn wirndook Yeerung* (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 *Wirn wirndook Yeerung* (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 *Carran Carran* (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

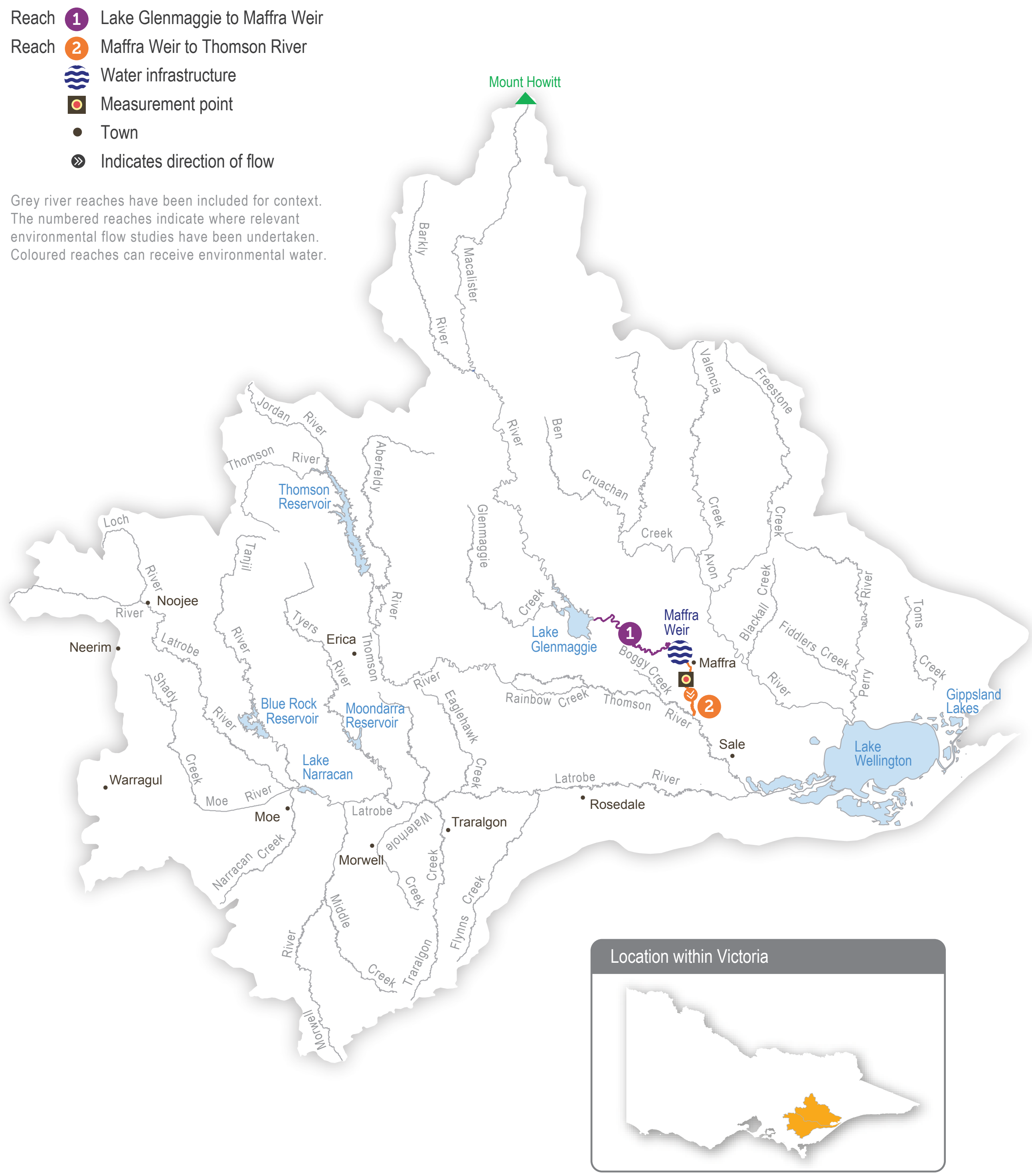
Seven migratory native fish species move between *Wirn wirndook Yeerung* (Macalister River), the estuary and the sea to complete their life cycle. These species include the Australian grayling, short-finned eel, long-finned eel, tupong, Australian bass, short-headed lamprey and common galaxias. Yellow-eye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

The streamside vegetation corridor along the regulated reaches of *Wirn wirndook Yeerung* (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 *Wirn wirndook Yeerung* (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 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 system (into which *Wirn wirndook Yeerung* [Macalister River] feeds). 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.

The 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 *Wirn wirndook Yeerung* (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.

The 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 *Wirn wirndook Yeerung* (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 *Wirn wirndook Yeerung* (Macalister River), have important cultural significance to the Gunaikurnai people.

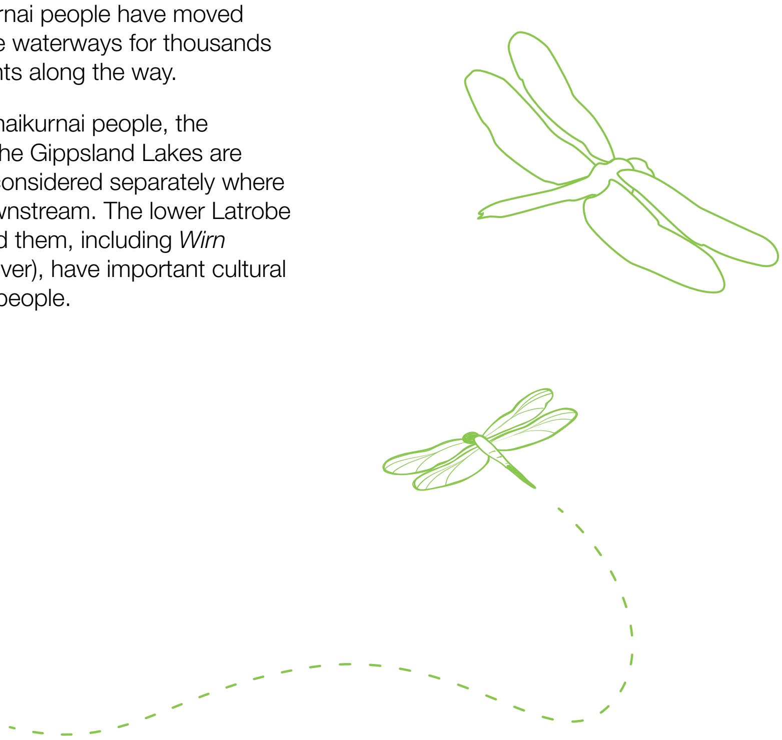
Watering requirements to support cultural values and uses include:

- 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 the Latrobe River 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 canoeing, kayaking and swimming)
- riverside recreation and amenity (such as fishing and hunting)
- socio-economic benefits (such as preventing erosion and potential loss of private land).



Recent conditions

Rainfall in the Macalister system in 2020-21 was slightly higher than the long-term average. High inflows in autumn 2020 filled Lake Glenmaggie, and additional rain events caused it to spill multiple times through winter and spring. Opening allocations of high-reliability water shares were 100 percent, and low-reliability water share allocations reached 100 percent in April 2021.

Releases of water for the environment in the Macalister system were made in line with the average and wet climate scenarios throughout 2020-21. All of the planned watering actions for 2020-21 were met through a combination of natural flows, operational and consumptive releases and environmental flows. Flows at Riverslea gauge (located in reach 2) exceeded 4,000 ML per day several times between July and October 2020. Water for the environment was used to maintain connectivity in the river as needed during the storage filling season and to deliver freshes in autumn and early winter to support fish migration.

Fish surveys conducted in *Wirn wirndook Yeerung* (Macalister River) in March 2021 caught many young-of-year tupong, which suggests high flows in spring 2020 supported successful recruitment for that species. On a landscape scale, west Gippsland catchments may provide refuge habitat for coastal migratory fish populations that moved out of east Gippsland catchments following the extensive bushfires in 2019-20. Environmental watering in 2021-22 aims to maintain or where able build on the environmental outcomes from 2020-21. Fish ecologists from the Arthur Rylah Institute for Environmental Research recommend maintaining target low flows throughout 2021-22 to promote the upstream dispersal and survival of new tupong recruits.

Scope of environmental watering

Table 2.4.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 2.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Wirn wirndook Yeerung* (Macalister River)

Potential environmental watering action	Expected watering effects	Environmental objectives
***Wirn wirndook Yeerung* (Macalister River) (targeting reach 2)[1]**		
Winter/spring low flow (300 ML/day for at least 120 days during July to November 2021 and June 2022)	• Provide permanent wetted habitat for waterbugs and maintain water depth over riffles to enable fish passage between local habitats • Increase water depth to provide sustained wetting of low-level benches, limiting the encroachment of terrestrial vegetation	
Spring/summer fresh(es) (one to two freshes of 700-1,500 ML/day for three to 10 days during September to December)	• 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 mid- and higher-level benches to water woody vegetation and move organic matter into the channel to transport food resources downstream (when delivered at upper magnitude) • Provide flow with sufficient shear stress to scour biofilms and flush fine sediment from pools and small gaps to improve geomorphic habitat and food resources for waterbugs (when delivered at upper magnitude)	
Spring/summer low flow (60-90 ML/day during September to February)	• Maintain the water depth in pools and hydraulic habitat for native fish[2] • Maintain permanent wetted habitat in pools and riffles for waterbugs[2] • Provide longitudinal connectivity for local movement of platypus and rakali, as well as protection from predation, access to food sources and maintenance of refuge habitats[2]	
Trigger-based summer/autumn low flow (40-60 ML/day for five to 13 days when triggered, during December to May)	• Maintain permanent wetted habitat in pools and riffles for fish and waterbugs to survive • Provide 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	

Table 2.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Wirn wirndook Yeerung* (Macalister River) *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn fresh(es) (one to three freshes of 140 ML/day for three to five days during December to March)	• Increase water 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 dispersal of seeds and propagules from emergent vegetation throughout the reach • Provide flow with sufficient shear stress to flush fine sediment from small gaps to improve geomorphic habitat	
Autumn fresh (one fresh of 350 ML/day for five days during April to May)	• Cue the downstream migration of Australian grayling towards the estuary for spawning • Additional benefits for *Carran Carran* (Thomson River) and the Latrobe system are expected when delivered for greater than three days: ◦ fully flush the upper Thomson River estuary (when delivered for greater than three days and combined with freshes in *Carran Carran* (Thomson River) and contribute freshwater to the lower reaches of *Durt-Yowan* (Latrobe River) and wetlands	
Autumn/winter low flow (60-90 ML/day during March to August)	• Maintain pool and riffle habitat for waterbugs and a minimum depth over riffles to allow fish (e.g. Australian grayling, tupong and Australian bass) to migrate downstream towards the estuary habitat to spawn or breed[2] • Provide connectivity throughout the river for the local movement of platypus and rakali (water rats), as well as protection from predation and access to food • Provide low-velocity flow and clear water to enable the establishment of submerged vegetation[2]	
Autumn/winter fresh (one fresh of 700 ML/day for five days during July to August 2021 or May to June 2022)	• Cue the downstream migration towards the estuary of Australian bass for spawning and of tupong for breeding • Increase the wetted area and improve water quality by flushing pools, providing habitat and conditions for waterbugs • Wet low and mid-level benches to facilitate the dispersal of emergent and fringing vegetation seeds and propagules throughout the reach	

1 All freshes target reach 2 specifically. Low flows target both reach 1 and 2, but the magnitudes targeted apply to both reaches.

2 At 90 ML per day, expected watering effects are met in reach 1 and 2. At 60 ML per day, expected watering effects are met in reach 2 only.

Scenario planning

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

Under all climate scenarios, providing year-round low flows to *Wirn wirndook Yeerung* (Macalister River) is the highest-priory watering action, to maintain habitat connectivity for aquatic animals. Year-round operational passing flows of 60 ML per day meet flow objectives for reach 2, providing the minimum connectivity requirement. Increasing flows to 90 ML per day where water availability allows is preferred, as it has additional benefits for reach 1. Where possible, low flows will be delivered at the upper end of the recommended range and for longer durations under average and wet climate scenarios, to provide more habitat and food to help grow waterbug, fish and platypus populations and to exclude terrestrial vegetation from the main channel. Low-flow requirements are expected to be met by passing flows and consumptive water orders during the irrigation season, but water for the environment will likely be needed to meet minimum low-flow targets to support fish movement between mid-April and mid-August, when water from the upper catchment is harvested to fill Lake Glenmaggie.

Under drought and dry climate scenarios, low inflows to Lake Glenmaggie may trigger reduced operational passing flows any time over summer and autumn. While maintaining low flows of at least 60 ML per day is the target under all scenarios, under this circumstance potentially large volumes of water for the environment would be required to meet this target continuously, which is unlikely to be possible with available supply. As a result, the low-flow target may be allowed to drop to 40 ML per day for five to 13 days at a time. Water quality would be regularly monitored in this situation, and where necessary water for the environment may also be used to deliver summer/autumn freshes to avoid a serious water quality outcome and loss of environmental values.

Delivering at least one fresh of 350 ML per day in autumn and 700 ML per day in spring (both for five days) is a high priority under all climate scenarios, to provide a migration trigger for native fish to move into or out of the system to complete their life cycles. An additional 700 ML per day fresh may also be delivered in late autumn or winter to further trigger fish migration, where water availability allows: most likely under dry and average climate scenarios. Over summer and autumn, at least one smaller-magnitude fresh will likely be delivered under drought and dry climate scenarios, to maintain water quality over the warmer months, with additional events possible under average and wet climate scenarios. Several other large freshes are recommended to slow the recession following a spill from Lake Glenmaggie or to cue additional fish movement in autumn/winter, but they are a lower priority and will need to be at least partly met via operational releases under most scenarios.

Under all climate scenarios, a minimum of 1,900 ML is prioritised for carryover into 2022-23, to meet critical early-season low-flow requirements in *Wirn wirndook Yeerung* (Macalister River).

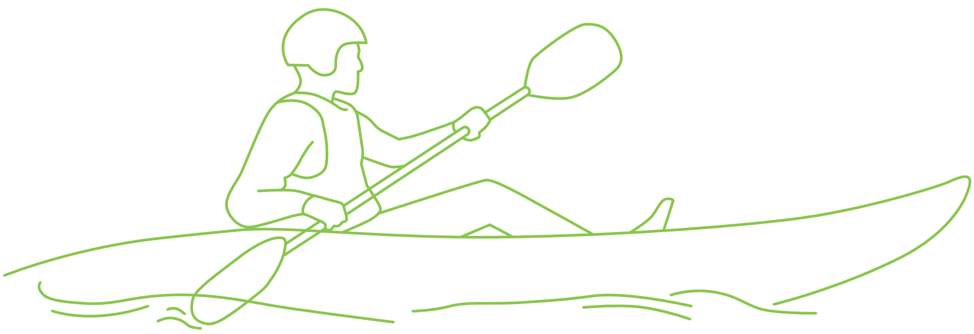


Table 2.4.2 Potential environmental watering for *Wirn wirndook Yeerung* (Macalister River) under a range of planning scenarios

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
Predicted supply of water for the environment	• 13,400 ML	• 16,700 ML	• 18,700 ML	• 23,200 ML
Potential environmental watering – tier 1 (high priorities)	• Spring/summer fresh (one fresh, between September to November at mid-duration [five days] but lower magnitude) • Spring/summer low flow (delivered at upper magnitude in November only, following fresh) • Trigger-based summer/autumn low flow • Summer/autumn fresh (one fresh, at lower duration) • Autumn fresh (one fresh) • Autumn/winter low flow (delivered at upper magnitude in April to August[1])	• Spring/summer fresh (one fresh, between September to November at mid-duration [five days] but lower magnitude) • Spring/summer low flow (delivered at upper magnitude in November only, following fresh) • Trigger-based summer/autumn low flow • Summer/autumn fresh (one fresh, at lower duration) • Autumn fresh (one fresh) • Autumn/winter low flow (delivered at upper magnitude in April to August[1]) • One autumn/winter fresh	• Spring/summer fresh (one fresh, between September to November at mid-duration [five days] but lower magnitude) • Spring/summer low flow (delivered at upper magnitude in November only, following fresh) • Summer/autumn freshes (three freshes) • Autumn fresh (one fresh) • Autumn/winter low flow (delivered at upper magnitude in April to August[1]) • Autumn/winter fresh (one fresh)	• Spring/summer fresh (one fresh, between September to November at mid-duration [five days] but lower magnitude) • Spring/summer low flow (delivered at upper magnitude in November only, following fresh) • Summer/autumn freshes (three freshes) • Autumn fresh (one fresh) • Autumn/winter low flow (delivered at upper magnitude in April to August[1]) • Autumn fresh (one fresh)

Table 2.4.2 Potential environmental watering for *Wirn wirndook Yeerung* (Macalister River) under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Average	Wet
	Tier 1b (supply deficit)			
	• Spring/summer low flow (upper magnitude continuous) • Autumn/winter fresh (one fresh) • Autumn/winter low flow (upper magnitude continuous)	• Spring/summer low flow (upper magnitude continuous) • Autumn/winter low flow (upper magnitude continuous)	• One additional spring/summer fresh (at upper magnitude) • Spring/summer low flow (upper magnitude continuous) • Autumn/winter low flow (upper magnitude continuous)	• Winter/spring low flow (upper magnitude) • One additional spring/summer fresh (at upper magnitude) • Spring/summer low flow (upper magnitude continuous) • Autumn/winter low flow (upper magnitude continuous)
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 11,100 ML (tier 1a) • 10,000 ML (tier 1b) • 0 ML (tier 2)	• 16,300 ML (tier 1a) • 5,300 ML (tier 1b) • 0 ML (tier 2)	• 18,800 ML (tier 1a) • 8,500 ML (tier 1b) • 0 ML (tier 2)	• 21,400 ML (tier 1a) • 38,200 ML (tier 1b) • 0 ML (tier 2)
Priority carryover requirements	• 1,900 ML			

1 Otherwise deliver at 60 ML per day (passing flow rate).

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, by East Gippsland CMA
Above: Great egret, by Keith Ward

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 before flowing through the Snowy River National Park in Victoria and into Bass Strait (Figure 2.5.1).

There are four major dams and multiple diversion weirs in the upper Snowy River catchment that capture and 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).

The 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.

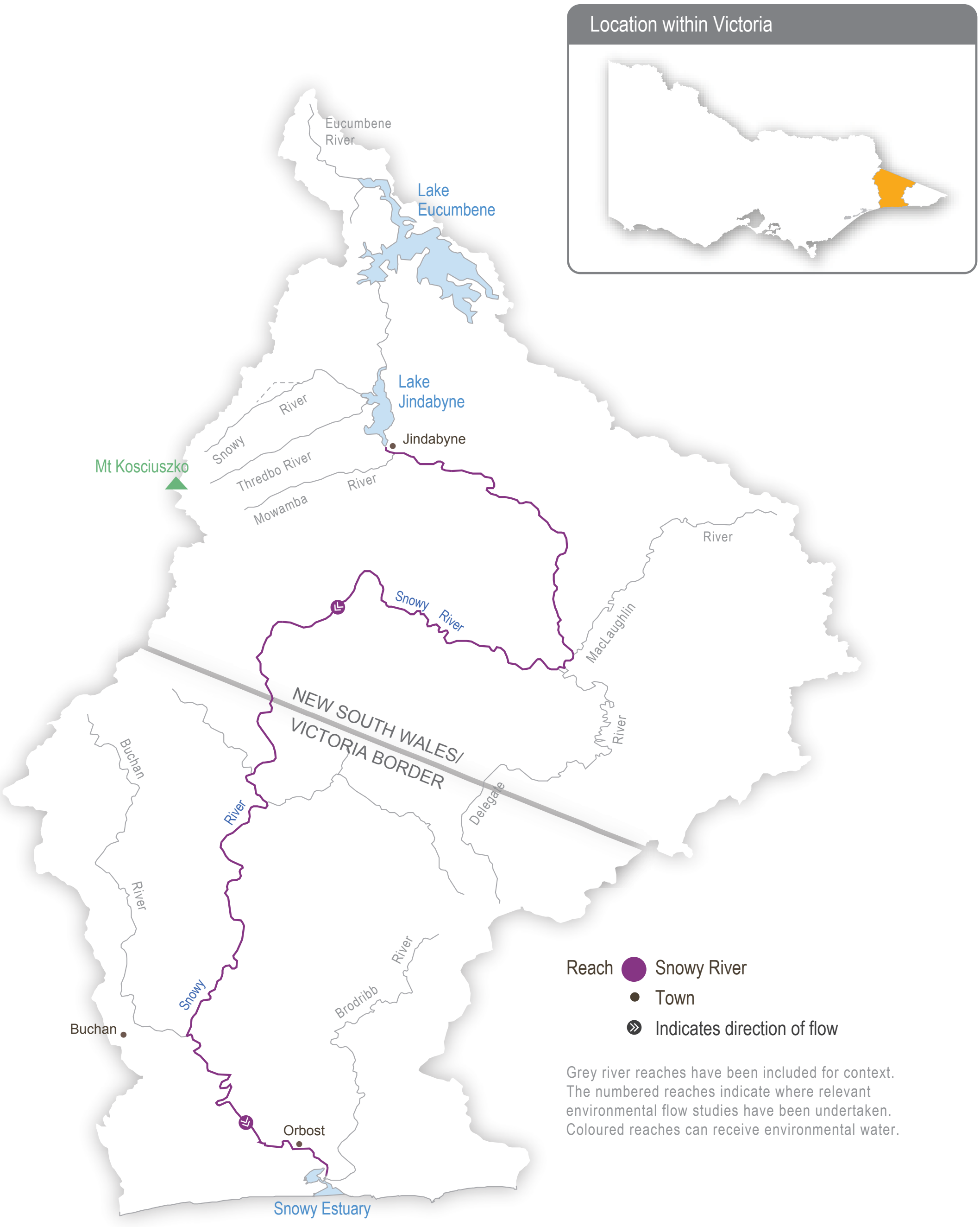
The Victorian, NSW and Commonwealth governments agreed to recover some of the water and in 2002 delivered this first environmental flow to the Snowy River below Jindabyne Dam to help restore the damage done by decades of limited flow. The Victorian share of water for the environment available for use in the Snowy system is held in the Victorian Murray, Goulburn and Loddon systems. The NSW share of water for the environment available for use in the Snowy system is held in the NSW Murray and Murrumbidgee systems. Collectively, the water is made available for environmental flows in the Snowy River via a substitution method, whereby water for the environment allocated in Victoria and NSW replaces water that was earmarked for transfer from the Snowy to Victoria and NSW to support irrigation demands. The NSW Department of Planning, Industry and Environment plans environmental flow releases in the Snowy River in consultation with the Snowy Advisory Committee. The committee includes representatives of the Aboriginal community, local community, the Victorian Government, NSW Government, and environmental experts. The committee brings together local knowledge and expert advice to help inform the management and delivery of water for environmental outcomes.

Water for the environment is delivered daily to the Snowy River below Jindabyne Dam. The annual allocation of water for the environment varies based on water availability, rainfall and inflows. At most, it is equivalent to 21 percent of what the average annual natural flows were before the construction of the Jindabyne Dam.

Environmental values

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.

Figure 2.5.1 The Snowy system



Recent conditions

While dry conditions were observed in late autumn and early winter 2020, above-average rainfall was recorded in the Snowy River catchment over late winter, shifting to average conditions over spring. Summer storms brought about by La Niña conditions resulted in very much above-average rainfall across the catchment, and a minor flood occurred in March 2021. Water availability for environmental flows in the Snowy River is determined by allocations in the Murray, Goulburn, Loddon and Murrumbidgee rivers. In 2020-21, water availability for the Snowy River was relatively low, due to dry conditions in 2019-20. Total water allocated for environmental releases was 91,476 ML[1], which was among the lowest allocations received since 2011. For comparison, 117,871 ML was released in 2019-20.

The water year in the Snowy system runs from 1 May to 30 April, and the daily flow regime is planned in advance by the Snowy Advisory Committee. Relatively small peak magnitudes for high flows and shorter durations for freshening flows were delivered from Lake Jindabyne in 2020-21 because of reduced water availability. Four winter/spring high-flow events were released (one less than in 2019-20), and a flushing flow occurred in September 2020, although it had a limited effect on the flow in Victoria. In the lower Snowy River within Victoria, several peaks over winter and again in October were observed, which was likely from a combination of the upstream environmental flow releases and contributions from major tributaries within Victoria (such as the Buchan River). Wetter conditions and consistent inflows into storages throughout the Murray-Darling Basin in 2020-21 will significantly boost allocation for Snowy River environmental releases in 2021-22.

East Gippsland CMA has monitored the lower reaches of the Snowy River and its estuary for the past nine years. Their results indicate that the managed environmental flows help improve physical and ecological processes, increase ecosystem productivity and improve aquatic habitat. Extensive bushfires in December 2019 and January 2020 affected most of the Snowy catchment. Although rivers and streams had poor water quality, particularly after heavy rain events, the prevailing conditions have provided good growing conditions for natural vegetation to regenerate. It will take years for the catchment to recover from impacts of this scale.

Scope of environmental watering

The total volume available for release to the Snowy River in 2021-22 is 209,577 ML. This is one of the highest allocations of water for the environment made available for the Snowy River.

Due to operating rules in the system, the daily flow regime that will be delivered in 2021-22 is pre-planned: the storage manager will make daily releases of varying magnitude from Lake Jindabyne between May 2021 and April 2022 to mimic the typical flow pattern of a mixed snowmelt/rainfall river system characteristic of the Snowy Mountains. A 'natural flow scaling' approach is applied and the continuous daily releases aim to support ecological processes in the Snowy River below Jindabyne Dam and maintain a healthy river that is much smaller than the natural channel that existed before the river was regulated.

Following several years of dry conditions, the increased water availability for the environment allows for a larger number of high-flow releases in 2021-22, with greater peak magnitudes. The flow pattern is similar to previous years and mimics a snowmelt river with higher flows during winter and spring. Nine high-flow releases are scheduled between June and November 2021. These include a large flushing flow in October 2021 that has a target peak flow rate equivalent to 10,362 ML per day, which will be held for about eight hours to flush sediment and wet high benches and backwaters. Other peak flows will mimic winter rainfall and spring snowmelt events. Collectively, the multiple high-peak flows of the planned regime aim to improve the physical attributes of the river by scouring and depositing sediment and improving in-stream habitat for native fish, platypus, frogs and waterbugs. Moderate to high flow rates will be sustained from July to December, helping to mix water in the estuary to benefit plants and fish (such as Australian bass). Lower flow rates will be maintained from December or January until the end of the water year in April 2022.

For further information, visit the NSW Department of Planning, Industry and Environment's Water for the environment website: https://www.environment.nsw.gov.au/topics/water/water-for-the-environment/snowy-and-montane

1 The actual release volume that was delivered in 2020-21 may alter slightly due to accounting adjustments and will be verified in Snowy Hydro Limited's Annual Water Operating Plan.

Moorabool Yulluk (Moorabool River), by the VEWH

Section 3

Central region

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

3.1 Central region overview

The systems in the central region that can receive water from the VEWH's environmental entitlements are the Yarra and Tarago in the east and the Werribee, Moorabool and Barwon (upper Barwon River and lower Barwon wetlands) in the west. The VEWH doesn't hold an environmental entitlement in the Maribyrnong system, but in some years the VEWH purchases available allocation to allow environmental watering in selected reaches of the Maribyrnong system.

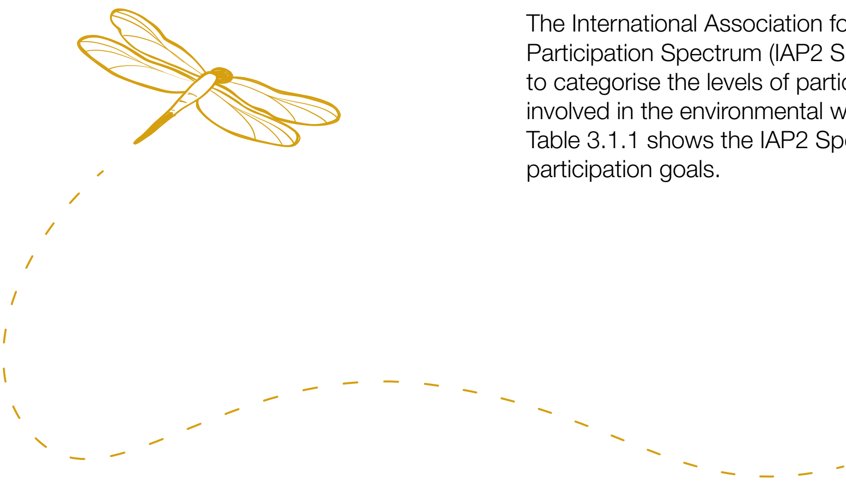
Environmental values, recent conditions, environmental watering objectives and planned actions for each system in the central region are presented in the system sections that follow.

Traditional Owners in the central region

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

The Bunurong Land Council Aboriginal Corporation, Eastern Maar Aboriginal Corporation, Wadawurrung Traditional Owners Aboriginal Corporation 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 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 VEWH and its program partners also 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 how community benefits from environmental flows can be provided while optimising environmental priorities for the year ahead. Aboriginal cultural, social and recreational values and uses are considered for each system in the following system sections.

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.

Table 3.1.2 shows the partners, stakeholder organisations and individuals with which Melbourne Water and Corangamite CMA engaged when preparing the Moorabool, Barwon (upper Barwon River and lower Barwon wetlands), Yarra, Tarago, Maribyrnong and Werribee 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 Melbourne Water and Corangamite CMA and stakeholders of the environmental watering program in the central region based on Melbourne Water 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, 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, 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.

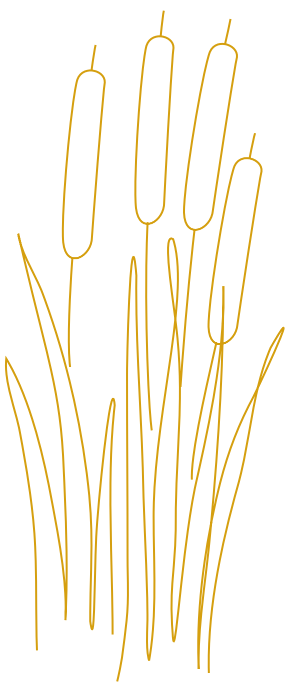


Table 3.1.2 Partners and stakeholders engaged by Corangamite Catchment Management Authority in developing seasonal watering proposals for the Moorabool system, upper Barwon River and lower Barwon wetlands and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

	Moorabool system	Upper Barwon River	Lower Barwon wetlands
Community groups and environment groups	**IAP2 level: Involve** • Corangamite Waterwatch and Corangamite EstuaryWatch • Geelong Landcare Network • People for A Living Moorabool	**IAP2 level: Involve** • Environment Victoria • Friends of the Barwon • Geelong Field Naturalists Club • Land and Water Resources Otway Catchment • Otway Agroforestry Network Ltd • Upper Barwon Landcare Network • Winchelsea Land and Rivercare group	**IAP2 level: Involve** • Corangamite Waterwatch and Corangamite EstuaryWatch • Geelong Environment Council Inc. • Geelong Field Naturalists Club
Government agencies	**IAP2 level: Collaborate** • Barwon Water • Central Highlands Water • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water	**IAP2 level: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning • Southern Rural Water	**IAP2 level: Collaborate** • Barwon Water • City of Greater Geelong • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water • Victorian Fisheries Authority
	IAP2 level: Consult • Golden Plains Shire Council • Moorabool Shire Council	**IAP2 level: Consult** • Colac Otway Shire Council	
Landholders/farmers	**IAP2 level: Involve** • Landholders on the Moorabool Stakeholder Advisory Committee	**IAP2 level: Involve** • Landholders on the Upper Barwon Surface Water Advisory Group	**IAP2 level: Involve** • Landholders on the Lower Barwon Community Advisory Committee
Local businesses	**IAP2 level: Involve** • Adelaide Brighton Cement		**IAP2 level: Involve** • Commercial eel fishers
Recreational users			**IAP2 level: Involve** • Association of Geelong and District Angling Clubs Inc. and VRFish • Field and Game Australia (Geelong Branch) • Geelong Gun and Rod Association Inc.
Traditional Owners	**IAP2 level: Collaborate** • Wadawurrung Traditional Owners Aboriginal Corporation	**IAP2 level: Consult** • Wadawurrung Traditional Owners Aboriginal Corporation	**IAP2 level: Collaborate** • Wadawurrung Traditional Owners Aboriginal Corporation
		IAP2 level: Inform • Eastern Maar 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 (grouped in alphabetical order)

Community groups and environment groups	**IAP2 level: Inform** • Collingwood Children's Farm • Environment Victoria • Friends of Yarra Flats Park • Friends of Yarran Dheran Nature Reserve • Independent community members • Native Fish Australia • Waterwatch coordinators • Yarra Riverkeeper	**IAP2 level: Inform** • Cannibal Creek Water Monitoring Group • Environment Victoria • Friends of Mt Cannibal Flora and Fauna Reserve • Friends of Robin Hood Reserve • Independent community members • Native Fish Australia • Waterwatch Coordinators	**IAP2 level: Inform** • Environment Victoria • Friends of Holden Flora Reserve • Friends of the Maribyrnong Valley Inc. • Independent community members • Jacksons Creek EcoNetwork • Native Fish Australia • Waterwatch Coordinators	**IAP2 level: Inform** • Ecolinc • Environment Victoria • Friends of Toolern Creek Reserve • Friends of Werribee Gorge & Long Forest Mallee Inc. • Independent community members • Moorabool Environment Group/ Platypus Alliance - Bacchus Marsh • Native Fish Australia • NatureWest • Pinkerton Landcare and Environment Group • Waterwatch Coordinators • Werribee Riverkeeper • Western Region Environment Centre

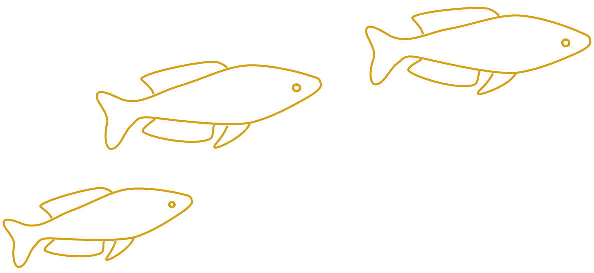


Table 3.1.3 Partners and stakeholders engaged by Melbourne Water in developing seasonal watering proposals for the Yarra, Tarago, Maribyrnong and Werribee systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order) *(continued)*

	Yarra system	Tarago system	Maribyrnong system	Werribee system
Government agencies	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery)	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery) • Southern Rural Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery) • Southern Rural Water • Western Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery) • Southern Rural Water • Western Water
	IAP2 level: Inform • Aboriginal Victoria • Banyule City Council • City of Boroondara • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Manningham City Council • Nillumbik Shire Council • Parks Victoria • Port Phillip and Westernport CMA • Victorian Fisheries Authority • Yarra City Council • Yarra Ranges Shire Council	**IAP2 level: Inform** • Aboriginal Victoria • Baw Baw Shire Council • Cardinia Shire Council • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Parks Victoria • Port Phillip and Westernport CMA • Victorian Fisheries Authority	**IAP2 level: Inform** • Aboriginal Victoria • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Hume City Council • Maribyrnong City Council • Moonee Valley City Council • Parks Victoria • Port Phillip and Westernport CMA • Victorian Fisheries Authority • Victoria Police	**IAP2 level: Inform** • Aboriginal Victoria • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Melton City Council • Parks Victoria • Port Phillip and Westernport CMA • Wyndham City Council • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Inform** • Individual landholders • Licensed diverters	**IAP2 level: Inform** • Individual landholders	**IAP2 level: Inform** • Licensed diverters from the Maribyrnong River at Keilor	**IAP2 level: Inform** • Individual landholders • Zoos Victoria
Local businesses	**IAP2 level: Inform** • Melbourne Adventure Hub • Warburton Holiday Park • Warrior Spirit Adventures	**IAP2 level: Inform** • Glen Cromie Reserve	**IAP2 level: Inform** • Atlas Ecology Pty Ltd • Blackbird Cruises	**IAP2 level: Inform** • Camp Sunnystones • Habitat Creations

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 (grouped in alphabetical order) *(continued)*

Recreational users	**IAP2 level: Inform** • Paddle Victoria • Patterson Lakes Canoe Club • VRFish • Whitehorse Canoe Club Inc.	**IAP2 level: Inform** • Local anglers • VRFish	**IAP2 level: Inform** • VRFish	**IAP2 level: Inform** • VRFish • Werribee & District Anglers Club
Technical experts	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University
Traditional Owners	**IAP2 level: Collaborate** • Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation **IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council 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 • Wadawurrung Traditional Owners Aboriginal Corporation • Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation

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 central region will not be fully met without simultaneously addressing issues such as barriers to fish movement, poor water quality, reduced contribution of groundwater to surface water flows, 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 waterway managers' on-ground works programs and complementary projects that are likely to support environmental watering outcomes in the central region include:

- ongoing investigations into the surface water and groundwater interactions in *Moorabool Yulluk* (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)
- a landscape-scale approach to improve the management of billabongs along *Birrarung* (Yarra River) to help meet cultural, ecological and liveability objectives
- works to protect and enhance streambanks along priority reaches including willow removal, revegetation and fencing to exclude stock
- the development of the *Central and Gippsland Region Sustainable Water Strategy*, to provide higher security and reliability of the supply of water for the environment for all flow-stressed systems in the central region including to achieve long-term outcomes.

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 2021-22 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 2021-22

Rainfall across the central region can vary from the eastern to the western systems. In 2020-21, the Yarra and Tarago systems had above-average rainfall. Natural events met many planned environmental watering actions in both of these systems in 2020-21, and strong allocations of water for the environment and carryover will enable a large proportion of potential watering actions to be delivered in 2021-22. The other systems in the central region had average or above-average rainfall in 2020-21, but inflows to system storages were variable. Low inflows to Rosslynne Reservoir meant there was no opportunity for the VEWH to purchase water for environmental use in the Maribyrnong system. In the Werribee system, Pykes Creek and Melton reservoirs filled and spilled, but Merrimu Reservoir remained below 50 percent capacity throughout 2020-21. Lal Lal Reservoir filled and spilled in spring 2020-21, which provided important flow and allocations of water for the environment in the Moorabool system. Upper Barwon Reservoir only reached 70 percent capacity in 2020-21, but it was sufficient to deliver the full allocation of water for the environment for the year in the Barwon River.

The Bureau of Meteorology has forecast slightly above-average rainfall across the central region in autumn and winter 2021, but La Niña conditions have weakened, which may lead to drier conditions later in 2021-22. Large carryover volumes and secure water allocations will allow a wide range of watering actions to be delivered in the Yarra, Tarago and Werribee systems under all climate scenarios, to build on 2020-21 outcomes to improve environmental condition and ecosystem resilience. In contrast, the Maribyrnong system remains relatively dry, and Rosslynne Reservoir will need significant inflows during winter and spring 2021 to create an opportunity to purchase and use water for environmental flows. Environmental watering options in the Moorabool and Barwon systems in 2021-22 will be more heavily influenced by local climatic conditions than the Melbourne Water systems, due to their smaller and more variable environmental allocations. Larger flows to improve environmental condition will only be delivered in *Moorabool Yulluk* (Moorabool River) and the upper Barwon River under average and wet climate scenarios. Flows will be delivered at the lower end of their recommended range in *Moorabool Yulluk* (Moorabool River) and the upper Barwon River under drought and dry climate scenarios, to maintain refuge habitats and limit any decline in environmental condition. Environmental watering in the lower Barwon wetlands is not affected by annual allocations of water for the environment, and the proposed fill in winter/spring and partial draw down in summer/autumn should be possible under all climate scenarios.

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

Birrarung (Yarra River) is central to the Dreaming of the Wurundjeri Woi wurrung people.

In 2017 the Victorian Government recognised *Birrarung* (Yarra River) as one living integrated entity in the *Yarra River Protection Act (Wilip gin Birrarung murron) 2017*. It was the first piece of legislation in Australia to confer such rights to a river and associated lands, to be co-titled in a Traditional Owner language and to incorporate a traditional language in the preamble.

The Act recognises the Woi wurrung people as Traditional Owners of *Birrarung* (Yarra River).

Top: Birrarung (Yarra River) at Heidelberg, by Melbourne Water
Above: Ducks at Annulus Billabong, by Andrew Lees

The Yarra system includes *Birrarung* (Yarra River), the Plenty River and Yarra billabongs.

System overview

Birrarung (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 (Figure 3.2.1). Over time, *Birrarung* (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 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 *Birrarung* (Yarra River) to Sugarloaf Reservoir.

Flow in the upper reaches of *Birrarung* (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 *Birrarung* (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 *Birrarung* (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 *Birrarung* (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 2021-22 onwards.

Environmental values

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

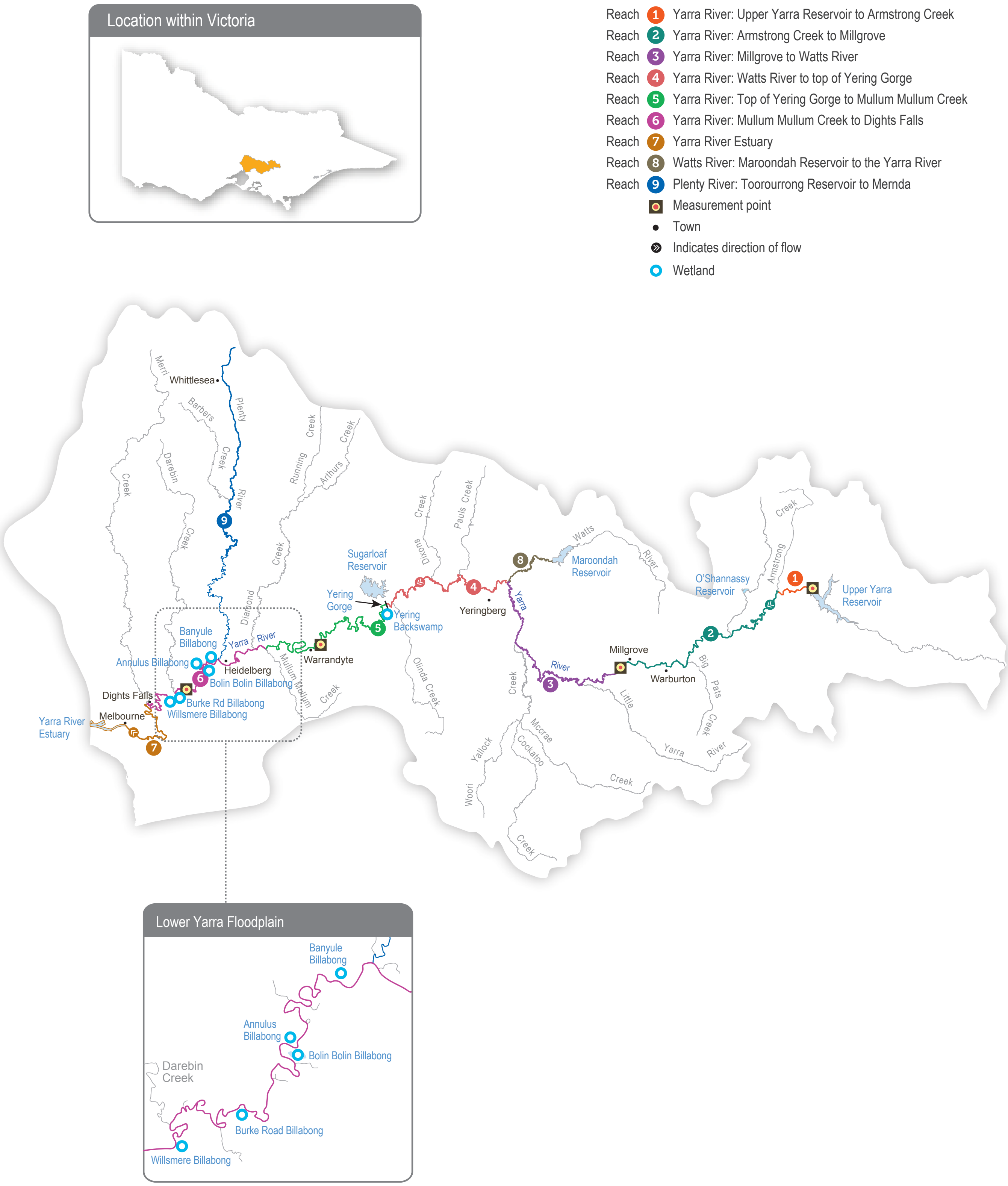
The Plenty River (reach 9) provides habitat for waterbugs and native fish species (such as common galaxias). Platypus have been detected in the Plenty River in the past, but none have been recorded in recent surveys.

Billabongs are an important feature of the *Birrarung* (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 *Birrarung* (Yarra River).

Environmental watering objectives in *Birrarung* (Yarra River), the 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-*Birrarung* (Yarra River) floodplain
	Maintain the form of the river channel Scour silt from riffles and clean cobbles
	Maintain the population of resident platypus
	Increase and maintain native streamside and aquatic vegetation on the riverbank and in the channels Increase and maintain the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows on the floodplain and billabongs
	Maintain and increase the abundance and diversity of waterbugs to support aquatic food webs
	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 overarching partnership that will frame the relations and obligation between the two organisations. The intent is to embed Wurundjeri Woi wurrung as active partners in the planning, delivery, and monitoring of all works associated with *Birrarung* (Yarra River).

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.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

There are a large number of places of tangible and intangible cultural significance for the Wurundjeri Woi wurrung people on the lower *Birrarung* (Yarra River) floodplain. Where possible, Melbourne Water and the Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation will work together to link water for the environment with cultural outcomes for Wurundjeri Woi wurrung.

A recent example is a vegetation monitoring and water quality monitoring project at the billabongs with the Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation's Narrap Team, The University of Melbourne and Melbourne Water. The group has been out monitoring the vegetation watering outcomes and held an on-Country knowledge-sharing day to discuss learnings. Monitoring is underway at Annulus Billabong following a delivery of water for the environment in 2020-21, and similar work will likely be undertaken in 2021-22.

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 the *Birrarung* (Yarra River) catchment in 2020-21 was above the long-term average, and tributary inflows significantly contributed to flow in *Birrarung* (Yarra River) and the Plenty River throughout the year. O'Shannassy Reservoir was offline for most of the year for maintenance, so most flow from the O'Shannassy River catchment passed directly into *Birrarung* (Yarra River). Maintenance work at Upper Yarra Reservoir required operational releases to *Birrarung* (Yarra River) during September and October 2020. These operational releases replaced the need for environmental flows that were planned during that time. The operational releases were adjusted where possible to align with environmental flow needs, and they largely met the expected watering effects.

In *Birrarung* (Yarra River), natural rain events combined with the larger-than-normal inflows from the O'Shannassy River and operational releases from Upper Yarra Reservoir achieved most of the planned watering actions for 2020-21. As a result, only a small portion of available water for the environment was used in 2020-21, and there is a large carryover volume for 2021-22. Water for the environment was released in conjunction with a natural fresh in May 2021 to support Australian grayling migration and spawning. In the Plenty River, natural rain events achieved most of the high-priority planned watering actions. An opportunity to supplement winter/spring low flows with water for the environment could not occur, due to poor water quality and valve delivery constraints at Yan Yean Reservoir.

Yering Backswamp has received water for the environment annually since 2013. Wet conditions in early May 2020 primed the site for a series of top-ups using water for the environment in late May, June and July. Wet conditions in August maintained water levels, which helped support water-dependant vegetation and aquatic animals. The wetland was allowed to gradually dry out by December, in accordance with the site's management plan. Annulus Billabong last filled in 2011 by an overbank flow from *Birrarung* (Yarra River), and it held water until 2012. Water for the environment was delivered to the site for the first time from October to December 2020 to support the growth of threatened wetland plant species and provide habitat for frogs, waterbugs and eels. This delivery was undertaken safely and successfully during a COVID-19 lockdown period, providing great recreational opportunities for many local visitors. Bolin Bolin was filled in 2017 with a combination of overbank flows and environmental watering. Drying at the site since has resulted in the return of terrestrial and exotic plant species. Overbank flows in August 2020 partially filled Bolin Bolin wetland, and further watering is planned in 2021-222 to improve vegetation outcomes.

Monitoring is showing that upgrades to the Dights Falls fish ladder in November/December 2020 are allowing more native fish to move between the *Birrarung* (Yarra River) estuary and the freshwater reaches. At Yering Backswamp, Melbourne Water has initiated a monitoring program to understand how bat species use the site as water levels vary. Monitoring by Melbourne Water, the Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation's Narrap team and citizen scientists indicated that the new watering actions at Annulus Billabong supported at least four frog species.

Scope of environmental watering

Table 3.2.1 describes the potential environmental watering actions in 2020-21, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 3.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Birrarung* (Yarra River), the Plenty River and Yarra billabongs

Potential environmental watering action	Expected watering effects	Environmental objectives
***Birrarung* (Yarra River)** **The highest-priority reaches for *Birrarung* (Yarra River) are reaches 2 (upper *Birrarung*) and 5 (lower *Birrarung*); water delivered to these reaches generally benefits other reaches**		
Winter/spring low flow (June to November) Reach 2: 200 ML/day Reach 5: 350 ML/day	• 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	
Winter/spring fresh(es) (one to two freshes for three to seven days during June to November) Reach 2: 700 ML/day Reach 5: 2,500 ML/day	• 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 for 14 days in September) Reach 2: 700 ML/day Reach 5: 2,500 ML/day	• 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) • Trigger spawning of Macquarie perch	
Summer/autumn low flow (December to May) Reach 2: 80 ML/day Reach 5: 200 ML/day	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish, waterbugs and platypus	
Summer/autumn fresh(es) (one to three freshes for two to four days during December to May) Reach 2: 350 ML/day Reach 5: 750 ML/day	• 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 the localised movement of fish and platypus • Wet the banks of the river to maintain flood-tolerant vegetation on the banks	

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

Autumn high flow (one high flow for seven to 14 days during April to May) Reach 2: 560 ML/day Reach 5: 1,300 ML/day	• 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 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	
Summer/autumn low flow (10 ML/day from December to May)	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish and waterbugs	
Summer/autumn freshes (four freshes of 55 ML/day for two days)	• 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 the localised movement of fish • Wet the banks of the river to maintain flood-tolerant vegetation on the banks	
Annulus Billabong (partially fill in winter/spring)	• 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	
Bolin Bolin (partially fill in winter/spring)	• Wet the deepest part of the wetland to about 100-150 cm to provide habitat for frogs, waterbugs and eels • Wet the remaining area of the wetland to about 50-100 cm to support the growth of threatened wetland plant species and encourage the regeneration of spreading aquatic herbs	
Yering Backswamp (complete fill in autumn/ 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 the 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. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry climate scenario.

In the Yarra system, current scenario planning is considered only under dry, average and wet climate scenarios. A combination of the highly reliable environmental allocation (17,000 ML each year), and high carryover volume from 2020-21 will provide sufficient supply for most required watering actions in 2021-22, and there is no need to significantly restrict watering actions in very dry or drought conditions.

Environmental flow planning in *Birrarung* (Yarra River) primarily focuses on providing sufficient low flow throughout the year to maintain habitat for aquatic life and on providing high flows at critical times to support the migration and breeding requirements of native fish. Summer/autumn low flows and freshes, an autumn high flow, a spring high flow and winter/spring low flows and freshes are needed to achieve these outcomes under all climate scenarios, but the extent to which these flows are likely to be met by natural tributary inflows varies between dry, average and wet scenarios. Water for the environment will be used to fill the main deficits under each scenario, where possible.

It is anticipated that summer/autumn low flows and winter/spring freshes are likely to be met through a combination of natural flows and environmental flows in average and wet climate scenarios. The higher-than-normal carryover volume from 2020-21 will potentially allow autumn and spring high flows to be delivered in *Birrarung* (Yarra River) under all climate scenarios in 2021-22. The autumn high flow is a priority because it was not delivered in 2017-18 or 2018-19, and it is needed in most years to support Australian grayling breeding. A spring high flow is recommended under all climate scenarios as it has only been met twice since 2017-18, and it is generally required at least once every two years to support Macquarie perch breeding and the upstream migration of Australian grayling and tupong.

The highest-priority potential watering actions for the Plenty River are winter/spring low flows, summer/autumn low flows and freshes under all climate scenarios to maintain water quality and aquatic habitat for native plants and animals. Winter/spring freshes are planned under average and wet climate scenarios, and they will likely be met through a combination of environmental flows and natural flows. Environmental watering in the Plenty River in 2021-22 will be implemented 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, Bolin Bolin Billabong and Annulus Billabong is considered a high priority under all scenarios in 2021-22, because having some billabongs inundated across the landscape provides refuge habitat for rare and threatened species. There are numerous billabongs throughout the *Birrarung* (Yarra River) catchment that are drier than natural, due to river regulation and modifications to natural flow paths. Melbourne Water has finalised 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.

A minimum of 12,000 ML carryover into 2022-23 is required (in addition to the 17,000 ML annual entitlement) to deliver the highest-priority flows if average conditions continue into the following year.

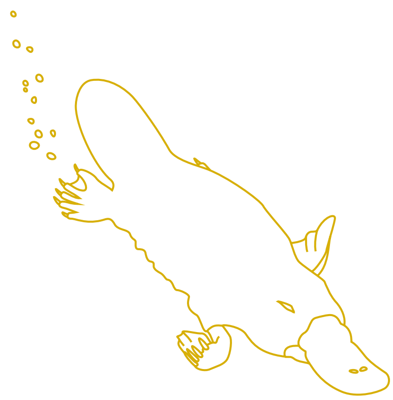


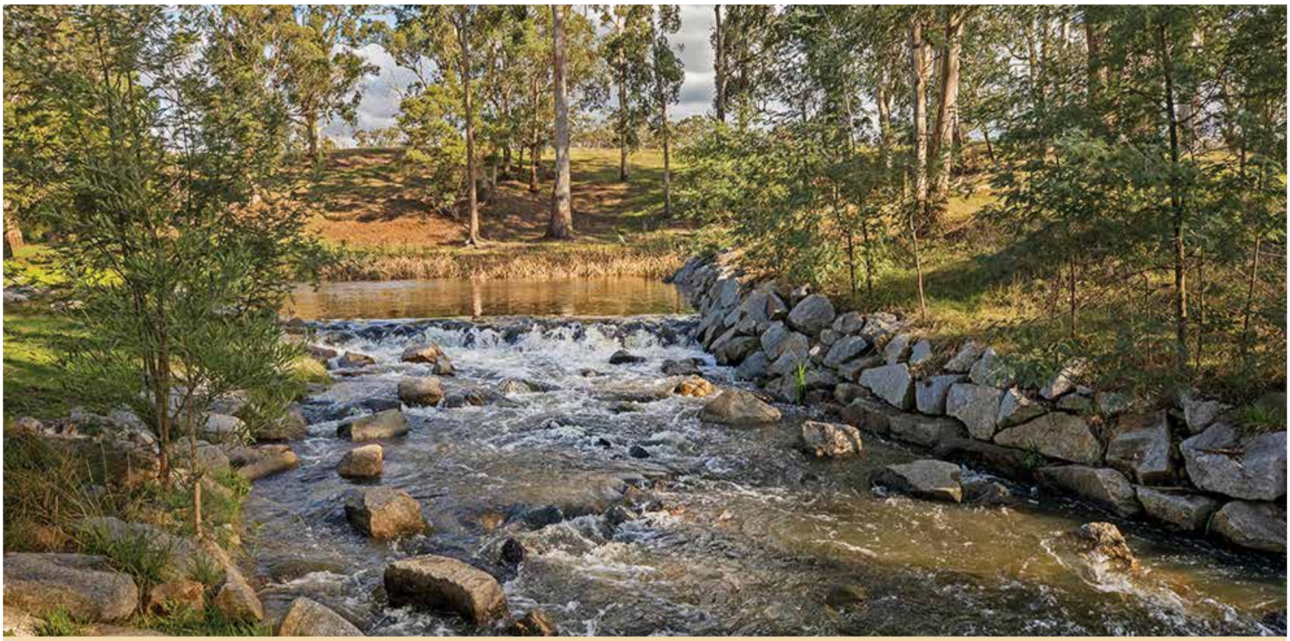
Table 3.2.2 Potential environmental watering for *Birrarung* (Yarra River), the Plenty River and Yarra billabongs under a range of planning scenarios

Expected river conditions	• Low streamflow year-round • Lack of unregulated freshes and high flow • 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 flow • Potentially poor water quality, particularly in summer • Pools may stratify • Small reservoirs may spill • Overbank flow is 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
Predicted supply of water for the environment	• 48, 000 ML		
Potential environmental watering – tier 1 (high priorities)			
	• Winter/spring low flow • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow) • Targeted billabong watering (Annulus, Bolin Bolin, Yering)	• Winter/spring low flow • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow) • Targeted billabong watering (Annulus, Bolin Bolin, Yering)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow) • Targeted billabong watering (Annulus, Bolin Bolin, Yering)
	• Winter/spring freshes (two freshes)	• Winter/spring freshes (two freshes)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A		

Table 3.2.2 Potential environmental watering for *Birrarung* (Yarra River), the Plenty River and Yarra billabongs under a range of planning scenarios *(continued)*

Planning scenario	Dry	Average	Wet
Plenty River (targeting reach 9)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (four freshes)	• Winter/spring low flow • Winter/spring freshes (four freshes) • Summer/autumn low flow • Summer/autumn freshes (four freshes)	• Winter/spring low flow • Winter/spring freshes (four freshes) • Summer/autumn low flow • Summer/autumn freshes (four freshes)
	Tier 1b (supply deficit)		
	• Winter/spring freshes (four freshes)	• N/A	
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 37,100 ML (tier 1a) • 14,000 ML (tier 1b)	• 36,000 ML (tier 1a) • 10,000 ML (tier 1b)	• 32,700 ML (tier 1a)
Priority carryover requirements	• 12,000 ML		

3.3 Tarago system



Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

Short-finned eels migrate from Victorian rivers all the way to the Coral Sea to spawn: this can be up to 5,000 km and take over a year! Melbourne Water is working with scientists at the Arthur Rylah Institute to monitor how short-finned eels and other migratory species respond to environmental flows in the Tarago River.

Top: Tarago River, by Melbourne Water
Above: Mountain galaxias, by Melbourne Water

System overview

The Tarago River rises in the Tarago State Forest and flows into the Tarago Reservoir at Neerim (Figure 3.3.1). The reservoir harvests inflows from all upstream tributaries to supply towns on the Mornington Peninsula and around the Western Port area. Water is released from the reservoir to supply downstream irrigators. Below the reservoir, the Tarago 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 they 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 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
Improve water quality in river pools, ensuring adequate oxygen concentration in the water to support fish, crustaceans and waterbugs

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.

Bunurong Land Council Aboriginal Corporation has expressed a desire to be more involved in environmental flows planning and management in the Tarago system.

Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation is interested in undertaking a program of work to determine cultural values and uses in the Tarago system using their preferred method.

There are more opportunities for Melbourne Water and the VEWH to work with the Traditional Owner groups to identify and integrate cultural values and their flow requirements into the environmental watering program on an ongoing basis.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.3.1, Melbourne Water considered how environmental flows could support values and uses including:

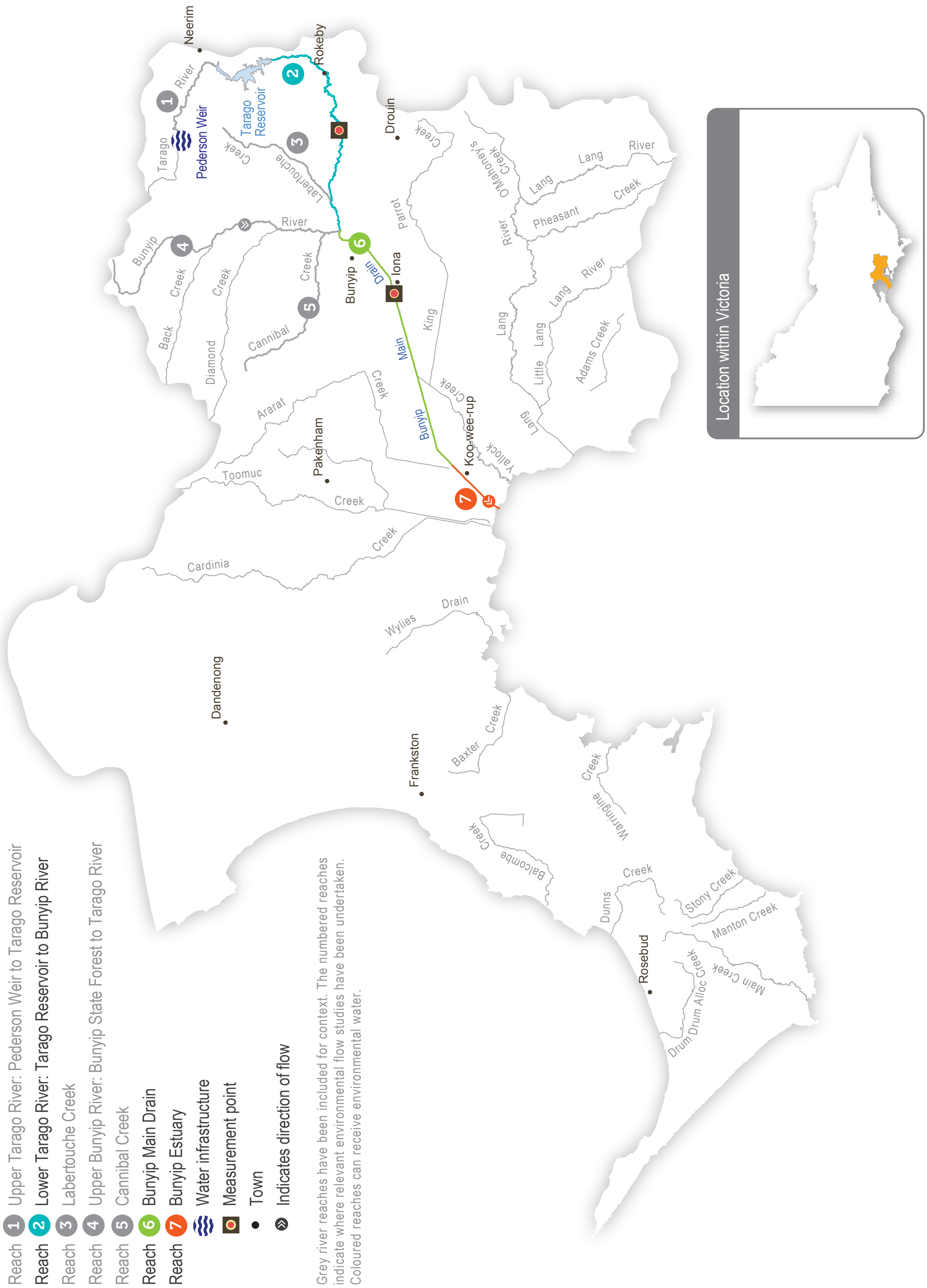
- riverside recreation and amenity (such as day visitors, short- and long-term visitors and camping)
- socio-economic benefits (such as irrigators and stock and domestic users)

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 the following 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 the release of a summer fresh in the Tarago River to coincide with long weekends in January or March 2020, so visitors and long-term residents of the Glen Crombie Caravan Park can enjoy the additional flows in the river.

Figure 3.3.1 The Tarago system



Recent conditions

The Tarago River catchment received above-average rainfall in winter and spring 2020, which delivered significant inflows into the storage. Tarago Reservoir filled and spilled in October 2020, January 2021 and April 2021. The Tarago environmental entitlement received its full allocation — 3,000 ML share of storage — in July 2020, and use throughout the year was replenished by frequent inflows. Opportunistic use of water held under the Tarago Reservoir airspace agreement contributed significantly to planned environmental watering actions. Rainfall also contributed to flows in the Tarago and Bunyip rivers downstream of the reservoir.

Natural inflows and storage spills maintained the recommended low flows in the Tarago River throughout much of 2020-21, and they also delivered five winter/spring freshes and three summer/autumn freshes. Water for the environment was used to deliver an additional winter/spring fresh in September 2020 and one summer/autumn fresh in January 2021.

Water for the environment was managed in line with an average climate scenario throughout 2020-21. All planned potential watering actions were met. Melbourne Water delivered a winter/spring high flow in September using environmental water held under the airspace agreement. This temporary arrangement between the VEWH, the storage manager and other entitlement holders allows the VEWH to save its share of inflows in spare reservoir capacity if its share of storage is full. This can help reserve enough environmental water to provide for some of the higher flow requirements that VEWH would otherwise not have sufficient water for.

The high flow improved water quality downstream of the reservoir and provided opportunities for the upstream migration of juvenile native fish species including Australian grayling, common galaxias and tupong. It is the first time since 2012-13 that water for the environment has been used to deliver a winter/spring high flow in the Tarago River.

Water for the environment was used to deliver a summer/autumn fresh at the end of January to flush sediment and organic material from the river bed. The fresh coincided with a public holiday, which improved conditions for riverside campers and other visitors. An autumn high flow may be delivered using water for the environment in May 2021 to cue Australian grayling to spawn.

Between 1,500 and 2,000 ML of water for the environment will be carried over in the Tarago system to help meet critical priorities in 2021-22 including summer and autumn freshes and an autumn high flow.

Scope of environmental watering

Table 3.3.1 describes the potential environmental watering actions in 2020-21, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 3.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Tarago River

Potential environmental watering action	Expected watering effects	Environmental objectives
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 an increased low flow to flush the system and wet additional habitat for fish and macroinvertebrates	
Winter/spring fresh(es) (one to two freshes with a peak of 100-200 ML/day for two days during June to September)	• Flush sediment and scour biofilm from stream substrate and large woody debris to maintain habitat for macroinvertebrates and fish including river blackfish • Create extra depth to allow greater fish movement between pools and reaches • Cue the downstream migration of species such as eel and tupong • Wet the banks and low benches to maintain the fringing aquatic vegetation	

Table 3.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Tarago River *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Spring high flows (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 (e.g. Australian grayling) from the sea or estuary into the river • Wet the higher benches to maintain the fringing aquatic vegetation and ensure vertical zonation of the fringing vegetation • Encourage female platypus to select a nesting burrow higher up the bank, to reduce the risk of higher flow later in the year flooding the burrow when juveniles are present	
Summer/autumn low flows (20 ML/day [or natural] during December to May)	• Maintain an adequate depth through riffles to support waterbugs and allow access to habitats for fish and platypus • Maintain adequate foraging habitat for fish and platypus • Maintain water quality and increase oxygen in pools	
Summer/autumn fresh(es) (one to five freshes of 75 ML/day for two days during December to May)	• Flush fine silt from hard substrates 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 high flow 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 the downstream migration and spawning for diadromous fish (e.g. Australian grayling) • Assist the dispersal of juvenile platypus	

Scenario planning

Table 3.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry scenario.

Winter, spring, summer and autumn freshes and low flows are considered high priorities under all climatic conditions, to maintain the quality and quantity of habitat for native fish and platypus and to provide specific cues for them to breed and migrate. Under average and wet climate scenarios, it is expected that most of these watering actions will be met with natural flows, but water for the environment will likely be needed to help achieve them under a dry climate scenario.

Australian grayling rely on autumn high flows to cue migration and spawning at least two out of every three years. The recommended autumn high flow was fully achieved in 2019-20 and partially achieved in 2018-19 and 2020-21, and it is therefore a high priority to deliver in 2021-22. There is unlikely to be enough water for the environment to deliver a full autumn high flow under a dry or average climate scenario, but a partial high flow is still expected to cue some fish to move and successfully spawn.

Under average and wet climate scenarios, a spring high flow may be delivered to support the migration of native fish. This flow is required for the successful recruitment of some species and is recommended to be delivered in most years where possible. It was delivered in 2020-21, but only sporadically in the prior decade: before last year, it had not been achieved using environmental flows since 2012-13. The flow may be delivered naturally or with a combination of natural flow and water for the environment under average and wet climate scenarios. However, there is unlikely to be enough water for the environment to deliver this event under a dry climate scenario.

Carrying over 1,000 ML of water into 2022-23 will be a high priority under all climate scenarios, to ensure there is sufficient water to deliver summer and autumn freshes in the following year.

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

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

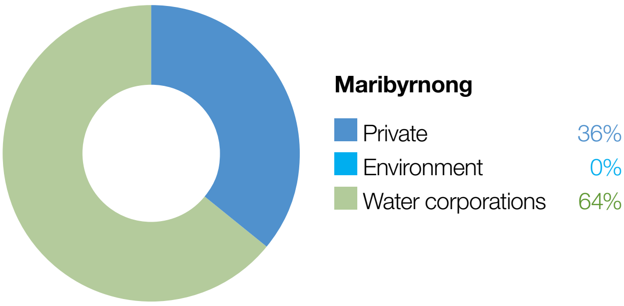
Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflow • Some reduction to passing flow • Irrigation releases likely	• Average streamflow • Partial freshes naturally provided	• Above-average streamflow • Partial or full freshes naturally provided • Irrigation releases unlikely
Predicted supply of water for the environment	• 2,000-2,500 ML	• 2,500-3,500 ML	• 3,800-5,000 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow, partially achieved)	• Winter/spring low flow • Spring high flow (one high flow, partially achieved) • Summer/autumn low flow • Summer/autumn freshes (five freshes) • Autumn high flow (one high flow, partially achieved)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (five freshes) • Autumn high flow (one high flow)
	Tier 1b (supply deficit)		
	• Spring high flow (one high flow, partially achieved) • Winter/spring freshes (two freshes)	• Tier 1a spring high flow fully achieved • Winter/spring freshes (two freshes)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 1,000-1,500 ML (tier 1a) • 1,000-1,200 ML (tier 1b)	• 2,000-3,000 ML (tier 1a) • 1,500-1,800 ML (tier 1b)	• 0-3,500 ML (tier 1a)
Priority carryover requirements	• 1,000 ML		

3.4 Maribyrnong system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Not Applicable



Proportion of water entitlements in the Maribyrnong basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

Did you know...?

The Maribyrnong River is known to the Wurundjeri Woi wurrung as *Mirrangbamurn*.

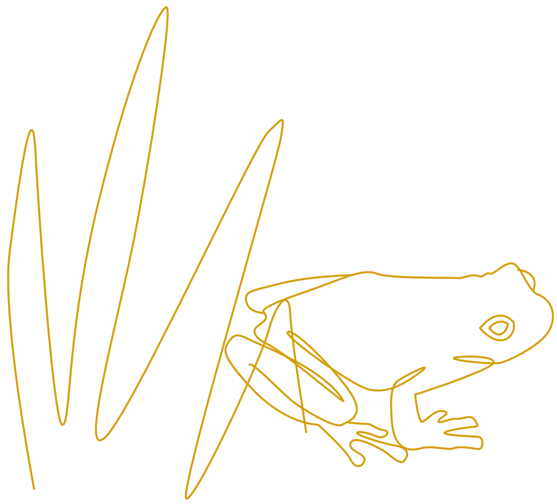
Top: Mirrangbamurn (Maribyrnong River), by Melbourne Water
Above: Platypus, by Paul Carracher

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 (Figure 3.4.1). These two tributaries join at Keilor North to form *Mirrangbamurn* (Maribyrnong River), which flows south to join *Birrarung* (Yarra River) at Yarraville, before flowing into Port Phillip Bay.

Rosslynne Reservoir is in the upper reaches of Jacksons Creek near Gisborne and 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, the 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 platypus population
Maintain and improve the condition, abundance, diversity and structure of in-stream 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

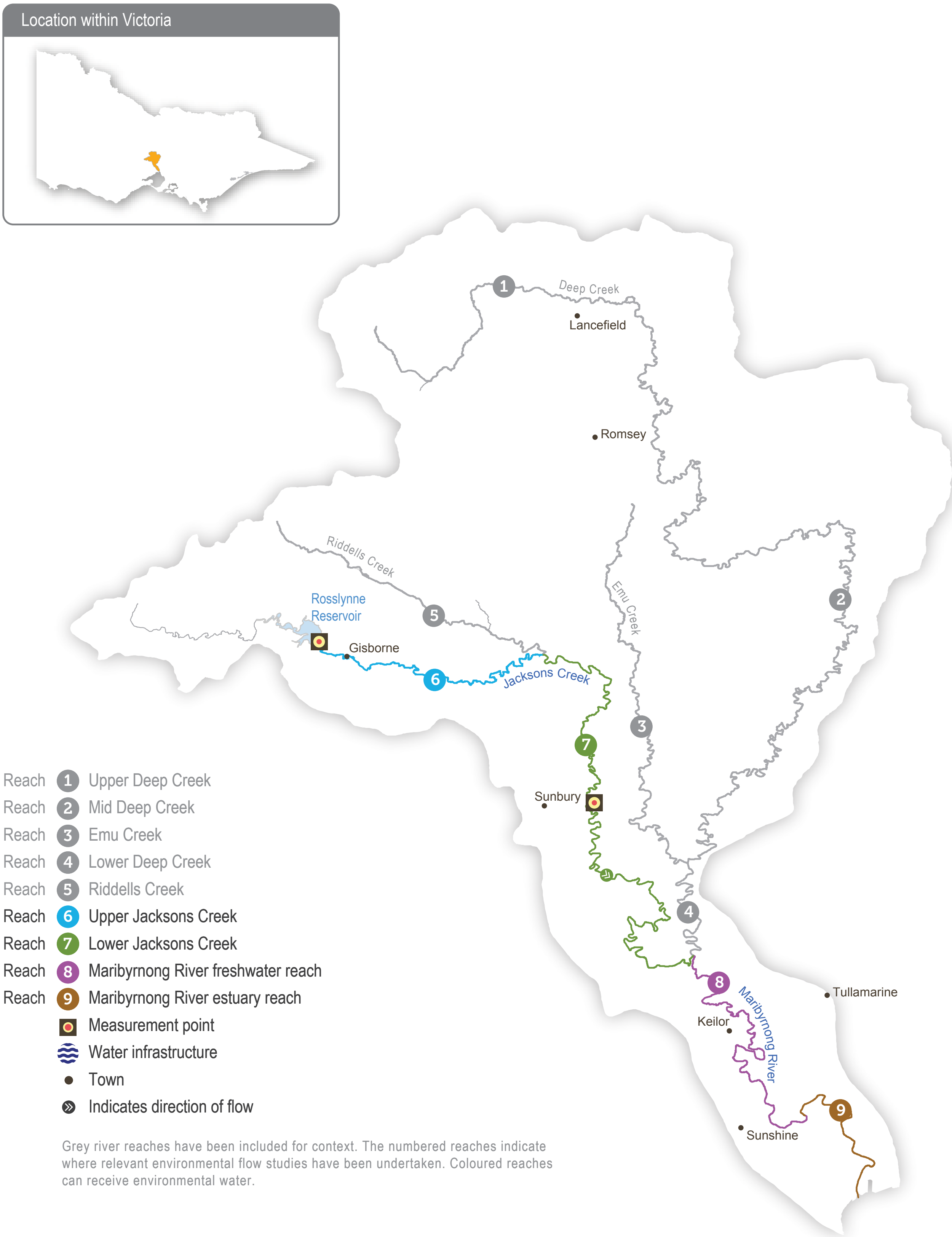
Melbourne Water has made initial contact with the Boon Wurrung Foundation, Bunurong Land Council Aboriginal Corporation and Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation to discuss environmental watering in the Maribyrnong system.

There are more opportunities for Melbourne Water and the VEWH to work with the Traditional Owner groups to identify and better integrate cultural values and their flow requirements into the environmental watering program on an ongoing basis.

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, by planning flows that will 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 had above-average rainfall during winter and spring 2020, leading to high soil moisture and above-average tributary inflows downstream of Rosslynne Reservoir. Conditions remained near-average for the remainder of the year, but inflows to Rosslynne Reservoir were well-below average during 2020-21, and the storage remained below 30 percent capacity. The VEWH did not purchase allocation from licence holders due to low water availability in the Maribyrnong system, meaning no water for the environment was available for use in 2020-21.

The wetter-than-average conditions in the catchment below Rosslynne Reservoir meant winter/spring low flows in reach 7 were partially met by tributary inflows. Local rainfall runoff and passing flows (delivered by Southern Rural Water's bulk entitlement) met most of the summer and autumn low-flow watering actions recommended for reaches 6 and 7 and two summer/autumn freshes in reach 7. These flows maintained water quality and suitable habitat and food resources for native fish, platypus and waterbugs, despite the lack of environmental water.

Scope of environmental watering

Table 3.4.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 3.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Maribyrnong system

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring low flow (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 • Prevent fine sediment settling and smothering waterbug habitat • Provide passage for small-bodied native fish and platypus between habitats	
Summer/autumn low flow (6 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 freshes (two to three freshes of 40 ML/day for seven days during December to May)	• Flush pools to maintain water quality • Prevent fine sediment settling and smothering waterbug habitat • 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	

Scenario planning

Table 3.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry scenario.

There is no environmental entitlement in the Maribyrnong system, so environmental watering actions can only occur in 2021-22 if other entitlement holders have water they don't require and are willing to sell to the VEWH. Any water that the VEWH can purchase will be used to help meet recommended targets for winter/spring low flows and summer/autumn low flows where needed, to maintain adequate habitat and dispersal opportunities for small-bodied native fish and platypus and to deliver summer/autumn freshes to prevent adverse water-quality outcomes. Proposed flows will primarily target reach 7, but they will provide similar outcomes in reach 6 en route.

Adequate low flows and summer/autumn freshes are a high priority under all climate scenarios. They are likely to be met by a combination of natural runoff, higher passing flows and a larger groundwater contribution under average and wet climate scenarios. They are less likely to be achieved under a dry climate scenario, but low inflows to Rosslynne Reservoir will likely limit opportunities to purchase water for environmental use. Any water that is available for environmental use under a dry climate scenario will be used to supplement summer/autumn low flows for a short period or provide summer/autumn freshes to prevent drying in critical habitats or poor water quality.

The VEWH is unable to carry over water in the Maribyrnong system to support multi-year planning.

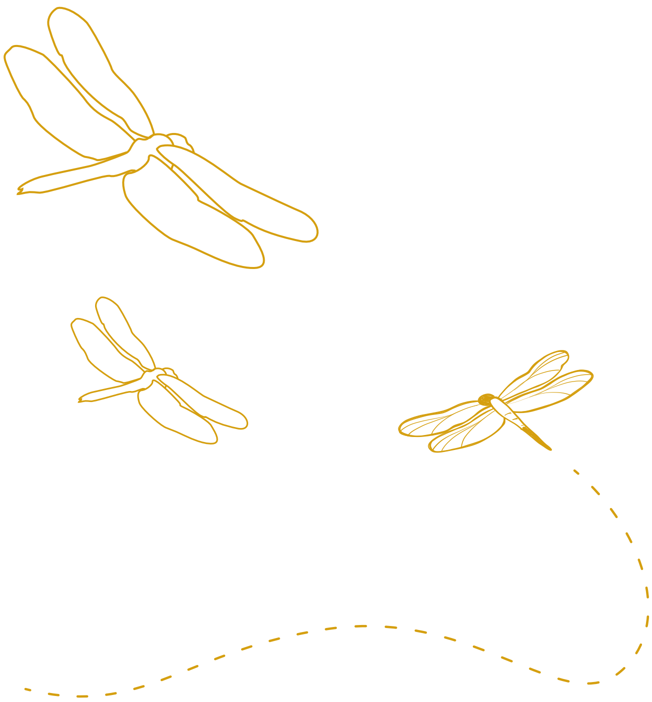


Table 3.4.2 Potential environmental watering for the Maribyrnong system under a range of planning scenarios

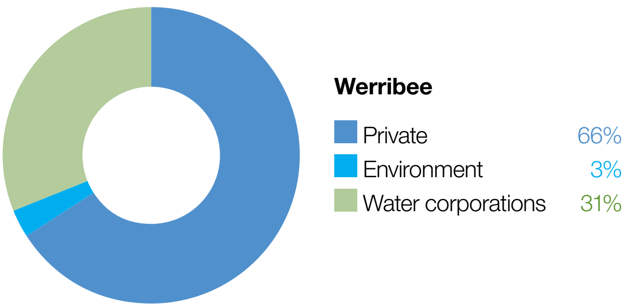
Planning scenario	Dry	Average	Wet
Expected river conditions	• Low volumes of unregulated flows • Passing flows may meet some low-flow objectives • Some baseflow from groundwater contributions in lower Jacksons Creek	• Unregulated flows meet some objectives • Passing flows may meet several low-flow objectives • 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
Predicted supply of water for the environment	• There is no environmental entitlement in the Maribyrnong system. Water will need to be purchased from willing sellers to support tier 1b watering actions.		
Maribyrnong system (targeting reaches 6 and 7)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• N/A		
	Tier 1b (supply deficit)		
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (three freshes)
Possible volume of water for the environment required to achieve objectives	• 300 ML (tier 1b)	• 300 ML (tier 1b)	• 300 ML (tier 1b)

3.5 Werribee system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder



Proportion of water entitlements in the Werribee basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

Did you know...?

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

Top: Wirribi Yaluk (Werribee River), by Melbourne Water
Above: Pyrites Creek, by Melbourne Water

System overview

Wirribi Yaluk (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 (Figure 3.5.1). 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), *Wirribi Yaluk* (Werribee River) between Melton Reservoir and the Werribee Diversion Weir (reach 8), *Wirribi Yaluk* (Werribee River) between the Werribee Diversion Weir and Werribee Park Tourism Precinct (reach 9) and the Werribee River estuary below the Werribee Park Tourism Precinct.

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 lower *Wirribi Yaluk* (Werribee River).

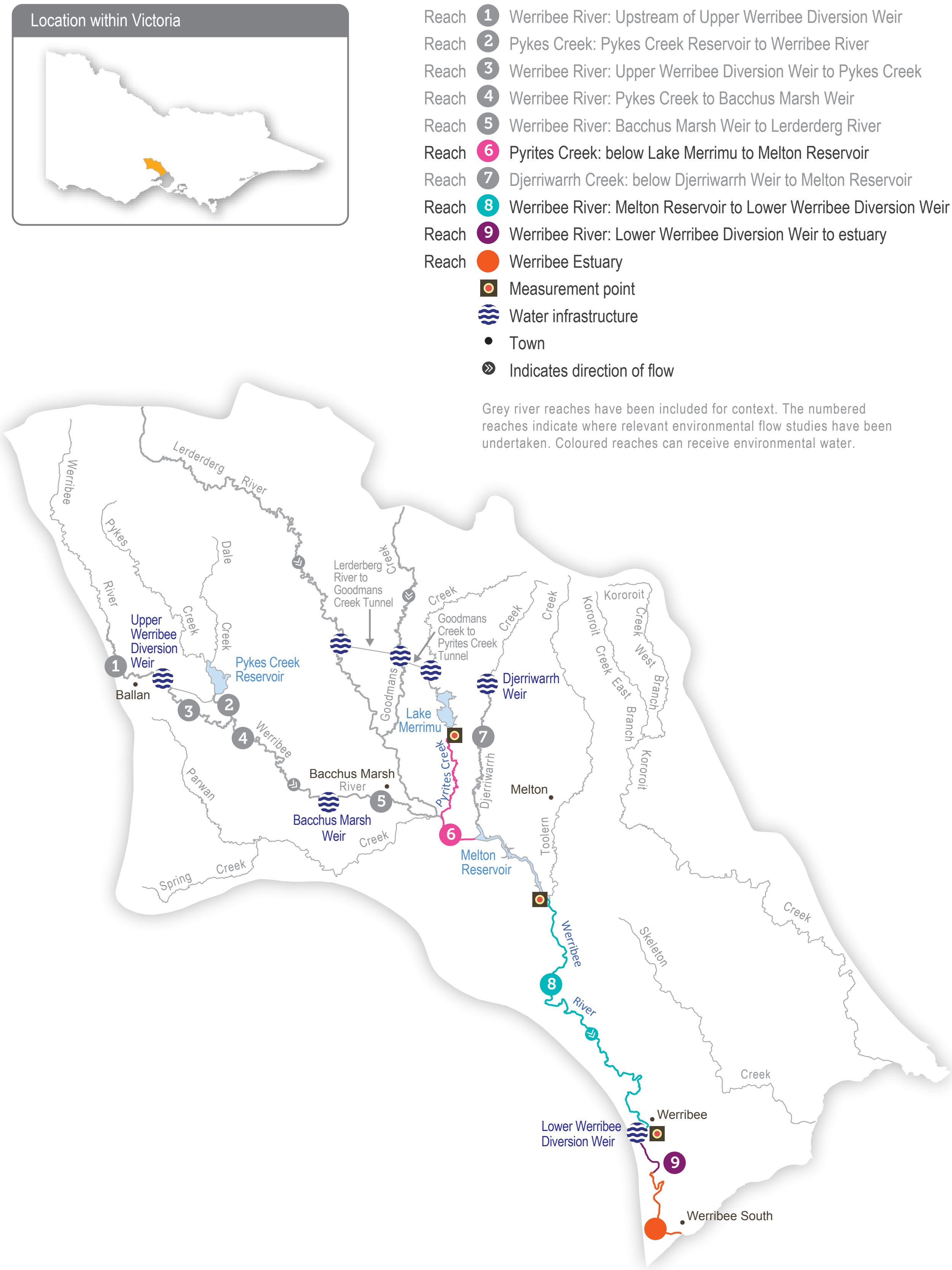
Environmental values

The Werribee system supports a range of native fish including Australian grayling, 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, a diverse waterbug community and platypus inhabit the upper and 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, and it provides 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 and Australian grayling 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



Traditional Owner cultural values and uses

Melbourne Water has made initial contact with the Wadawurrung Traditional Owners Aboriginal Corporation and Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation to discuss environmental watering in the Werribee system.

There are more opportunities for Melbourne Water and the VEWH to work with the Traditional Owner groups to identify and better integrate cultural values and their flow requirements into the environmental watering program on an ongoing basis.

The Wadawurrung Traditional Owners Aboriginal Corporation has reviewed the environmental values for the Werribee system and has identified the following values that also have cultural significance to Wadawurrung Traditional Owners.

Reach	Extent	Key environmental values with cultural significance to the Wadawurrung
8	*Wirribi Yaluk* (Werribee River)	
9	*Wirribi Yaluk* (Werribee River) between Wyndham Vale and Bluestone Ford	
Estuary	Werribee River downstream of Bluestone Ford	

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 canoeing, fishing, kayaking and swimming)
- riverside recreation and amenity (such as picnicking)
- community events and tourism (such as Werribee Zoo).

Recent conditions

The Werribee system catchment experienced wetter-than-average conditions in autumn 2020 and throughout 2020-21. High rainfall in autumn 2020 caused Pykes Creek Reservoir and Melton Reservoir to fill and spill, and both storages spilled on several occasions throughout late spring and summer 2020-21. Allocations against high-reliability water shares in Melton Reservoir reached 100 percent by December 2020, and low-reliability water shares reached 80 percent by March 2021. In contrast, Lake Merrimu had below-average inflows and contributed only a small volume to the environmental entitlement in 2020-21.

Pyrites Creek did not have any significant natural high-flow events in 2020-21. Water for the environment was used to deliver a spring fresh, a spring/summer high flow and maintain low flows to the end of December. These flows enabled connections between habitat pools for native fish, frogs and waterbugs. The flows supported the recruitment and growth of native vegetation within the creek and on the banks, and it flushed sediment from pools along the length of the reach. Most of the water delivered during the high flow in September and the fresh in December was re-harvested at Melton Reservoir and used to deliver watering actions in lower *Wirribi Yaluk* (Werribee River).

Spills from Melton Reservoir provided some large natural flows through reaches 8 and 9 and the Werribee River estuary during spring and summer. Water for the environment was used to deliver a partial spring/summer high flow in September to support the upstream migration of native fish from the estuary. Small environmental flows were delivered during summer and autumn to freshen the lower reaches and flush algal blooms that developed near the Werribee Zoo. The storage manager's increased passing flows below the Werribee Diversion Weir met the low-flow watering actions during late summer, autumn and winter.

Water for the environment was managed in the Werribee system in accord with an average climate scenario in 2020-21. Most planned watering actions were fully met. The spring high flow in Pyrites Creek and winter/spring fresh in the lower *Wirribi Yaluk* (Werribee River) were only partially delivered due to capacity constraints at reservoir outlets, but the expected watering effects and environmental objectives for these flows were likely met.

Delivering a partial winter/spring fresh in 2021-22 under dry and average conditions and a full winter/spring fresh under wet conditions will remain a high priority, to support black bream recruitment following a fish death event in early 2020 linked to low oxygen and an excess influx of nutrients in stormwater.

Scope of environmental watering

Table 3.5.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 3.5.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Werribee system

Potential environmental watering action	Expected watering effects	Environmental objectives
Pyrites Creek (reach 6)		
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	
Spring fresh(es) (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 • 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 • Improve water quality and the quantity of food and habitat for waterbugs, frogs and native fish • Wet depressions adjacent to the stream that frogs can use for breeding	
Spring/summer high flow(s) (one to three high flows of 130 ML/day for two days during September 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)		
Winter/spring low flow (up to 80 ML/day during June to November)	• Provide flow to allow fish to move upstream past natural and artificial barriers • Facilitate the downstream movement of diadromous fish to the estuary • 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, fish, platypus and frogs • Maintain flow through pool habitats to allow mixing or suppression/dilution of saline groundwater	
Winter/spring fresh(es) (one to four freshes of 250-350 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 flow 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 (10 ML/day during December to May)	• Increase the growth and recruitment of in-stream and water-dependent streamside vegetation • Maintain access to habitat and improve water quality 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, expected watering effects and associated environmental objectives for the Werribee system *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn fresh(es) (one to five freshes of 80 ML/day for two days during November to May)	• Increase 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 of water within pools by dispersing azolla and blue-green algae blooms	

Scenario planning

Table 3.5.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry scenario.

The Pyrites Creek catchment downstream of Merrimu Reservoir relies on passing flows, operational releases and environmental flows for virtually all of its flow. 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 lower *Wirribi Yaluk* (Werribee River) is also heavily reliant on passing flows, operational deliveries and environmental flows to provide low flows and freshes, but unregulated spills from Melton Reservoir, downstream tributary inflows and local runoff including stormwater from Werribee provide larger flows, especially in wet years. The highest-priority watering actions for lower *Wirribi Yaluk* (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 lower *Wirribi Yaluk* (Werribee River) but managed environmental flows are important to control water quality and disperse small algae blooms and provide regular opportunities for fish and platypus to move throughout lower *Wirribi Yaluk* (Werribee River). These flows will also support streamside and aquatic vegetation.

The number of freshes delivered to Pyrites Creek and lower *Wirribi Yaluk* (Werribee River), as well as the magnitude of the winter/spring fresh in lower *Wirribi Yaluk* (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 lower *Wirribi Yaluk* (Werribee River) under a wet scenario, but more water for the environment would need to be secured to deliver these flows under dry and average climate scenarios.

A minimum of 600 ML is planned to be carried over into 2022-23. Maintaining sufficient carryover in both Lake Merrimu and Melton Reservoir will be prioritised over the delivery of tier 1b potential watering actions, to ensure high-priority flows can be delivered to Pyrites Creek (reach 6) and lower *Wirribi Yaluk* (Werribee River) in 2022-23.

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

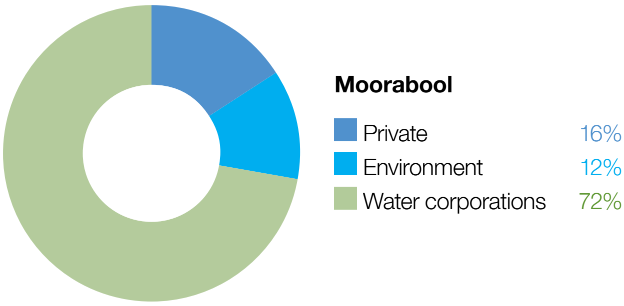
Planning scenario	Dry	Average	Wet
Expected river conditions	• Minor natural flow below Melton Reservoir • Minimal passing flows to reach 6, possible transfers during summer • Some consumptive releases out of storage into reach 8 in summer/autumn	• Unregulated spills in winter/spring from Melton Reservoir into reaches 8 and 9 and the estuary; most low flow in reach 6 met by passing flow • 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 flow in reach 6 provided • Consumptive releases out of storage into reach 8 in summer/autumn
Predicted supply of water for the environment	• 1,805 ML	• 2,141 ML	• 2,641 ML
Pyrites Creek (targeting reach 6)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring/summer low flow • Spring freshes (three freshes) • Summer high flow (one high flow)	• Winter/spring/summer low flow • Spring freshes (four freshes) • Summer high flows (three high flows)	• Winter/spring/summer low flow • Spring freshes (four freshes) • Summer high flows (three high flows)
Werribee River (targeting reach 9 and estuary)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring fresh (one fresh, partially achieved) • Summer/autumn freshes (three freshes)	• Winter/spring fresh (one fresh, partially achieved) • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn low flow (one month) • Summer/autumn freshes (five freshes)
	Tier 1b (supply deficit)		
	• Tier 1a winter/spring fresh at increased magnitude • Summer/autumn low flow	• Tier 1a winter/spring fresh at increased magnitude • Summer/autumn low flow	• Summer/autumn low flow at increased duration
Possible volume of water for the environment required to achieve objectives	• 1,060 ML (tier 1a) • 1,580 ML (tier 1b)	• 1,250 ML (tier 1a) • 1,580 ML (tier 1b)	• 1,880 ML (tier 1a) • 900 ML (tier 1b)
Priority carryover requirements	• 600-800 ML		

3.6 Moorabool system

Waterway manager – Corangamite Catchment Management Authority

Storage manager – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder



Proportion of water entitlements in the Moorabool basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

Did you know...?

Moorabool Yulluk (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 and which is renowned for its night-time, eerie, high-pitched wailing. Wadawurrung parents 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.

Top: Moorabool Yulluk (Moorabool River) at She Oaks, by Corangamite CMA
Right: Moorabool Yulluk (Moorabool River) in-stream vegetation, by Corangamite CMA

System overview

Moorabool Yulluk (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 (Figure 3.6.1). *Moorabool Yulluk* (Moorabool River) is a highly regulated catchment with major storages that include Lal Lal, Moorabool and Bostock reservoirs.

The lower section of *Moorabool Yulluk* (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 system 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 Yulluk* (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 inflows 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

Moorabool Yulluk (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. *Moorabool Yulluk* (Moorabool River) flows into the Barwon River, connecting it to the Ramsar-listed lower Barwon wetlands.

Environmental watering objectives in *Moorabool Yulluk* (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

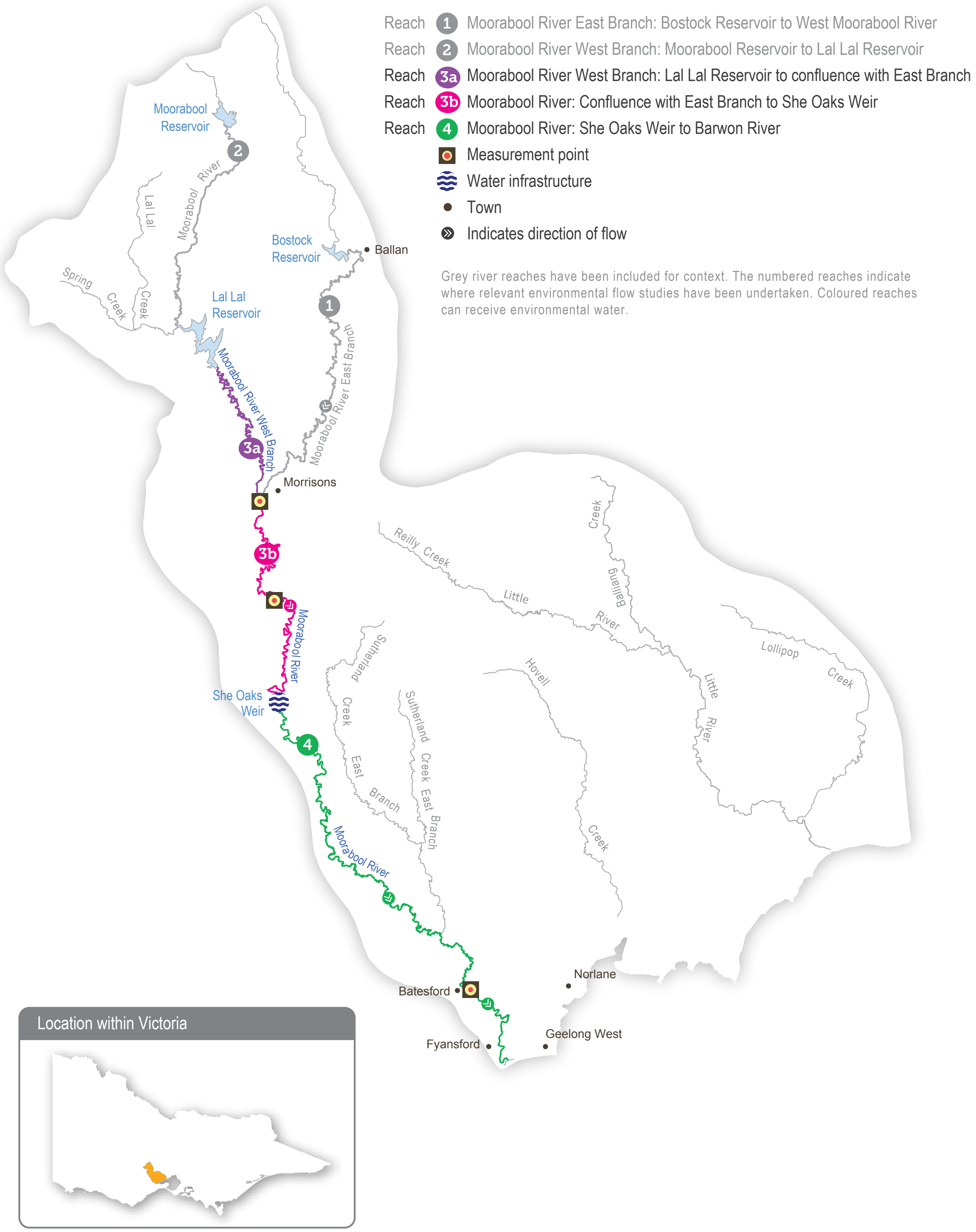
Traditional Owner cultural values and uses

The Wadawurrung are the Traditional Owners of the land of *Moorabool Yulluk* (Moorabool River) and parts of the Barwon, Leigh and Yarrowee rivers.

Wadawurrung Traditional Owners have a strong connection to the river and place high cultural value on *Moorabool Yulluk*. They are a key partner in advocating for additional water recovery to help support environmental outcomes and cultural water objectives.

In 2020, the Wadawurrung Traditional Owners released *Paleert Tjaara Dja – Let's make Country good together 2020 – 2030 Wadawurrung Country Plan*. Waterways, rivers, estuaries and wetlands – *Yulluk* – are identified as key values to look after.

Figure 3.6.1 The Moorabool system



In 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 apply to all waterways within Wadawurrung Country, including *Moorabool Yulluk* (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.

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 camping, fishing, kayaking and swimming)
- riverside recreation and amenity (such as birdwatching, bushwalking, camping, picnicking and lookouts)
- community events and tourism
- socio-economic benefits (such as domestic stock users).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 3.6.1 with the following icon.

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

Summer/autumn freshes provide a freshening flow in *Moorabool Yulluk* (Moorabool River) and are planned to coincide with school holidays and public holidays where possible. These flows improve opportunities for riverside and water-based recreation, in particular camping and fishing.

Recent conditions

Rainfall in the Moorabool system catchment was close to the long-term average throughout most of 2020-21, but above average in late winter to early spring and during summer. Lal Lal Reservoir filled and spilled in early October 2020, when each entitlement holders total share of reservoir capacity was reached.

Water for the environment was used to help meet target low flow in early winter, but natural catchment inflows dominated flow patterns through late winter and spring. The natural spill at Lal Lal Reservoir in October 2020 delivered a peak flow of 1,040 ML per day at Morrison's gauge, which was sufficient to connect low-lying parts of the floodplain, support channel-forming geomorphological processes and provide migration triggers for native fish. Total monthly rainfall over January 2021 contributed significantly to catchment inflows, delivering a natural fresh of 50 ML per day earlier in the month and again in early February. These and other associated rain events helped meet many of the recommended summer/autumn freshes. Summer/autumn low-flow targets were largely met with a combination of passing flows and operational water transfers, with limited amounts of water for the environment used to make up deficits only where required.

Environmental watering in the Moorabool system was managed according to an average climate scenario throughout 2020-21, and all planned watering actions were met. About 2,100 ML was delivered in 2020-21, which ensures water availability of about the same volume or more could be delivered next year depending on catchment conditions and inflows.

Scope of environmental watering

Table 3.6.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 3.6.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Moorabool Yulluk* (Moorabool River)

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring low flow (10-60 ML/day continuous from June to November)	• Maintain in-stream vegetation • Maintain connectivity and allow fish movement through the reach • Reduce intrusion by terrestrial vegetation into the stream bed	
Winter/spring fresh(es) (one to three freshes of 80-162 ML/day for five days during June to November)	• Maintain pool and riffle habitats and provide connectivity to support fish and platypus movement through the reach • Trigger downstream spawning migration of tupong (May-August) and upstream migration of juvenile *Turrpurt* (galaxias), tupong, *Buniya* (short-finned eel) and Australian grayling (September-November) • Provide flow variability to maintain species diversity of the fringing vegetation and promote the growth and recruitment of streamside vegetation • Flush silt, scour pools and remove biofilms from hard substrates and the stream bed to maintain waterbug communities and transport organic matter to prevent blackwater events	
Summer/autumn low flow (5-10 ML/day continuous from December to May)	• Maintain pool and riffle habitat for fish, waterbugs platypus and submerged aquatic vegetation • Maintain water quality for biota by reducing periods of low oxygen, high temperature and high electrical conductivity	
Summer/autumn fresh(es) (one to three freshes of 30-60 ML/day for three to five days from December to May)	• Trigger downstream spawning migration of adult *Buniya* (short-finned eel) (January-February), tupong (May-August), Australian grayling (April-May) and short-headed lamprey • Maintain pool and riffle habitat and the condition of streamside vegetation, and promote recruitment • Allow fish and platypus to move through the reach to access habitat • Flush silt and scour biofilms and algae from the stream bed and substrates to improve habitat quality for waterbugs • Maintain water quality for biota by reducing periods of low oxygen, high water temperature and salinity	

Scenario planning

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

Moorabool Yulluk (Moorabool River) requires continuous low flows throughout the year and periodic freshes under all climate scenarios except drought to achieve the intended environmental outcomes. Under drought and dry climate scenarios, the main objective is to provide sufficient habitat to maintain existing populations of native fish and platypus, and therefore flows can be delivered at the lower end of their recommended size range and frequency. However, flows generally need to be larger under average and wet climate scenarios to help grow populations of native fish and platypus and to improve the condition of in-stream and streamside vegetation.

Under average and wet climate scenarios, most of the recommended flows are expected to be provided through a combination of natural flows, passing flows, operational releases and deliveries of water for the environment. Continuous low flows, at least one winter/spring fresh and one summer/autumn fresh are likely to be delivered at the lower end of their recommended ranges under a dry climate scenario. These flows should be sufficient to maintain existing populations of native fish and platypus and to maintain the condition of aquatic and streamside vegetation. Delivering a 60 ML per day fresh for five days in autumn will be a high priority under average and wet climate scenarios, and they will be delivered where possible under a dry scenario to trigger Australian grayling migration and spawning. These autumn high flows are required two out of every three years to maintain and grow Australian grayling populations. They occurred in the Moorabool system in 2018-19 and 2019-20, and delivering them in 2021-22 will help the populations recover from past dry periods and provide a buffer in case there is a return to drier conditions in 2022-23.

Under a drought scenario, there will be less contribution from natural events and the expected volume of water for the environment available will not be sufficient to deliver all of the required flows to maintain the condition of existing environmental values. The highest environmental watering priority under a drought scenario will be to maintain connecting flows for as long as possible during summer and autumn, because this is when the system is at the greatest risk of drying up or having poor water quality. If it is not possible to maintain continuous flow, water for the environment available will be used to deliver freshes to periodically top up refuge pools and prevent adverse water-quality events. Even with these proposed watering actions, some decline in environmental condition and the size of plant and animal populations is expected under a drought scenario.

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

Carryover of 1,000 ML has been identified to ensure there is sufficient water to deliver low flows in summer and autumn in 2022-23 if there is another drought.

Table 3.6.2 Potential environmental watering for *Moorabool Yulluk* (Moorabool River) under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Little to no rainfall with no inflow to Lal Lal Reservoir • Regular periods of no flow	• Below-average rainfall and inflow into Lal Lal reservoir • 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 flow persistent throughout winter • Overbank conditions in some parts during spring/autumn
Predicted supply of water for the environment[1]	• 3,800 ML	• 4,600 ML	• 5,600 ML	• 7,600 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Summer/autumn low flow	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn fresh (one fresh)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn freshes (three freshes)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn low flow • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)			
	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn fresh (one fresh)	• Winter/spring low flow • Winter/spring fresh (one fresh)	• Winter/spring freshes (two freshes)	• Winter/spring fresh (one fresh)
Potential environmental watering – tier 2 (additional priorities)	• As per tier 1, but at a higher magnitude	• As per tier 1, but at a higher magnitude	• As per tier 1, but at a higher magnitude	• As per tier 1, but at a higher magnitude
Possible volume of water for the environment required to achieve objectives	• 250 ML (tier 1a) • 3,373 ML (tier 1b) • 10,420 ML (tier 2)	• 2,500 ML (tier 1a) • 565 ML (tier 1b) • 10,690 ML (tier 2)	• 2,500 ML (tier 1a) • 1,130 ML (tier 1b) • 11,160 ML (tier 2)	• 2,085 ML (tier 1a) • 2,650 ML (tier 1b) • 11,160 ML (tier 2)
Priority carryover requirements	• Up to 1,000 ML			

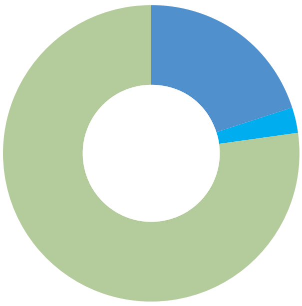
1 The expected availability of water for the environment is the estimated volume of water that may be held in the VEWH's share of storage capacity in Lal Lal Reservoir during 2021-22 under drought, dry, average and wet scenarios. The *Moorabool River Environmental Entitlement 2010* allows the use of up to 7,500 ML of water 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.

3.7 Barwon system

Waterway manager – Corangamite Catchment Management Authority

Storage manager – Barwon Water

Environmental water holder – Victorian Environmental Water Holder



Proportion of water entitlements in the Barwon basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

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.

Did you know...?

Environmental flows are small in the upper Barwon River but they are essential to enhance and maintain habitat, improve water quality and increase feeding opportunities for our iconic platypus species. Citizen scientists were at the river learning spotting skills with the Australian Platypus Conservancy. They learnt how to use the Australian Platypus Monitoring Network's app and were diligent enough to spy two platypuses! The Upper Barwon Landcare Network also caught a glimpse of a couple of these critters when undertaking riverside vegetation restoration work. Platypus have also been detected, using DNA sampling techniques, in the upper Barwon River near Birregurra recently.

Top: Upper Barwon River, by the VEWH
Right: Reedy Lake coastal saltmarsh, by Corangamite CMA

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 (Figure 3.7.1). The Leigh River and *Moorabool Yulluk* (Moorabool River) 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. Water can be released directly from the reservoir into the west branch, or into the east branch via a diversion tunnel. The junction of the two branches is near Boundary Creek. Downstream of the reservoir, operational water can be diverted into the Wurdee Boluc inlet channel, a 57-km, concrete-lined channel that transfers water to Wurdee Boluc Reservoir.

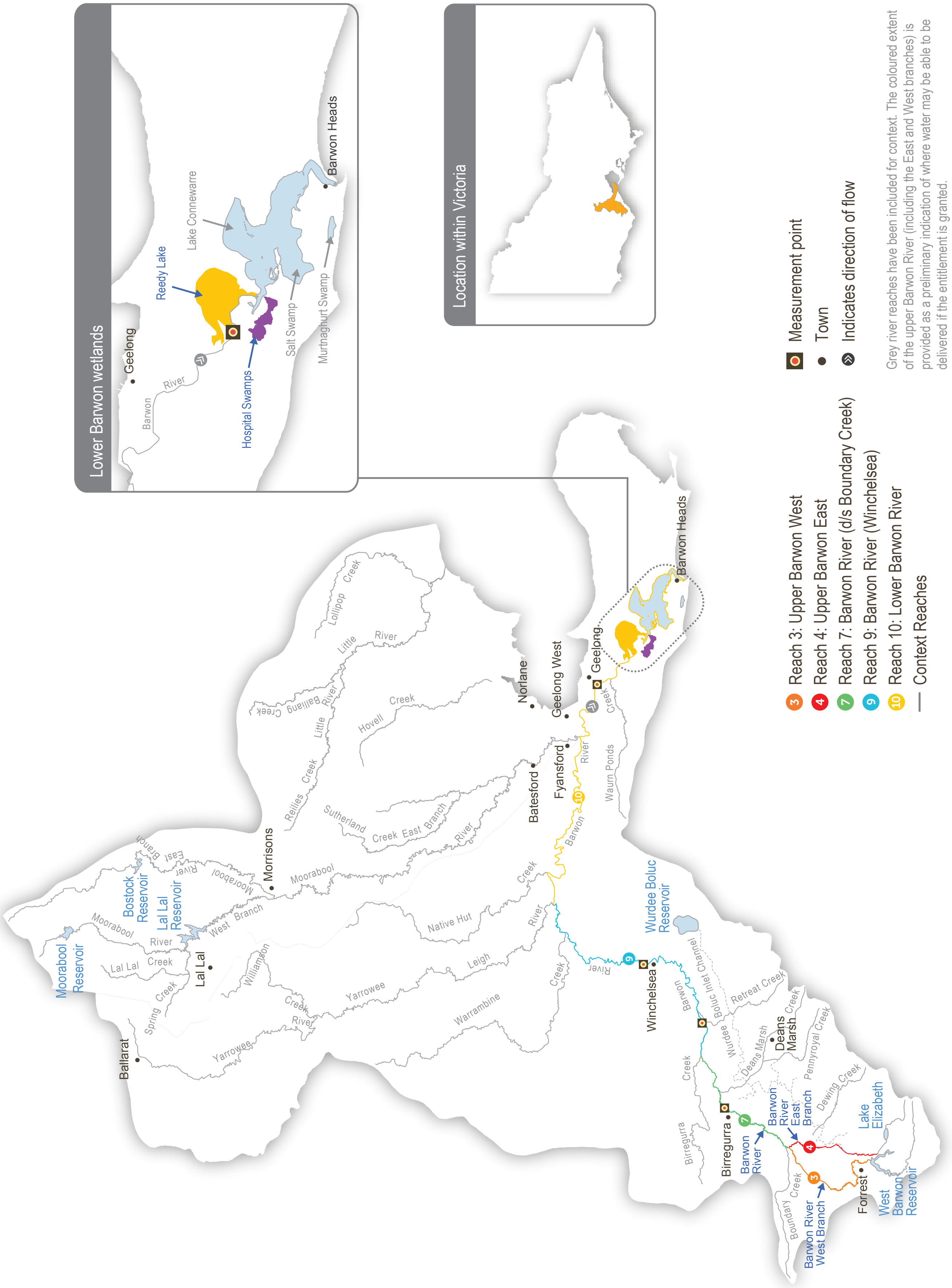
Barwon Water releases passing flows in the order of 1-5 ML per day in both the upper east and west branch from the West Barwon Reservoir. These releases may increase to 15 ML per day in September in a wet year. Flood spills from the reservoir and natural inflows from unregulated and partly regulated 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) under particular climatic conditions.

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, which 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, 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 pygmy perch, southern pygmy perch and river blackfish
Maintain the abundance and improve the condition and extent of platypus populations
Improve the condition and extent of in-stream 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 reaches of the Barwon River that can be most influenced by water delivered from the West Barwon Reservoir sit in Eastern Maar Country. In February 2020, the Eastern Maar Aboriginal Corporation received Registered Aboriginal Party status under the *Aboriginal Heritage Act 2006* over a large portion of land in south-west Victoria including the Barwon River upstream of Winchelsea. The Eastern Maar Aboriginal Corporation was invited to be involved in the development of Corangamite CMA's seasonal watering proposal, as good opportunities exist within these reaches to support Eastern Maar values and aspirations associated with the waterway.

The Corangamite CMA is working with Wadawurrung Traditional Owners to understand opportunities to provide for cultural values and uses and other aspirations for management of water for the environment in the Barwon River downstream of Winchelsea.

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 birdwatching, camping and walking)
- socio-economic benefits (such as domestic and stock uses).

Recent conditions

Rainfall in the Barwon River catchment in 2020-21 was slightly above the long-term average. Wet conditions from August to October contributed high inflows to catchment storages, but West Barwon Reservoir did not fill beyond 70 percent capacity. Allocations against the environmental entitlement increased from 536 ML in July 2020 to 1,000 ML in October 2020.

Operational releases and passing flows maintained low flows in the upper Barwon River throughout most of the year. High-rainfall events delivered several natural high-flow events during winter and spring 2020 and two natural freshes in January 2021. These high flows and freshes provided opportunities for fish and platypus to migrate and likely improved the condition of native vegetation and in-stream habitats. Water for the environment was used to supplement low flows in the west branch of the upper Barwon River as needed, to achieve recommended flow targets during summer and autumn.

Water for the environment in the upper Barwon River was managed in line with an average climate scenario during 2020-21, and all planned watering actions were achieved.

A lack of flow data from key locations has limited the assessment of previous environmental flow releases in the upper Barwon River. A new streamflow gauge was installed on the east branch (near King Creek junction) in 2020, and data from that site will support future environmental flow management.

Scope of environmental watering

Table 3.7.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 3.7.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the upper Barwon River

Winter/spring low flow (10-50 ML/day or natural) (June to November) (east and west branch)	• Maintain connectivity and 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 sufficient flow velocity, to mix pools	
Summer/autumn low flow (0.5-5 ML/day from December to May, east branch) Summer/autumn low flow (30 ML/day or natural from December to May, west branch)	• Maintain an adequate depth of permanent water in the channel/pools to provide habitat to support resident and migratory fish, platypus and waterbugs • Reduce encroachment by terrestrial plants into the aquatic zone • Provide minimum velocity to mix and flush pools	
Summer/autumn freshes (two to three freshes of 9-35 ML/day for two days from December to May, east branch) Summer/autumn freshes (five to six freshes of 50 ML/day for six days from December to May, west branch)	• Provide longitudinal connectivity with water over riffles to allow fish to migrate upstream and fish and platypus to move between pools to breed, feed and find new habitats • Submerge woody debris and clean hard surfaces to provide breeding substrate for resident freshwater fish • Mobilise sediment and scour algae to maintain waterbug communities in the dry period by flushing organic matter into the channel to provide food after inundating benches for platypus • Provide a mosaic of wetted areas to improve emergent and streamside vegetation on terraces, the channel edge and lower bank • Provide minimum velocity to mix and flush 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. Under drought and dry climate scenarios, water for the environment available will be used to maintain a continuous flow in the east branch of the Barwon River for as long as possible in summer and autumn. The east branch is prioritised over the west branch because it has higher environmental values and a smaller channel capacity, so even relatively small flows have the potential to deliver significant environmental outcomes.

The increased volume of water for the environment available under average and wet climate scenarios will be shared between the east and west branches and will be used to supplement natural events. In the east branch, the priority will be to deliver summer/autumn low flows as well as freshes. The summer/autumn freshes will help to improve water quality and provide opportunities for fish and platypus to disperse throughout the system to breed and take advantage of increased food and habitat under wet and average climatic conditions. Any remaining water for the environment under an average or wet climate scenario will be used to supplement summer/autumn low flows in the west branch and contribute to flows further downstream.

The tier 1a and 1b watering actions described should help to maintain current environmental values and conditions in the upper Barwon River. However, a larger environmental entitlement and complementary works that address non-flow-related impacts in the catchment (such as constrictions) will be needed to significantly improve environmental conditions.

It is intended to carry over up to 500 ML at the end of 2021-22, 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
Predicted supply of water for the environment	• 500 ML	• 800 ML	• 1,000 ML	• 2,000 ML
East branch				
Potential environmental watering - tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Summer/autumn low flow	• Summer/autumn low flow	• Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Summer/autumn low flow • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)			
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow	• Winter/spring low flow
West branch				
Potential environmental watering - tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• N/A		• Summer/autumn low flow	• Summer/autumn low flow
	Tier 1b (supply deficit)			
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 250 ML (tier 1a) • 17,008 ML (tier 1b)	• 300 ML (tier 1a) • 16,547 ML (tier 1b)	• 500 ML (tier 1a) • 14,057 ML (tier 1b)	• 1,500 ML (tier 1a) • 12,337 ML (tier 1b)
Priority carryover requirements	• 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. The system has long been of a place of high significance to the Wadawurrung Traditional Owners. *Paleert Tjaara Dja – Let's make Country good together 2020 – 2030 Wadawurrung Country Plan* acknowledges the special place the system has in their Dreaming: '*The chain of ponds from the Barwon River to Reedy Lake, Hospital Lake, Lake Connewarre and Estuary Bay is connected through water and our Connewarre (Black Swan) Dreaming*'.

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 the 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 naturally 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 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 was completed in 2020. The review's recommendations have informed the 2021-22 watering actions and future directions.

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

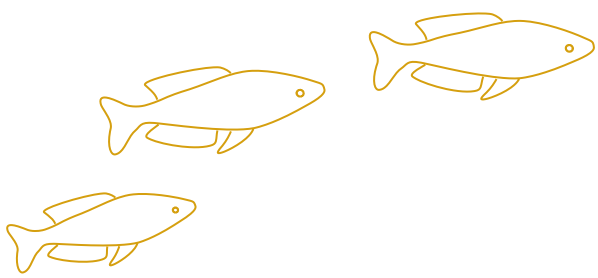
	Provide habitat for fish breeding and growth and improved conditions for migration and dispersal, when wetlands are connected to the Barwon River Reduce carp populations
	Provide varying water levels and conditions to promote soil salinisation, to support the persistence and growth of threatened salt-dependent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

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.

The Wadawurrung have identified cultural values which apply 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 water holes and refuge pools
- maintaining access to culturally important story places and ceremonial places
- protection of artefact sites
- use of appropriate Wadawurrung language for places of cultural importance
- increased opportunities for the Wadawurrung to be involved in monitoring and evaluation activities
- including the Wadawurrung in all communication around releases of water for the environment and other wetland-related activities.



Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.7.3, Corangamite CMA consulted widely with stakeholders to ensure it considered social, cultural and economic matters relevant to water management in the lower Barwon wetlands. Opportunities for social, recreational and economic values and uses are incorporated into planning and watering decisions if they do not compromise environmental outcomes. Expert advice (such as a flow ecology study and the 2020 Lower Barwon Review) emphasised that the entire recommended watering regime — filling the wetlands and allowing water levels to draw down at the right times — must be implemented to improve biodiversity and protect the long-term health of the wetlands, so it may not be possible to meet some community expectations at all times (such as keeping the wetlands permanently full). However, Corangamite CMA plans to ensure management of water levels in the wetlands can meet ecological requirements and also support a range of values and uses where possible including:

- water-based recreation (such as boating, duck hunting and fishing)
- riverside recreation and amenity (such as birdwatching and spending time outdoors)
- community events and tourism (such as community events and Traditional Owner events)
- socio-economic benefits (such as commercial fishing).

Corangamite CMA works with its community advisory group and stakeholders and seeks to balance these interests where possible, while maintaining the overall health of the wetlands to help sustain these activities into the future.

Recent conditions

Rainfall across the lower Barwon River catchment in 2020-21 was mostly above the long-term average. High-flow events in the Barwon River during spring and summer provided natural inflows to Reedy Lake and Hospital Swamps.

The Corangamite CMA had planned to draw down water levels in Reedy Lake from early summer 2020-21, to provide the recommended drying cycle and associated effects to maintain the character of the wetland as per the Lower Barwon Review, but the drawdown was delayed by the natural inflows and an associated bird breeding event. A partial drawdown commenced in February 2021, once the breeding birds had fledged their chicks. The planned drawdown at Hospital Swamps was also delayed by natural inflows from the Barwon River and stormwater inflows from a neighbouring development site.

The late drawdown in both wetlands meant the target low water level of 0.3 m AHD could not be met in Reedy Lake, and it was achieved much later than planned in Hospital Swamps. The incomplete and delayed drawdowns reduced the quantity of shallow foraging habitat for wading waterbirds and limited growing conditions for coastal salt marsh vegetation. The wetter-than-average conditions in 2020-21 are a natural year-to-year variation, and they are not expected to compromise the long-term environmental objectives for the site provided the lakes can draw down in coming years.

Scope of environmental watering

Table 3.7.3 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

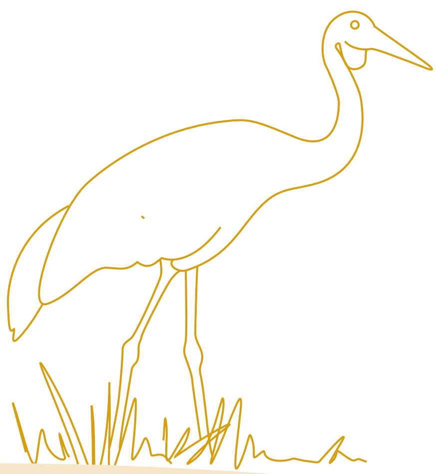
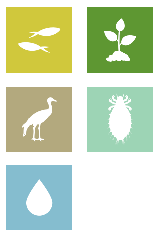


Table 3.7.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the lower Barwon wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Reedy Lake		
Autumn/winter/spring fill (April/early May to November) (targeting 0.8m AHD)	• Maintain a mosaic of water depths and resources across the wetland to support waterbird breeding events • Inundate fringing wetland vegetation to provide foraging habitat for waterbirds • Maintain a sufficient depth of water around wetland vegetation to provide fish breeding habitat • Temporarily inundate the outer edges of the wetland to initiate growth and recruitment of diverse vegetation communities while permanently inundating the inner wetland vegetation communities • Allow fish to move between the river, lake and estuary • Stimulate waterbug communities to breed for waterbird feeding • Dilute soil and surface water salts and initiate the decomposition of organic matter	
Summer/autumn drawdown (December to April/early May, top-up or drawdown as required) (targeting 0.3m AHD)	• Lower the water level by natural evaporation and assisted drawdown (if required and as informed by waterbird monitoring) to dry out wetland fringing vegetation, to reduce potential waterlogging of saltmarsh communities to support germination • Expose mudflats and margins to provide feeding habitat for wading/ migratory waterbirds and frogs • Manage reed colonisation of low-lying areas by allowing drying and saline groundwater intrusion to reduce growth • Support a drying phase for vegetation communities that require drying to grow and recruit • Reduce water levels to restrict carp movement and access to habitat • Allow vegetation to decay and soils to oxidise and release nutrients, to improve lake productivity and maintain biogeochemical processes • Enable surface water/groundwater interaction by allowing saline groundwater to discharge to the wetland bed	
Hospital Swamps		

Autumn/winter/spring fill (May to November) (targeting 0.5m AHD)	• Maintain a mosaic of water depths and resources across the wetland and inundate various vegetation communities and create nesting, breeding and feeding opportunities for waterbirds, fish and waterbugs
	• Increase water levels to trigger fish spawning and waterbird breeding:
	  • high water levels will allow fish to access the wetland from the river
	  • more freshwater will dilute the salt in the soil and dilute surface water over the winter
	• Inundate the outer edges and margins to initiate the growth and maintain the condition of important wetland vegetation communities
		

Summer/autumn drawdown (December to April) (by natural evaporation and assisted drawdown, if required) (targeting 0.1-0.3m AHD)	• Lower the water level by natural evaporation and assisted drawdown (if required and as informed by waterbird monitoring if available) to dry out the wetland fringing vegetation and expose mudflats and margins to support feeding by wading/migratory waterbirds and frogs • Manage reed colonisation in low-lying areas by allowing drying and saline groundwater intrusion to reduce growth • Support a drying phase for vegetation communities that require drying to grow and recruit • Reduce water levels to restrict carp movement and access to habitat • Allow vegetation to decay and soils to oxidise and release nutrients, to improve lake productivity and maintain biogeochemical processes • Enable surface water/groundwater interaction by allowing saline groundwater to discharge to the wetland bed	

Scenario planning

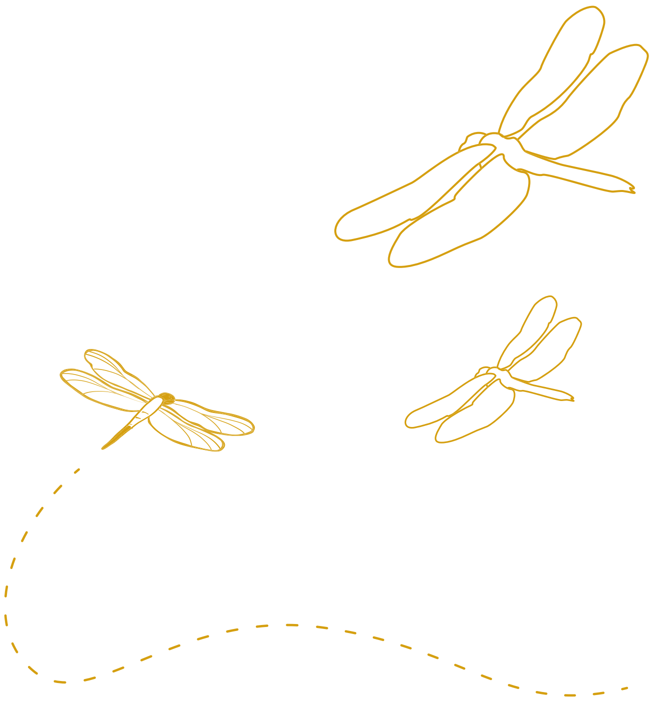
Table 3.7.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

An independent review of the lower Barwon wetlands watering trial from 2016-17 to 2019-20 was completed in 2020. The review confirmed that the current wetting and drying regimes for Reedy Lake and Hospital Swamps are appropriate, but it recommended that the timing of planned drawdowns should be adaptively managed to avoid disturbing any significant waterbird breeding at either site.

The 2012 FLOWS study for the lower Barwon wetlands and the 2020 Lower Barwon Review recommend a four-year watering cycle: filling the wetlands in autumn/winter/spring every year and having low water levels during summer in three out of four years to facilitate partial drying. Water levels in both wetlands remained high throughout 2019-20, and the planned drying event in 2020-21 was only partly implemented, to avoid disturbing a waterbird breeding event. Drying the wetlands out in summer 2021-22 is a high priority under all climate scenarios, to achieve the recommended water regime. The planned summer/autumn drawdown will be delayed if there is significant waterbird breeding. It is also acknowledged that the planned wetland drying may be difficult to implement under a wet climate scenario, especially if there are multiple high-flow events in the Barwon River during summer and autumn.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Limited to no inflow from the Barwon River in winter/ spring • Dry conditions over summer will dry the wetlands	• Some natural inflow from the Barwon River in winter/ spring • Dry conditions over summer will assist in the drying of the wetlands	• Some natural inflow from the Barwon River in winter/ spring • Conditions over summer may assist the drying of the wetland water levels	• Overbank flow from the Barwon River is likely to fill the wetlands • Stormwater inflow and local rain/runoff will provide regular top-ups • Extensive drying of the wetlands is unlikely
Reedy Lake				
Potential environmental watering	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown
Hospital Swamps				
Potential environmental watering	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown



Fish survey at Myaring Bridge Glenelg River, by Arthur Rylah Institute for Environmental Research

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 *Bochara-Bogara-Pawur* (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 *Barringgi Gadyin* (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 System Headworks, which is a series of on-stream reservoirs, off-stream storages and connecting channels that harvest water (mainly near the Grampians) and distribute it to entitlement holders throughout the Wimmera catchment and parts of the Avoca, Loddon, Glenelg and Mallee catchments.

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 areas.

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.

Traditional Owners in the western region

Traditional Owners and their Nations in the western region continue to 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.

The Burrandies Aboriginal Corporation (based in South Australia) represents the Boandik Traditional Owners, who share cultural connections to the western parts of the Glenelg River catchment including the small part in South Australia.

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 the Barengi Gadjin Land Council, were recognised in a Native Title Consent Determination. The 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 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, including the Glenelg River.

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 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 VEWH and its program partners also 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 how community benefits from environmental flows can be provided while optimising environmental priorities for the year ahead. Aboriginal cultural, social and recreational values and uses are considered for each system in the following system sections.

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]

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 the Glenelg, Wimmera and Wimmera-Mallee wetlands 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 tables also show the level of engagement between Glenelg Hopkins CMA, Mallee CMA, North Central CMA and Wimmera CMA and stakeholders of the environmental watering program in the western region, based on the CMAs' 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 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 Catchment Management Authority in developing seasonal watering proposals for the Glenelg system and other key foundation documents that have directly informed the proposal (grouped in alphabetical order)

Partner/stakeholder	Glenelg system
Community groups and environment groups	**IAP2 level: Inform** • Friends of the Glenelg River Inc. • Glenelg River User Group
Government agencies	**IAP2 level: Collaborate** • GWMWater
	IAP2 level: Consult • Parks Victoria
	IAP2 level: Inform • Department of Environment, Land, Water and Planning • Limestone Coast Landscape Board • Victorian Fisheries Authority • Wimmera CMA
Landholders/ farmers	**IAP2 level: Collaborate** • Individual landholders
Local businesses	**IAP2 level: Inform** • Balmoral Bush Nursing Centre • Balmoral Local Post Office • Nelson Boat and Canoe Hire • Nelson River Cruises • Paestan Canoe Hire • Vickery Bros
Recreational users	**IAP2 level: Consult** • Balmoral District Angling Club • Casterton Angling Society Inc. • Dartmoor Angling Club • Southwest Victoria fishing reports • VRFish
	IAP2 level: Inform • Individual anglers
Traditional Owners	**IAP2 level: Collaborate** • Barengi Gadjin Land Council • Burrandies Aboriginal Corporation • Gunditj Mirring Traditional Owners Aboriginal Corporation

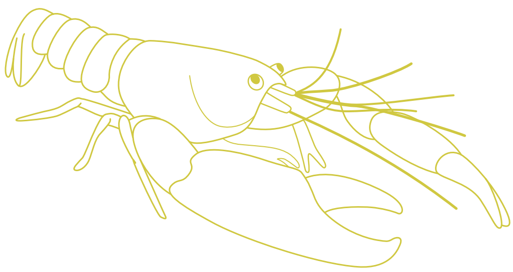


Table 4.1.3 Partners and stakeholders engaged by Wimmera Catchment Management Authority in developing the seasonal watering proposal for the Wimmera system and other key foundation documents that have directly informed the proposal (grouped in alphabetical order)

Community groups and environment groups	**IAP2 level: Consult** • Friends of Bungalally and Burnt Creek Group • Lake Lonsdale Action Group • Yarriambiack Creek Advisory Committee
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Glenelg Hopkins CMA • GWMWater
	IAP2 level: Involve • Hindmarsh Shire Council • Horsham Rural City Council
	IAP2 level: Consult • Murray-Darling Basin Authority • Northern Grampians Shire Council • Parks Victoria • Victorian Fisheries Authority • Yarriambiack Shire Council
Landholders/ farmers	**IAP2 level: Inform** • Wimmera community members, especially landholders and stock and domestic water users
Recreational users	**IAP2 level: Consult** • Dimboola Boat and Water Ski Club • Dimboola Fishing Classic • Dimboola Rowing Club • Hindmarsh Ski Club • Horsham Fishing Competition Inc. • Horsham Triathlon Committee • Jeparit Anglers Club • Murtoa Angling Club • Natimuk Lake water ski club • Paddle Victoria • Stawell and District Angling Club • Warracknabeal Angling Club • Wimmera Anglers Association • VRFish
Traditional Owners	**IAP2 level: Collaborate** • Barengi Gadjin Land Council

Table 4.1.4 Partners and stakeholders engaged by Mallee Catchment Management Authority, North Central Catchment Management Authority and Wimmera Catchment Management Authority seasonal watering proposals for the Wimmera-Mallee wetlands and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

Partner/stakeholder	Wimmera-Mallee wetlands
Community groups and environment groups	**IAP2 level: Inform** • Berriwillock Landcare • Birchip Landcare Group • Birchip Cropping Group • Cokum community group • Community members on the Mallee CMA Land and Water Advisory Committee • Culgoa Landcare • Donald and District Landcare Group • Green Lake Regional Park • Hopetoun Landcare • Lake Tuhum Committee • Lalbert Landcare • Millewa-Carwarp Landcare • Nullawil Landcare • Ouyen Lake Project • OzFish Unlimited • Sea Lake Landcare • Ultima Landcare • Waitche Landcare • Wimmera Bushwalking Club • Woomelang-Lascelles Landcare
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • GWMWater • Mallee CMA • North Central CMA • Parks Victoria • Victorian Environmental Water Holder
	IAP2 level: Inform • Buloke Shire Council • Department of Environment, Land, Water and Planning • Mildura Rural City Council • Yarriambiack Shire Council
Landholders/ farmers	**IAP2 level: Collaborate** • Private landholders
Local businesses	**IAP2 level: Inform** • Ouyen Lake Project • Wimmera Mallee Tourism
Recreational users	**IAP2 level: Consult** • Natimuk & District Field & Game Inc.
	IAP2 level: Inform • Recreational users in the local community
Traditional Owners	**IAP2 level: Collaborate** • Barengi Gadjin Land Council • Dja Dja Wurrung Clans Aboriginal Corporation

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 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 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.

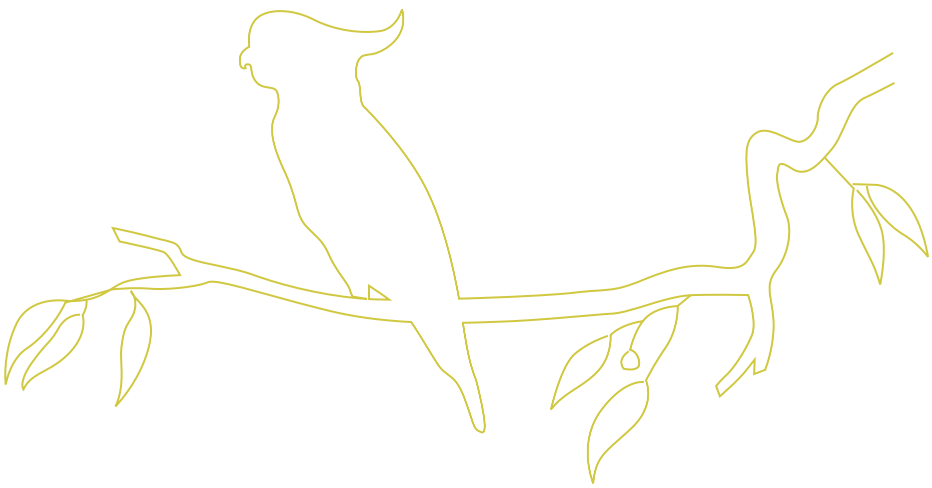
Examples of catchment management authority (CMA) on-ground works programs likely to support environmental watering outcomes in the western region include:

- major works to improve fish passage for over 1,000 km including fish passage works at Sandford Weir, Dergholm Gauge and Warrock are used in combination with the 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 a regulating structure to reconnect Langlands Anabranch in the Horsham weir pool, as well as walking tracks to manage recreational access along the Wimmera River to reduce bank erosion
- weed and rabbit control 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 throughout the Wimmera and Glenelg catchments, to support the re-establishment of streamside and in-stream vegetation, with over 2,000 km of fencing erected, 500,000 trees planted and 796 ha directly seeded along the Glenelg River alone
- sand management, including the removal of around 30,000 m^3 of excess bedload sand a year to improve the availability and quality of habitat for native fish, platypus and crayfish
- carp management activities in the Wimmera and Glenelg systems, to reduce the number of carp and to better understand their behaviour in both rivers to help improve environmental watering outcomes
- installation of 870 pieces of large wood in Glenelg River reach 2 using red gum trunks and root balls, to restore complex habitat for native fish
- 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, Mallee, North Central and Wimmera 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 2021-22 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 2021-22

Rainfall across the western region in 2020-21 varied seasonally and geographically. In the Glenelg system, rainfall was above the long-term average for much of winter and spring, with natural inflows delivering most of the planned watering actions from July to December 2020. Water for the environment was needed to help maintain continuous flows from Rocklands Reservoir to the estuary from December 2020 through to May 2021. Rainfall in the Wimmera system remained below average for the fourth consecutive year. A high-rainfall event in February 2021 delivered the largest flow in the Wimmera River since 2016, but other parts of the Wimmera system had few natural events, and inflows to the catchment's storages were low. Water for the environment was used to maintain drought refuges in the MacKenzie River and Burnt Creek from mid-October 2020 and to maintain flow in the Wimmera River downstream of Dimboola from January 2020. Water for the environment was also used to freshen water quality and prevent a hypoxic blackwater event in the Wimmera River after the February flood. No flows were delivered in the Mount William Creek, due to natural top-ups in the upper section and accumulated passing flows that refilled pools in December 2020.

Water storages across the Wimmera-Mallee System Headworks were collectively at 31 percent capacity at the start of 2020-21. They rose to 40 percent in November 2020 and were below 30 percent of capacity at the end of April 2021, which is slightly less than at the same time in 2020. The VEWH received 57 percent allocation against its environmental entitlement for the Wimmera and Glenelg rivers in 2020-21. The wetlands environmental entitlement and CEWH did not receive any allocation in 2020-21.

Below-average rainfall and well-above-average temperatures are predicted for the western region in winter 2021. The Wimmera-Mallee storages will need significant inflows before any allocations are made to the environmental entitlement. The storage manager has indicated that entitlement holders will receive low allocations in 2021-22 under drought, very dry, dry and average climate scenarios, and they are unlikely to receive full allocations even under a wet scenario.

If environmental allocations do not significantly increase in winter/spring 2021, water for the environment for the rest of 2021-22 will be managed in line with drought, very dry and/or dry climate scenarios in the Wimmera and Glenelg systems. This will be the fifth consecutive year that environmental watering actions in the Wimmera and Glenelg systems have been managed according to drier-than-average climate scenarios. The focus in 2021-22 will likely 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 2020-21 will be critical in supporting these watering actions. If inflows into the storages support higher environmental allocations, water for the environment may be used to deliver winter/spring freshes and low flow in the Glenelg River through to reach 3, 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 storages will need to be well above average, to allow wet-scenario watering actions to be delivered in 2021-22.

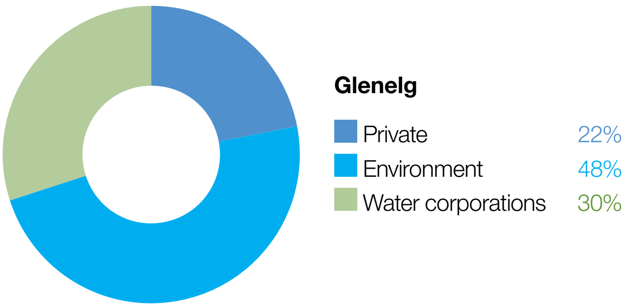
The Wimmera-Mallee wetlands entitlement is not likely to receive any allocation in 2021-22 under drought, very dry or dry climate scenarios and only small volumes under average and wet climate scenarios, so managed environmental deliveries to those sites will rely on carryover from 2020-21. The continuing 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. Carryover will also be prioritised to allow critical wetland deliveries in future years until new allocations are made.

4.2 Glenelg system

Waterway manager – Glenelg Hopkins Catchment Management Authority

Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder



Proportion of water entitlements in the Wimmera and Glenelg basins held by private users, water corporations and holders of water for the environment on 30 June 2020.

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

Did you know...?

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

Top: Swans and ducks on the Glenelg River at Moree Bridge, by the VEWH
Above: Spiny crayfish, by Glenelg Hopkins CMA

System overview

Bochara-Bogara-Pawur (Glenelg River) rises in the Grampians and flows west through Harrow and then south to Casterton and Dartmoor (Figure 4.2.1). 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.

Moora Moora Reservoir and Rocklands Reservoir are Wimmera-Mallee System Headworks water storages in the Glenelg River system that contribute to the supply of water to towns and properties across the Wimmera, Mallee, Glenelg, Loddon and Avoca river catchments. 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 water for the environment managed 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 the potential use of water for the environment 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, Glenelg spiny crayfish and a newly described species of river blackfish. It is also home to platypus and populations of native fish including estuary perch, kooyang (short-finned eel), tupong and three species of pygmy perch including the threatened variegated pygmy perch and Yarra pygmy perch. Some of these fish species migrate long distances to and from the Glenelg River estuary to complete their life cycles.

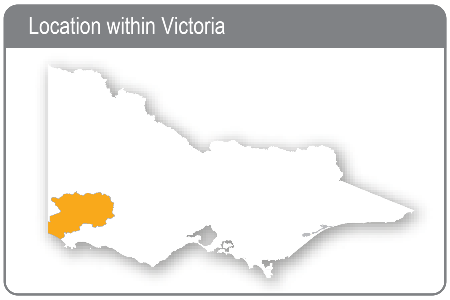
Frasers Swamp is another important feature of the upper Glenelg system and is home to a healthy growling grass frog population.

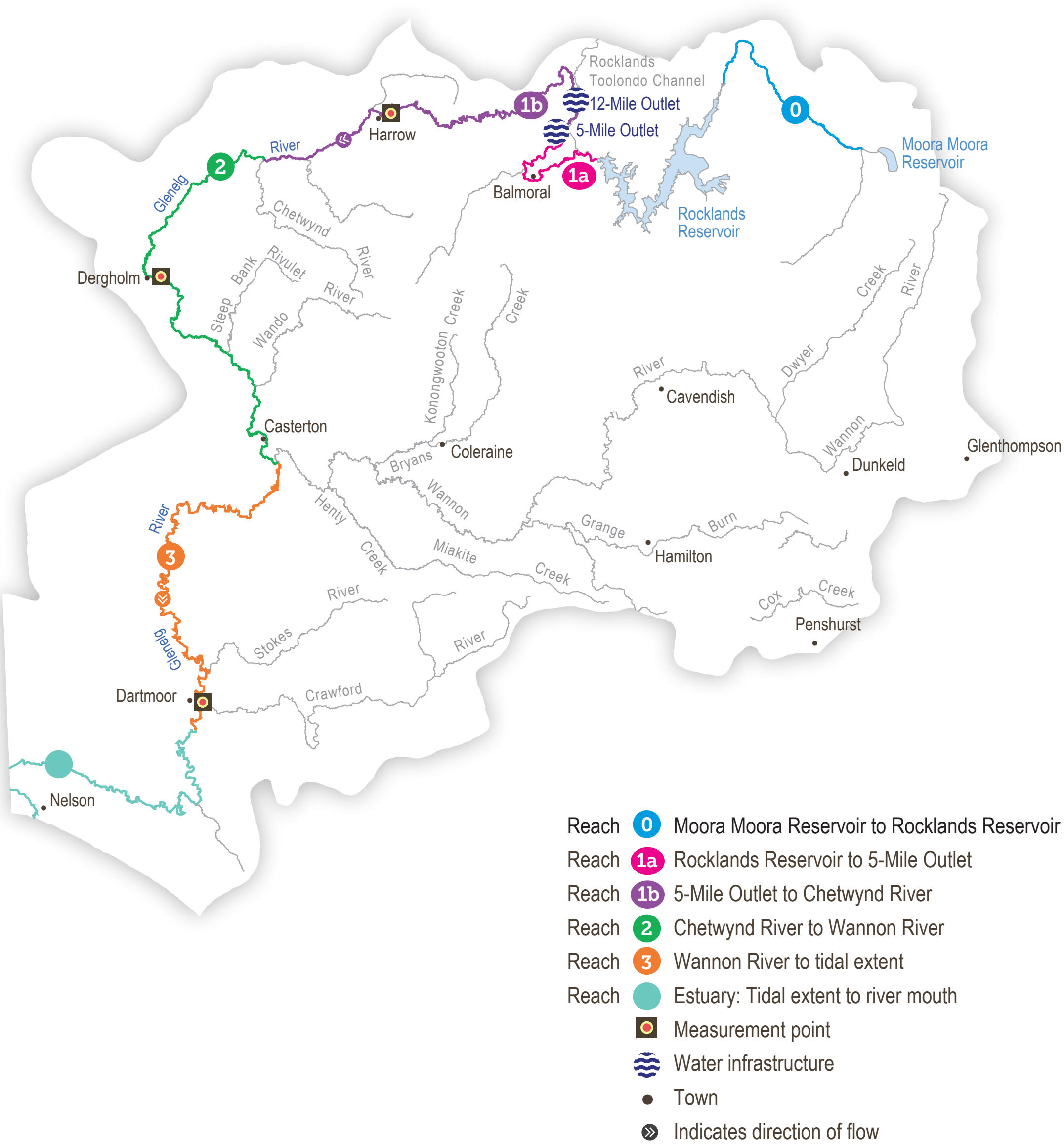
The Glenelg River supports a variety of streamside vegetation communities and species including the endangered Wimmera bottlebrush. Streamside and floodplain vegetation is comprised of river red gum woodlands with paperbark, bottlebrush and tea tree understorey.

Environmental watering objectives in the Glenelg River

- Protect, maintain and where possible enhance populations of endemic fish, including threatened and diadromous species
- Maintain deep pool habitats and connectivity along the river
- Maintain the platypus population
- Maintain healthy and diverse mosaics of water-dependent vegetation (such as river red gums and Wimmera River bottlebrush)
- Maintain a wide range and large number of waterbugs to 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 Dhauwurd 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 the region's creation stories. *Bochara-Bogara-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, the 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
- that improving the health and abundance of totem species and their habitat by environmental watering also benefits Traditional Owners' 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 Owners' values in the *Bochara-Bogara-Pawur* system align strongly with environmental values. Traditional Owners' values are holistic and interrelated: they are bound up with the health of the river system overall, and the Country of which the river is part. Traditional Owners' wellbeing is connected to the health of the river and of Country.

Gunditjmara Traditional Owners have identified that it is a priority to spend time on the river and increase cultural practices and connection to Country. They have highlighted the importance of increasing ceremony and on-Country gatherings along the river, including at Casterton and Nelson.

During the current phase of the Glenelg River Cultural Flows project, on-Country gatherings were planned at important sites along the river, to identify and discuss cultural values with Traditional Owners who are connected to the river. Due to COVID-19, these physical gatherings could not take place, so the project partners undertook 'virtual visits', where Traditional Owners visit important places on the river to take photos and footage of the site, which are then uploaded to an online 'virtual tour' platform. The initial sites to be featured on the platform are Piccaninnie Ponds in South Australia, Jananginj Njaui (Victoria Gap, Gariwerd), and Red Cap Creek Streamside Reserve near Casterton.

Senior Traditional Owners have recorded stories and information at several important sites: about the history and culture of the river and how it needs to be looked after for future generations. The stories and other information will inform the cultural flows plan and will become part of the 'virtual tour'.

Figure 4.2.2 *Glenelg River Environmental Flow Seasonal Calendar* arises from the six seasons of Gunditjmara Country, and it was produced by Gunditj Mirring Traditional Owners Aboriginal Corporation. The northern part of the river upstream of the Harrow area is in Jadawadjali Country and the south-western part of the system is in Boandik Country. The calendar illuminates flow regimes along one reach of the Glenelg River — reach 1b, from 5-Mile Outlet to Chetwynd River — and aligns them with corresponding environmental events and observations. The calendar reflects the seasonal flow conditions that all Traditional Owner groups recognise.

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. In recognition of this knowledge, the Gunditjmara seasons have been incorporated into Table 4.2.1, as a complementary description of the timing of potential watering actions. The six seasons will eventually be embedded in the flow recommendations and scenario planning in future years.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

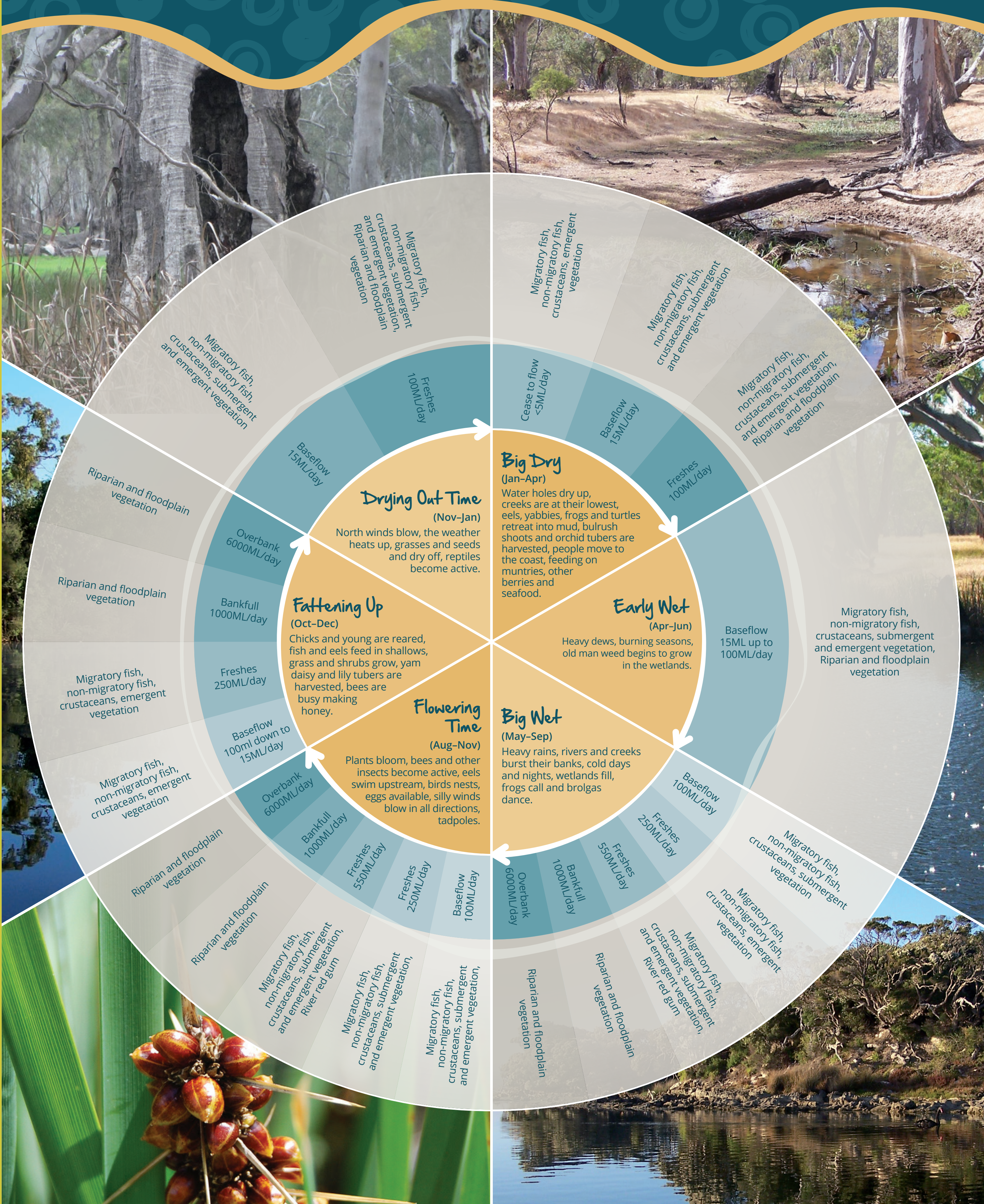
The timing of the summer/autumn fresh is planned to support the annual Johnny Mullagh Cup cricket match between the Gunditj Mirring and Barengi Gadjin Traditional Owners. The fresh will improve water quality in swimming holes and improve amenity for Traditional Owners attending the cricket event, which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

Following page: Figure 4.2.2 Glenelg River Environmental Flow Seasonal 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)
- community events and tourism (such as the Johnny Mullagh Cup and visitation)
- socio-economic benefits (such as diversions for domestic and stock uses, greater wellbeing and economic benefits for regional communities).

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 the following icons.

	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 that 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

Rainfall and temperatures in the Glenelg system in 2020-21 were close to the long-term average, and large rain events over spring and summer contributed to significant tributary inflows below Rocklands Reservoir. However, rainfall in the catchments of the Wimmera-Mallee System Headworks storages was well below the long-term average, which limited allocations of environmental water. Allocations to the Wimmera-Glenelg environmental entitlement only reached 57 percent by April 2021, and many environmental watering actions in 2020-21 were provided by water that had been carried over from 2019-20 and passing flows that were accumulated during winter/spring 2020.

Catchment runoff, tributary inflows and managed passing flows maintained minimum low-flow requirements and provided several freshes in the Glenelg River during winter and spring 2020. Large natural flows during September and October peaked at 1,837 ML per day in reach 1b, 5,269 ML per day in reach 2 and 16,916 ML per day in reach 3, providing natural connections between the river and some low-lying floodplain areas. These flows improved the health of vegetation on the banks and floodplain areas, and they allowed native fish and platypus to access feeding and breeding habitat along the length of the river. Water for the environment was used to maintain a continuous connection between Rocklands Reservoir and the estuary between December 2020 and May 2021 and to deliver one summer/autumn fresh to reach 1b to support native fish, platypus and vegetation objectives.

The limited supply of water for the environment in the Wimmera-Glenelg environmental entitlement meant that the Glenelg system was managed under a drought climate scenario, even though local climatic conditions were closer to average. All high-priority watering actions that were planned for the drought climate scenario were delivered in 2020-21, including summer/autumn low flows to reaches 1b and 2. Two additional watering actions were also delivered: summer/autumn low flow to reach 1a and summer/autumn fresh to reach 1b. Natural flows and passing flows during winter and spring met additional priorities under the drought climate scenario including winter/spring low flows in reaches 1a, 1b and 2 as well as two winter/spring freshes in reaches 1b and 2.

If dry conditions persist, environmental watering actions in the Glenelg River during 2021-22 will likely focus on maintaining connectivity and water quality in reaches 1a, 1b and 2 to support recently recruited native fish including galaxiids, river blackfish, pygmy perch and estuary perch and to provide foraging opportunities for platypus.

Scope of environmental watering

Table 4.2.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 4.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Glenelg River

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 June to November)	• Wet benches to increase habitat and allow widespread fish passage	
Winter/spring fresh(es) 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 vegetation on the riverbanks to support recruitment and growth and maintain habitat diversity • Provide adequate depth for fish passage and cue fish movement • Encourage female platypus to select a nesting burrow higher up the bank to reduce the risk of higher flow later in the year flooding the burrow when juveniles are present • Scour sand from pools to improve the quality of fish habitat	
Winter/spring fresh(es) in reach 2 (one to five freshes of 300 ML/day for one to five days during June to November)		
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 December to May)		

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

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn freshes in reach 1a (one to two freshes of 60 ML/day for two to three days during December to May)	• Flush fine silt from the stream bed and hard substrate to improve the quality 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 to lower temperatures • Provide sufficient flow to allow native fish and platypus to access habitat	
Summer/autumn fresh(es) in reach 1b (one to two freshes of 100 ML/day for two to three days during December to May/Big Dry to Early Wet*)		
Summer/autumn fresh(es) in reach 2 (one to two freshes of 150 ML/day for two to three days during December to May)		
Summer/autumn fresh(es) in reach 3 (one to two freshes of 150 ML/day for three days each or natural during December to May)		

* See Figure 4.2.2: Glenelg River Environmental Flow Seasonal Calendar

Scenario planning

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

In the Glenelg system, water for the environment is delivered to support varying ecological objectives. In reach 1a, deliveries under dry and drought climate scenarios focus on protecting water quality and preventing the swampy reach from drying out, to support frogs and aquatic vegetation. Under wetter conditions, the priority is to increase flows to improve flowing habitat for native fish and improve the extent of emergent vegetation. In reach 1b, environmental flows aim to maintain the connection to the lower reaches for native fish and platypus and ensure that water quality does not decline in critical drought refuge pools. Under wetter conditions, larger environmental flows are needed to improve the condition of emergent vegetation on the banks and to scour sand from pools, to improve native fish habitat. Reaches 2 and 3 have greater contributions from tributaries, and environmental flows in these reaches are used to stimulate native fish to move and breed, as well as to support in-stream vegetation, which provides additional habitat for native fish, platypus and crayfish.

The highest priority under all scenarios is to maintain connectivity and water quality between pool and swamp habitats upstream of Casterton, as these are the reaches that are most affected by Rocklands Reservoir.

Increased water availability under dry, average and wet climate scenarios will be used to deliver summer/autumn freshes to as many reaches as possible, to allow fish and platypus to move throughout the system to access food and alternative habitats and to wet streamside vegetation. Under a drought climate scenario, there is unlikely to be enough water for the environment to influence flow downstream of Casterton.

If more water is available, the next priorities under all scenarios will be to deliver winter/spring low flow and winter/spring freshes in all reaches, to facilitate the migration and spawning of native fish from the upper reaches down to the estuary. Providing periods of additional or increased flow during winter/spring is likely to also support the re-establishment of small-bodied native fish populations in the upper Glenelg River and Frasers Swamp, located in reach 1.

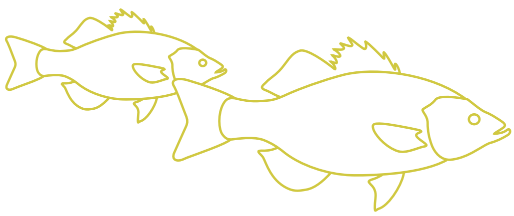
Reserving water for carryover into the 2021-22 water year will be a priority under all scenarios, to ensure sufficient water is available to deliver the highest-priority flows during summer and autumn 2022-23. The volume carried over against the Wimmera-Glenelg environmental entitlement will be decided in consultation with the Wimmera and the Glenelg Hopkins CMAs during the year, and it will be based on use during 2021-22, seasonal conditions and seasonal outlooks for 2022-23.

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

Expected river conditions	• No volumes of passing flow and low volumes of compensation and natural flow	• 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
Predicted supply of water for the environment	• 21,742 ML	• 25,392 ML	• 35,532 ML	• 46,078 ML	• 55,812 ML
Potential environmental watering – tier 1 (high priorities)					
	• Summer/ autumn low flow	• Summer/ autumn low flow • Summer/ autumn fresh (one fresh)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Winter/spring low flow • Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Winter/spring low flow • Summer/ autumn low flow • Summer/ autumn freshes (two freshes)
	• Winter/spring low flow • Summer/ autumn freshes (two freshes)	• Winter/spring low flow • Summer/ autumn fresh (one additional fresh)	• Winter/spring low flow	• N/A	
Potential environmental watering – tier 1 (high priorities)					
	• Summer/ autumn low flow	• Summer/ autumn low flow • Summer/ autumn fresh (one fresh)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Winter/spring freshes (five freshes) • Summer/ autumn low flow • Summer/ autumn freshes (two freshes)
	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/ autumn freshes (two freshes)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/ autumn fresh (one additional fresh)	• Winter/spring low flow • Winter/spring freshes (two freshes)	• Winter/spring low flow • Winter/spring freshes (three freshes)	• Winter/spring low flow

Table 4.2.2 Potential environmental watering for the Glenelg River under a range of planning scenarios *(continued)*

Planning scenario	Drought	Very dry	Dry	Average	Wet
Glenelg River (targeting reach 2)					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• Summer/ autumn low flow	• Summer/ autumn low flow • Summer/ autumn fresh (one fresh)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)
	Tier 1b (supply deficit)				
	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/ autumn freshes (two freshes)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/ autumn fresh (one additional fresh)	• Winter/spring low flow • Winter/spring freshes (two freshes)	• Winter/spring low flow • Winter/spring freshes (three freshes)	• Winter/spring low flow • Winter/spring freshes (five freshes)
Glenelg River (targeting reach 3)					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• N/A	• Summer/ autumn fresh (one fresh)	• Summer/ autumn freshes (two freshes)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)
	Tier 1b (supply deficit)				
	• Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Summer/ autumn low flow • Summer/ autumn fresh (one additional fresh)	• Winter/spring low flow • Summer/ autumn low flow	• Winter/spring low flow	• Winter/spring low flow
Possible volume of water for the environment required to achieve objectives	• 10,155 ML (tier 1a) • 43,843 ML (tier 1b)	• 11,440 ML (tier 1a) • 41,017 ML (tier 1b)	• 13,935 ML (tier 1a) • 38,503 ML (tier 1b)	• 25,660 (tier 1a) • 34,457 ML (tier 1b)	• 30,514 ML (tier 1a) • 42,118 ML (tier 1b)

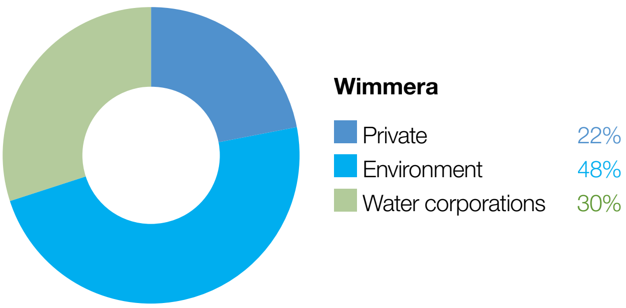


4.3 Wimmera system

Waterway manager – Wimmera Catchment Management Authority

Storage manager – GWMWater

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



Proportion of water entitlements held across the Wimmera and Glenelg basins held by private users, water corporations and holders of water for the environment on 30 June 2020.

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

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.

Top: Wimmera River at Horsham, by David Fletcher
Above: Ranch Billabong following water for the environment delivery, by Wimmera CMA

System overview

Barringgi Gadyin (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, Mount William Creek and Burnt Creek (Figure 4.3.1). These tributaries, and Bungalally Creek and the Wimmera River below Mount William Creek, can receive environmental flows. In exceptionally wet periods, Lake Hindmarsh will 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. Water that is harvested in the system headworks 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 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 via spills from nearby Green Lake when there was significant runoff 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. Water can be actively delivered to Dock Lake from Green Lake via a gravity-fed channel.

Ranch Billabong, near Dimboola, is located on land managed by Barengi Gadjin Land Council Aboriginal Corporation. The billabong was disconnected from the Wimmera River by changes to a road that traverses land between the river and the billabong. Restoring elements of the natural water regime at Ranch Billabong aims to improve habitat for native animal and plant communities and is an important outcome for Traditional Owners and their Nations.

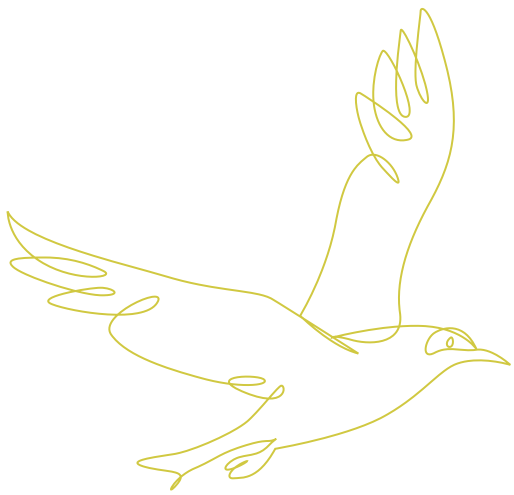
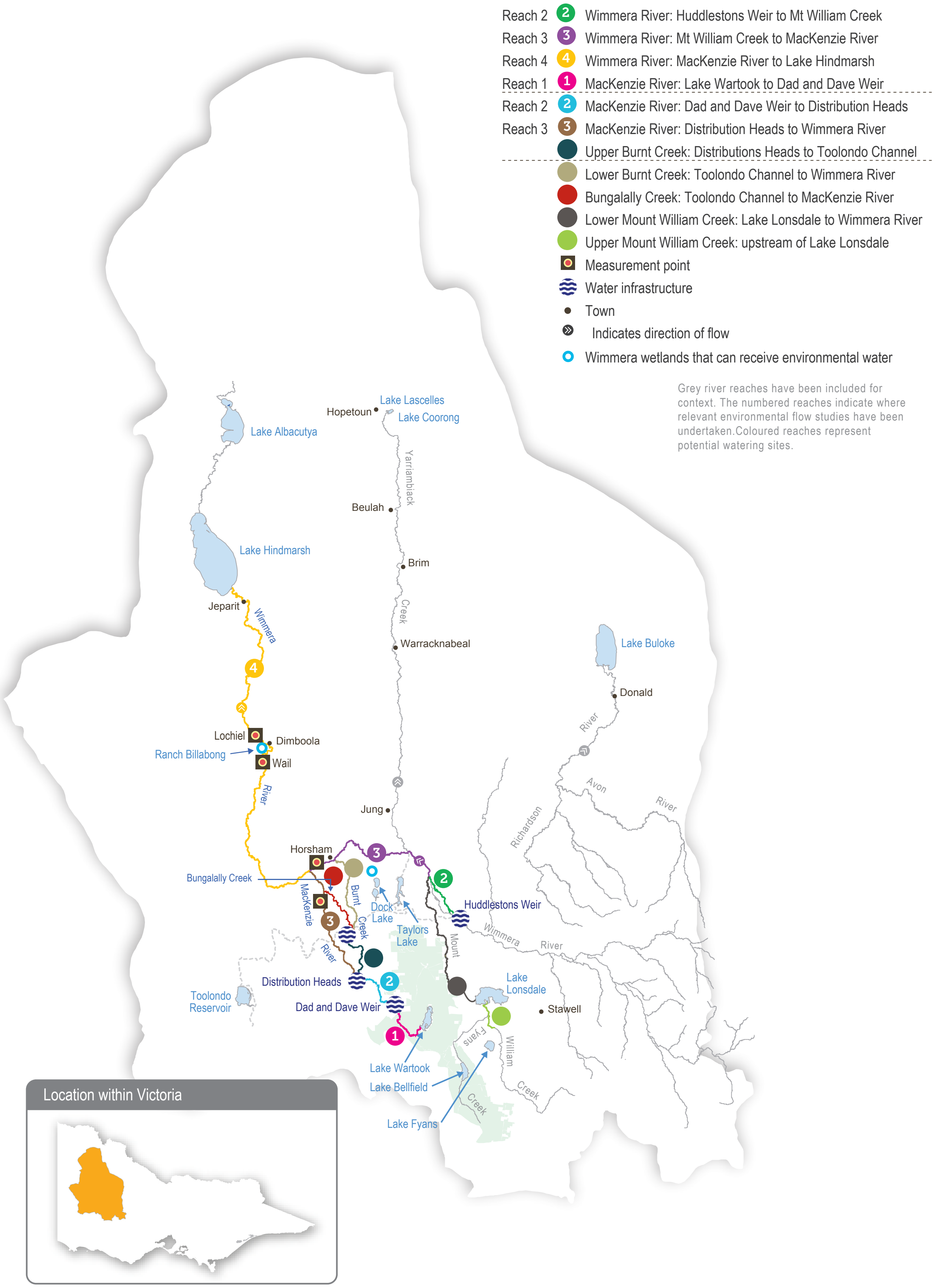


Figure 4.3.1 The Wimmera system



Environmental values

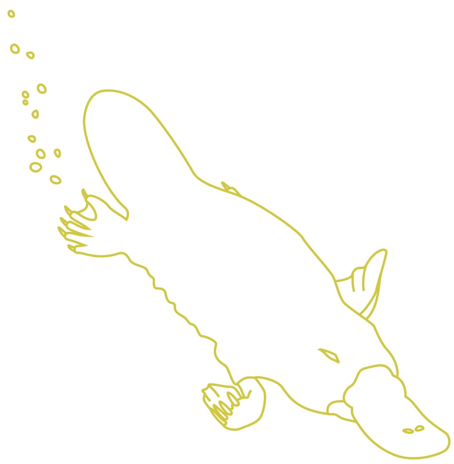
The Wimmera River supports abundant native fish populations including one of Victoria's few self-sustaining populations of freshwater catfish. The Wimmera River also supports native waterbird, turtle, frog and rakali (water rat) populations.

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 populations of threatened Glenelg spiny crayfish and western swamp crayfish and turtles as well as the critically endangered Wimmera bottlebrush. 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, southern pygmy perch and rakali (water rats).

Dock Lake is a natural wetland that was modified and used as part of the Wimmera-Mallee System Headworks until 2010. When it is wet, Dock Lake supports large populations of feeding and breeding waterbirds and frogs.

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 River 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 and prevent the colonisation of waterways by terrestrial plant species
Increase the abundance and distribution of platypus populations 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 native 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 to break down dead organic matter and support the waterway's food web Maintain crayfish populations by providing feeding and breeding habitat
Maintain water quality to provide suitable conditions for waterbugs, native fish and other water-dependent plants and animals

Traditional Owner cultural values and uses

The Wimmera's waterways are important to the Wotjobaluk people and there are heritage values 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, the Barengi Gadjin Land Council and Wimmera CMA considered these values as well as opportunities to enhance contemporary cultural events (such as the Wotjobaluk festival).

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

In the Wimmera system, Wimmera CMA and the Barengi Gadjin Land Council on behalf of the Wotjobaluk people work in partnership to provide Aboriginal environmental outcomes at Ranch Billabong. The delivery of water for the environment 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).

Water for the environment has been delivered to Ranch Billabong consecutively for the last three years (2018, 2019, 2020). Notable ecological enhancements at the site include improved water quality and vegetation condition, consistent with the aspirations of the Traditional Owners. The Barengi Gadjin Land Council manages the site, and is controlling weed species and enhancing accessibility by building walking tracks and boardwalks. Following on from this work, Wimmera CMA and Barengi Gadjin Land Council will continue to work together to deliver environmental water.

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 canoeing, fishing, rowing and water skiing)
- riverside recreation and amenity (such as birdwatching, cycling, 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; Wimmera River Park Run, Peter Taylor Memorial Barefoot Water Ski Tournament and Night Jump at Dimboola, and general visitation)
- socio-economic benefits (such as improved water quality for consumptive water users including irrigation and stock and domestic users).

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 the following icons.

Watering planned to support angling activities

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

Water for the environment can be used to temporarily raise water levels in the Horsham, Dimboola and Jeparit weir pools to improve conditions for community events including fishing competitions and water skiing and rowing events. Water for the environment held in the weir pools is released after the community events, to support ecological objectives further downstream when required.

Recent conditions

The Wimmera region had near-average rainfall, average temperatures but well-below average streamflow during 2020-21, continuing the very low streamflows experienced in the region since 2017. The Wimmera-Glenelg environmental entitlement received 57 percent allocation in 2020-21. The CEWH did not receive any allocation in the Wimmera system for the fourth year in a row, and carryover from previous years was exhausted in 2019-20.

Natural and passing flows delivered low flows and several freshes to the Wimmera River throughout winter and spring 2020. A large rainfall event in October 2020 caused flow in the Wimmera River at Horsham to peak at 636 ML per day and another event in late January–early February 2021 delivered a peak flow of 1,825 ML per day. The February event was the largest flow in the Wimmera River since 2016, and it washed a high load of organic material into the river, which caused a hypoxic blackwater event for parts of the river from near Horsham to Dimboola. Water for the environment was released from Taylors Lake during and after the event to help dilute the blackwater and prevent widespread fish deaths. Water for the environment was also used to meet recommended low-flow targets and deliver some additional freshes during summer and autumn.

Some of the planned passing flows from Lake Lonsdale were suspended in winter and spring 2020, and the accumulated water was used to protect refuge pools in lower Mount William Creek in December 2020.

Water for the environment was used to support environmental values in Ranch Billabong in winter 2021. The MacKenzie River and Burnt Creek had lower-than-average natural flow during winter and spring 2020, and water for the environment was delivered to these systems from late spring 2020 to help maintain aquatic habitat and refuge pools for native fish, crayfish and platypus.

Limited supply in the Wimmera-Glenelg environmental entitlement meant deliveries of water for the environment in the Wimmera system were managed in line with the drought climate scenario, even though local climatic conditions were closer to a dry scenario. All planned watering actions under the drought scenario were either fully or partially met in 2020-21 with a combination of environmental, unregulated and passing flows. Environmental monitoring in autumn 2021 detected an increased distribution of western swamp crayfish in the lower reaches of Burnt Creek. This finding may have implications for the future management of lower Burnt Creek.

Scope of environmental watering

Table 4.3.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

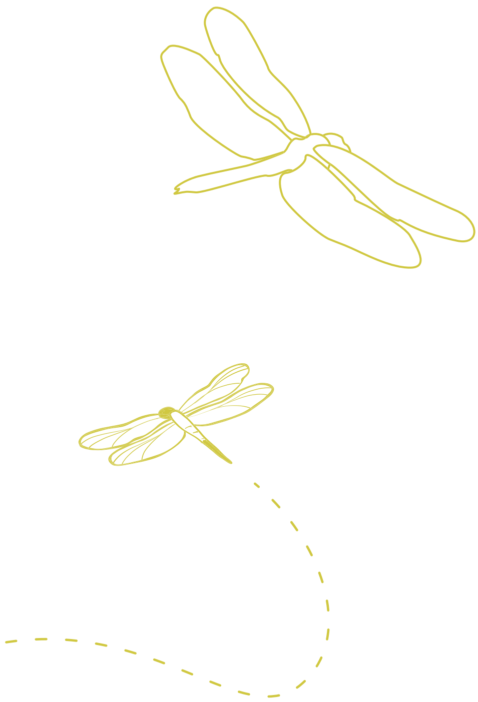


Table 4.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Wimmera system

Winter/spring low flows (30 ML/day during June to November)	• Maintain access to habitat for native fish, waterbugs and in-stream vegetation	
Small winter/spring fresh(es) (one to five freshes of 70 ML/day for one to five days during June to November)	• Increase water depth to provide a stimulus for fish movement • Provide flow variability to maintain water quality and diversity of fish habitats	
Large winter/spring fresh(es) (one to three freshes of 200 ML/day for one to three days during June to November)	• Wet lower benches, entrain organic debris and maintain habitat for waterbugs and fish	
Summer/autumn low flows (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 inundated stream channel for aquatic vegetation and prevent the growth of terrestrial plants in the stream bed	
Summer/autumn fresh(es) (one to five freshes of 70 ML/day for two to four days during December to May)	• Flush pools to prevent a decline in water quality and to maintain habitat for fish and waterbugs • Provide fish passage to allow fish to move through the reach	
Year-round low flows (10 ML/day or natural, year-round)	• Maintain edge habitats and deeper pools and runs for waterbugs • Maintain soil moisture for streamside vegetation and near-permanent inundated stream channel for aquatic vegetation and 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 downstream during autumn and winter	
Small winter/spring fresh(es) (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 • Flush pools to prevent a decline in water quality • Maintain soil moisture for streamside vegetation	

Table 4.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Wimmera system *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Large winter/spring fresh (one fresh of 190 ML/day for one to two days during June to November)	• Disturb biofilms on rocks or woody debris to stimulate new growth and provide food for waterbugs • Maintain soil moisture for streamside vegetation • Stimulate fish and platypus movement by increasing flow rates and water depth	
Summer/autumn freshes (three to four freshes of 35 ML/day for two to seven days each during December to May)	• Flush pools to prevent a decline in water quality and to increase habitat availability for waterbugs and native fish	
Upper Burnt Creek		
Year-round low flows targeting upper Burnt Creek (1 ML/day or natural, year-round)	• Maintain edge habitats and shallow-water habitat for waterbugs • Maintain soil moisture for streamside vegetation and near-permanent inundated stream channel for aquatic vegetation and prevent the growth of terrestrial plants in the stream bed • Maintain a sufficient area of pool habitat for native fish and crayfish populations	
Small winter/spring fresh(es) (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(es) (one to three freshes of 160 ML/day for one to three days during June to November)	• Disturb biofilms on rocks or woody debris to stimulate new growth and provide food for waterbugs • Allow fish to move throughout the reach • Inundate streamside vegetation to maintain plant condition and facilitate recruitment	
Summer/autumn freshes (three freshes of 30 ML/day for two to seven days each 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	
Lower Burnt Creek		
Bankfull fresh (one fresh of 45 ML/day for two days at any time)	• Inundate 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)	• Inundate floodplain vegetation to maintain plant condition and facilitate recruitment • Move organic debris from the floodplain to support waterbugs in the channel • Maintain the structural integrity of the channel and floodplain	
Bungalally Creek		
Bankfull (one fresh of 60 ML/day for two days at any time)	• Inundate 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	

Table 4.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Wimmera system *(continued)*

Top up pools (winter/spring and summer/autumn)	• Maintain edge and shallow-water habitat for native fish and waterbugs • Maintain water quality	
Year-round low flow (5 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 inundated stream channel for aquatic vegetation and prevent the growth of terrestrial plants in the stream bed	
Winter/spring fresh(es) (one to five freshes of 100 ML/day for one to seven days during June to November)	• Wet benches to entrain organic debris and allow native fish to move throughout the reach • Flush surface sediments from hard substrates to support waterbugs • Inundate the streamside zone to maintain its condition and facilitate the recruitment of streamside vegetation communities	
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 allow the movement of fish and waterbugs throughout the reach during the low-flow season	
Winter/spring partial fill	• Trigger the growth and germination of wet-phase wetland vegetation communities • Support feeding and breeding habitat for waterbirds, frogs, waterbugs and turtles	
Top-ups (winter/spring and summer/autumn)	• Inundate wetland vegetation to maintain plant condition and facilitate recruitment • 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.

In the Wimmera system, water for the environment is delivered to support particular ecological objectives in the different rivers and creeks. 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 and Burnt Creek that rely on water from Lake Wartook and Moora Moora Reservoir, and for lower Mount William Creek that relies on water from Lake Lonsdale.

Wimmera River

In the Wimmera River, the highest-priority potential watering actions under all climate scenarios are the delivery of winter/spring and summer/autumn low flows and freshes. Under drought and very dry climatic conditions, there will not be enough water for the environment to deliver the recommended flows all season, and the available supply will be delivered intermittently and at lower magnitudes to maintain pool habitats for native fish and prevent adverse water quality (such as low oxygen and high salinity). The main objective under drought and very dry conditions will be to minimise the loss of aquatic plants and animals. Under a dry scenario, there should be enough water to deliver low flows for part of each season and some freshes to maintain the current condition of native fish populations. Increased water availability, as well as more natural catchment flows under average and wet climate scenarios, will allow low flows to be delivered most of the time as well as more freshes, which will help to further improve the ecological health of the river.

MacKenzie River/Burnt Creek/Bungalally Creek

In the MacKenzie River and Burnt Creek under drought and dry climate scenarios, the highest priority will be to deliver small volumes of water to critical drought refuges in Burnt Creek and reach 3 of the MacKenzie to protect populations of native fish, platypus and crayfish that have re-established in those reaches after the Millennium Drought. Under average and wet conditions, water for the environment will be delivered to increase flowing habitat (including providing continuous flow through the MacKenzie River to connect it to the Wimmera River), improve the health of aquatic and emergent vegetation, and support native fish movement through to the lower section of Burnt Creek. Maintaining the connection between reach 3 of the MacKenzie River and the Wimmera River is a high priority under average and wet climate scenarios, to allow fish to move between the two systems to help grow the populations and increase genetic diversity. A bankfull flow may also be delivered to Bungalally Creek under average and wet climate scenarios, to improve the health of streamside vegetation.

Mount William Creek

Poor water quality and low water availability in Lake Lonsdale are likely to prevent the targeted delivery of water for the environment to lower Mount William Creek under drought, very dry and dry climate scenarios. Any available water under these scenarios will be used to deliver low flows and small freshes to lower Mount William Creek and to top up refuge pools immediately upstream of Lake Lonsdale (upper Mount William Creek) to improve water quality and habitat availability for native fish populations. Increased water availability under average or wet climate scenarios will be used to deliver a mix of low flows and freshes through the whole lower Mount William Creek system and connect it to the Wimmera River. These larger flows are necessary to allow small-bodied native fish to disperse, to help recover populations that have been impacted by multiple years of below-average flow and extended cease-to-flow conditions.

Ranch Billabong and Dock Lake

Under all climatic conditions, small top-ups are planned to inundate Ranch Billabong to improve water quality and support the ongoing recovery of the river red gum and associated understorey vegetation surrounding the billabong. Environmental watering objectives for Dock Lake require large volumes of water that can only be achieved with significant contributions from natural events, so environmental watering is only a priority at Dock Lake under wet conditions.

Reserving water for carryover into the 2022-23 water year will be a priority under all scenarios, to ensure sufficient water to deliver the highest-priority flows during summer and autumn 2022-23. 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 2021-22, environmental conditions and seasonal outlooks for 2022-23.

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

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
Predicted supply of water for the environment	• 21,742 ML	• 25,392 ML	• 35,532 ML	• 46,078 ML	• 55,812 ML
Potential environmental watering – tier 1 (high priorities)					
	• Winter/spring low flow (one month) • Summer/autumn low flow (one month)	• Winter/spring low flow (two months) • Summer/autumn low flow (two months)	• Winter/spring low flow (two months) • Winter/spring fresh (one fresh, small) • Summer/autumn low flow (two months) • Summer/autumn freshes (two freshes)	• Winter/spring low flow (four months) • Winter/spring freshes (three freshes, small) • Summer/autumn low flow (four months) • Summer/autumn freshes (two freshes)	• Winter/spring low flow (four months) • Winter/spring freshes (three freshes, small) • Winter/spring freshes (two freshes, large) • Summer/autumn low flow (four months) • Summer/autumn freshes (three freshes)
	• Winter/spring low flow (increased duration) • Winter/spring fresh (one fresh, small) • Summer/ autumn low flow (increased duration) • Summer/autumn fresh (one fresh)	• Winter/spring low flow (increased duration) • Winter/spring fresh (one fresh, small) • Summer/ autumn low flow (increased duration) • Summer/autumn fresh (one fresh)	• Winter/spring low flow (increased duration) • Winter/spring freshes (three freshes, small) • Winter/spring fresh (one fresh, large) • Summer/ autumn low flow (increased duration) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (increased duration) • Winter/spring freshes (two freshes, small) • Winter/spring freshes (two freshes, large) • Summer/ autumn low flow (increased duration) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (increased duration) • Winter/spring freshes (two freshes, small) • Winter/spring fresh (one fresh, large) • Summer/autumn freshes (two freshes)

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

Planning scenario	Drought	Very dry	Dry	Average	Wet
MacKenzie River (targeting reach 3)[1]					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• Winter/spring low flow (one month) • Summer/autumn low flow (one month) • Summer/autumn freshes (four freshes, small)	• Winter/spring low flow (two months) • Summer/autumn low flow (two months) • Summer/autumn freshes (four freshes, small)	• Winter/spring low flow (two months) • Summer/autumn low flow (two months) • Summer/autumn freshes (four freshes, small)	• Winter/spring low flow (four months) • Winter/spring fresh (one fresh, small) • Summer/autumn low flow (four months)	• Winter/spring low flow (four months) • Winter/spring freshes (two freshes, small) • Summer/autumn low flow (four months) • Summer/autumn fresh (one fresh, small)
	Tier 1b (supply deficit)				
	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/autumn low flow (increased duration) • Summer/autumn freshes (increased duration)	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/autumn low flow (increased duration) • Summer/autumn freshes (increased duration)	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/autumn low flow (increased duration) • Summer/autumn fresh (one fresh, small) • Summer/autumn freshes (increased duration)	• Winter/spring low flow (increased duration) • Winter/spring freshes (four freshes, small) • Winter/spring fresh (one fresh, large) • Summer/autumn low flow (increased duration) • Summer/autumn freshes (four freshes)	• Winter/spring low flow (increased duration) • Winter/spring freshes (three freshes, small) • Winter/spring fresh (one fresh, large) • Summer/autumn low flow (increased duration) • Summer/autumn freshes (four freshes)
Upper Burnt Creek					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• Winter/spring low flow (one month) • Summer/autumn low flow (one month)	• Winter/spring low flow (two months) • Summer/autumn low flow (two months)	• Winter/spring low flow (two months) • Summer/autumn low flow (three months)	• Winter/spring low flow (four months) • Winter/spring freshes (five freshes, small) • Summer/autumn low flow (four months) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (four months) • Winter/spring freshes (five freshes, small) • Summer/autumn low flow (four months) • Summer/autumn freshes (three freshes)

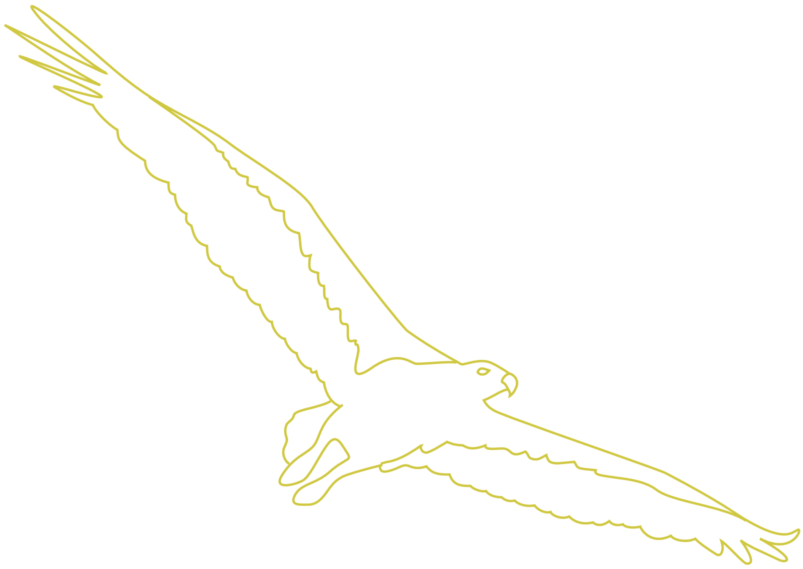
Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios *(continued)*

Potential environmental watering – tier 1 (high priorities)	• Winter/spring low flow (increased duration) • Winter/spring fresh (one fresh, small) • Summer/ autumn low flow (increased duration) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (increased duration) • Winter/spring freshes (two freshes, small) • Summer/ autumn low flow (increased duration) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (increased duration) • Winter/spring freshes (three freshes, small) • Summer/ autumn low flow (increased duration) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (increased duration) • Winter/spring fresh (one fresh, large) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (increased duration)	• Winter/spring low flow (increased duration) • Winter/spring freshes (three freshes, large) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (increased duration)
Potential environmental watering – tier 1 (high priorities)	• N/A			• Bankfull	• Bankfull
Potential environmental watering – tier 1 (high priorities)	• N/A			• Bankfull	• Bankfull
Potential environmental watering – tier 1 (high priorities)	• Top-ups				
Potential environmental watering – tier 1 (high priorities)	• N/A		• Year-round low flow (two months) • Winter/spring freshes (three freshes) • Summer/autumn freshes (three freshes)	• Year-round low flow (three months) • Winter/spring freshes (five freshes) • Summer/autumn freshes (three freshes)	• Year-round low flow (four months) • Winter/spring freshes (five freshes) • Summer/autumn freshes (three freshes)

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

Planning scenario	Drought	Very dry	Dry	Average	Wet
Potential environmental watering – tier 1 (high priorities)	**Tier 1b (supply deficit)**				
	• Year-round low flow • Summer/autumn freshes (three freshes)	• Year-round low flow • Winter/spring fresh (one fresh) • Summer/autumn freshes (three freshes)	• Year-round low flow (increased duration) • Winter/ spring freshes (increased duration) • Summer/ autumn freshes (increased duration)	• Year-round low flow (increased duration) • Winter/ spring freshes (increased duration) • Summer/ autumn freshes (increased duration)	• Year-round low flow (increased duration) • Winter/ spring freshes (increased duration) • Summer/ autumn freshes (increased duration)
Dock Lake					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• N/A				• Partial fill
Ranch Billabong					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• Top-ups				
Possible volume of water for the environment required to achieve objectives	• 6,120 ML (tier 1a) • 26,660 ML (tier 1b)	• 7,070 ML (tier 1a) • 29,510 ML (tier 1b)	• 11,120 ML (tier 1a) • 26,535 ML (tier 1b)	• 18,100 ML (tier 1a) • 20,415 ML (tier 1b)	• 21,000 ML (tier 1a) • 24,975 ML (tier 1b)

1 Potential watering actions targeting reach 3 of the MacKenzie River will also benefit reach 2.



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...?

Citizen scientists make an invaluable contribution by collecting environmental data across the Wimmera-Mallee wetlands. During the past year, community volunteers have contributed to the collection of data about bird species and their abundance, frog species and microbat recordings. This information indicates to land and water managers which species are at these sites and their ecological response to watering.

Top: White-plumed honeyeaters at Mutton Swamp, by Jenny Stephens
Above: Swamp wallaby at Tarkedia Dam, by Michael Gooch

System overview

The Wimmera-Mallee wetlands include 52 wetlands on public and private land spread across north-west Victoria (Figure 4.4.1). From the late 1800s until the construction of the Wimmera Mallee Pipeline Project (WMPP) in 2010, 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 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 some of the 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.

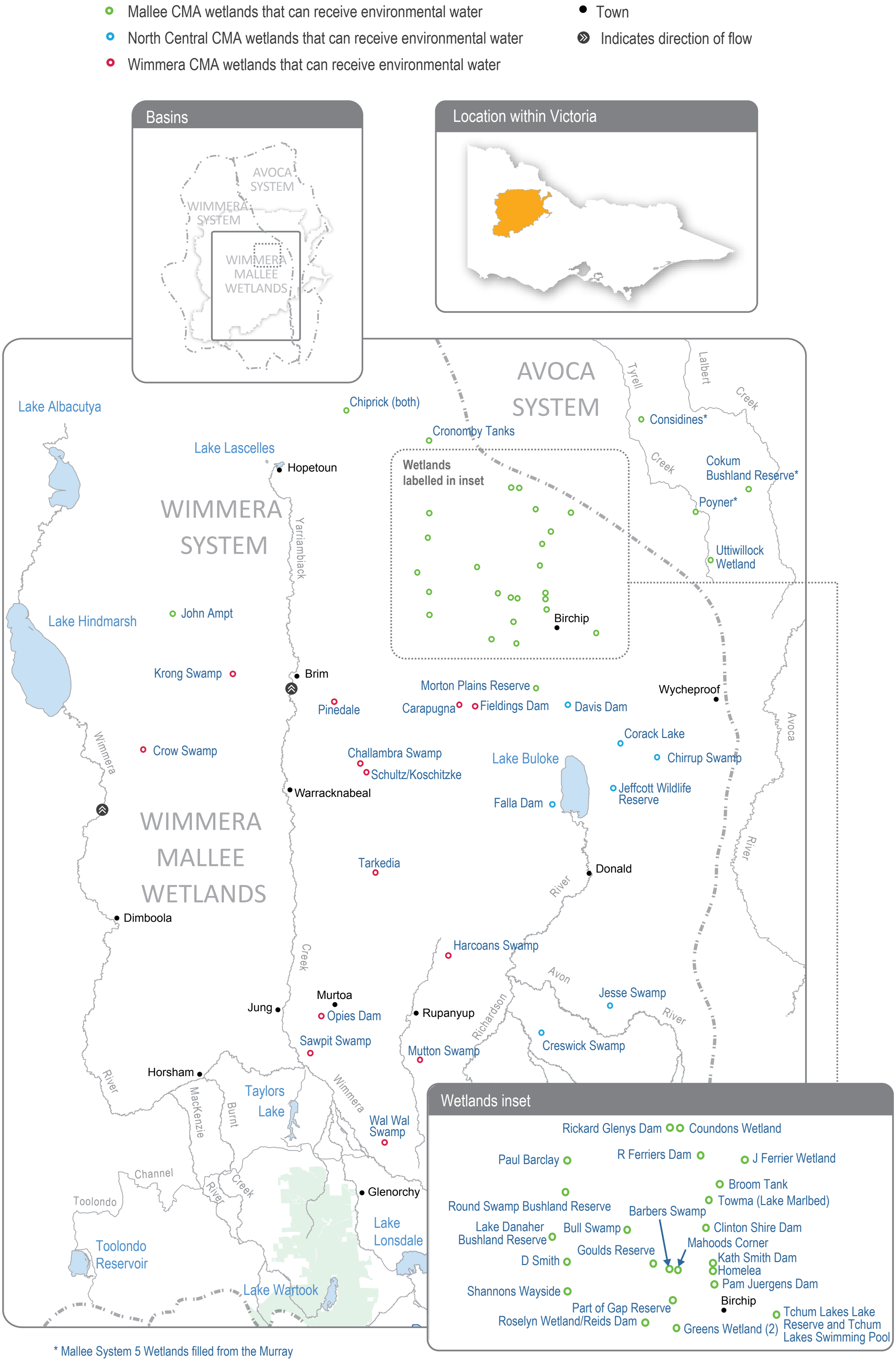
Environmental values

There are many 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 support different vegetation communities. 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 wetland vegetation communities
Maintain and increase populations of waterbirds and other native birds by providing resting, feeding and breeding habitat

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 longstanding cultural heritage and importance of these sites to the 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 sites have artefacts and scar trees recorded in or adjacent to them, and further cultural surveys could better inform management of water for the environment at those sites.

The Barengi Gadjin Land Council is the Registered Aboriginal Party for a significant land area of the Wimmera-Mallee wetlands. The Barengi Gadjin Land Council represents the Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagalk. The Barengi Gadjin Land Council has discussed the significance of the wetlands and their aspiration to undertake work at these sites in future, and it provided the following statement to Mallee CMA when discussing environmental watering:

> *The Wimmera-Mallee is living cultural landscape and there is a lack of recorded data regarding the cultural values over many sections of the Wimmera-Mallee Pipeline. Several highly significant places are outlined through our Country Plan, but like all places across our Country, the rivers, creeks, lakes, wetlands and swamps, and all other landscape features in this area are of high cultural significance. We wish to care for Country again through our traditional land management practices and revive and share the ancient narrative of this area. Mapping the cultural values of places along the Wimmera-Mallee pipeline will be essential in contributing to integrated catchment management.*
>
> *We are unable to identify places of particular cultural values and uses confidently until Aboriginal Water Assessment/Cultural Heritage Surveys are systematically undertaken across Wimmera-Mallee pipeline sites. All of the swamps, wetlands and soaks of this area are of high cultural significance as they are linked to Traditional trading routes that extend in all directions. It is essential that all of these places are managed correctly and water quality and biodiversity are improved.*

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 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, photography, picnicking and walking)
- community events and tourism (such as citizen science including the collection of data about bird species and abundance, frog species and microbat recordings).

Recent conditions

Rainfall across the Wimmera-Mallee region was close to the long-term average during 2020-21, but inflows to storages in the Wimmera-Mallee System Headworks were low and did not replenish storage levels, which are low due to much drier-than-average conditions in the past four years. The Wimmera-Mallee pipeline wetland environmental entitlement received no allocation in 2020-21, and all deliveries of water for the environment to the wetlands in 2020-21 were supplied with water carried over from previous years.

Deliveries of water for the environment to the Wimmera-Mallee wetlands were made in accord with a dry climate scenario. Watering objectives for 2020-21 were almost fully achieved, with water for the environment deliveries or natural inflows providing the required water regime for 38 of the 42 wetlands planned under a dry climate scenario. Landowners' consent could not be obtained in time to support planned environmental watering actions at two wetlands, one wetland did not receive water due to unauthorised grazing by livestock, and a planned watering action at another wetland was met by local runoff. Water for the environment was delivered to 23 wetlands in the Mallee CMA region, ten wetlands in the Wimmera CMA region and five wetlands in the North Central CMA region in winter/spring 2020 and/or autumn/winter 2021. Some wetlands received water once during 2020-21, while others received additional top-ups to maintain their water-dependent values.

Visual surveys at the wetlands across the region have found that water for the environment delivered to the Wimmera-Mallee wetlands provided feeding and breeding habitat for many animals (such as eastern long-necked turtles, frogs, yabbies, rainbow bee-eaters, ducks, grebes and other water and woodland birds). Many wetlands had a noticeable increase of new growth of aquatic and semi-aquatic plants including nardoo, water milfoil, water ribbons and cane grass. Fringing plant species including black box trees, chariot wheels (a nationally threatened forb species) and lignum plants had new canopy growth and greater abundance at some watered wetlands. If dry conditions continue in 2021-22, water for the environment will be essential to maintain aquatic and semi-aquatic plants and provide habitat for water-dependant animal species. Under wetter conditions, water for the environment will be used to complement natural inflows and wet a larger proportion of fringing vegetation (such as black box and lignum), to improve its resilience in future dry years.

Scope of environmental watering

Table 4.4.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects. Two wetlands — Bull Swamp and Homelea — are not planned to receive water for the environment in 2021-22, to allow them to draw down and dry before a planned fill in 2022-23.

Table 4.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Wimmera-Mallee wetlands

Mallee wetlands		
Goulds Reserve Lake Danaher Bushland Reserve Morton Plains Reserve Tchum Lakes Reserve (North Lake – wetland) Tchum Lakes Swimming Pool (North Lake – dam)	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for waterbirds and terrestrial species • Stimulate the growth of aquatic and fringing vegetation and allow the plants including ridged water milfoil, black box and spiny lignum to complete their life cycles	
Cokum Bushland Reserve Part of Gap Reserve Rickard Glenys Dam	• Stimulate the growth of aquatic and fringing vegetation 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	
Broom Tank Clinton Shire Dam Greens_Wetland J Ferrier Wetland	• Stimulate the growth of aquatic and fringing vegetation 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	
Considines Cronomby Tanks	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs and turtles	
Newer Swamp	• Stimulate the growth of aquatic and fringing vegetation and allow the plants including black box and lignum to complete their life cycles	
Chiprick Coundons Wetland D Smith Wetland John Ampt Kath Smith Dam Mahoods Corner Pam Juergens Dam Paul Barclay Poyner R Ferriers Dam Shannons Wayside	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbirds, turtles and terrestrial species	

Table 4.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Wimmera-Mallee wetlands *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Roselyn Wetland Uttiwillock Wetland	• Stimulate the growth of aquatic and fringing vegetation 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	
Towma (Lake Marlbed)	• Stimulate the growth of aquatic and fringing vegetation 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	
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 in the larger wetland footprint to support refuge and feeding and breeding opportunities for frogs • Provide a permanent water source in deeper pool section of wetland 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, semi-permanent water source in spring • Stimulate aquatic and fringing vegetation growth in winter/spring	

Table 4.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Wimmera-Mallee wetlands *(continued)*

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, 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	
Carapugna	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, turtles waterbirds and terrestrial species • Stimulate the growth of aquatic and fringing vegetation and allow the plants including chariot wheels, sneezeweed, ridged water milfoil and spiny lignum to complete their life cycles	
Challambra Swamp		
Crow Swamp		
Fieldings Dam		
Harcoans Swamp		
Krong Swamp		
Mutton Swamp		
Opies Dam		
Pinedale		
Sawpit Swamp		
Schultz/Koschizke		
Tarkedia Dam		
Wal Wal Swamp		

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 for 2021-22 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 life cycles of wetland plants. Under wetter scenarios, water for the environment may be delivered, depending on the capacity in the pipeline system, to water larger areas of the wetland. Large rainfall events and catchment inflows may partially or completely fill some wetlands, and water for the environment may be used to top up, fill or overtop wetlands to improve fringing wetland plant communities 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. Reserving water for carryover into the 2022-23 water year will be a priority under all scenarios, to ensure sufficient water is available to support critical environmental demands in 2022-23 and beyond. The volume carried over against the Wimmera-Glenelg environmental entitlement will be decided in consultation with the North Central, Mallee and Wimmera CMAs during the year, and it will be based on use during 2021-22, seasonal conditions and seasonal outlooks for 2022-23.

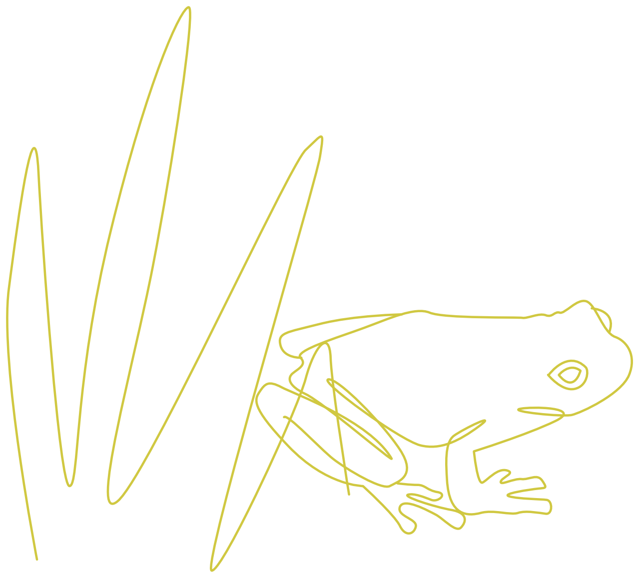
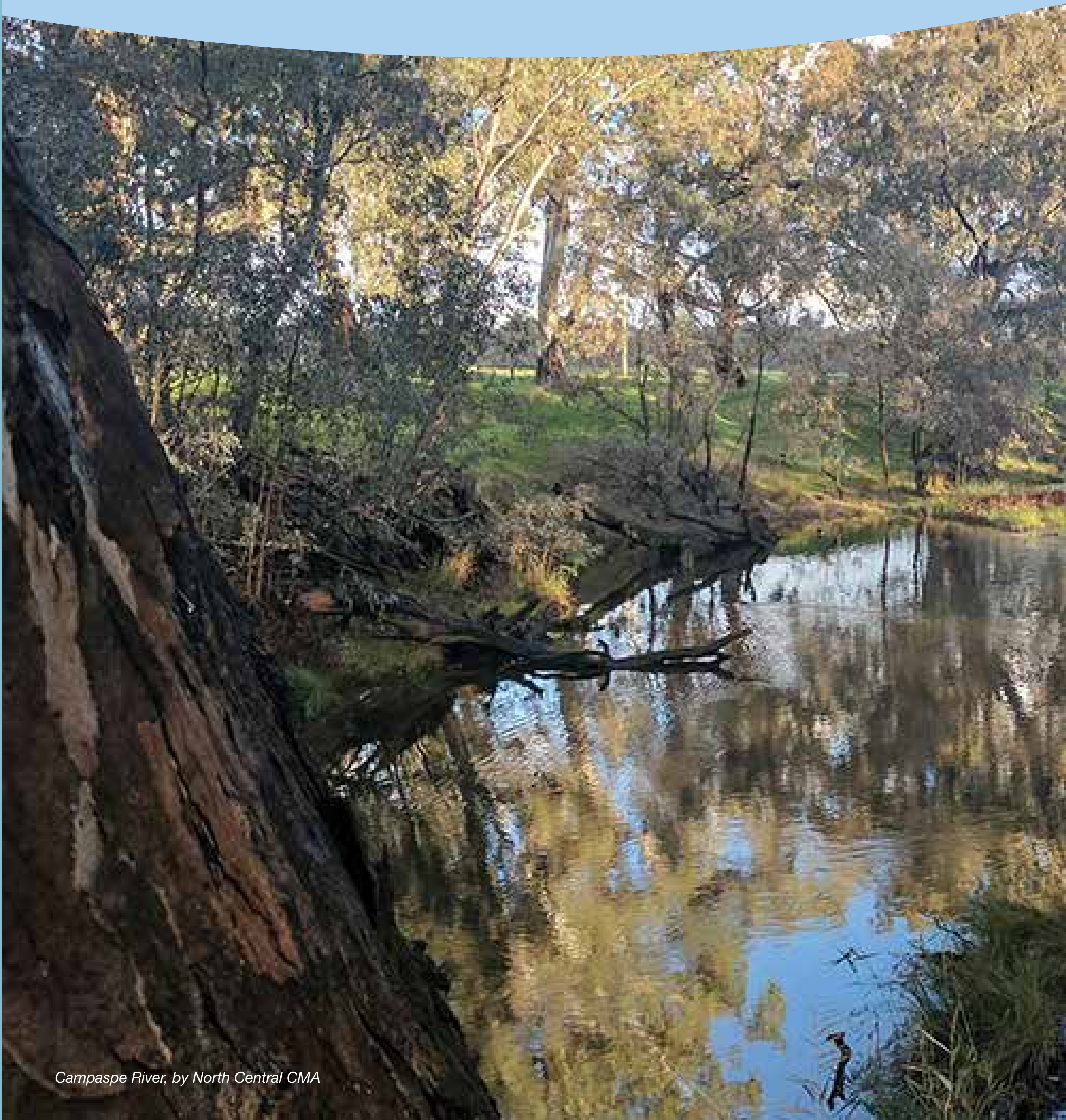


Table 4.4.2 Potential environmental watering for the Wimmera-Mallee wetlands under a range of planning scenarios

Predicted supply of water for the environment	• 375 ML	• 375 ML	• 395 ML	• 735 ML
Potential environmental watering – tier 1 (high priorities)	• Barbers Swamp • Broom Tank • Carapugna • Challambra Swamp • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Creswick Swamp • Cronomby Tanks • Crow Swamp • Davis Dam • D Smith • Fieldings Dam • Greens Wetland • Harcoans Swamp • Jeffcott Wildlife Reserve • Jesse Swamp • J Ferrier • John Ampt • Krong Swamp • Mahoods Corner • Morton Plains • Mutton Swamp • Opies Dam • Paul Barclay • Pinedale • Poyner • R Ferrier • Rickard Glenys • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Tarkedia • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp	• Barbers Swamp • Broom Tank • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundon Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • Davis Dam • D Smith • Falla Dam • Fieldings Dam • Greens Wetland • Harcoans Swamp • Jeffcott Wildlife Reserve • Jesse Swamp • J Ferrier • John Ampt • Kath Smith • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains • Mutton Swamp • Opies Dam • Pam Juergens • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner • R Ferrier • Rickard Glenys • Roselyn Wetland	• Barbers Swamp • Broom Tank • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundon Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • Davis Dam • D Smith • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • Jeffcott Wildlife Reserve • Jesse Swamp • J Ferrier • John Ampt • Kath Smith • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains • Mutton Swamp • Newer Tank • Opies Dam • Pam Juergens • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner • R Ferrier	• Barbers Swamp • Broom Tank • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundon Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • Davis Dam • D Smith • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans Swamp • Jeffcott Wildlife Reserve • Jesse Swamp • J Ferrier • John Ampt • Kath Smith • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains • Mutton Swamp • Newer Tank • Opies Dam • Pam Juergens • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner • R Ferrier

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

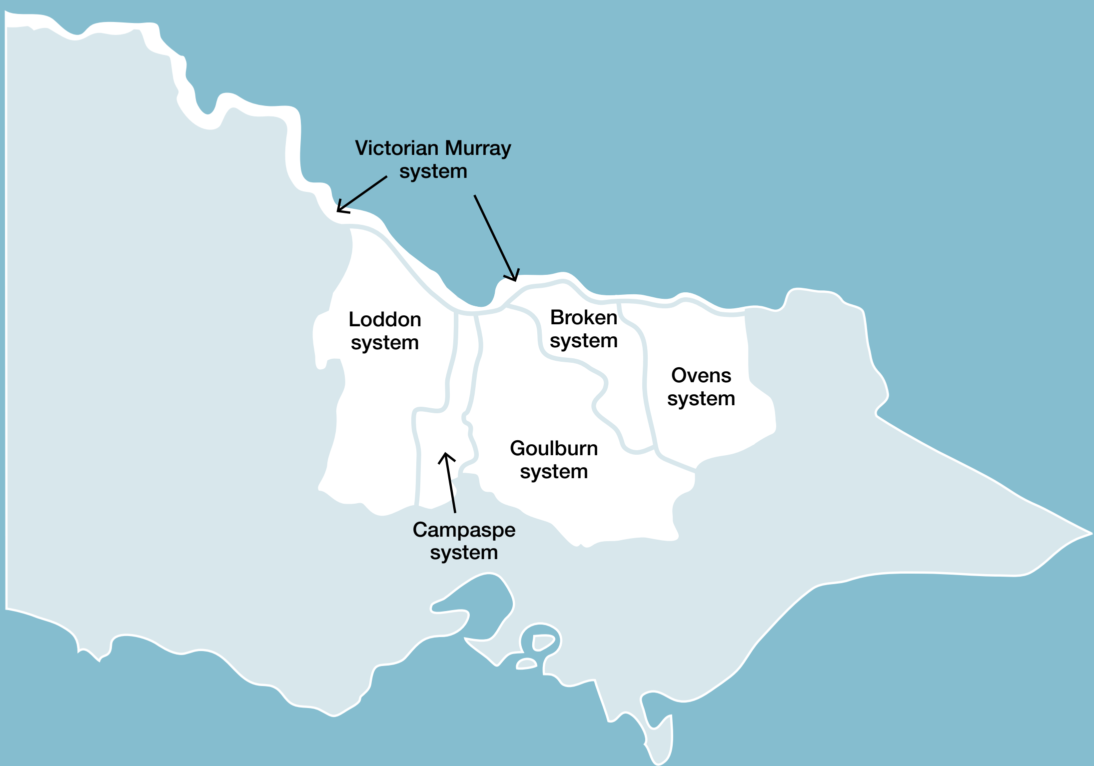
Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 1 (high priorities) *(continued)*		• Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia • Tchum Lakes – Swimming Pool • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp	• Rickard Glenys • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia • Tchum Lakes – Swimming Pool • Tchum Lakes – Wetland • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp	• Rickard Glenys • Roselyn Wetland • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia • Tchum Lakes – Swimming Pool • Tchum Lakes – Wetland • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp
Possible volume of water for the environment required to achieve objectives	• 150 ML	• 199 ML	• 464 ML	• 608 ML



Campaspe River, by North Central 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 Goulburn Broken, Mallee, North Central and North East 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 and their Nations in the northern region continue to 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, Wemba Wamba, 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 and Ngintait), Taungurung Land and Waters Council 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 Nation Aboriginal Corporation to improve collaboration in the management of their Country including Barmah State Forest and reserves along the Goulburn River. In 2010, the Traditional Owner Land Management Agreement under the *Conservation, Forests and Lands Act 1987* over Barmah National Park was signed, enabling 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 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 VEWH and its program partners also 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 how community benefits from environmental flows can be provided while optimising environmental priorities for the year ahead. Aboriginal cultural, social and recreational values and uses are considered for each system in the following systems sections.

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.

Tables 5.1.2 to 5.1.5 show the partners, stakeholder organisations and individuals with which Goulburn Broken CMA, Mallee CMA, North Central CMA and North East CMA engaged when preparing the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek, lower Broken Creek, Hattah Lakes, lower Murray wetlands, Lindsay, Mulcra and Wallpolla islands, Gunbower Creek and Forest, central Murray wetlands and Boort wetlands, Campaspe River, Coliban River, Loddon River, Birchs Creek, Guttrum Forest and Ovens 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 consulted for operational information as part of the development of all annual seasonal watering proposals by CMAs.

Tables 5.1.2 to 5.1.5 also show the level of engagement between Goulburn Broken CMA, Mallee CMA, North Central CMA and North East CMA and stakeholders of the environmental watering program in the northern region, based on the CMAs' 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 the 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.

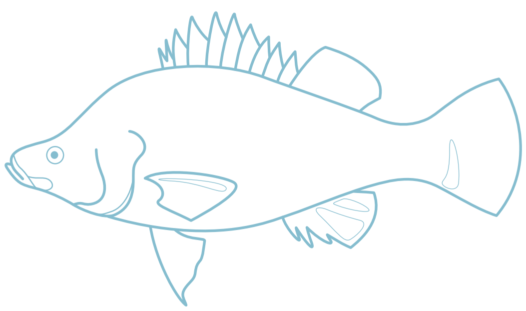


Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken Catchment Management Authority in developing seasonal watering proposals for the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek and lower Broken Creek systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

	Barmah Forest	Goulburn system	Goulburn wetlands	Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
Community groups and environment groups	**IAP2 level: Consult** • Goulburn Murray Landcare • Goulburn Valley Environment Group • Turtles Australia Inc.	**IAP2 level: Consult** • Goulburn Valley Environment Group	**IAP2 level: Consult** • Goulburn Murray Landcare • Goulburn Valley Environment Group • Turtles Australia Inc.	**IAP2 level: Consult** • Goulburn Murray Landcare • Goulburn Valley Environment Group • Turtles Australia Inc.	**IAP2 level: Inform** • Broken Boosey Conservation Management Network • Broken Creek Field Naturalists Club • Goulburn Murray Landcare	**IAP2 level: Inform** • Broken Boosey Conservation Management Network • Broken Creek Field Naturalists Club • Goulburn Murray Landcare
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Greater Shepparton City Council • Moira Shire Council • Murray-Darling Basin Authority • NSW Department of Planning, Industry, and Environment • Parks Victoria • NSW National Parks and Wildlife Service	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Murray-Darling Basin Authority • Parks Victoria	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Greater Shepparton City Council • Moira Shire Council • Parks Victoria	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • 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 **IAP2 level: Inform** • Moira Shire Council

Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken Catchment Management Authority 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 (grouped in alphabetical order) *(continued)*

Landholders/ farmers	**IAP2 level: Consult** • Individual landholders who are on the Goulburn Broken Wetland Management Group	**IAP2 level: Consult** • Individual landholders who are on the Goulburn Environmental Water Advisory Group	**IAP2 level: Consult** • Individual landholders who are on the Goulburn Broken Wetland Management Group • Landowners that adjoin wetlands that receive water for the environment and/or use the delivery channel	**IAP2 level: Consult** • Individual landholders who are on the Goulburn Broken Wetland Management Group • Landowners that adjoin wetlands that receive water for the environment and/or use the delivery channel	**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** • Trelly's Outdoor	**IAP2 level: Consult** • Local ecotourism operator • Trelly's Outdoor	**IAP2 level: Consult** • Trelly's Outdoor	**IAP2 level: Consult** • Trelly's Outdoor		
Recreational users	**IAP2 level: Consult** • Field & Game Australia		**IAP2 level: Consult** • Field & Game Australia	**IAP2 level: Consult** • Individual community members on the Broken Environmental Water Advisory Group • Field & Game Australia	**IAP2 level: Consult** • Individual community members on the Broken Environmental Water Advisory Group	**IAP2 level: Consult** • Individual community members on the Broken Environmental Water Advisory Group **IAP2 level: Inform** • Nathalia Angling Club • Numurkah Fishing Club

Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken Catchment Management Authority 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 (grouped in alphabetical order) *(continued)*

	Barmah Forest	Goulburn system	Goulburn wetlands	Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
Technical experts		**IAP2 level: Consult** • Staff from the Monitoring, Evaluation and Research Program, Goulburn River (Commonwealth Environmental Water Office program)	**IAP2 level: Consult** • Scientists and consultants on the Goulburn Broken Wetland Technical Reference Group	**IAP2 level: Consult** • Scientists and consultants on the Goulburn Broken Wetland Technical Reference Group		
Traditional Owners	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation

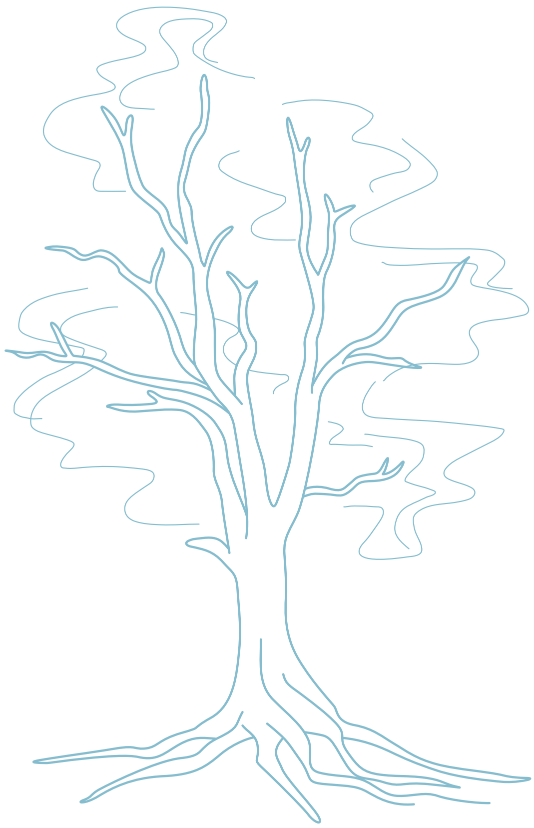


Table 5.1.3 Partners and stakeholders engaged by Mallee Catchment Management Authority in developing seasonal watering proposals for the Hattah Lakes, lower Murray wetlands and Lindsay, Mulcra and Wallpolla islands systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

Community groups and environment groups Government agencies	**IAP2 level: Inform** • Community members on the Mallee CMA Land and Water Advisory Committee	**IAP2 level: Inform** • Community members on the Mallee CMA Land and Water Advisory Committee • Mallee Conservation and Landcare Group • Mallee Landcare Group • OzFish Unlimited	**IAP2 level: Inform** • Community members on the Mallee CMA Land and Water Advisory Committee • Lindsey Point Landcare Group • Millewa-Carwarp Landcare Group • Wider community • OzFish Unlimited
	IAP2 level: Inform • Mallee Conservation and Landcare Group • Mid-Murray Field Naturalists • OzFish Unlimited		
	IAP2 level: Collaborate • Commonwealth Environmental Water Office • Murray-Darling Basin Authority • Parks Victoria	**IAP2 level: Collaborate** • NSW Department of Planning, Industry, and Environment • Parks Victoria	**IAP2 level: Collaborate** • NSW Department of Planning, Industry, and Environment • Parks Victoria
	IAP2 level: Involve • Department of Environment, Land, Water and Planning	**IAP2 level: Involve** • Lower Murray Water • Swan Hill Rural City Council	**IAP2 level: Involve** • Lower Murray Water
	IAP2 level: Consult • Goulburn-Murray Water		**IAP2 level: Consult** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning (Water and Catchments) • Murray-Darling Basin Authority) • SA Water
	IAP2 level: Inform • Mildura Rural City Council	**IAP2 level: Inform** • Mildura Rural City Council	**IAP2 level: Inform** • Mildura Rural City Council • Victorian Fisheries Authority
Landholders/farmers	**IAP2 level: Inform** • Landholders and farmers who live around the Hattah Lakes	**IAP2 level: Collaborate** • Bullock Swamp landholder	**IAP2 level: Inform** • Lindsay Point irrigators • Neighbouring Landholder

Table 5.1.3 Partners and stakeholders engaged by Mallee Catchment Management Authority in developing seasonal watering proposals for the Hattah Lakes, lower Murray wetlands and Lindsay, Mulcra and Wallpolla islands systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order) *(continued)*

	Hattah Lakes	Lower Murray wetlands	Lindsay, Mulcra and Wallpolla islands
Local businesses	**IAP2 level: Inform** • Hattah Store owners • Mallee Tours • Mildura Regional Development • Mildura Visitor Information and Booking Centre • Murray Offroad Adventures • Victorian Apiarists' Association (Sunraysia branch) • Wild Side Outdoors	**IAP2 level: Inform** • Mallee Tours • Mildura Regional Development • Mildura Visitor Information and Booking Centre • Murray Offroad Adventures • Victorian Apiarists' Association (Sunraysia branch) • Wild Side Outdoors	**IAP2 level: Inform** • Lake Cullulleraine Store • Mallee Tours • Mildura Regional Development • Mildura Visitor Information and Booking Centre • Murray Offroad Adventures • Victorian Apiarists' Association (Sunraysia branch) • Wild Side Outdoors
Recreational users	**IAP2 level: Inform** • BirdLife Mildura • Mildura 4WD Club • Sunraysia Bushwalkers Inc.	**IAP2 level: Inform** • BirdLife Mildura • Cabarita Community Inc. • Mid-Murray Field Naturalists • Mildura 4WD club • Sunraysia Bushwalkers Inc.	**IAP2 level: Inform** • BirdLife Mildura • Mildura 4WD Club • Sunraysia Bushwalkers Inc.
Traditional Owners	**IAP2 level: Collaborate** • Traditional Owners of Hattah Lake	**IAP2 level: Collaborate** • First People of the Millewa-Mallee Aboriginal Corporation • Local Aboriginal community • Robinvale Community Elders/Knowledge Holders	**IAP2 level: Involve** • First People of the Millewa-Mallee Aboriginal Corporation • Local Aboriginal community

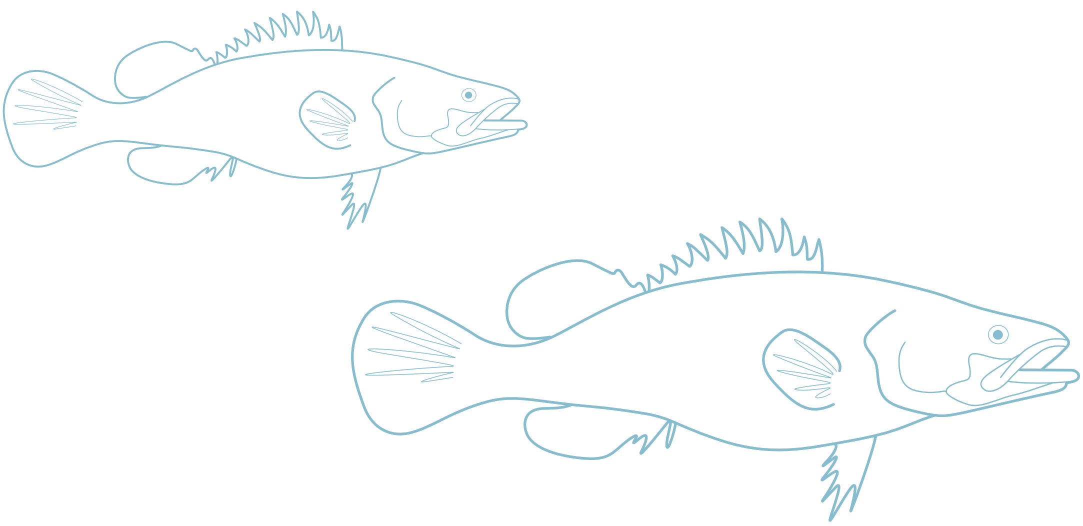


Table 5.1.4 Partners and stakeholders engaged by North Central Catchment Management Authority in developing seasonal watering proposals for the Gunbower Creek and Forest, central Murray wetlands and Boort wetlands, Campaspe River, Coliban River, Loddon River, Birchs Creek and Guttrum Forest systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

Community groups and environment groups	**IAP2 level: Consult:** • BirdLife Australia • Community members on the Gunbower Island Community Reference Group' • Gunbower Landcare Group	**IAP2 level: Inform** • Birdlife Australia	**IAP2 level: Consult** • Echuca Moama Landcare Group • Strathallan Family Landcare	**IAP2 level: Consult** • Malmsbury and District Landcare Group			
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Forestry Corporation of NSW • Goulburn-Murray Water • Murray-Darling Basin Authority • Parks Victoria • VicForests	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Coliban Water • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Goulburn-Murray Water	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Forestry Corporation of NSW • Goulburn-Murray Water • Murray-Darling Basin Authority • Parks Victoria • VicForests
	IAP2 level: Inform • Gannawarra Shire Council • Campaspe Shire Council	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Game Management Authority	**IAP2 level: Inform** • Game Management Authority	**IAP2 level: Consult** • Department of Environment, Land, Water and Planning	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Parks Victoria	

Table 5.1.4 Partners and stakeholders engaged by North Central Catchment Management Authority 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 (grouped in alphabetical order) *(continued)*

	Gunbower Creek and Forest	Central Murray wetlands and Boort wetlands	Campaspe system	Coliban River	Loddon system	Birchs Creek	Guttrum Forest
Landholders/ farmers	**IAP2 level: Consult** • Community members (including irrigators) on the Gunbower Island Community Reference Group	**IAP2 level: Inform** • Individual landholders and community members	**IAP2 level: Consult** • Individual Landhold-ers and community members	**IAP2 level: Inform** • Individual Landhold-ers and community members	**IAP2 level: Inform** • Individual landholders and community members	**IAP2 level: Inform** • Individual landholders and community members	**IAP2 level: Inform** • Adjacent landholders
Recreational users		**IAP2 level: Inform** • Field and Game Australia	**IAP2 level: Inform** • Local canoe club • Paddle Victoria • VRFish	**IAP2 level: Inform** • VRFish		**IAP2 level: Inform** • VRFish	
Technical experts	**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists		**IAP2 level: Collaborate** • Arthur Rylah Institute (Department of Environ-ment, Land, Water and Planning)				**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists
Traditional Owners	**IAP2 level: Collaborate** • Barapa Barapa Traditional Owners **IAP2 level: Inform** • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Barapa Barapa Traditional Owners • Dja Dja Wurrung Clans Aboriginal Corporation • Wemba Wamba Traditional Owners • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Dja Dja Wurrung Clans Aboriginal Corporation • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Dja Dja Wurrung Clans Aboriginal Corporation	**IAP2 level: Collaborate** • Barapa Barapa Traditional Owners • Dja Dja Wurrung Clans Aboriginal Corporation • Wemba Wamba Traditional Owners	**IAP2 level: Consult** • Dja Dja Wurrung Clans Aboriginal Corporation	**IAP2 level: Collaborate** • Barapa Barapa Traditional Owners • Wemba Wamba Traditional Owners

Table 5.1.5 Partners and stakeholders engaged by North East Catchment Management Authority in developing the seasonal watering proposal for the Ovens system and other key foundation documents that have directly informed the proposal (grouped in alphabetical order)

	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 • Rural City of Wangaratta • Victorian Fisheries Authority
Landholders/farmers	**IAP2 level: Collaborate** • Catholic Education Sandhurst Limited
Technical experts	**IAP2 level: Involve** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Collaborate** • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation

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 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 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 catchment management authority (CMA) on-ground works programs that are likely to support environmental watering outcomes in the northern region include:

- the implementation 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. These works are in addition to fish screens that were installed in Gunbower Creek to reduce the number of native fish lost to irrigation channels, and other fish passage works that will create a fish migratory pathway between the Loddon River, Pyramid Creek, Ghow Swamp and Gunbower Creek
- restoration of Australasian bittern habitat through revegetation of tall marsh vegetation communities in Guttrum Forest. Planting will coincide with a planned delivery of water for the environment to help tall marsh become established
- planting native aquatic plants in lower Broken Creek to accelerate the recovery of in-stream vegetation that will provide shelter and foraging habitat for native fish, platypus and other aquatic animals.

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 assessed risks associated with potential environmental watering actions for 2021-22 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?

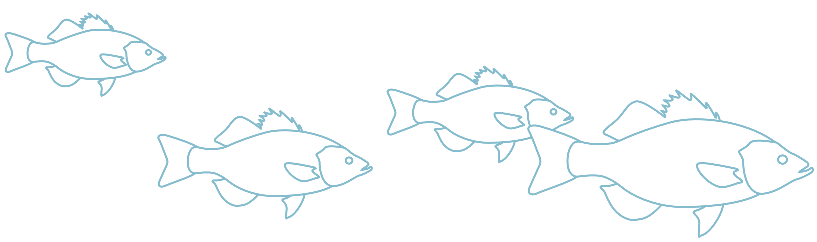
Northern Victoria is a part of the Murray-Darling Basin and deliveries of water for the environment in the northern region are subject to the requirements of the Basin Plan 2012, also known as the Murray-Darling Basin Plan or just the Basin Plan. The Murray-Darling Basin Authority developed the Basin 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 are 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
- managers of water for the environment 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.

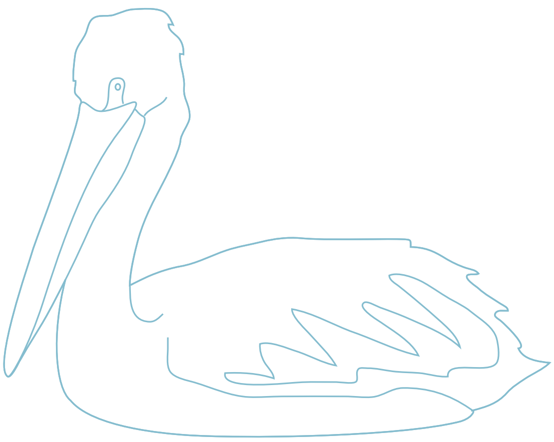


Northern Victoria and the southern Murray-Darling Basin

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, 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 South Australia 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, as well as complementary outcomes for Traditional Owners (as set out in the *Statement on environmental water use in 2021-22* on pages 202-3) and local communities.

Annual planning is documented in basin annual environmental watering priorities (by the Murray-Darling Basin Authority under the Basin Plan), in annual portfolio management plans (by the Commonwealth Environmental Water Office) and 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 increasingly emphasising the coordination of 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 South Australia and through the barrages to the Coorong to trigger upstream migration of fish (such as lamprey)
- delivering a spring flow from Hume Reservoir to support floodplain sites (such as Barmah-Millewa Forest) and the river channel from the mid-Murray to the lower Murray all the way to the Lower Lakes and Coorong in South Australia. This event carries carbon and nutrients from the floodplain to the river and transports them through the system, increasing food availability, helping native fish to move and breed and supporting native aquatic plants in the river channel.

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 South Australia. 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 South Australia 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 water for the environment 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.

Murray system-scale planning and Traditional Owners in the southern Murray-Darling Basin

Environmental water holders consider the objectives and cultural values of First Nations in the Murray-Darling Basin, and they seek to support these where possible. 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.

In April 2021, a forum on Latji Latji Country in Mildura brought together Traditional Owner representatives from many parts of the southern Murray-Darling Basin to share information about the health of Country and discuss preferred outcomes from the management of environmental water. The forum was funded by the Commonwealth Environmental Water Office and organised with the Murray-Darling Basin Authority's Living Murray Program and the Murray Lower Darling Rivers Indigenous Nations.

The *Statement on environmental water use in 2021-22* made by participants at the Southern Basin First Nations' Environmental Watering Forum 2021 is reproduced on the following pages. This statement will be used to guide environmental water planning for the 2021-22 water year, particularly through the Southern Connected Basin Environmental Watering Committee. It will work hand-in-hand with existing, site-based First Nations planning and environmental water delivery along the Murray (see Traditional Owner cultural values and uses in the system sections following).

Southern Basin First Nations' Environmental Watering Forum 2021

Statement on environmental water use in 2021-22

In April 2021,Traditional Owners from many parts of the Southern Murray Darling Basin came together on Latji Latji Country, in Mildura to share information about the health of Country and discuss preferred outcomes from the management of environmental water.

We want water holders, managers and decision makers to hear these key messages:

Respect water, Country and lore

First Nations are willing to share and collaborate with Government agencies to improve river health. But the inherent risks of the settler – colonial water management systems, that have been imposed on our Country, must be addressed. The current water regime in the Murray – Darling Basin ignores the principles and knowledges that underpin our practices of caring for Country.

Water can never be 'owned'. Water and rivers have life and spirit which cannot be bought and sold. All 'ownership' of water in this Country is based on the dispossession of First Nations and imposition of colonial legal frameworks. We have never ceded our inherent rights as guardians and caretakers of rivers and waters. First Nations lore provides a holistic, interconnected management system, where all elements contribute to the good of the whole.

We want to collaborate, but we do not accept or endorse the legal and management frameworks that have been imposed on our rivers. We ask our partners to respect our water spirits, knowledge and lore.

Address our concerns

We have major concerns about the legal, policy and governance setting that dictate how our rivers flow and how we get a voice. These include:

- Overallocation of water and water allocation decisions which do not leave enough in our rivers to sustain their survival or meet our cultural needs
- Over Reliance on damaging infrastructure to regulate and replicate complex natural systems, with little real benefit to our Country
- Short term decision making that doesn't properly account for a changing climate
- Limited commitment to and resourcing for First Nations participation and empowerment
- Decision making that marginalises First Nations' rights and interests
- Commodification and trading of water that disregards the limitations of natural systems
- Water theft and illegal extraction
- Inequitable access to water and poor distribution of the social and economic benefits it can bring

The settler-colonial water framework has generated perverse outcomes which we contend with on a daily basis. The mindset of water management needs to change.

Recognise that our rivers are at risk

We see powerful examples where environmental water is helping to heal Country, but the overall policy and legal settings mean our waterways and cultural values are at risk.

Our biodiversity is suffering. We are struggling to save remnants of our ecologically and culturally significant landscapes. We are being asked to prioritise some places, while we watch others decline or die. We are grappling with this reality.

Infrastructure, including dams, weirs, regulators and pumps, is segmenting our waterways and damaging our Country with little real benefit. There is too much regulation of the floodplain and huge investment in infrastructure without proper engagement with our people.

Fluctuating river levels and unseasonably high flows, driven by consumptive demand, are degrading our waterways and cultural values. Land Use is driving unsustainable water demands and limited channel capacity means we can't get water to where we need it.

Water holes are silting up. Bank erosion and slumping is causing huge impacts on cultural heritage.

Poor water quality, algal blooms and salinity are being compounded by the disruption of natural systems that flush and clean our rivers and wetlands. Waterways, creeks and wetlands are being left to dry out, exposing cultural sites and degrading cultural values.

The health of significant trees and medicinal plants is declining because of lack of water, impacting on our cultural sustainability, health and wellbeing. Culturally significant birds and animal species are not seen where they used to be. There are not enough native fish in the system.

Delivering water to our wetlands and billabongs through artificial systems can mean delivering the wrong water for Country. Legal and infrastructure constraints restrict us from being able to direct water to where we need it

Help us protect and grow the things that are important to us

We are passionate about working together to protect and sustain our waterways.

We need the agency and life force of the river to be respected. We want to see more water going out onto Country and filling all our creeks and billabongs. We want water holders and managers to work with us, looking at the whole system and how to restore it to what it was, with adequate flows and proper timing. We want overbank flows to support total system health.

We want increased recovery of water for the environment, not decreased.

We want to see the Murray Mouth open and salt being flushed from the system.

We want the lakes, billabongs, creeks, wetlands and rivers that are important to us to get the water they need to thrive. We want to see dry and degraded wetlands restored to life with culturally informed watering to protect our cultural heritage values.

We want regular re-connecting flows from floodplains and billabongs, allowing the life in our natural nurseries to restock and replenish the river. We need adequate, sustained flows through our rivers to keep them connected and mitigate variation from irrigation demand.

We want healthy water to flow out of our Country to all mobs downstream. We want the nutrition and healthy water from upstream to replenish Country. We want to build back biodiversity and Traditional Owner management to improve water quality. We want to collaborate with all mobs to ensure a healthy system, renewing cultural connections between Nations.

We need to exercise self-determination over the development and operation of infrastructure on Country. We want to be empowered to use our natural and cultural infrastructure, billabongs, fish traps and breeding structures, to slow down flows and recharge the landscape.

We need adequate healthy water for improved tree health and thriving floodplain forests with red gum, black box and yellow box.

We need flows to replenish the floodplain and support our important cultural plants like old man weed, grasses and sedges, nardoo, cumbungie and milfoil.

We want to see water birds, ducks, swans and brolgas, returning and thriving in our wetlands.

We need connectivity and good water quality to support native fish including black bream, congoli, crayfish, mussels, small bodies fish, shrimp, shield shrimp, yabbies', yellowbelly, Murray cod, catfish, black fish, Murray hardyhead and trout cod. We want turtles, platypus, frogs and all the other animals that rely on water to be able to return to Country.

We want co-management of all environmental water. We want to be empowered to make the decisions about how environmental water is used. Prioritisation and water planning should be driven from the ground up, by First Nations. Give us control and we will show you how to heal Country and, in doing so, we will maintain intergenerational transfer of knowledge.

We want water managers to listen deeply to what Traditional Owners and Elders have to say and to help us access your science to back our objectives (not the other way round).

We need policy changes, transparency and reviews of the existing entitlement system. We need to review and amend the Basin Plan to reflect our knowledge, science and human rights. We need Traditional Owners involved in the highest level of all Government agencies and we need our own agencies and statutory bodies.

Seasonal outlook 2021-22

Rainfall across northern Victoria in 2020-21 was close to the long-term average in most areas, although slightly below the long-term average in the north-west and parts of the eastern ranges. Mean maximum temperatures were close to or slightly above average across the region. Winter rainfall resulted in some relatively small, unregulated flow events in the Goulburn, Ovens and Kiewa rivers. Further rain in spring gradually increased storage levels and provided occasional unregulated pulses that remained within the channel in the regulated rivers. Environmental flows were delivered to rivers and wetlands across the region in 2020-21 to provide what would have occurred naturally without river regulation and to support native plants and animals.

Inter-valley transfers (IVTs) from the Goulburn system to the Murray system over summer and autumn were reduced from 50,000 ML per month in 2019-20 to 40,000 ML per month in 2020-21, to help protect native vegetation and reduce bank erosion in the lower Goulburn River. Anecdotal evidence suggests the rate of bank erosion has slowed and there has been some recovery of native vegetation, but the river is far from fully recovered. Monitoring will continue to assess the condition of the banks and bank vegetation over the next few years.

The climate outlook from June to August 2021 indicates average to above-average rainfall and average to above-average temperatures are likely. However, it appears autumn 2021 will be relatively dry, so moderate to high rainfall will be needed to wet the catchments before there will be significant natural inflows to waterways and storages. Above-average rainfall throughout winter and spring 2021 should increase water in storage and deliver some natural flow pulses in the rivers. Environmental flows may piggyback onto or extend the duration of natural events, where doing so helps achieve particular environmental flow objectives. If 2021-22 is considerably drier than average, environmental flows will mainly be used to maintain rather than improve the health of native plants and animals in the region's rivers and wetlands.

Many of the Murray River floodplains have not been inundated since 2016-17, and they are prioritised for environmental watering in 2021-22 under all climate scenarios to prevent native plant communities from exceeding their tolerable dry period. Watering floodplain wetlands at Hattah Lakes, and across Lindsay, Mulcra and Wallpolla Islands will be especially important in 2021-22 because proposed construction activities for the Victorian Murray Floodplain Restoration Project will prevent planned environmental flows to these sites in 2022-23 and 2023-24. A watering event that commenced at Hattah Lakes in autumn 2021 is likely to continue into winter and spring 2021, while planned watering actions at Gunbower Forest are likely to commence in winter or spring 2021 even under a dry climate scenario. Without these environmental flow events, the health of the plant and animal communities that live on the floodplain will significantly decline.

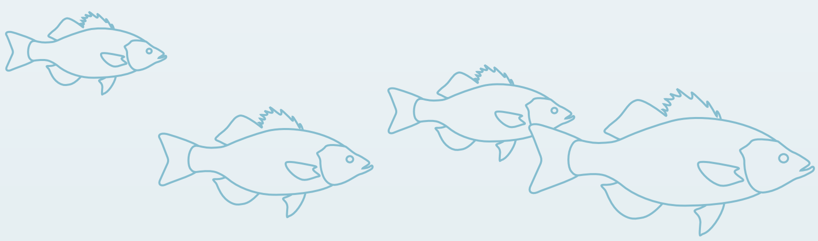
Operational inter-valley transfers of water (IVTs) from the Goulburn system via lower Broken Creek and the Goulburn and Campaspe rivers to the Murray River are again expected to feature prominently in summer and autumn 2021-22. Specific IVT limits will be determined through the review of the Goulburn to Murray trade rule, which is due to conclude in June 2021. Proposed rates of IVT delivery remain above recommended environmental flow rates, but importantly they remain significantly lower than in past years. It will be essential to enable environmental flows to be adaptively managed year-round, to support the health of the lower Goulburn River and other waterways, including downstream sites.

The allocation outlook for 2021-22 provided by the Northern Victoria Resource Manager on 17 May 2021 indicated low opening allocations across all systems, particularly for the smaller Broken and Bullarook systems that are likely to have zero opening allocation. The larger Murray, Goulburn, Campaspe and Loddon systems are expected to open below 25 percent allocation to high-reliability water shares. Carried-over water can be delivered in all systems, and it will likely be important for meeting early-season demands from July 2021.

Under an extreme dry[1] scenario, very little increase in water allocation is expected during 2021-22. Under a dry climate scenario, the Broken and Campaspe systems may reach 30 percent allocation, while the Murray, Goulburn and Loddon systems may reach 60 percent allocation. All systems should get close to or reach 100 percent allocation under average or wet scenarios in 2021-22. The Northern Victoria Resource Manager has not provided an outlook for low-reliability entitlements, but for planning purposes the VEWH has assumed no allocation against low-reliability entitlements during 2021-22 unless there are significantly above-average inflows to storages.

Under drought and dry climate scenarios, environmental flows are expected to focus on protecting and maintaining habitat for native plants and animals, to avoid decline or loss. Examples include watering selected wetlands in the Kerang Lakes to maintain vegetation and provide refuge for waterbirds and maintaining low flow in rivers to protect native fish and platypus. In some systems (such as the Goulburn River), relatively high volumes of carryover will enable the delivery of some larger watering actions — actions that can usually be delivered only under average climate scenarios — to be delivered in a dry climate scenario, to improve or enhance environmental outcomes.

If conditions and allocations improve, water for the environment may be used to deliver larger events to improve the health of the environment. Under average and wet climate scenarios, larger floodplain watering events are planned at icon sites along the Murray River, and additional wetlands will likely be watered 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 floodplains to rivers to increase the productivity of food webs and provide food for native 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.



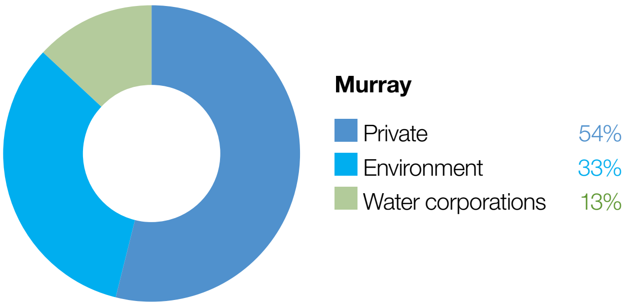
1 Northern Victoria Resource Manager resource outlooks refer to the driest outlook as ‘extreme dry’. In the seasonal watering plan, the driest climate scenario is usually called ‘drought’.

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, Water NSW

Environmental water holders – Victorian Environmental Water Holder (including the Living Murray program), Commonwealth Environmental Water Holder



Proportion of water entitlements in the Murray basin held by private users, water corporations and environmental water holders on 30 June 2020.

Did you know...?

Long-term data for the Murray, Goulburn, Broken, Ovens and King rivers was used to examine the effects of flow and environmental flow management on the recruitment of Murray cod. While specific links between flows and recruitment varied across rivers, the data is evidence that managing flows in line with a more natural flow regime will significantly improve outcomes for Murray cod. The same is also likely to apply to species with similar breeding strategies (such as trout cod and river blackfish).

Top: Barmah Lake vegetation response, by Keith Ward, Goulburn Broken CMA
Right: River redgum at Hattah Lakes, by the VEWH

Traditional Owners have a unique connection to their lands and water, including what is referred to as the Murray River system. Traditional Owners within their traditional borders refer to the Murray in their own languages. For example, the Yorta Yorta People know the Murray as *Dhungulla*. They possess distinct cultural boundaries, language and cultural practices. The Victorian Murray system referred to in this plan includes waterways, storages, weirs, locks and regulators managed under state and federal legislation. This system overlays many Traditional Owner boundaries.

Within the Victorian Murray system, there are many significant floodplains and wetland systems covering the Goulburn Broken, North Central and Mallee CMA areas. They are sites of significance for Traditional Owners, with tangible and intangible cultural connections dating back many thousands of years and continuing to the present day. 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 (CEWH); 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 Forest is located within Yorta Yorta's traditional boundaries. The Barmah-Millewa Forest covers 66,000 ha and spans the New South Wales – Victoria border between Tocumwal, Deniliquin and Echuca (Figure 5.2.1). The Barmah-Millewa Forest is listed under the Convention on Wetlands of International Importance (the Ramsar Convention) and is on 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 and culturally significant sites to the Yorta Yorta.

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 utilised 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 (commonly referred to 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. The Yorta Yorta People see this narrow part of their *Dhungulla* as a culturally significant creation story, and it provides ecosystem services both from a culturally and environmentally signifcant viewpoint. The name 'the Barmah Choke' is not a culturally appropriate name for the Yorta Yorta and is seen as a negative way to view their traditional lands and waters. Yorta Yorta People may refer to this as the 'Pama Narrows'.

Before the river was regulated, Barmah-Millewa Forest would have regularly flooded with high flows from rainfall in winter and spring. These regular floods shaped a rich, productive forest environment. The construction and operation of Hume Reservoir and Dartmouth Dam have greatly reduced the size and frequency of natural winter/spring floods in Barmah-Millewa Forest. Also, operational deliveries to supply water to users downstream of the Barmah Choke can cause unseasonal low-level floods, which can damage the forest and banks of the river depending on the timing and volume of the flows. Country for the Yorta Yorta People continues to change, but the changes have been rapid post-settlement due to infrastructure installation and river regulation. This has changed Country culturally and environmentally for the Yorta Yorta People. Their language word for water is *Wala* and this includes if an area is wet but may imply to others a 'flood' which is viewed as negative water.

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-Millewa Forest is also limited by a flow constraint below Yarrawonga Weir to minimise impacts to adjacent farming operations in NSW. The current constraint limits regulated flows to a maximum river level of 3.3 m at the Tocumwal gauge (about 18,000 ML per day downstream of Yarrawonga Weir), subject to various conditions. Regulated flow up to a river level of 3.0 m on the Tocumwal gauge (about 15,000 ML per day downstream of Yarrawonga Weir) can be delivered at any time during the year and is not subject to conditions. 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 and returns to the river can often be used at sites further downstream as part of multi-site watering events.

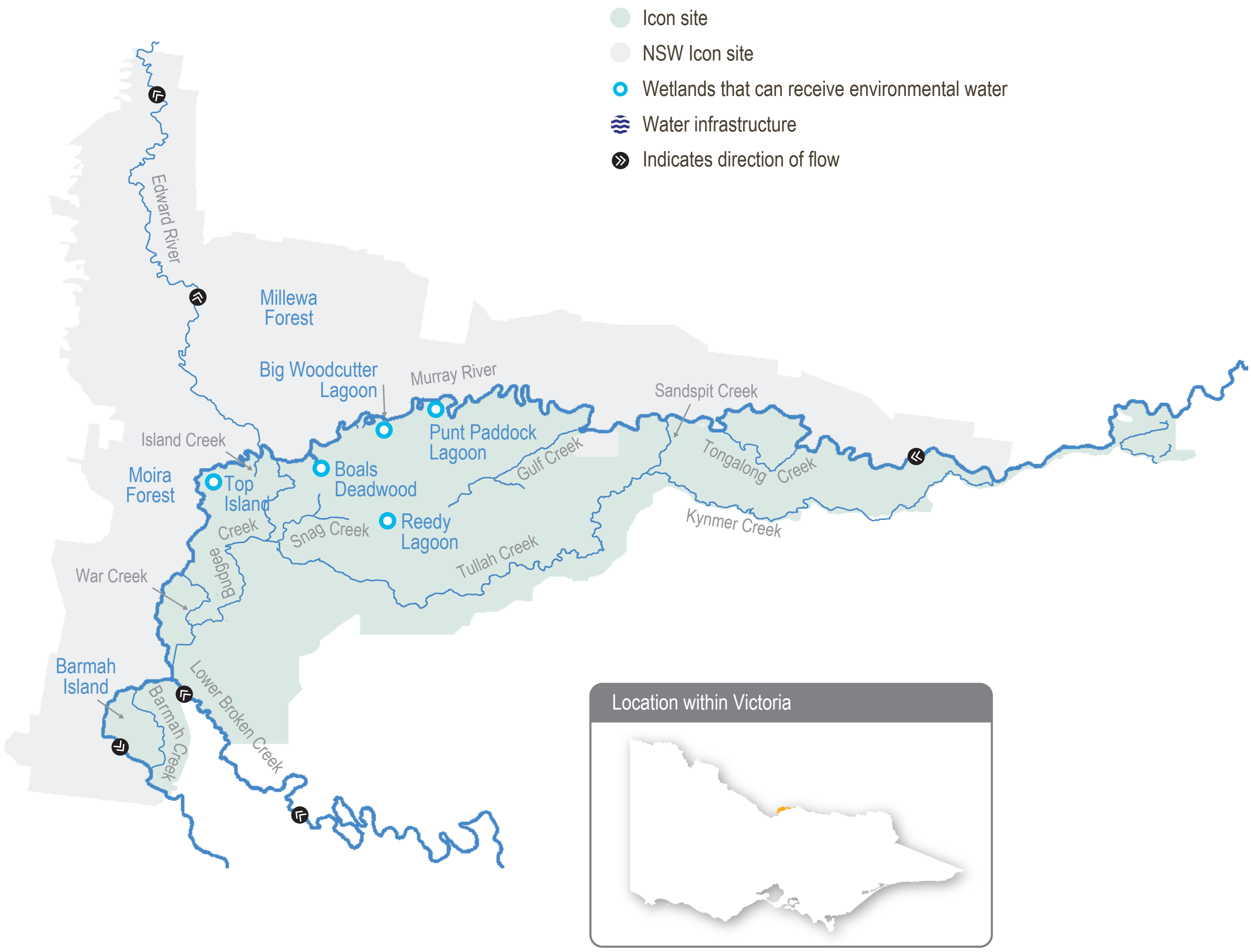
Environmental values

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 frog populations
Protect forest waterways from increased erosion
Maintain turtle populations 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
Reduce the risk of low-oxygen events in summer

Figure 5.2.1 Barmah Forest



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

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 the Yorta Yorta Nation Aboriginal Corporation during the water for the environment planning process to get 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 refuges, which protects turtles that are an important totemic species for the Yorta Yorta People
- watering to support floodplain marsh vegetation, which includes important food, fibre and medicinal plants (such as sneezeweed and weaving sedge)
- healthier river red gums, which has benefits for important Yorta Yorta sites and significant markings such as a scarred tree and furthers connections to Country
- broader restoration to achieving health of Country.

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 boating and fishing)
- riverside recreation and amenity (such as birdwatching, camping, benefits physical, mental and social wellbeing of residents and visitors)
- community events and tourism (such as boat tours)
- socio-economic benefits (such as apiarists and irrigation diverters).

Recent conditions

Despite a La Niña event in south-eastern Australia, Barmah Forest experienced drier-than-average conditions throughout most of 2020-21. Maximum temperatures were generally close to the monthly long-term average, and there were no prolonged hot spells in summer. Local rainfall was below the long-term mean (measured at Echuca) in winter, spring and summer. Carryover of water combined with Murray allocations in Victoria (100 percent of high-reliability water shares) and New South Wales (50 percent of general security) provided sufficient water for the environment to meet the planned watering actions in Barmah Forest.

Forest regulators were opened from August 2020 to December 2020 to allow a natural connection between the Murray River and the waterways within Barmah Forest. Two small natural floods occurred in Barmah Forest in July and August 2020. Water for the environment was delivered to the forest from October to mid-December, to mimic some of the low-level flooding that would have naturally occurred without river regulation. The environmental watering event was part of a coordinated 'southern spring flow' that aimed to achieve environmental objectives along the Murray River from Hume Reservoir to the sea. Managed environmental flows slowly reduced through December to enable fish and turtles to return to the main channel, but a short pulse was delivered during the flow recession to trigger golden and silver perch spawning. One regulator remained open in Barmah Forest from mid-December to February to maintain water levels in a wetland until breeding white ibis, straw-necked ibis and royal spoonbills successfully fledged their chicks.

All watering actions for Barmah Forest aligned with an average scenario were delivered as planned in 2020-21, noting the delivery of autumn/winter low flows in May and June 2021 had not occurred at the time of writing. Maintaining a 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. Low-level flooding in spring supported wetland plant growth and flowering for species (such as Moira grass) that were unable to flower in 2019-20 due to floodplain watering ending mid-October 2019. The targeted wetland watering through summer helped some 450 pairs of ibis and spoonbills successfully fledge young birds. This was the first successful nesting for these species in Barmah Forest since 2016-17. Bitterns were also recorded calling throughout the forest wetlands in 2020-21, and they are likely to have bred. The drying phase implemented throughout the forest in summer/autumn 2020-21 is important to maintain plant diversity and wetland productivity.

The spring environmental flow to the forest was diverted a little more into Barmah Forest than Millewa Forest in 2020, to achieve the best possible outcomes for the floodplain marshes in Barmah Forest while somewhat compromising the equivalent outcomes in Millewa Forest. This reflected a delivery targeting 3.0 m in the Murray River at Tocumwal (about 15,000 ML per day downstream of Yarrawonga). Delivering to the current maximum constraint of 3.3 m at Tocumwal in 2021-22 would improve floodplain marsh vegetation outcomes in both Barmah and Millewa forests, as well as increase lateral connection and provide more habitat for native fish, turtles, frogs and waterbirds.

Scope of environmental watering

Table 5.2.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

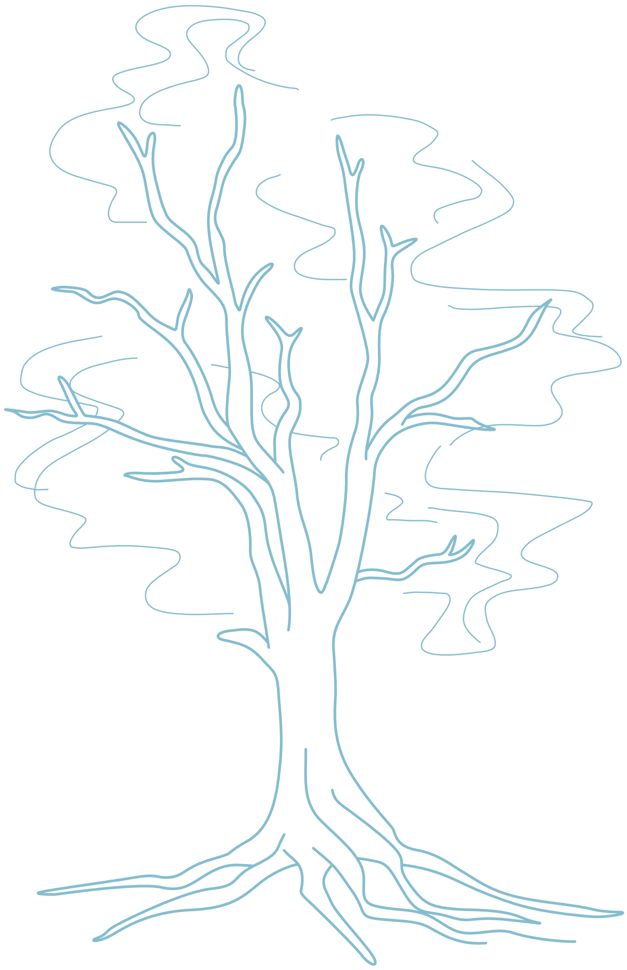


Table 5.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Barmah Forest

Winter/spring forest low flow to various waterways in Barmah Forest (variable flow rates and duration during July to November)	• Provide a gradual connection of waterways with the Murray River to minimise erosion within those waterways • Provide flow in forest waterways to ensure adequate refuge pools persist for native fish and turtles • Provide adequate depth and connection between floodplain waterways and the river to facilitate the movement of native fish • Remove accumulated organic matter from waterways to cycle carbon to the river system and minimise the risk of hypoxic blackwater by ensuring through-flow commence in the cooler months	
Winter/spring/summer low flow (8,500-18,000[1] ML/day below Yarrawonga Weir during August to December)	• Maintain a sufficient water level in the Murray River main channel to avoid Murray cod nest abandonment, increase juvenile survival and improve dispersal opportunities	
Spring/summer fresh(es) in the Murray River channel (one to three freshes that increase flow by at least 500 ML/day and maintain it for two to eight days during October to December)	• Provide variable water levels once water temperatures exceed 22°C, to trigger spawning of native fish species, primarily 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 refuge pools to provide habitat for native fish and turtles • Flush refuge pools to maintain water quality	
Spring/summer/autumn low flow to floodplain waterways including Sandspit, Gulf, Big Woodcutter, Boals and Island creeks and Punt Paddock Lagoon (200 ML/day for 30 to 60 days during November to April)	• Replenish refuge pools in permanent waterways to maintain water quality, fish and turtle populations • Maintain connectivity between the forest and 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 waterbird breeding and maintain a depth of at least 0.5 m beneath reed bed nesting breeding colonies • Maintain wetting duration and depth for growth of wetland vegetation	

Table 5.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Barmah Forest *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Spring wetting of floodplain marshes (variable flow rates of > 9,500-18,000[1] ML/day below Yarrawonga Weir for three months during September to December)	• Wet open plains for sufficient depth and duration to allow the growth of floodplain marsh vegetation • Inundate 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	

1 The maximum flow constraint is a level of 3.3 m at the Tocumwal gauge in the Murray River, estimated at 18,000 ML/day downstream of Yarrawonga Weir. The maximum flow rate actually delivered may vary for these actions.

Scenario planning

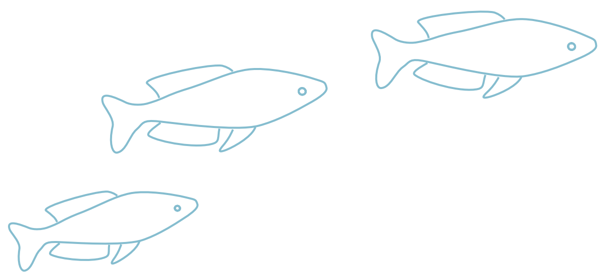
Table 5.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

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 to transport carbon and nutrients and 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 that trigger the spawning of silver perch.

Under extreme dry 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.

A new action for 2021-22 is the winter/spring/summer low flow in the Murray River channel to maintain sufficient water levels for successful Murray cod nesting and recruitment under dry to wet climate scenarios. This watering action aims to increase the Murray cod population and improve the recovery of this species. The volume needed to achieve this depends on the contribution of natural flows and the delivery of operational water downstream through the Barmah Choke. This action will provide environmental return flows downstream for use at other sites along the Murray River.



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 may require large volumes of water to be directed into the forest, with water for the environment provided as a directed release from Hume Reservoir targeting specific flow rates downstream of Yarrawonga Weir 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.

A prolonged, low-level, spring watering event in 2021-22 is desirable, to help floodplain vegetation flower, set seed and recruit. Some floodplain inundation will occur when flow downstream of Yarrawonga exceeds 9,500 ML per day, but a higher flow will inundate more of the floodplain to a greater depth and therefore deliver a better environmental outcome for floodplain vegetation and benefit native fish, turtles and waterbirds. Ideally, the flow will be delivered up to 3.3 m on the Tocumwal gauge (about 18,000 ML per day downstream of Yarrawonga Weir) to inundate larger areas to an appropriate depth in Barmah and Millewa forests, compared to 2019-20 and 2020-21.

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 2021-22 under the dry and extreme dry scenarios, but it would provide environmental benefit and may be delivered under certain circumstances. For example, if the 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, even under an extreme dry or dry climate scenario. A multi-site environmental watering objective supporting whole-of-River-Murray and/or downstream environmental objectives during winter and spring may also deliver flow through Barmah Forest, and it could be supplemented to optimise environmental outcomes. The volume of water for the environment required to achieve the floodplain marsh flow objectives under the dry or extreme dry climate scenarios depends on demands for operational water or environmental multi-site events, and it is therefore not estimated in Table 5.2.2 below.

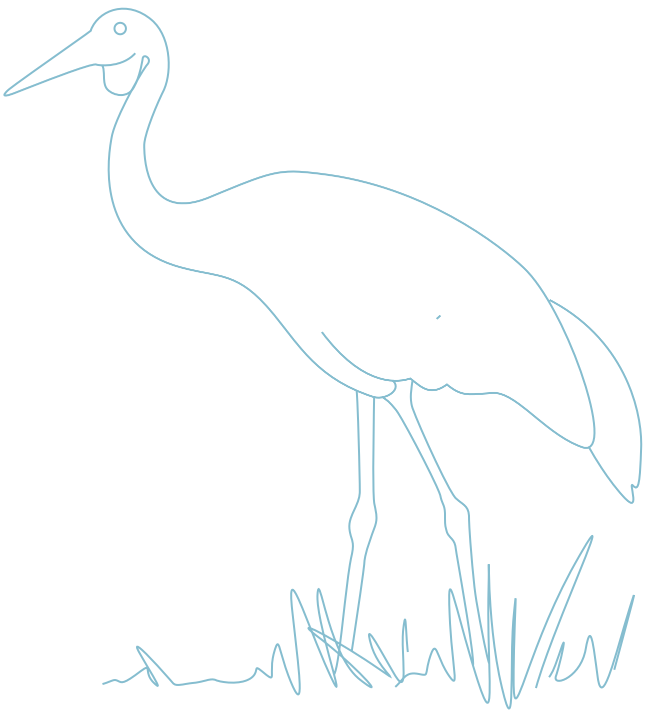


Table 5.2.2 Potential environmental watering for the Barmah Forest under a range of planning scenarios

Planning scenario	Extreme dry	Dry	Average	Wet
Expected river conditions	• Unregulated flow periods unlikely • Flow in the Murray River will remain within the channel all year	• Some small unregulated flows in late winter/spring • Low chance of overbank flow in late winter/spring	• Likely chance of small-to-medium unregulated flows in winter/spring • Likely chance of overbank flow in winter/spring	• High probability of moderate to large unregulated flows in winter/spring • Expected large overbank flow
Potential environmental watering – tier 1 (high priorities)[1]	• Winter/spring forest low flow • Spring/summer freshes (one to three freshes) • Spring/summer/ autumn freshes (to Gulf and Boals creeks)	• Winter/spring forest low flow • Winter/spring/ summer low flow • Spring/summer freshes (one to three freshes) • Spring/summer/ autumn low flow • Fill or top-up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands	• Winter/spring forest low flow • Winter/spring/ summer low flow • Spring/summer freshes (one to three 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 (in Murray River)	• Winter/spring forest low flow • Winter/spring/ summer low flow • Spring/summer freshes (one to three 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 (in Murray River)
Potential environmental watering – tier 2 (additional priorities)	• Spring wetting of floodplain marshes	• Spring wetting of floodplain marshes		
Possible volume of water for the environment required to achieve objectives[2]	• 8,500 ML (tier 1)	• 61,500 ML (tier 1)	• 576,000 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 water for the environment delivered to Barmah Forest is returned to the Murray River — around 80 percent under the dry to wet climate scenarios — and can be reused 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 a 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

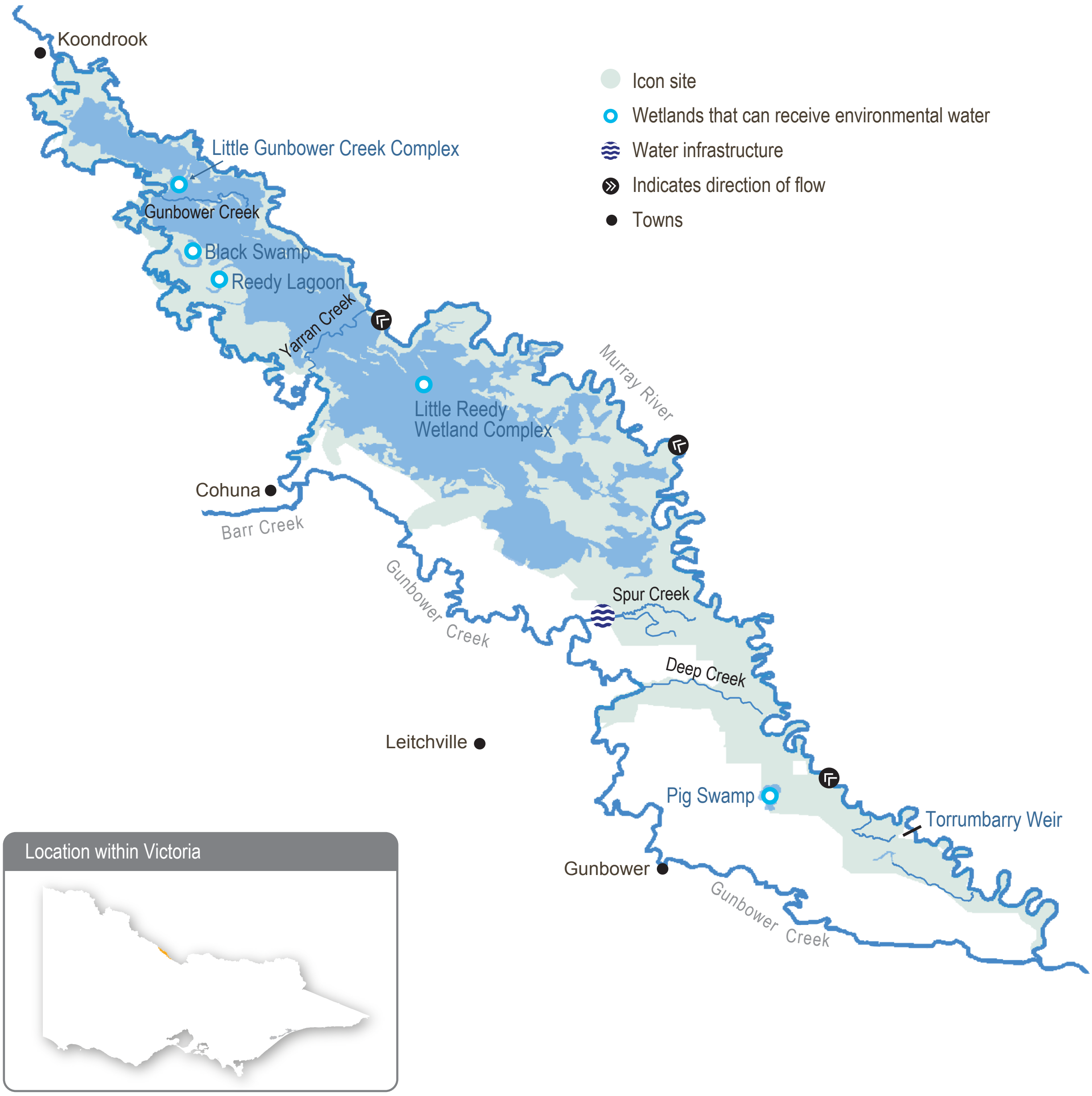
Gunbower Forest contains many important environmental values. It includes rare and diverse wetland habitats and large areas of remnant vegetation communities (such as river red gum forest and woodlands). It is also home to vulnerable and endangered plants and animals including river swamp wallaby grass, 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 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 and black 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

The middle 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 Traditional Owner groups when undertaking annual water for the environment planning and throughout the year as part of the Living Murray Indigenous Partnerships Program.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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 5.2.3 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

Watering planned and/or delivered in partnership with Traditional Owners to support 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 Wemba Wamba Traditional Owners and continues to have a focus on Gunbower Forest.

Barapa Barapa Wemba Wamba Water For Country project members identified a range of opportunities for 2021-22 watering to support cultural values (Table 5.2.3).

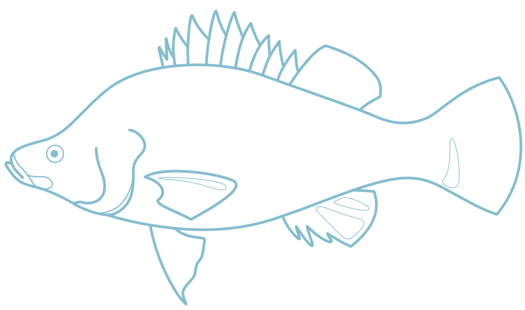


Table 5.2.3 Cultural values and uses at Gunbower Forest as identified by the Barapa Barapa Wemba Wamba Water For Country project

Value/use	How the value/use will be considered by environmental watering in 2021-22
Cultural plants, 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. • The watering actions via the lower landscape regulators in 2021 and the Hipwell Road event in autumn 2022 will support cultural plants that Barapa Barapa Traditional Owners value and provide opportunities for cultural practices to continue. • The amount of resources available is linked to the scale of watering able to be achieved. Floodplain watering via the Hipwell Road Regulator provides a greater amount of resources and enables abundant harvests with less travel and effort to harvest the desired amount of resources. • Barapa Barapa Traditional Owners recognise the value of resources that occur on the drawdown after the inundation of the forest floodplain, providing food for animals and cultural plants (such as old man weed). This can be supported by allowing wetlands to draw down naturally after receiving water, to expose mudflats. • Having a diversity of habitat and vegetation responses is a priority for Barapa Barapa Traditional Owners. They consider it important to have a range of water depths, which creates a more diverse vegetation response and results in a variety of resources becoming available over a longer period. • Delivering water to the floodplain supports this by inundating wetlands of varying depth and condition, which supports a variety of cultural and ecological values.
Healthy Country	• Providing drought refugia and maintaining areas with healthy habitat is a high priority for Barapa Barapa Traditional Owners. In the absence of natural flooding, they feel it is 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. • Environmental watering actions will ensure water is present on the floodplain and in high-priority wetlands regardless of whether flooding is received. This will provide refuge habitat for forest fauna and the provision of water in Reedy Lagoon ensures high-quality habitat is available. • Barapa Barapa Traditional Owners have also expressed the importance of looking after areas that are in good condition by conducting follow-up watering. This will be by delivering the Hipwell Road environmental watering event to build upon outcomes achieved by the lower landscape watering in 2021.
Cultural heritage	• Barapa Barapa Traditional Owners value having water in natural creeks and billabongs off main wetlands which can contain cultural heritage sites including earth mounds and a large canoe tree on the edge of a large flood runner. • Delivering water to the floodplain supports this with water flowing through natural creeks and floodrunners on the floodplain. Environmental watering results in lower levels than natural flooding, which can ensure that earth mounds or other cultural heritage are not overtopped and harmed. • Barapa Barapa Traditional Owners have noted that areas of black box and river red gum have cultural heritage values, however the changed watering regime since regulation and climate change 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, which is supported by delivery of water to the floodplain. The lower landscape regulators can target small areas of river red gum, however the Hipwell Road watering event planned in autumn 2022 will inundate large areas of river red gum and potentially suppress black box encroachment within the flood footprint.
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 and opportunities will be provided to pursue this in spring 2021. • Traditional Owners have indicated that a smoking ceremony should be a regular activity each year when water is delivered, as it is something that their ancestors would have done when the floodwaters arrived and would represent a restoration of an important cultural practice. The timing of environmental water deliveries will be communicated to Traditional Owners so that opportunities to practice their culture can be realised.
Cultural resources	• Barapa Barapa Traditional Owners have expressed that the ongoing survival of fish populations are important as a standing food resource. Wetland fish populations persisting in Reedy Lagoon following the 2020 watering event will be supported by top-ups in spring 2021 and autumn 2022 ensuring a permanent fish population remains across multiple years.

The Barapa Barapa Wemba Wamba 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 the planning for and management of water for the environment. 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 2021-22 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 the Barapa Barapa Wemba Wamba Water for Country project members 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 2021-22 (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:

- water-based recreation (such as boating, canoeing, duck hunting, fishing, and stand-up paddle boarding and water skiing)
- riverside recreation and amenity (such as birdwatching, camping, photography and walking)
- community events and tourism (such as park visitation, tour and activity operators)
- socio-economic benefits (such as consumptive water users including irrigation and domestic use, timber harvesting and education).

Recent conditions

Rainfall and temperatures in the Gunbower Forest and surrounding areas were close to the long-term average during 2020-21. Carryover of water in the Murray system was important to meet demands for water for the environment early in the water year. Allocations against high-reliability water shares in Victorian Murray entitlements to water for the environment, which are used to supply Gunbower Forest and Gunbower Creek, reached 55 percent in October 2020 and 100 percent in February 2021. Water for the environment was delivered to Gunbower Forest and Gunbower Creek in line with an average climate scenario in 2020-21, and most planned actions were achieved.

Small peaks in the Murray River delivered minor inflows to Gunbower Forest via low-lying flood runners in July 2020. Another short peak in September 2020 was excluded from the forest by closing the regulators on the Murray River to prevent nuisance flooding of Yarran Creek. In late winter/spring 2020, water for the environment was used to fill Reedy Lagoon and Black Swamp within Gunbower Forest. Some of the water from Black Swamp spilled into wetlands within the Little Gunbower wetland complex. Other wetlands within Gunbower Forest were allowed to draw down during the first half of 2020-21, to reduce carp. Additional deliveries of water for the environment in autumn 2021 topped up Reedy Lagoon and filled the Little Reedy wetland complex. The planned autumn top-up watering action at Black Swamp did not proceed, to allow the wetland to dry and hence reduce carp abundance ahead of a planned fill in winter/spring of 2021-22.

Fishway construction activities in Gunbower Creek limited deliveries of water for the environment to Gunbower Forest via the Hipwell Road Regulator in autumn and early winter 2021. Vegetation monitoring in autumn 2020 detected a slight decline in the condition of river red gums in some parts of the forest. Delivering water to selected wetlands and river red gum stands is proposed after the construction works conclude in winter/spring 2021, and more extensive floodplain watering in autumn/winter/spring 2022 is a high priority to improve tree and understorey condition and provide habitat for native fish and waterbirds.

In Gunbower Creek, water for the environment was used to maintain access to habitat and food resources for native fish during winter 2020 (when irrigation flows cease) and to promote spawning and improve the quality of nursery habitats for native fish (especially Murray cod) during spring and summer. Construction of new fishways at Cohuna Weir and Koondrook Weir commenced in May 2021 and should be completed by August 2021. During the construction period, there will be little flow in Gunbower Creek, and pool habitats will be maintained downstream of the weirs to support native fish.

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 improvements in abundance and age structure within the resident Murray cod population over time. Freshwater catfish are also breeding in Gunbower Creek. Environmental flows will be necessary to help restore native fish habitat and support fish dispersal from the managed refuge pools once the fishway construction activities are complete. The fishways are expected to significantly improve the abundance and diversity of fish populations over time by allowing fish to move between Gunbower Creek and the Murray River. This will enable fish that successfully breed in Gunbower Creek to migrate into the Murray system and for species (such as golden perch and trout cod) that breed elsewhere to move into Gunbower Creek to feed and develop. Greater fish movement into and out of Gunbower Creek will help to grow populations of native fish within Gunbower Creek and across the broader region.

Scope of environmental watering

Table 5.2.5 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.2.5 Potential environmental watering actions, expected watering effects and associated environmental objectives for Gunbower Creek and Forest

Gunbower Forest		
	• Maintain water depth and extent to support the growth and successful recruitment of wetland vegetation • Maintain water depth and quality to provide habitat for small-bodied native fish • Provide a diversity of water depths throughout the season to provide feeding and breeding habitat for water-dependent biota including waterbirds, turtles and frogs	
Black Swamp and Little Gunbower wetland complex fill (winter/spring 2021)		
Black Swamp, Little Gunbower wetland complex, Little Reedy wetland complex and Reedy Lagoon overtop (winter/spring/summer 2021)	• Increase water depth and extent to support the growth and successful recruitment of wetland and surrounding river red gum understorey flood-dependent vegetation • Increase water depth and quality to provide habitat for small-bodied native fish • Maintain a diversity of water depths throughout the season to provide feeding and breeding habitat for water-dependent biota including waterbirds, 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	
Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates to maintain an appropriate wetted extent during winter/spring 2021)	• Extend the duration of floodplain and wetland inundation over the optimal growth season • Maintain water depth and quality to provide habitat for small-bodied native fish including Murray-Darling rainbowfish • Maintain a diversity of water depths throughout the season to provide feeding and breeding habitat for water-dependent biota including waterbirds, turtles and frogs	

Table 5.2.5 Potential environmental watering actions, expected watering effects and associated environmental objectives for Gunbower Creek and Forest *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Trigger-based top-up of 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 autumn/ winter top-up (2022)	• Maintain water depth and extent to support the growth and successful recruitment of wetland vegetation • Maintain water depth and quality to provide habitat for small-bodied native fish including Murray-Darling rainbowfish • Maintain a diversity of water depths throughout the season to provide feeding and refuge habitat for water-dependent biota including waterbirds, turtles and frogs	
Gunbower Forest floodplain, floodrunners and wetlands inundation (with variable flow rates during autumn/winter 2022)	• Inundate river red gums and the flood-dependent and flood-tolerant understorey species • Provide access to breeding habitat and food resources for native fish (such as Murray cod) • Provide habitat for frogs, turtles, small-bodied native fish and waterbirds including colonial nesting species	
Gunbower Creek		
Irrigation season low flow (300-500 ML/day during August to March)	• Maintain habitat and food resources for native fish (such as Murray cod) by minimising large variations in the water level during the irrigation season • Provide cues for the migration and spawning of native fish • Maintain connectivity between Gunbower Creek, lagoons and fishways, to maintain habitat for the movement of native fish • Dilute low-oxygen water exiting Gunbower Forest below Koondrook Weir if required	
Autumn/winter low flow (above 200 ML/day during March to June 2022)[1]	• Maintain habitat and food resources for native fish (such as Murray cod) during the off-irrigation period and/or when Hipwell Road regulator is operational • Maintain connectivity between Gunbower Creek, lagoons and fishways, to maintain habitat and support the movement of native fish	
Autumn/winter freshes (500 ML/ day for one to four weeks during July to August 2021 and May to June 2022)	• Make delivery in response to high flow in the 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 the Murray River and Gunbower Creek	

1 This flow is prioritised only when deliveries are occurring to Gunbower Forest through Hipwell Road regulator.

Scenario planning

Table 5.2.6 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Gunbower Forest

The highest-priority potential watering actions under all climate scenarios for Gunbower Forest are to provide water to Reedy Lagoon, Black Swamp and the Little Gunbower and Little Reedy wetland complexes in winter/spring 2021. These are permanent and semi-permanent wetlands, and water is needed to improve their health, support the growth and recruitment of wetland plants and provide feeding and breeding habitat for small-bodied native fish, frogs, turtles and waterbirds following a drying phase over much of the forest during summer and early autumn 2021. These wetlands will be topped up or filled where possible under a drought climate scenario, to maintain their environmental conditions. Larger deliveries will be provided under dry, average and wet climate scenarios, to overtop the wetlands and so improve the condition of floodplain vegetation communities and environmental values in connected flood runners. Additional top-ups may be delivered to Reedy Lagoon in autumn/winter 2022 if dry conditions are forecast for 2022-23, to maintain water quality and increase habitat for small-bodied native fish. If a waterbird breeding event commences in any wetland, top-ups may be needed under any scenario to maintain water depth and habitats through spring and summer 2021-22 until juvenile waterbirds have fledged.

Inundating the Gunbower Forest floodplain, floodrunners and wetlands will be a high priority in autumn/winter 2022 under all climate scenarios. Floodplain watering is proposed for autumn/winter 2022 even if a natural flood occurs between winter and early summer 2021, because successive floodplain inundation will consolidate plant and animal outcomes. Water for the environment may also be used to increase the level or duration of a natural flood in winter/spring 2021, to target vegetation communities at higher elevations and allow wetland plants to flower, set seed and germinate. The floodplain area that can be targeted by environmental flows last received water in winter/spring 2018, and the river red gum vegetation communities are being stretched beyond their tolerances for dry conditions. The need for watering is supported by annual vegetation surveys that indicate the condition of the river red gum canopies is beginning to decline following several years of dry climatic conditions, and understorey plants have not had an opportunity to complete their life cycles. As these trees and plants provide important food and nesting resources as well as physical habitat, it is important to maintain the condition of these areas for floodplain fauna.

If conditions are suitable 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.

Gunbower Creek

No water will be delivered in Gunbower Creek between mid-May and mid-August 2021 (off-irrigation period) due to the construction of fishways at Koondrook Weir and Cohuna Weir. These fishways will provide extensive opportunities for fish movement once constructed. Water will be held in selected pools during the construction period to provide habitat for native fish, and conditions will be monitored in those pools to protect resident fish. Once the construction work is complete, the highest priority for Gunbower Creek will be to maintain continuous low flow for the rest of the year to restore fish habitat and food and allow fish to disperse throughout the system. The low-flow magnitude may be increased to 500 ML per day at any time if required to dilute low-oxygen water exiting the Gunbower Forest outfall located downstream of Koondrook Weir.

The Gunbower Creek low-flow magnitude may also be deliberately increased to 500 ML per day under average or wet climate scenarios, to align with higher flow in the Murray River and support native fish breeding or movement. A minimum carryover volume of 56,000 ML is required to support high-priority watering action in the Gunbower Creek and Forest system in 2022-23. The volume will provide certainty of supply for low flow in Gunbower Creek during the non-irrigation season, to maintain flowing habitat and continue the autumn/winter/spring delivery to Gunbower Forest's floodplain, floodrunners and wetlands that is expected to commence in autumn 2022.

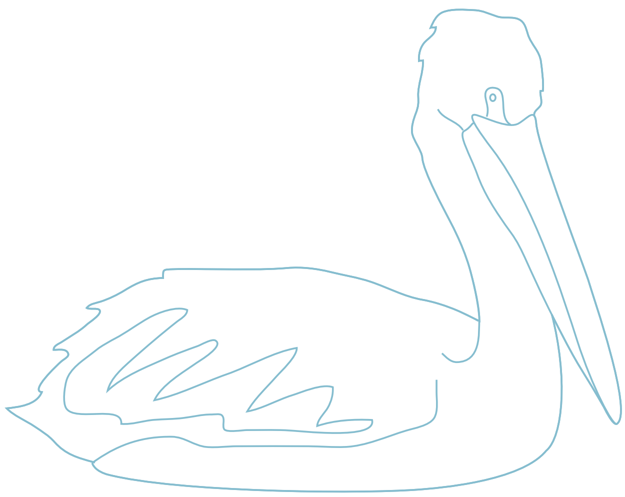


Table 5.2.6 Potential environmental watering for Gunbower Creek and Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural inflow into Gunbower Forest	• No natural inflow into Gunbower Forest	• Minor natural inflow into Gunbower Forest may occur in winter/spring	• Overbank flow is likely in winter/ spring
Gunbower Forest				
Tier 1 (highest priorities)[1]	• Little Reedy wetland complex and Reedy Lagoon winter/ spring top-up • Black Swamp and Little Gunbower wetland complex winter/spring fill • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon autumn/winter top-up • Gunbower Forest, floodplain, floodrunners and wetlands inundation	• Black Swamp, Little Gunbower wetland complex, Little Reedy wetland complex and Reedy Lagoon overtop in winter/spring • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon autumn/winter top-up • Gunbower Forest, floodplain, floodrunners and wetlands inundation	• Black Swamp, Little Gunbower wetland complex, Little Reedy wetland complex and Reedy Lagoon overtop in winter/spring • Yarran Creek fresh • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon autumn/winter top-up • Gunbower Forest, floodplain, floodrunners and wetlands inundation	• Black Swamp, Little Gunbower wetland complex, Little Reedy wetland complex and Reedy Lagoon overtop in winter/spring • Yarran Creek fresh • Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon autumn/winter top-up • Gunbower Forest, floodplain, floodrunners and wetlands inundation
Gunbower Creek				
Tier 1 (highest priorities)[1]	• Irrigation season low flow • Autumn/winter low flow	• Irrigation season low flow • Autumn/winter low flow	• Irrigation season low flow • Autumn/winter low flow	• Irrigation season low flow • Autumn/winter low flow • Autumn/winter freshes
Possible volume of water for the environment required to achieve objectives	• 44,300 ML	• 59,000 ML	• 62,500 ML	• 87,000 ML
Priority carryover requirements	• 56,000-60,000 ML			

1 Tier 1 potential environmental watering at Gunbower Creek and Forest is not classified into tier 1a and 1b, because the water available for use is shared across various systems and it is not possible to reliably estimate supply.

5.2.3 Central Murray wetlands

System overview

The central Murray wetlands are located on the lower Loddon River and Murray River floodplains (Figure 5.2.3). The wetland system includes Guttrum and Benwell state forests, Hird Swamp, Johnson Swamp, Lake Cullen, Lake Elizabeth, Lake Murphy, McDonalds Swamp, Muringa wetlands, Richardson's Lagoon, Round Lake, Third Reedy Lake and the Wirra-Lo wetland complex.

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.

Eleven of the central Murray wetlands can receive water for the environment from permanent infrastructure: Hird Swamp, Johnson Swamp, Lake Cullen, Lake Elizabeth, Lake Murphy, McDonalds Swamp, Muringa wetlands, Richardson's Lagoon, Round Lake, 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.

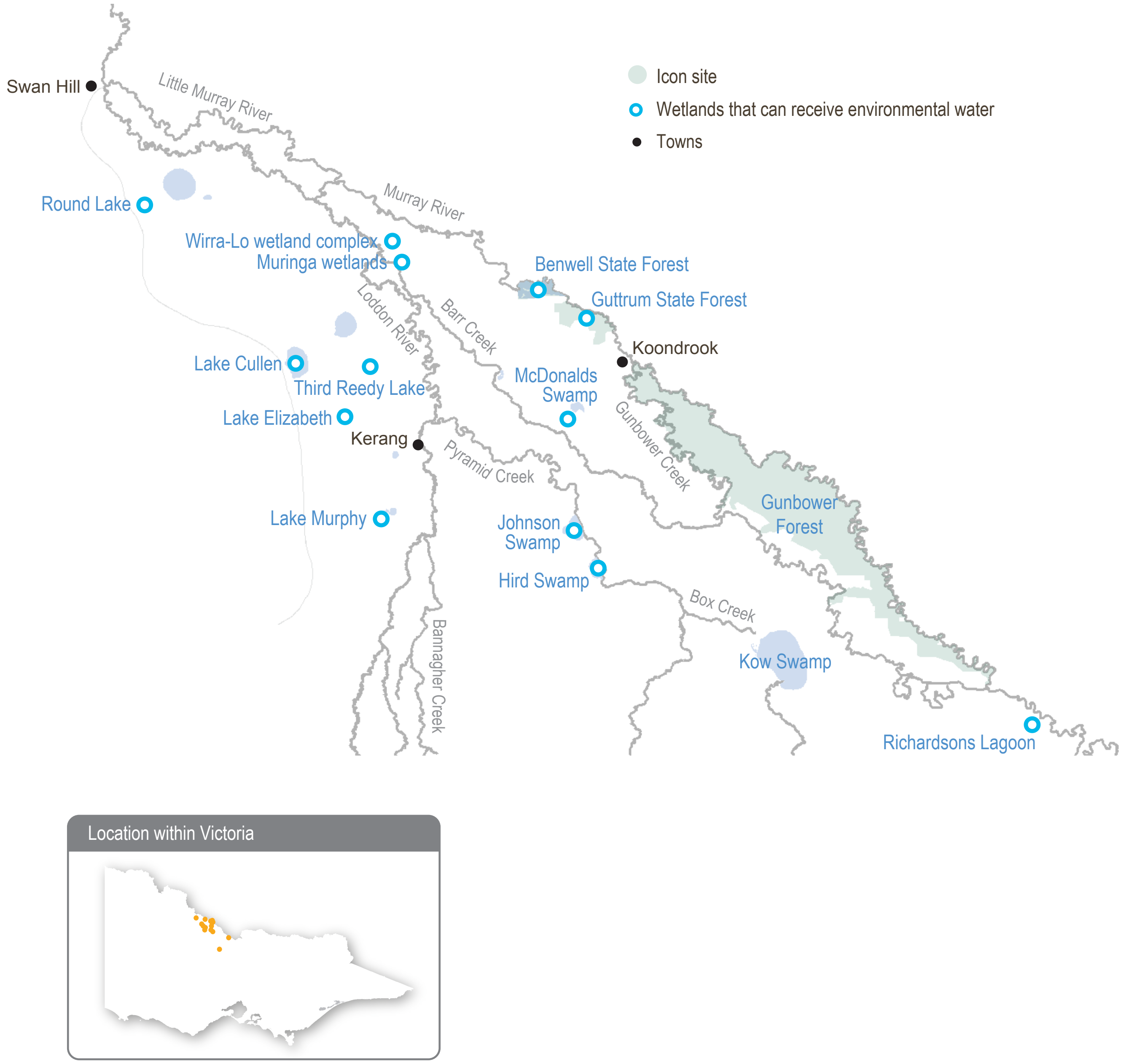
Environmental values

The central Murray wetlands 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, Third Reedy Lake 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 flat-headed gudgeon)
	Maintain and improve populations of the 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)

Figure 5.2.3 The Central Murray wetlands



Traditional Owner cultural values and uses

The wetlands and surrounding land in the central Murray area have rich cultural values belonging to the Traditional Owners, including the Barapa Barapa, Wemba Wamba and Yorta Yorta People. Their traditional knowledge is a living cultural evident throughout the landscape in tree markings, significant cultural sites, and cultural tools for cultural practices. The rivers and floodplains are a food and fibre source 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 it promotes the growth of culturally important plants that provide food, medicine and weaving materials for Traditional Owner groups. The presence of water itself can be a cultural value, as well as the quality of the water: healthy water promotes a healthy Country.

Barapa Barapa, Wemba Wamba and Yorta Yorta Traditional Owners have contributed to planning for water for the environment for wetlands important to them in the central Murray region in 2021-22. Focus areas include the following.

- Barapa Barapa and Wemba Wamba 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 Wemba Wamba 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 (DST) project, which is guiding vegetation works at McDonalds Swamp, as well as Lake Leaghur and Lake Yando – which are sites within the Boort wetlands (see subsection 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 the Barapa Barapa Traditional Owners.
- Yorta Yorta Traditional Owners have considered watering priorities for 2021-22, with a particular focus on Richardsons Lagoon. The Yorta Yorta Traditional Owners support the proposed fill and top-ups at the lagoon. The watering can support the growth of cultural plants which enables a continuation of cultural practices (such as harvesting, medicine and weaving). Deliveries of water for the environment can be managed so the revegetated areas are provided with an appropriate water regime — plants are watered but are not drowned — to ensure their ongoing survival and to provide opportunities for natural recruitment.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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 5.2.7 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

Barapa Barapa and Wemba Wamba input to watering actions for Guttrum Forest in 2021-22

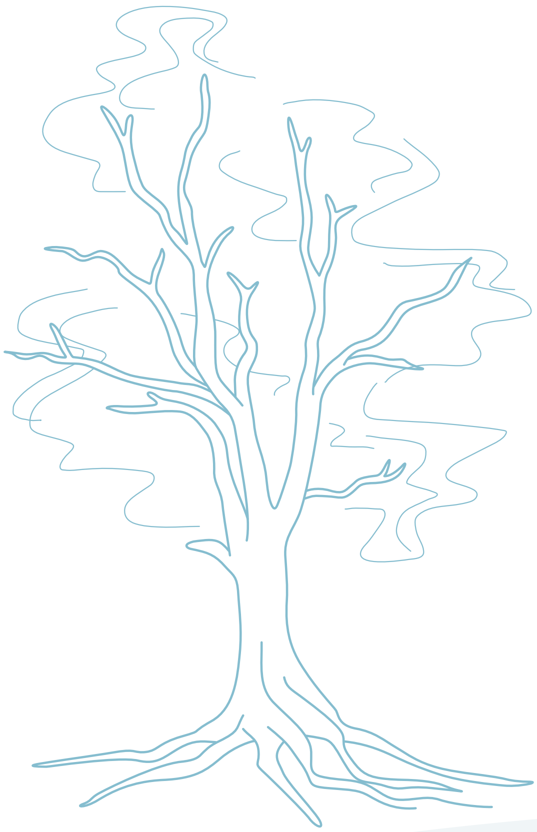
The proposed delivery of water for the environment to Guttrum Forest during 2021-22 has been planned in conjunction with the Barapa Barapa and Wemba Wamba peoples, for whom the wetlands and surrounding forest are places of high cultural significance. The Traditional Owners have been an important part 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 Wemba Wamba 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.

Table 5.2.7 outlines the values and uses considered in the planning for and management of water for the environment at Guttrum Forest in 2021-22.

Table 5.2.7 Barapa Barapa and Wemba Wamba 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. • An autumn fill followed by a spring top-up will ensure that the duration of inundation will be long enough to support aquatic vegetation during its optimal growth period. Allowing the wetland to draw down 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.
Cultural practice	• In 2019-20 when environmental water was first delivered in Guttrum Forest, a smoking ceremony and celebration was held to welcome the water back to the wetland. The Traditional Owners have indicated that this should be a regular activity each year when water is delivered, as it is something that their ancestors would have done when the floodwaters arrived and would represent a restoration of an important cultural practice.



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 canoeing, fishing, kayaking, swimming and water sports)
- riverside recreation and amenity (such as birdwatching, duck hunting, camping, cycling, running and walking)
- 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, stock and domestic users).

Recent conditions

Rainfall across the central Murray wetlands (based on records at Kerang) was slightly below the long-term average in 2020-21, but monthly temperatures were close to the long-term averages. Water for the environment used in the central Murray wetlands is supplied from entitlements held in the Murray system. Allocations against high-reliability water shares in the Murray system reached 100 percent in November 2020.

Seven central Murray wetlands received water for the environment in 2020-21 in line with planning under an average scenario.

Hird Swamp was filled in spring, to provide feeding and breeding habitat for waterbirds, especially Australasian bittern. Additional water was delivered through Hird Swamp in summer and discharged into Pyramid Creek to transport carbon and nutrients to the creek system to support native fish. Hird Swamp has similar habitat and environmental values to nearby Johnson Swamp, which can also receive environmental water, but Johnson Swamp was allowed to draw down in 2020-21 to support dry-phase ecosystem processes.

Round Lake and Lake Elizabeth were filled in spring and topped up over summer and autumn to maintain water levels and salinity within the target range for endangered Murray hardyhead. Brolga Swamp, Bunyip Swamp East and Bunyip Swamp West within the Wirra-Lo wetland complex were watered in spring, summer and autumn to support growling grass frogs, waterbirds and wetland vegetation communities. Red Gum Swamp, which is also within the Wirra-Lo wetland complex, could not be watered as planned due to access issues associated with a change in land ownership.

After completing its drying cycle, McDonalds Swamp received a partial fill in autumn 2020 to prime the wetland for a 2020 spring fill. Water for the environment was delivered to promote the growth of native aquatic plants and to support waterbird breeding and feeding. The fill inundated more of the wetland area than previous deliveries of water for the environment and provided more habitat for waterbirds to feed and breed. Monitoring undertaken at the wetland detected Australasian bitterns. Richardson's Lagoon was filled in spring 2020, to provide feeding and breeding habitat for waterbirds, frogs and turtles.

Third Reedy Lake was watered over summer and autumn 2020-21, to maintain habitat for southern purple spotted gudgeon, while longer-term management plans to protect the species were being developed. Several larger populations of southern purple spotted gudgeon were recorded at other wetlands near Kerang during 2020-21, which means it is no longer essential to maintain a constant water level at Third Reedy Lake. A more variable water regime will be implemented at Third Reedy Lake from 2021-22, to support a wider range of environmental outcomes.

Water for the environment was delivered to Reed Bed Swamp and Little Reed Bed Swamp in Guttrum Forest during late autumn and winter 2021, to support the recovery and health of wetland vegetation and river red gums around the wetland complex. The inundation aimed to drown river red gum saplings that were encroaching into the wetlands and to provide feeding habitat for waterbirds, turtles and woodland birds in winter.

Scope of environmental watering

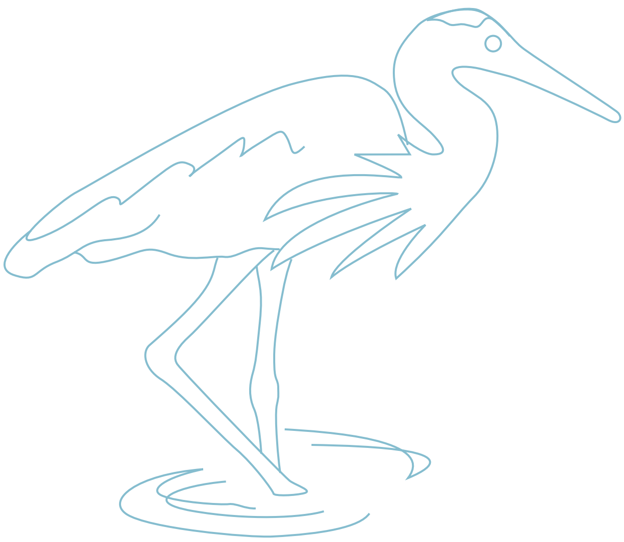
Table 5.2.8 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

Table 5.2.8 Potential environmental watering actions, expected watering effects and associated environmental objectives for the central Murray wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Guttrum Forest (top-ups in winter/spring and further top-ups as required)	• Wet the fringing adult river red gums to support their growth and drown river red gum saplings within the wetland bed to maintain open-water habitat • Promote the growth and re-establishment of aquatic vegetation and tall marsh vegetation at the fringe of the wetland • Maintain the depth of the wetland to support frogs and waterbird feeding and breeding	
Guttrum Forest (partial fill in autumn/winter 2022)	• Increase the 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	
Johnson Swamp (partial fill in autumn)	• Drown terrestrial weeds to limit their growth and reduce their extent • Promote the germination and establishment of aquatic vegetation • Inundate the wetland fringe to provide habitat for waterbirds, frogs and turtles and provide conditions suitable for macroinvertebrates and small-bodied native fish that are food for waterbirds	
Lake Elizabeth (fill in spring, top-ups as required)	• Maintain salinity within 15,000-80,000 EC to support suitable habitat and breeding conditions for Murray hardyhead and growing conditions of salt-tolerant aquatic plants that provide habitat for Murray hardyhead • Provide permanent water habitat for waterbirds	
Lake Murphy (fill in winter/spring, top-ups as required)	• Create wet area habitat for native waterbirds, frogs and turtles • Stimulate the germination of aquatic vegetation • Inundate and increase soil moisture to support the growth of recently planted river red gums	
McDonalds Swamp (partial fill in autumn)	• Drown terrestrial weeds to limit their growth and reduce their extent • Promote the germination and establishment of aquatic vegetation • Provide habitat for waterbirds, frogs and turtles • Support the growth of planted river red gums and other aquatic and herbland vegetation as part of the DST project	
Muringa wetlands: north and south (fill in winter/spring, top-ups as required)	• Support the establishment and growth of reed beds to create feeding and nesting habitats for Australasian bitterns and growling grass frogs • Provide wetland habitat to support the occurrence of waterbirds and frogs	
Richardson's Lagoon (fill in winter/spring, top-ups as required)	• Inundate a mosaic of habitats for native waterbirds, frogs and turtles to use • Maintain the water level to support the condition of aquatic macrophytes and aquatic reeds and rushes around the deep lagoon channels • Support the growth of traditional plant species at a significant cultural site enabling continuation of cultural practices (e.g. harvesting, medicine, weaving).	
Round Lake (fill in spring, top-ups as required)	• Maintain salinity within 15,000-70,000 EC — it may go up to 80,000 EC — to support suitable habitat and breeding conditions for Murray hardyhead and growing conditions for submerged aquatic plants • Provide permanent water habitat for waterbirds	

Table 5.2.8 Potential environmental watering actions, expected watering effects and associated environmental objectives for the central Murray wetlands *(continued)*

Wirra-Lo wetland complex: Bunyip Swamp East and Bunyip Swamp West (fill in spring, top-ups as required)	• Inundate recently established reed beds to stimulate their growth to create feeding and nesting habitat for Australasian bittern	
Wirra-Lo wetland complex: Cattleyard Creek (fill in spring, top-ups as required)	• Inundate river red gum woodland trees to promote their growth and improve their condition • Promote the germination and establishment of aquatic vegetation	
Wirra-Lo wetland complex: Duck Creek North (fill in spring, top-ups as required)	• Improve soil moisture in the wetland fringe to promote the recruitment and increase the extent of river red gum trees • Inundate the aquatic and herbland vegetation to promote its growth and increase its extent • Maintain open-water and associated mudflat habitats for waterbirds to feed and breed	
Wirra-Lo Wetland complex: Emu Creek (fill in spring, top-ups as required)	• Inundate black box trees and the lignum vegetation community along the creekline to improve their condition • Promote the germination and growth of aquatic vegetation in the deeper sections of the wetland to support frogs and freshwater turtles • Provide soil moisture along the perimeter to maintain the condition of trees for terrestrial fauna including resident grey crowned babblers	
Wirra-Lo wetland complex: Lignum Swamp North (fill in spring, top-ups as required)	• Promote the establishment and growth of submerged and emergent aquatic vegetation to provide feeding and breeding habitat for growling grass frogs • Inundate habitat to provide feeding and breeding opportunities for frogs, waterbirds and turtles	
Wirra-Lo wetland complex: Red Gum Swamp (fill in spring, top-ups as required)	• Inundate established river red gum trees to promote their growth and maintain their condition • Inundate habitat to provide feeding and breeding opportunities for frogs, waterbirds and turtles	



Scenario planning

Table 5.2.9 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The North Central CMA has developed a wetland strategy that aims to manage combinations of wetlands at a landscape scale to address particular environmental objectives. In applying the criteria described in the strategy, the North Central CMA has identified potential watering actions for 11 wetlands under a drought climate scenario, 14 wetlands under a dry scenario and 15 wetlands under average and wet scenarios.

Watering actions at Guttrum Forest (in winter/spring and autumn/winter), Johnson Swamp, Lake Elizabeth, Lake Murphy and Richardsons Lagoon and at five wetlands within the Wirra-Lo wetland complex — Lignum Swamp North, Duck Creek North, Red Gum Swamp, Bunyip Swamp East and Bunyip Swamp West — are a high priority under all climate scenarios in 2021-22.

The proposed watering actions at Lake Elizabeth and Round Lake are needed to maintain permanent habitat for Murray hardyhead (which is critically endangered), while Lignum Swamp North and Red Gum Swamp provides habitat for the growling grass frog (which is endangered). Guttrum Forest also supports an endangered species — the Australasian bittern — and planned watering actions in spring aim to suppress the growth of river red gum saplings that have been slashed in the bed of the wetland and improve the condition of vegetation that provides important breeding habitat for Australasian bittern. Guttrum Forest's Reed Bed Wetland Complex will be allowed to draw down over summer 2021-22 before another partial fill in autumn/winter 2022, to boost productivity leading into the next spring.

Johnson Swamp, Lake Murphy and Richardson's Lagoon are all ephemeral wetlands, and proposed watering actions at these sites aim to initiate their wet phase that will contribute to a mosaic of wetlands in different stages of wetting and drying across the central Murray area. In accordance with the management plan, Johnson Swamp completely dried in December 2020 and the proposed partial fill in autumn 2022 is recommended to prime the wetland ahead of a planned fill in spring 2022. Lake Murphy last filled in 2018-19 and has been dry since spring 2019. Revegetation works have recently been completed at Lake Murphy, and a partial fill in late winter and early spring will increase the survival of planted river red gums and other vegetation communities. Watering at Richardson's Lagoon will allow wetland plants that germinated during spring 2020 to flower and set seed, including plant species of cultural importance to the Yorta Yorta People.

Within the Wirra-Lo wetland complex, five of the nine sites — Duck Creek North, Lignum Swamp North, Red Gum Swamp, Bunyip Swamp East and Bunyip Swamp West — are proposed to receive water for the environment under all climate scenarios. Lignum Swamp North and Red Gum Swamp require water to support growling grass frogs (as described above), and the river red gum community at Red Gum Swamp needs to be inundated because it has been dry for five years and is showing signs of stress. Watering at Bunyip Swamp East and Bunyip Swamp West will help recently planted vegetation communities to properly establish and expand. Duck Creek North contains red gum, aquatic and herbland vegetation in moderate condition that would benefit from watering, and the site will provide mudflat habitat for waterbirds, which will contribute to habitat diversity across the wetland complex.

Proposed watering actions at McDonalds Swamp and Cattleyard Creek and Emu Creek within the Wirra-Lo wetland complex are a high priority under dry to wet climate scenarios. McDonalds Swamp filled in spring 2020 and completely dried in January 2021, which helped to limit the growth of tall marsh vegetation. The wetland can tolerate dry conditions for several years, and it is not considered a priority for watering under a drought climate scenario. However, a partial fill is recommended in autumn 2022 under dry to wet climate scenarios, to prime the wetland for a larger fill in spring 2022. Extending the dry phase at McDonalds Swamp through the rest of 2021 and then watering it in 2022 will contribute to the mosaic of wetlands in different phases across the area. Cattleyard Creek at Wirra-Lo has not received water for the environment before, and the river red gums are showing signs of stress. It is not feasible to water this site under a drought scenario, but watering it under dry to wet climate scenarios is expected to significantly improve the vegetation condition. Emu Creek is dominated by lignum and black box vegetation that require less frequent inundation, and the proposed watering will mainly target deep sections of the wetland to trigger the germination and growth of aquatic vegetation to support native frogs and turtles. Water delivered to the deep parts of Emu Creek will increase soil moisture for fringing black box trees without inundating them.

It is planned to deliver water for the environment for the first time to the Muringa wetlands in 2021-22, to promote the growth and establishment of tall marsh, aquatic herblands and spike-sedge species as part of a remediation project. The proposed watering actions are a high priority under average and wet climate scenarios but are a lower priority under a dry climate scenario if the planned remediation works are deferred.

Third Reedy Lake and Hird Swamp will be allowed to draw down during 2021-22, to support dry-phase ecosystem processes in accordance with recommendations in their management plans.

Priority carryover for 2022-23 of 3,700 ML is essential to maintain water at sites for endangered fish and frogs and to provide a mosaic of refuge wetlands across the region in the event of dry or drought conditions.

Table 5.2.9 Potential environmental watering for the central Murray wetlands under a range of planning scenarios

Expected river conditions	• Catchment run-off and natural flow into the wetlands are unlikely	• Some catchment run-off and natural flow into the wetlands is possible, particularly in winter/spring	• Low-to-moderate catchment run-off and natural flow into the wetlands is likely, particularly in winter/spring	• Catchment run-off and natural flow into the wetlands is likely with potential widespread flooding in some wetlands, particularly in winter/ spring
Potential environmental watering – tier 1 (high priorities)[1]	• Guttrum Forest (winter/spring 2021) • Guttrum Forest (autumn/winter 2022) • Johnson Swamp • Lake Elizabeth • Lake Murphy • Richardsons Lagoon • Round Lake • Wirra-Lo wetland complex (Lignum Swamp North, Duck Creek North, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West)	• Guttrum Forest (winter/spring 2021) • Guttrum Forest (autumn/winter 2022) • Johnson Swamp • Lake Elizabeth • Lake Murphy • McDonalds Swamp • Richardsons Lagoon • Round Lake • Wirra-Lo wetland complex (Lignum Swamp North, Duck Creek North, Red Gum Swamp, Cattleyard Creek, Emu Creek, Bunyip Swamp East, Bunyip Swamp West)	• Guttrum Forest (winter/spring 2021) • Guttrum Forest (autumn/winter 2022) • Johnson Swamp • Lake Elizabeth • Lake Murphy • McDonalds Swamp • Muringa wetlands • Richardsons Lagoon • Round Lake • Wirra-Lo wetland complex (Lignum Swamp North, Duck Creek North, Red Gum Swamp, Cattleyard Creek, Emu Creek, Bunyip Swamp East, Bunyip Swamp West)	• Guttrum Forest (winter/spring 2021) • Guttrum Forest (autumn/winter 2022) • Johnson Swamp • Lake Elizabeth • Lake Murphy • McDonalds Swamp • Muringa wetlands • Richardsons Lagoon • Round Lake • Wirra-Lo wetland complex (Lignum Swamp North, Duck Creek North, Red Gum Swamp, Cattleyard Creek, Emu Creek, Bunyip Swamp East, Bunyip Swamp West)
Potential environmental watering – tier 2 (additional priorities)	• N/A	• Muringa wetlands	• N/A	
Possible volume of water for the environment required to achieve objectives	• 11,400 ML (tier 1)	• 11,300 ML (tier 1) • 100 ML (tier 2)	• 11,000 ML (tier 1)	• 8,730 ML (tier 1)
Priority carryover requirements	• 3,700 ML			

1 Tier 1 potential environmental watering at the central Murray wetlands is not classified into tier 1a and 1b, because the water available for use is shared across various systems and it is not possible to reliably estimate supply.

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 can deliver up to 1,000 ML per day to the southern 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 system. Lake Kramen is in the south-east area of Hattah-Kulkyne National Park and disconnected from the main Hattah Lakes complex, but the Hattah Lakes pump station can deliver up to 145 ML per day to Lake Kramen to restore flooding regimes.

Current infrastructure enables environmental flows to the southern Hattah Lakes and Lake Kramen. Future infrastructure being built under the Victorian Murray Floodplain Restoration Project will allow water to reach additional wetlands and the floodplain in the northern Hattah Lakes.

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 benefitted from the improved tree health.

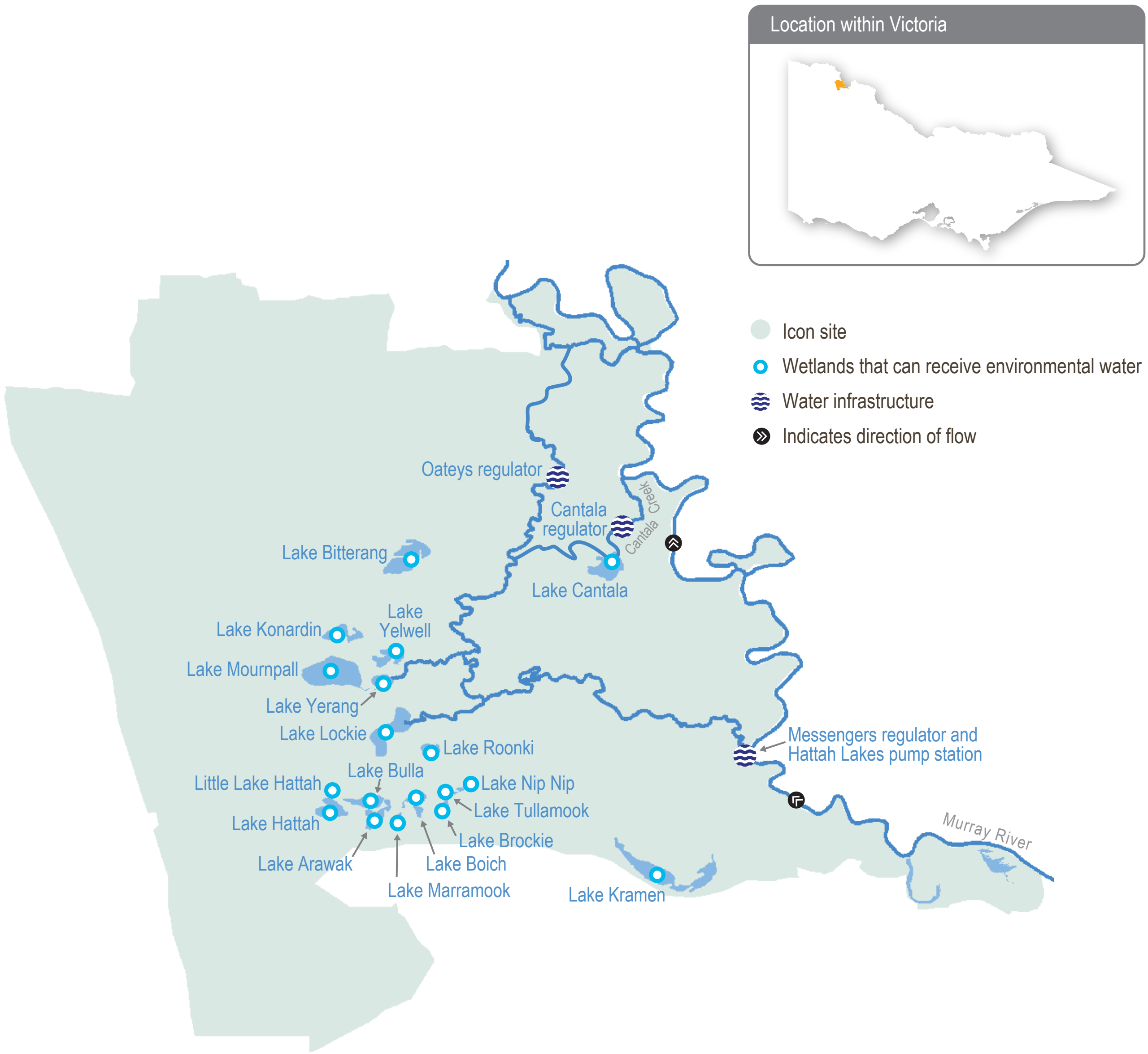
Hattah Lakes provides important waterbird breeding sites in an arid landscape. A total of 34 species of waterbirds are known to breed at the lakes when conditions are suitable. Another six species of waterbirds breed in the surrounding floodplain. Wetland drought refuge sites are limited in the region, making Hattah Lakes critically important for water-dependant flora, waterbirds and terrestrial animals.

The Hattah Lakes support large-bodied native fish species (such as golden perch) and small-bodied wetland species (such as carp gudgeon). Fish move between the lakes and the Murray River when flows are suitable and also persist in wetlands that retain water in the Hattah Lakes during dry years before dispersing again during flooding.

Environmental watering objectives in the Hattah Lakes

Increase the native fish populations
Restore carbon and nutrient cycling within and between wetlands, waterways and the floodplain, to increase ecosystem productivity
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



Traditional Owner cultural values and uses

The Hattah Lakes system is part of a highly sensitive region for Aboriginal cultural values and lies on the border of two documented language groups, the Latji Latji and the Jari Jari. More than 1,000 Indigenous archaeological sites at the Hattah Lakes are registered with Aboriginal Victoria, with the freshwater lakes and wetlands providing focal points for trade and cultural exchanges amongst the region's Traditional Owners. The local Aboriginal community maintains strong connections to the land and its resources such as native species used for food and medicine.

Mallee CMA has sought the input of Aboriginal Elders and members of the Aboriginal community who have expressed their connection with the Hattah Lakes area to environmental water planning. Mallee CMA held on-Country meetings and discussions with Elders and community members to explore their interests and aspirations for the Hattah Lakes region. Themes raised included:

- areas where environmental flows are planned to take place in 2021-22 and the quantity of water that will be delivered
- areas that Aboriginal Elders and other participants believe require water (such as black box in the northern part of Hattah-Kulkyne National Park)
- dying gum trees and black box, and future work that may assist with the delivery of water to these affected trees
- the protection of known burial sites by Parks Victoria Cultural Heritage rangers near Lake Mournpall in the Hattah Lakes system.

Social, recreational and economic 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 fishing, kayaking and swimming)
- riverside recreation and amenity (such as birdwatching, camping, photography and walking)
- community events and tourism (such as 'Junior Ranger' school holiday programs including bushwalking, birdwatching and bug hunting, school education programs and tours involving kayaking, bike riding and camping)
- socio-economic benefits (such as bee keeping, connecting with nature, ecotourism and social gatherings).

Recent conditions

Rainfall and temperatures in the Hattah Lakes region during 2021-22 were close to the long-term average. Victorian Murray allocations reached 55 percent of high-reliability water shares by mid-October and 100 percent by February 2021. Allocations and return flows from other environmental deliveries in upstream Goulburn and Murray river systems provided sufficient supply to achieve environmental watering requirements at Hattah Lakes during 2020-21.

High rainfall in the upper Murray River catchment and a large release of water for the environment to the Murray River resulted in flows of more than 15,000 ML per day in the Murray River at Robinvale on several occasions between July and November 2020, but these were well below the 26,000 ML per day flow that is needed for natural inflows to the Hattah Lakes. The river's flow gradually receded during summer and autumn to operational levels of between 5,000 to 11,000 ML per day.

The Hattah Lakes filled when water for the environment was delivered to them in 2017 and held water until February 2020. Lake Kramen was filled with water for the environment in spring 2019 and still retains some water.

Deliveries of water for the environment to the Hattah Lakes commenced again in May 2021. About 30,000 ML of water for the environment was pumped into the Hattah Lakes between May and June 2021 to fill low-lying wetlands to improve the condition of trees, stimulate the growth of aquatic plants, support carbon and nutrient cycles and provide food and habitat for waterbirds. Depending on climatic conditions and water availability, this watering event will be extended into winter and spring 2021, to inundate more wetlands to a greater depth to increase outcomes for various vegetation communities, waterbirds and native fish.

Scope of environmental watering

Table 5.2.10 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.2.10 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Hattah Lakes

Southern Hattah Lakes (top-up and fill of selected wetlands and lower floodplain during spring 2021)	• Stimulate the growth and improve the condition of river red gums fringing wetlands and on the lower floodplain • Provide breeding habitat for waterbirds • Stimulate new growth of aquatic vegetation • Inundate dry wetlands to release carbon and nutrients to increase food web productivity • Provide spawning and recruitment habitat for small-bodied native fish	
Hattah Lakes (floodplain inundation up to 45 m Australian Height Datum (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 survival and growth of trees that germinated in 2017 • Provide suitable conditions to support waterbird 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) • Inundate dry wetlands to release carbon and nutrients to increase food web productivity	

1 The Hattah Lakes pump station may also be operated at any time of the year for maintenance requirements.

Scenario planning

Table 5.2.11 outlines the potential environmental watering and expected water use under a range of planning scenarios.

In 2021-22, environmental watering is planned for Hattah Lakes under all climate scenarios except for drought.

In a wet climate scenario, substantial natural flow into Hattah Lakes is expected to occur, most likely in spring. Little or no water for the environment may be needed to supplement a large flood, but if there is only moderate natural flooding, the Hattah pumps or regulators may be used to increase the duration and spatial extent of inundation, to ensure parts of the floodplain that rely on natural floods are watered.

In the absence of a natural flood, the highest priority is to use the Hattah pumps in spring to top up the lakes that were partially filled in autumn 2021 and fill dry wetlands located at the margin of the system (such as Lake Bitterang and Lake Cantala). The proposed spring watering is important for two reasons. First, it will ensure that more wetland and floodplain vegetation communities do not exceed their optimal dry period. Second, it will capitalise on the autumn watering event that triggered a range of ecological and chemical processes, and so will achieve greater environmental outcomes than could be achieved if the water was delivered into dry wetlands.

The level of watering will likely vary between a dry and average climate scenario, based on likely water availability and to mimic natural variations in water levels that would be expected under different climatic conditions. In the dry climate scenario, water for the environment will aim to fill 16 targeted wetlands within the southern Hattah Lakes system. Under an average climate scenario, the intention is to fill the same 16 wetlands and also inundate some of the adjacent low-lying floodplain.

The water delivered to the Hattah Lakes in autumn 2021 will likely persist in some wetlands throughout 2021-22 without additional water. If drought conditions develop, this water will provide a refuge habitat for waterbirds, frogs and potentially some small-bodied fish. There is little value in trying to deliver extra water to trigger plant and animal growth and reproduction during drought conditions, because there may not be sufficient resources within the landscape to sustain new life. Up to 30,000 ML of available water will instead be prioritised for carryover, to help maintain refuge habitats within the Hattah Lakes in 2022-23 if drought conditions persist.

Table 5.2.11 Potential environmental watering for the Hattah Lakes under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected conditions	• Low flow year-round in the Murray River and no natural inflow to Hattah Lakes; substantial wetland drying will occur	• Rare high-flow events in the Murray River and no natural inflow to Hattah Lakes	• Short periods of high flow in the Murray River, most likely in late winter/ spring, providing minor natural inflow to Hattah Lakes	• Lengthy periods of high flow in the Murray River with major spills from storages resulting in widespread wetting of Hattah Lakes and floodplain
Potential environmental watering – tier 1 (high priorities)[1]	• N/A	• Southern Hattah Lakes spring top-up and fill targeting wetlands	• Southern Hattah Lakes spring top-up and fill targeting wetlands and low-level floodplain inundation	• Hattah Lakes (floodplain inundation up to 45.0 m AHD)
Possible volume of water for the environment required to achieve objectives	• N/A	• 30,000-47,000 ML	• 47,000 ML	• Up to 150,000 ML[2]
Priority carryover requirements	• up to 30,000 ML	• Not required under dry-wet scenarios		

1 Tier 1 potential environmental watering at Hattah Lakes is not classified into tier 1a and 1b, because the water available for use is shared across various systems and it is not possible to reliably estimate supply.

2 In a wet scenario, it is expected that natural floods will meet most of the required watering actions, with water for the environment making up the deficit if 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 is in the 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.

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

Promote carbon and nutrient cycling to enable wetland processes for food webs
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)

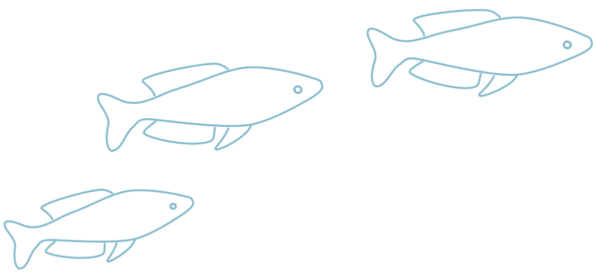
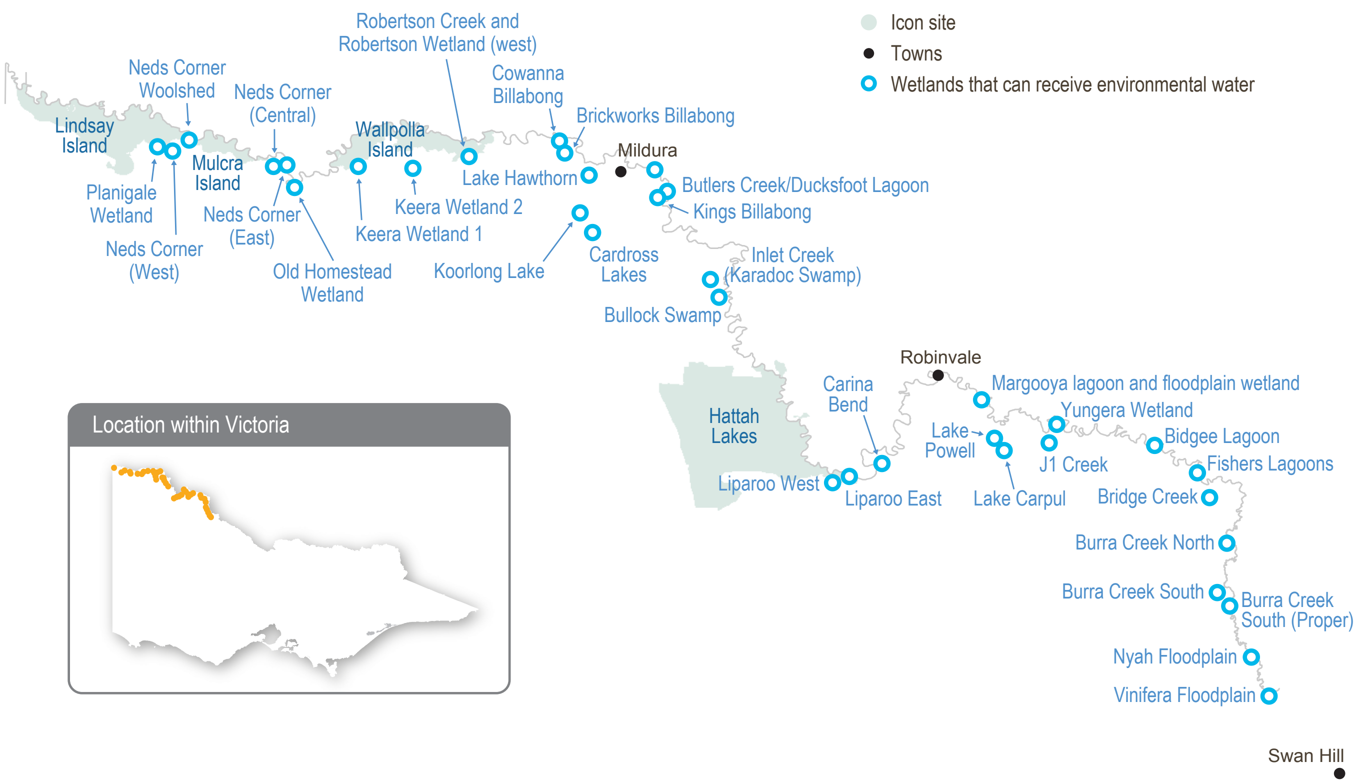


Figure 5.2.5 The lower Murray wetlands



Traditional Owner cultural values and uses

Watering of the lower Murray wetlands supports values such as traditional food sources and medicines and important species, and provides opportunities for teaching, learning and storytelling.

Mallee CMA has actively sought engagement, involvement and contributions on the proposed watering program for 2020-21 from the following Traditional Owners and Aboriginal Victorians:

- First People of the Millewa-Mallee Aboriginal Corporation, comprised of Latji Latji and Ngintait (Traditional Owners from Hattah to the South Australia border)
- other Aboriginal groups who have expressed an interest in the landscapes of the lower Murray wetlands including but not limited to Wemba Wamba, Wadi Wadi, Tati Tati, Weki Weki, Munatunga Elders and the Pearce family.

Discussions covered a range of options for how environmental flows can be delivered in 2021-2022 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.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

Watering planned and/or delivered in partnership with Traditional Owners to support 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.

An environmental flow was delivered to the creek in spring 2020-21 to complement the protection and restoration objectives, which was the first time the creek had received water since flooding in 2016. This has resulted in an improvement in the condition of trees and nearby shrubs and helped return and protect cultural values which can be used by community for learning, teaching and increasing overall wellbeing.

An environmental flow is planned for 2021-22 in all scenarios except drought. This will build on the outcomes from the previous watering event by further improving the condition of established vegetation and increasing protection against wind erosion by supporting the revegetation of native trees, shrubs and grasses. The event will be delivered in partnership with First People of the Millewa-Mallee Aboriginal Corporation as part of the continued work to protect this significant area.

Social, recreational and economic 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 and kayaking)
- riverside recreation and amenity (such as bike riding, birdwatching, bushwalking, camping, geocaching, photography and running)
- community events and tourism (such as day trips and sight-seeing; education programs for school, TAFE and university students; citizen science projects about birds, frogs and bats; and sporting events)
- socio-economic benefits (such as economic benefits for businesses in the accommodation, beekeeping, food and beverage, ecotourism, hospitality and retail sectors; creating a focal point for socialising; and providing natural, green spaces for the local community).

Recent conditions

After several years of very dry conditions, rainfall and temperatures in the lower Murray region were closer to the long-term average during 2020-21. Large rain events in late winter, spring and summer helped to water some floodplain vegetation but did not lead to much surface run-off or contribute significant inflows to floodplain wetlands. Flows in the Murray River were also not sufficient to naturally connect any wetlands on the lower Murray floodplain, so all the wetland watering described below was provided with water for the environment. Water availability was met through a combination of carryover and Murray allocations (100 percent of high-reliability water shares), which provided sufficient water for the environment to meet the planned watering actions.

In 2020-21, water for the environment was delivered to seven lower Murray wetlands that were identified as a high priority under an average climate scenario. Most deliveries occurred in late spring, to maintain native vegetation and provide habitat for fish and waterbirds. Environmental flows were delivered for the first time to Margooya floodplain wetland and Bidgee Lagoons. Inundation at Bidgee Lagoons was less than planned, so outcomes for that site were only partially achieved.

Robertson Creek was filled in spring 2020 to water black box, lignum and nitre goosefoot. It was the first time the site had received significant water since 2016, and further watering will be required to improve the condition of native vegetation communities, which are still recovering from prolonged drying through the Millennium Drought.

A slow through-flow was provided at Woolshed Creek in spring 2020, to consolidate the benefits of a similar watering event in 2019-20. The consecutive watering events have improved the condition of streamside vegetation along the creekline, and many species flowered in 2020-21. Growling grass frogs and waterbirds were also observed along the creekline during the watering event.

Top-ups were provided to three permanent wetland systems — Brickworks Billabong, Koorlong Lake and Lake Hawthorn — during summer and autumn, to protect habitat for endangered Murray hardyhead. The wetted margins of these wetlands also provide important foraging habitat for shorebirds.

Nyah Floodplain, Vinifera Floodplain, Burra Creek North and Burra Creek South have all been dry since 2019, and the river red gum communities at these sites are reaching the end of their optimal dry period. Burra Creek South Proper has been dry for the last seven years, and its vegetation community is in relatively poor condition.

Scope of environmental watering

Table 5.2.12 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

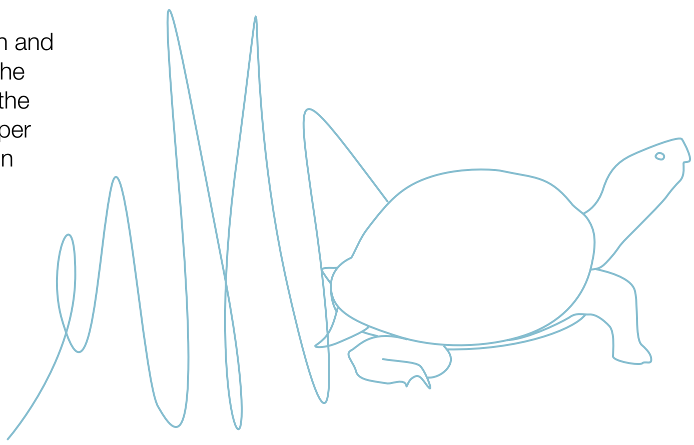


Table 5.2.12 Potential environmental watering actions, expected watering effects and associated environmental objectives for the lower Murray wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Bidgee Lagoons (fill in spring)	• Inundate adjacent river red gum and black box communities to stimulate growth and flowering to improve their condition and extent • Provide conditions and water levels to support the growth of annual aquatic and emergent vegetation and promote the diversity of emergent vegetation communities • Provide feeding and breeding opportunities for frogs • Mobilise leaf litter to promote carbon and nutrient cycling	
Brickworks Billabong (top-up in spring, top-ups as required over summer/ autumn) (target water level between 33 m Australian Height Datum [AHD] and 34 m AHD)	• Maintain water levels to inundate benthic herblands including ruppia beds to provide nursery habitat for Murray hardyhead and provide high levels of aquatic productivity • Maintain water quality suitable for Murray hardyhead • Provide shallow-water habitat and exposed mudflats to support foraging and resting of waterbirds including migratory waterbirds	
Bullock Swamp (partial fill in spring)	• Inundate adjacent black box and lignum to improve their condition • Provide feeding opportunities for waterbirds • Provide lateral spread of freshwater to refresh local groundwater which will support the condition of black box trees not directly inundated	
Burra Creek North (fill in autumn)	• Inundate the main creekline and adjacent red gum, lignum and black box vegetation communities to improve their condition • Provide habitat through improved vegetation communities and water resources for waterbirds and frogs • Mobilise leaf litter to promote carbon and nutrient cycling	
Burra Creek South (fill in autumn)	• Inundate the main creekline and adjacent red gum, lignum and black box vegetation communities to improve their condition • Provide habitat through improved vegetation communities and water resources for waterbirds and frogs • Mobilise leaf litter to promote carbon and nutrient cycling	
Burra Creek South Proper (fill in autumn)	• Inundate the main creekline and adjacent red gum, lignum and black box vegetation communities • Provide habitat through improved vegetation communities and water resources for birds and frogs • Mobilise leaf litter to promote carbon and nutrient cycling	
Fishers Lagoon (fill in spring) (target 54.2 m AHD)	• Promote the growth of aquatic vegetation and provide soil moisture for terrestrial vegetation communities • Provide temporary habitats for frogs and waterbirds • Inundate water-dependent Floodplain Grassy Wetland Ecological Vegetation Class (classified as endangered in the Murray Fans bioregion)	
Koorlong Lake (fill in spring, top-ups as required) (target between 36.7 m AHD and 38.0 m AHD)	• Increase and maintain the water level to support the growth of saline aquatic vegetation including 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 feeding resources for shorebirds and to maintain the Murray hardyhead population	
Lake Carpul (fill in spring)	• Provide a range of open-water, shallow-water and emergent-vegetation habitats for water-dependent birds to support breeding and feeding opportunities • Inundate and wet outer fringing river red gum, black box, lignum and vegetation communities to improve their condition • Mobilise carbon and nutrients within the wetland to support wetland processes	

Table 5.2.12 Potential environmental watering actions, expected watering effects and associated environmental objectives for the lower Murray wetlands *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Lake Hawthorn (fill in spring, top-ups as required) (target between 33 m AHD and 33.3 m AHD)	• Increase and maintain water levels 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 feeding resources for shorebirds and to maintain the Murray hardyhead population	
Lake Powell (fill in spring)	• Provide a range of open-water, shallow-water and emergent-vegetation habitats for water-dependent birds, to support breeding and feeding opportunities • Inundate and wet fringing river red gum, black box, lignum and vegetation communities to improve their condition • Mobilise carbon and nutrients within the wetland to support wetland processes	
Nyah Floodplain (fill in autumn)	• Inundate the base and littoral zone of Parnee Malloo Creek to support plant communities • Improve the condition of vegetation communities to provide a range of habitats and feeding and breeding resources for birds and frogs • Inundate the floodplain adjacent to Parnee Malloo Creek to promote the growth of herb and shrub layers • Inundate river red gum to improve their condition • Mobilise carbon and nutrients to promote chemical and biological processes	
Robertson Creek (fill in spring)	• Wet fringing river red gum, black box, lignum and vegetation communities to improve their condition • Provide lateral spread of freshwater to refresh local groundwater to support the condition of trees not directly inundated • Provide a range of open-water, shallow-water and inundated lignum habitats, to provide waterbird feeding opportunities and help protect the highly culturally significant site in the adjacent landscape	
Robertson Wetland (partial fill in spring) (target 28 m AHD)	• Wet fringing river red gum, black box, lignum and vegetation communities to improve their condition • Inundate cane grass beds to improve their condition and resilience • Provide a range of open-water, shallow-water and inundated lignum habitat to provide waterbird feeding opportunities	
Vinifera Floodplain (fill in autumn)	• Inundate the base and littoral zone of Parnee Malloo Creek to support plant communities • Improve the condition of vegetation communities to provide a range of habitats and feeding and breeding resources for birds and frogs • Inundate the floodplain adjacent to Parnee Malloo Creek to promote the growth of herb and shrub layers • Inundate river red gums to improve their condition • Mobilise carbon and nutrients to promote chemical and biological processes	

Scenario planning

Table 5.2.13 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Brickworks Billabong, Burra Creek North, Burra Creek South, Burra Creek South Proper, Koorlong Lake, Lake Hawthorn, Nyah Floodplain and Vinifera Floodplain are high priorities for watering in 2021-22 under all climate scenarios. Brickworks Billabong, Koorlong Lake and Lake Hawthorn are permanent wetlands that support populations of endangered Murray hardyhead. These sites require top-ups every year, to maintain salinity levels within a tolerable range and maintain submerged vegetation that provides habitat for fish. Burra Creek North, Burra Creek South, Burra Creek South Proper and the Nyah and Vinifera floodplains are ephemeral systems that support important vegetation communities and rely on periodic inundation to maintain the condition of that vegetation.

Burra Creek North, Burra Creek South, Nyah Floodplain and Vinifera Floodplain were last inundated in 2018-19, and their vegetation is in moderate condition. Burra Creek South Proper has been dry for almost seven years. Watering these five sites is a high priority in 2021-22, because planned construction work for the Victorian Murray Floodplain Restoration Project (VMFRP) will limit watering opportunities in 2022-23 and 2023-24, and the condition of vegetation communities will decline if they are not watered for another four years.

Bidgee Lagoons and Robertson Creek are priority watering sites under dry to wet climate scenarios, to consolidate and build on the environmental outcomes of watering in 2020-21. These two sites would not be expected to receive water naturally under a drought climate scenario, and potential watering opportunities in subsequent years will not be restricted by the proposed VMFRP construction works.

Some of the priority wetlands listed above are likely to receive natural inflows under a wet climate scenario, which may mean water for the environment is not needed. That possibility has been factored into the total volume of water for the environment that may be needed under that scenario.

Bullock Swamp, Fishers Lagoon, Lake Carpul, Lake Powell and Robertson Wetland have been identified as tier 2 watering actions for 2021-22. These sites do not require water every year, and it is not essential to water them in 2021-22. However, the environmental values at these sites will potentially benefit from water in 2021-22, and it would reduce the need to water them in 2022-23 or 2023-24. They may therefore be watered if the opportunity allows.

Carryover of about 2,000 ML is required in 2022-23 to protect Murray hardyhead in Brickworks Billabong, Koorlong Lake and Lake Hawthorn.

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	• Natural flow in the Murray River is too low to connect to wetlands • Wetlands rely on the 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 but overbank flow to wetlands is 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 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]	• Brickworks Billabong • Burra Creek North • Burra Creek South • Burra Creek South Proper • Koorlong Lake • Lake Hawthorn • Nyah Floodplain • Vinifera Floodplain	• Bidgee Lagoons • Brickworks Billabong • Burra Creek North • Burra Creek South • Burra Creek South Proper • Koorlong Lake • Lake Hawthorn • Nyah Floodplain • Robertson Creek • Vinifera Floodplain	• Bidgee Lagoons • Brickworks Billabong • Burra Creek North • Burra Creek South • Burra Creek South Proper • Koorlong Lake • Lake Hawthorn • Nyah Floodplain • Robertson Creek • Vinifera Floodplain	• Bidgee Lagoons • Brickworks Billabong • Burra Creek North • Burra Creek South • Burra Creek South Proper • Koorlong Lake • Lake Hawthorn • Nyah Floodplain • Robertson Creek • Vinifera Floodplain
Potential environmental watering – tier 2 (additional priorities)	• N/A		• Bullock Swamp • Fishers Lagoon • Lake Carpul • Lake Powell • Robertson Wetland	• Lake Carpul • Lake Powell
Possible volume of water for the environment required to achieve objectives[1]	• 6,495 ML (tier 1)	• 7,945 ML (tier 1)	• 8,245 ML (tier 1) • 8,210 ML (tier 2)	• 3,275 ML (tier 1) • 6,300 ML (tier 2)
Priority carryover requirements	• 2,000 ML			

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.

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 (see Figure 5.2.6). They form part of the Chowilla Floodplain and Lindsay-Wallpolla islands icon site that straddles the Victoria–South Australia-New South Wales 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 and extraction for consumptive use 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. The weir pools are colloquially called locks, in reference to structures at the weirs that allow vessels to navigate from one weir pool to the next. The weir pools are primarily managed as small water storages to ensure adequate water levels for off-stream diversion via pumps.

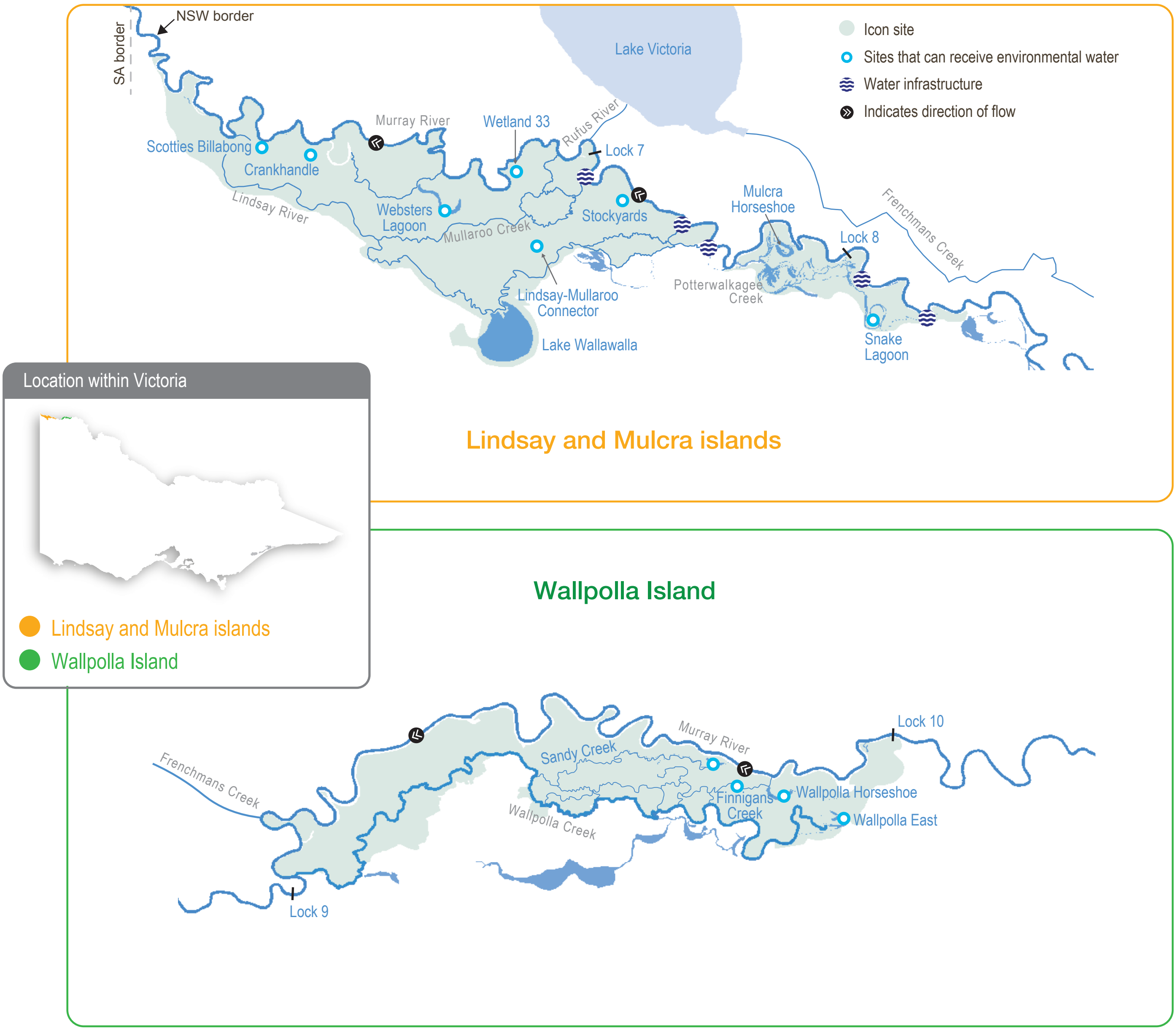
Water is diverted from weir pool 9 in the Murray River to Lake Victoria, where it is stored for later use to meet South Australian water demands. The diversion causes water to bypass Murray River weir pools 7 and 8, and at times it has a significant impact on flow in those reaches.

In recent years, the water levels in weir pools 7 and 8 have been managed to achieve ecological benefits in the Murray River channel. For example, weir pool levels have been raised during winter and spring then lowered during summer and autumn, to mimic seasonal river flows. The raising and lowering provide greater environmental benefits than a stable weir pool, because it wets and dries off-channel habitats and creates more variable flow patterns in the Murray River and connected floodplain streams. Changes in water levels during appropriate seasons helps establish fringing vegetation in shallow margins of the river channel and promotes cycling of nutrients and carbon as conditions fluctuate between wet and dry.

Static weir pool levels and reduced flow in the Murray River have a big effect on flow in the Lindsay River and Potterwalkagee Creek. When natural flow increases and/or when water levels in weir pools 7 and 8 are raised above the full supply level, flow to Potterwalkagee Creek increase and the upper Lindsay River starts flowing. When weir pools are lowered, flow to both the Lindsay River and Potterwalkagee Creek cease. Mullaroo Creek is less affected by weir pool levels and flow is controlled independently 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 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 flow 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 effectively manage weir pools and flows to floodplain habitats.

Figure 5.2.6 The Lindsay, Mulcra and Wallpolla islands



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, waterbirds and water-dependant plants. Terrestrial animals (such as woodland birds) also benefit from improved productivity and food resources when anabranch systems are inundated. Large floodplain wetlands (such as Lake Wallawalla) can retain water for several years after receiving inflows; they provide important refuges for wetland-dependent species and support terrestrial animals (such as small mammals and reptiles).

Mullaroo Creek supports one of the most significant populations of Murray cod in the mid-Murray River system. Mullaroo Creek provides fast-flowing habitat that Murray cod favour, which contrasts with the artificially slow-flowing and still habitats in the nearby Murray River weir pools. Fish in Mullaroo Creek breed and produce juveniles that contribute to populations in adjacent parts of the Murray system (such as in the Darling River in NSW and the lower Murray River in South Australia). 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 have 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

By 2030, increase the abundance of small-bodied native fish and the spread of age classes for long-lived native fish, compared to 2006-12 baseline levels
By 2030, improve or maintain populations of flow-dependent fauna
By 2030, improve the function of water-dependent ecosystems by maintaining or improving productivity linkages between the river and floodplain habitats
By 2030, improve or maintain populations of threatened flora that are flow-dependent By 2030, improve the condition and maintain the distribution of river red gum, black box and lignum, compared to 2006 baseline levels By 2030, improve the species richness and abundance of native wetland and floodplain aquatic vegetation functional groups
By 2030, maintain communities and species diversity of colonial nesting waterbirds, waterfowl, waders and piscivores By 2030, increase populations of colonial nesting waterbirds at Lake Wallawalla and non-colonial waterbirds at Mulcra Horseshoe and Wallpolla Horseshoe

Traditional Owner cultural values and uses

Mallee CMA has met on Country with the First People of the Millewa-Mallee Aboriginal Corporation (representing Latji Latji and Ngintait Traditional Owners) to discuss watering requirements for their Country.

The Traditional Owners have identified ways in which environmental water can support cultural values and uses, which are outlined in Table 5.2.14.

Table 5.2.14 Traditional Owner values and uses of watering sites in the Lindsay Mulcra Wallpolla icon site

Waterway	Traditional Owner group	Values / Uses / Objectives / Opportunities
Lindsay Island	Ngintait	• Black swan (Totem) nests in bull rush. Traditional Owners have observed a lack of bull rush around certain areas, so they would like to see it restored along the river banks, making for more nesting opportunities and a greater black swan population.
Lindsay Island	Ngintait	• Three-pronged grass are used for weaving. Traditional Owners are looking at places to plant seeds to grow this species, so elders can sit with community and teach weaving using the grass.
Lindsay-Mulcra-Wallpolla	Ngintait/Latji Latji	• Old Man Weed (*Centipeda cunninghamii*) is used for bush medicine. This grows in mud as water recedes. Both Traditional Owner groups from the Lindsay, Mulcra and Wallpolla region would like to see more of this.
Lindsay-Mulcra-Wallpolla	Latji Latji	• Latji Latji would like more opportunities to get back onto Country and begin discussions about managing Country.
Lake Wallawalla	Ngintait	• Protection of Cultural Heritage sites bordering Lake Wallawalla.

Their recommendations for watering actions have shaped planning for water for the environment for 2021-22 and beyond.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.15, Mallee CMA has also considered how environmental flows could support other values and uses such as:

- water-based recreation (such as canoeing, kayaking, fishing and yabbying)
- riverside recreation and amenity (such as bushwalking, camping, bird and wildlife watching, four-wheel driving and photography)
- community events and tourism (such as increased visitation and ecotourism and education programs for school, TAFE and university students)
- socio-economic benefits (such as for apiarists, local businesses providing accommodation and hospitality to tourists and local water delivery contractors).

Watering planned to support angling activities

Wallpolla Horseshoe is currently being managed as a nursery habitat for native golden and silver perch, which were released as fingerlings into the wetland in March 2019. This was undertaken in partnership with First People of the Millewa-Mallee Aboriginal Corporation, Victorian Fisheries and Mallee CMA.

Delivery of water for the environment to Finnigans Creek will be targeted to provide a connection between Wallpolla Horseshoe and Finnigans Creek, with the intent of allowing dispersal of stocked native fish from Wallpolla East to Finnigans Creek and eventually to the Murray River via Wallpolla Creek. Additional water will be proposed for Wallpolla Horseshoe, to support fish remaining in the wetland after the exit strategy is trialled.

Recent conditions

Rainfall and daily maximum temperatures at Lindsay, Mulcra and Wallpolla islands were close to the long-term average throughout 2020-21. Carryover of water in the Murray system was important, to meet demands for water for the environment early in the water year. Victorian Murray allocations reached 55 percent of high-reliability water shares by mid-October 2020 and 100 percent of high-reliability allocation by mid-February 2021. Allocations combined with carryover provided a sufficient supply of water for the environment to meet the planned watering actions identified for the Lindsay, Mulcra and Wallpolla islands system.

Flows in the Murray River throughout late autumn, winter and early spring 2020 allowed the Murray-Darling Basin Authority to achieve Lake Victoria's storage level targets. As a result, less water was diverted from the Murray River weir pool 9 to Lake Victoria in middle to late spring 2020 than would be the case in a drier year, but diversions occasionally occurred to meet Lake Victoria's requirements. Weir pools 7 and 8 were both held near to or above full supply levels from early winter 2020 to early summer, which meant additional water associated with natural inflows from the upper Murray catchment and a coordinated spring pulse of water for the environment delivered from Lake Hume was pushed into the upper Lindsay River (via Lindsay River north) and Potterwalkagee Creek for short periods. These flows were affected by occasional diversions to Lake Victoria, and they were not large enough to provide sustained flows in Lindsay River and Potterwalkagee Creek, let alone fill wetlands or inundate floodplain habitats on the islands. A spring high flow was also provided to Mullaroo Creek through the Mullaroo Creek regulator and fishway.

Flow in the Murray River returned to normal operating levels in summer and autumn 2021, and weir pools 7 and 8 were lowered to increase the amount of flowing-water habitat for native fish in the Murray River and to expose banks to support the establishment of vegetation. These actions ceased the flow to the Lindsay River and Potterwalkagee Creek, and flow in Mullaroo Creek was returned to low flow (600 ML per day) for the rest of 2020-21.

In spring 2020, water for the environment was delivered (via temporary pumps) to four wetlands on Lindsay Island for the first time since natural floods in 2016 and four wetlands/creeklines on Wallpolla Island watered the previous spring. In autumn/winter 2021, Lake Wallawalla was partially filled with water pumped from the Lindsay River.

Management of the system during 2020-21 was principally in line with a dry climate scenario, and the planned watering actions identified for those conditions in the *Seasonal Watering Plan 2020-21* were mostly achieved. The only required watering actions that were not fully achieved were the planned fills at Crankhandle and Scotties Billabong. Seepage rates at these sites were higher than expected, which meant the delivered water did not inundate as much of the fringing river red gum, black box and lignum vegetation communities as planned. Topping up these wetlands in spring 2021 will be a priority.

Recent condition monitoring shows that the health of river red gum, black box and lignum is generally in decline across the Lindsay, Mulcra and Wallpolla islands. In many areas, understory vegetation coverage is gradually transitioning to non-flood-dependant species. The poorest-quality vegetation is at Lindsay and Wallpolla islands, but without significant watering, the vegetation community on Mulcra Island is expected to deteriorate significantly. Environmental watering targeting selected wetlands on Lindsay and Wallpolla islands will be needed in 2021-22 to address the decline at specific sites, while larger-scale floodplain watering is recommended at Mulcra Island.

Scope of environmental watering

Table 5.2.15 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.2.15 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Lindsay, Mulcra and Wallpolla islands

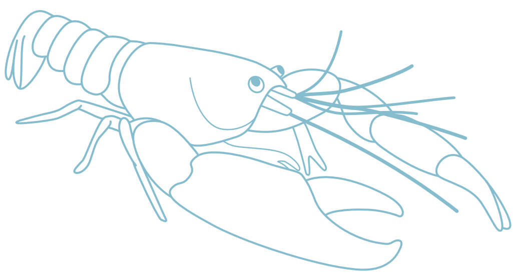
Potential environmental watering action	Expected watering effects	Environmental objectives
Lindsay Island – Mullaroo Creek		
Year-round low flow (minimum of 600 ML/day)	• Maintain fast-flowing habitat for native fish (such as Murray cod, silver perch and golden perch) • Maintain habitat for aquatic vegetation and soil moisture to maintain the condition of streamside vegetation	
Spring high-low flow (1,200 ML/day for three months during September to November)	• Increase the extent and velocity of fast-flowing water habitat to cue movement and spawning and improve recruitment opportunities for native fish • Provide improved fish passage between Mullaroo Creek and the Murray River via the Mullaroo Creek regulator fishway	
Lindsay Island – Lindsay River		
Winter/spring/summer low flow via the southern regulator (50 ML/ day for six months during July to December)	• Provide temporary flowing water to connect 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 bank soil moisture to support the growth of streamside vegetation	
Winter/spring/summer low flow via the northern regulator (95 ML/ day for six months during July to December)		
Lindsay Island wetlands		
Crankhandle (top-up in spring)	• Inundate the margins of the wetland to provide foraging and breeding opportunities for frogs, reptiles and waterbirds • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering • Increase soil moisture to maintain and improve the condition of streamside vegetation, particularly lignum • Stimulate the growth of aquatic vegetation	
Lake Wallawalla (partial to complete fill in winter/ spring)	• Provide shallow-water habitat, open-water habitat and shoreline habitat to create foraging opportunities for waterbirds • Stimulate the release of carbon and nutrients to increase the productivity of the floodplain food web, to increase the growth rate of yabbies • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering • Increase soil moisture to maintain and improve the condition of streamside vegetation, particularly river red gum • Provide roosting habitat over open water to support breeding colonial nesting birds	
Lindsay-Mullaroo connector (fill in spring)	• Provide shallow-water habitat to provide refuge (if conditions are dry in the next 2-3 years) and feeding habitat for frogs and waterbirds • Provide conditions for lake bed herbaceous plants and semi-aquatic plants to grow in the littoral zone in the drying phase after watering • Maintain habitat for aquatic vegetation and provide soil moisture to maintain and improve the condition of river red gums and black box	
Scotties Billabong (fill in spring)		
Stockyards (fill in autumn)		

Table 5.2.15 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Lindsay, Mulcra and Wallpolla islands *(continued)*

Websters Lagoon (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 during the drying phase after watering • Provide variable water levels in the littoral zone to provide feeding habitat for shorebirds • Provide open-water habitat as a refuge (if conditions are dry in the next 2-3 years) and feeding and breeding habitat for waterbirds	
Wetland 33 (top-up in spring)	• Provide shallow-water habitat to provide feeding habitat for frogs, reptiles and waterbirds • Maintain water of sufficient depth to encourage nesting waterbirds to complete the fledgling process	
Spring low flow via the Stony Crossing regulator (115-280 ML/day for three months during September to November)	• Provide temporary flowing water to connect 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	
Spring low flow via the upper Potterwalkagee Creek regulator (15-145 ML/day for three months during September to November)		
Winter/spring overbank flow via the Stony Crossing regulator (470 ML/day for 4 months during August to November)	• Provide a connection between Potterwalkagee Creek and the floodplain to allow the exchange of nutrients and carbon between the floodplain and the Murray River system • Provide off-channel habitat for small-bodied fish to feed and breed	
Winter/spring overbank flow via the upper Potterwalkagee Creek regulator (420 ML/day for 4 months during August to November)		
Mulcra Horseshoe (fill in spring)	• Provide shallow and open-water habitat to create foraging and breeding opportunities for waterbirds • Provide shallow-water habitat to provide refuge (if conditions are dry in the next 2-3 years) and feeding habitat for frogs and turtles • Stimulate the growth of emergent, aquatic and streamside vegetation • Provide moisture for lake bed herbaceous plants to grow during the drying phase of the wetland • Stimulate the release of carbon and nutrients to increase the productivity of the floodplain food web	

Table 5.2.15 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Lindsay, Mulcra and Wallpolla islands *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Mulcra Island floodplain (floodplain inundation in spring)	• Provide shallow- and open-water habitat to create foraging and breeding opportunities for waterbirds • Provide shallow-water habitat to provide feeding habitat for frogs and turtles • Increase soil moisture to maintain and improve the condition of streamside and floodplain vegetation, specifically river red gum, black box and lignum • Stimulate the release of carbon and nutrients from the sediment to increase the productivity of the floodplain food web • Provide a connection to the Murray River to allow the exchange of carbon and nutrients between the floodplain and the river	
Wallpolla island		
Finnigans Creek (low flow in spring)	• Provide connections between Wallpolla Horseshoe and Finnigans Creek to allow the dispersal of stocked native fish from Wallpolla East to Finnigans Creek and eventually to the Murray River via Wallpolla Creek • Provide variable water levels in the littoral zone to promote the growth of aquatic vegetation and increase soil moisture for streamside vegetation, particularly river red gums • Provide shallow-water habitat to provide refuge (if conditions are dry in the next 2-3 years) and feeding habitat for wetland-dependant species including frogs and waterbirds	
Wallpolla Horseshoe Lagoon (partial or complete fill in spring/ autumn)	• Provide connections between Wallpolla Horseshoe and Finnigans Creek to allow the dispersal of stocked native fish from Wallpolla East to Finnigans Creek and eventually to the Murray River via Wallpolla Creek • Wet/drown river red gum saplings in the inlet channel to Wallpolla Horseshoe to limit their coverage • Increase soil moisture to maintain and improve the condition of streamside and vegetation, specifically river red gum • Provide suitable breeding conditions for waterbirds • Provide permanent habitat for fish in the wetland • Provide shallow- and open-water habitat to create foraging and breeding opportunities for 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	



Scenario planning

Table 5.2.16 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The two categories of environmental watering opportunities at Lindsay, Mulcra and Wallpolla islands in 2021-22 are:

- environmental watering of anabranch waterways (Mullaroo Creek, Lindsay River and Potterwalkagee Creek) and floodplain wetlands in coordination with weir pool operation
- a program of environmental deliveries via temporary pumps to individual wetlands at Lindsay, Mulcra and Wallpolla islands.

Among the waterways and floodplain wetlands connected to the weir pools, two sites are proposed to receive water for the environment under all planning scenarios: Mullaroo Creek and Websters Lagoon. Permanent flowing water and a modest increase in flow in spring are essential for Mullaroo Creek in all scenarios, because there is strong evidence this watering regime promotes fish movement and breeding, particularly for Murray cod and golden perch. Websters Lagoon is a low-lying wetland close to the Murray River that benefits from having a wet-dry cycle and hydraulic connection to the Murray River every year.

Environmental flows are not proposed for Lindsay River and Potterwalkagee Creek under a drought climate scenario, but under dry, average or wet scenarios it would be necessary to deliver flows in winter/spring when weir pools 7 and 8 are raised. In a wet climate scenario, unregulated flow in the Murray River is likely to meet these anabranch flow requirements naturally. These flows are needed under dry to wet climate scenarios to connect pools and provide soil moisture to increase the growth and condition of streamside vegetation, which is in poor health after successive dry years.

Floodplain inundation at Mulcra Island is required under an average or wet climate scenario, because the Mulcra Island floodplain is reaching its dry-period limit and the vegetation condition has declined. Extensive inundation of the Mulcra Island floodplain is not feasible under a drought or dry climate scenario, because weir pool 8 would be too low to operate the floodplain infrastructure, but the Mulcra Horseshoe section of the floodplain can be watered via temporary pumping and will be a high priority under all scenarios.

Temporary pumps will be needed to deliver water for the environment to five wetlands on Lindsay Island in 2021-22. Crankhandle, the Lindsay-Mullaroo connector and Scotties Billabong were watered in 2020,-21 and they are all planned to receive follow-up watering in 2021-22. Consecutive years of watering will consolidate and build on the environmental benefits achieved last year and are expected to improve the growth and condition of river red gum and black box surrounding the wetlands and creeklines.

Stockyards is a priority watering site under all climate scenarios in 2021-22, because it has not been inundated since 2016 and the health of river red gums and black box at the site is very poor. The largest proposed watering action at Lindsay Island is a fill of Lake Wallawalla. Between 6,000 ML (dry climate scenario) and 10,000 ML (average climate scenario) is proposed to be pumped to the wetland to extend the environmental watering event that began in May 2021. Under a wet climate scenario, water for the environment may be delivered on top of natural inflows to Lake Wallawalla, to ensure fringing black box communities are inundated.

It will be particularly important to water the nominated wetlands on Lindsay Island in 2021-22, because the impending construction activities associated with the Victorian Murray Floodplain Restoration Project (VMFRP) will limit watering opportunities in 2022-23 and 2023-24. When complete, the VMFRP will significantly improve the deliverability of water for the environment at Lindsay Island. It is necessary to water selected sites across Lindsay Island in 2021-22, to build environmental resilience until the VMFRP infrastructure becomes operational.

Wetland 33 on Lindsay Island is a tier 2 watering priority in 2021-22, because the water retained from the delivery in spring 2020 is expected to support the environmental objectives in 2021-22, which include providing habitat for waterbird breeding. It is unlikely that follow-up watering will be needed at Wetland 33 in 2021-22, but Mallee CMA will monitor water levels during winter-spring 2021 and may deliver a spring top-up if circumstances change.

The main focus of water for the environment at Wallpolla Island in 2021-22 will be to provide connectivity between the Murray River, Wallpolla Creek, Wallpolla Horseshoe and Finnigans Creek, to allow native fish that were stocked into Wallpolla Horseshoe to disperse and supplement regional populations. The Wallpolla Horseshoe fish exit strategy — where deliveries to Wallpolla Horseshoe and Finnigans Creek will be coordinated to attract fish into Wallpolla Creek and eventually to the Murray River — will be attempted under all climate scenarios except drought.

Table 5.2.16 Potential environmental watering for Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Year-round low flow in the Murray River and no natural floodplain wetting • Weir pools will be maintained at full supply level in winter and drawn down below full supply level during spring, summer and autumn • Substantial wetland drying will occur	• Rare high-flow events in the Murray River and no natural floodplain wetting • Weir pools will be raised in winter and spring and drawn down below full supply level in summer and autumn • 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 will be 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 flow
Lindsay Island				
Potential environmental watering – tier 1 (high priorities)[1]	• Year-round low flow (Mullaroo Creek) • Spring low flow (Mullaroo Creek) • Stockyards (fill in autumn) • Websters Lagoon (fill in spring)	• Year-round low flow (Mullaroo Creek) • Spring low flow (Mullaroo Creek) • Winter/spring/summer low flow (Lindsay River via the north and south regulator) • Crankhandle (top-up in spring) • Lake Wallawalla (partial to complete fill in winter/spring) • Lindsay-Mullaroo connector (fill in spring) • Scotties Billabong (fill in spring) • Stockyards (fill in autumn) • Websters Lagoon (fill in spring)	• Year-round low flow (Mullaroo Creek) • Spring low flow (Mullaroo Creek) • Winter/spring/summer low flow (Lindsay River via the north and south regulator) • Crankhandle (top-up in spring) • Lake Wallawalla (partial to complete fill in winter/spring) • Lindsay-Mullaroo connector (fill in spring) • Scotties Billabong (fill in spring) • Stockyards (fill in autumn) • Websters Lagoon (fill in spring)	• Year-round low flow (Mullaroo Creek) • Spring low flow (Mullaroo Creek) • Winter/spring/summer low flow (Lindsay River via the north and south regulator) • Crankhandle (top-up in spring) • Lake Wallawalla (partial to complete fill in winter/spring) • Lindsay-Mullaroo connector (fill in spring) • Scotties Billabong (fill in spring) • Stockyards (fill in autumn) • Websters Lagoon (fill in spring)
Potential environmental watering – tier 2 (additional priorities)	• N/A	• Wetland 33 (top-up in spring)	• Wetland 33 (top-up in spring)	• Wetland 33 (top-up in spring)
Possible volume of water for the environment required to achieve objectives[2]	• 800 ML (tier 1)	• 9,000 ML (tier 1) • 50 ML (tier 2)	• 13,000 ML (tier 1) • 50 ML (tier 2)	• 0-6,000 ML (tier 1)

Table 5.2.16 Potential environmental watering for Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Average	Wet
Mulcra Island				
Potential environmental watering – tier 1 (high priorities)[1]	• Mulcra Horseshoe (fill in spring)	• Spring low flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek) • Mulcra Horseshoe (fill in spring)	• Overbank flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek) • Mulcra Horseshoe (fill in spring) • Mulcra floodplain inundation (floodplain inundation in spring)	• Spring low flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek) • Overbank flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek) • Mulcra Horseshoe (fill in spring) • Mulcra floodplain inundation (floodplain inundation in spring)
Possible volume of water for the environment required to achieve objectives[3]	• 1,500 ML (tier 1)	• 1,900 ML (tier 1)	• 3,300 ML (tier 1)	• 0-3,300 ML (tier)
Wallpolla Island				
Potential environmental watering – tier 1 (high priorities)[1]	• Wallpolla Horseshoe (partial or complete fill in spring and autumn)	• Wallpolla Horseshoe (partial or complete fill in spring and autumn) • Finnigans Creek (low flow in spring)	• Wallpolla Horseshoe (partial or complete fill in spring and autumn) • Finnigans Creek (low flow in spring)	• Wallpolla Horseshoe (partial or complete fill in spring and autumn) • Finnigans Creek (low flow in spring)
Possible volume of water for the environment required to achieve objectives	• 400 (tier 1)	• 1,200 (tier 1)	• 1,200 (tier 1)	• 0-1,200 (tier 1)

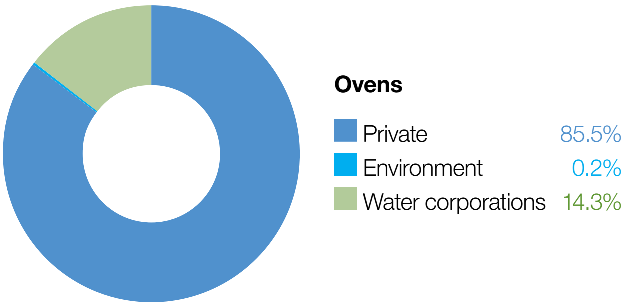
1 Tier 1 environmental watering at Lindsay, Mulcra and Wallpolla islands is not classified as tier 1a or tier 1b, because the water available to use is shared across various systems, and it is not possible to reliably determine supply specifically available for the islands.

2 These estimates include the use of water for the environment for Mullaroo Creek, Lindsay River and the Lock 7 weir pool. Water for the environment used at these sites may be accounted for in Victoria or New South Wales.

3 The estimates include the use of water for the environment for Potterwalkagee Creek, Mulcra Island and the Lock 8 weir pool. Water for the environment used at these sites may be accounted for in Victoria or New South Wales.

5.3 Ovens system

Waterway manager – North East Catchment Management Authority
Storage manager – Goulburn-Murray Water
Environmental water holder – Commonwealth Environmental Water Holder



Proportion of water entitlements in the Ovens basin held by private users, water corporations and environmental water holders on 30 June 2020.

Did you know...?

In 2021, 36 ML of water owned by the Taungurung Land and Waters Council was delivered as an environmental flow down the King River. The flow has contributed to healing Country by providing a boost to the health and productivity of the waterway.

Top: Buffalo River, by Natalie Ord, courtesy of North East CMA
Above: Water vegetation and frog spawning 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 (Figure 5.3.1). The system has 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 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 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 2021-22 will assess the viability of the population.

Environmental watering objectives in the Ovens River

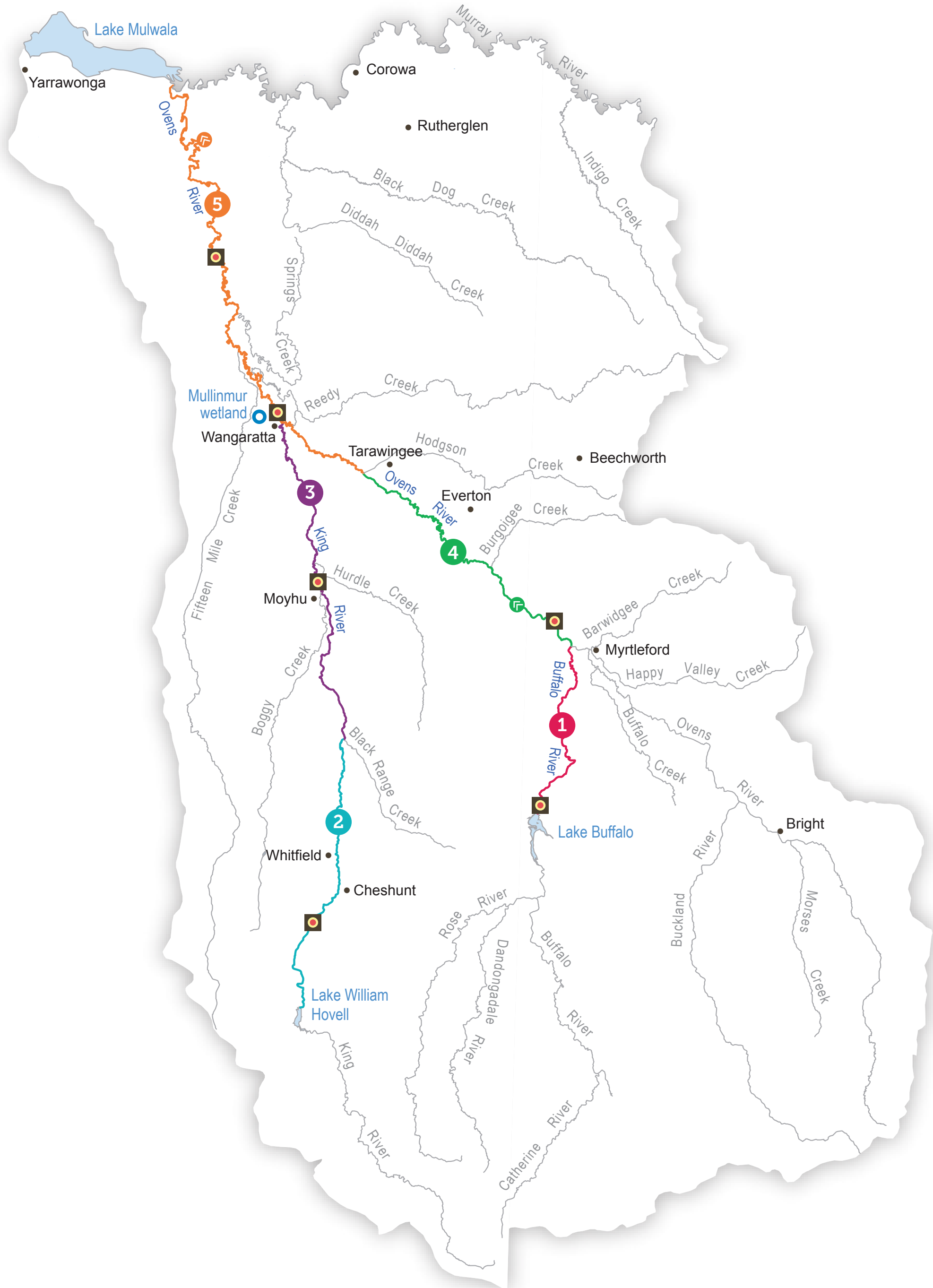
- Maintain the size and distribution of native fish populations
- Maintain the form of the riverbank and channel and ensure river bed surfaces are in suitable condition to support all stream life
- Maintain the condition and extent of wetland vegetation communities
- Maintain an adequate abundance and 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

Reach 1 Buffalo River: Lake Buffalo to the Ovens River
Reach 2 King River: Lake William Hovell to Moyhu
Reach 3 King River: Moyhu to the Ovens River
Reach 4 Ovens River: Buffalo River to Everton/Tarrawingee
Reach 5 Ovens River: Everton/Tarrawingee to the Murray River at Lake Mulwala

Wetlands that can receive environmental water
Measurement point
Town
Indicates direction of flow

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



Traditional Owner cultural values and uses

North East CMA has consulted with the Taungurung Land and Waters Council and the Yorta Yorta Nation Aboriginal Corporation in planning for water for the environment for the Ovens system. The environmental and ecological objectives of the seasonal watering proposals were supported and align with the broad values of these Traditional Owner groups.

Taungurung Land and Waters Council are interested in identifying off-stream wetlands that require watering to improve the ecological and cultural values of their Country.

Yorta Yorta Nation Aboriginal Corporation has developed a new *Whole of Country Plan*, which will support more culturally informed planning for water in the lower Ovens River in future.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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 5.3.1 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

The 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. The Taungurung Land and Waters Council's allocation has been released from Lake William Hovell three times 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 in the water level to inundate new habitat for in-stream 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, visitation for mental health and wellbeing)
- community events and tourism (such as providing a setting for community gatherings, school outdoor learning, sporting events, and citizen science projects)
- socio-economic benefits (such as businesses used by anglers, stock and domestic use).

Environmental flows will be delivered to Mullinmur Wetland over summer, to 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 site will continue 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 environmental education 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.

An education hub has recently been built at the site, providing a great space for school groups and community groups to develop and share knowledge in nature. Six photo points have also been placed around the wetland, to enable citizen-science opportunities. Anyone can take a photo from the specially made phone holders and upload them to Instagram, documenting the changes at the site.

A team of Waterwatch citizen scientist volunteers have provided water-quality recordings before and after environmental watering, helping waterway managers to understand the optimal conditions for native fish and plant species.

Recent conditions

The Ovens catchment experienced slightly below-average rainfall across the 2020-21 season. Lake William Hovel received 80 percent of its long-term average inflows, and Lake Buffalo received 85 percent of its average inflows. Lake William Hovell began the season at full capacity, and rainfall through winter quickly filled Lake Buffalo, which reached full capacity by spring. Allocations against Ovens system environmental water shares remained at 100 percent during the season, and the Ovens River and reaches of the King and Buffalo rivers directly below their storages retained much of their natural flow variability throughout the year.

Local rainfall delivered natural, high-flow events in the Ovens system in July, August, October and February. The October event was the largest, with flow peaking at 11,300 ML per day in Wangaratta. Water for the environment was released in conjunction with operational bulk water transfers from Lake Buffalo, to deliver a small autumn fresh in late March to improve water quality and connect habitat for native fish and waterbugs in the Buffalo River (reach 1) and Ovens River (reaches 4 and 5). Taungurung Land and Waters Council donated some of their annual water allocation to the VEWH to support environmental outcomes in the King River. This water and some water for the environment were released from Lake William Hovell in late March, to improve habitat quality and food resources for fish and waterbugs in reaches 2 and 3 of the King River.

Mullinmur Wetland was topped up with natural flows from the Ovens River in October 2020 and again in February 2021. These natural events negated the need for planned deliveries of water for the environment to the wetland in 2020-21. A native fish population assessment will determine if catfish stocked in Mullinmur Wetland moved into the Ovens River during the October or February high flow events. Surveys are also being conducted at Mullinmur Wetland to determine whether deliveries of water for the environment over the last two years have had the intended effect on native vegetation.

Scope of environmental watering

Table 5.3.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Ovens system

Potential environmental watering action	Expected watering effects	Environmental objectives
Mullinmur Wetland (top-up during November to February)	• Maintain the water level within the wetland to support the growth and recruitment of aquatic vegetation • Maintain habitat for freshwater catfish	
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 for three days in reach 5 during March to April)	• Provide flow cues to stimulate the movement of native fish • Increase 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)	• Increase connectivity between pools for fish movement • Provide small variations in river levels to move sediment and maintain waterbug habitat • Maintain sufficient oxygen levels	

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 River. Under dry and average conditions, the main objective for water for the environment in the Ovens River will be to deliver summer/autumn low flow variability to limit the duration of extremely low flow or cease-to-flow events that can stress native fish and waterbugs. Under average conditions, the objective will be to provide a higher flow, to support fish movement and breeding and to increase the abundance and diversity of waterbugs. There is not enough water for the environment to deliver the recommended autumn fresh in full, so releases of water for the environment will need to be timed to coincide with operational water releases to achieve the intended outcome. All the recommended environmental flows for the Ovens River system are expected to be met naturally under a wet climate scenario.

The main priority for Mullinmur Wetland in 2021-22 will be to provide top-ups throughout the warmer months, to offset seepage and evaporation and maintain wetland vegetation and suitable habitat for the freshwater catfish broodstock. This will likely require some active deliveries of water for the environment under drought and dry climate scenarios, but it may be met by natural connections to the Ovens River under average and wet climate scenarios.

Table 5.3.2 Potential environmental watering for the Ovens system under a range of planning scenarios

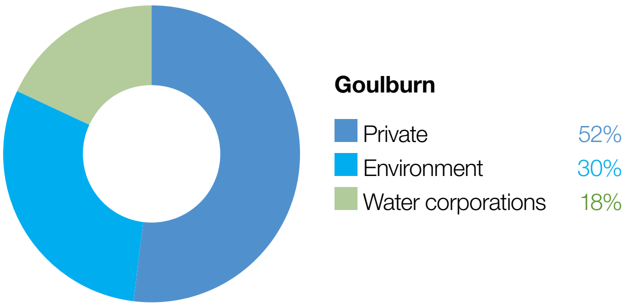
Expected river conditions	• Possible winter/early spring natural flow • Very low flow through summer and autumn • No bulk water release	• Possible winter/early spring natural flow • Very low flow through summer and autumn • Bulk water release unlikely	• High winter/spring natural flow • Moderate flow in summer and autumn with occasional natural freshes • Bulk water release likely	• High natural flow throughout most of the year • Bulk water release likely • All flow objectives achieved naturally
Predicted supply of water for the environment	• 123 ML			
Potential environmental watering – tier 1 (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	• Autumn fresh • Summer/autumn low flow variability • Mullinmur Wetland top-up
Possible volume of water for the environment required to achieve objectives	• 123 ML	• 123 ML	• 123 ML	• 0 ML

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 and environmental water holders on 30 June 2020.

Did you know...?

Yorta Yorta people know the lower Goulburn River as *Kaiela*, meaning 'father water'. Taungurung people know the mid-Goulburn River as *Waring*, and they have a special connection to the river 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.

Top: Goulburn River, by Goulburn Broken CMA
Right: Wetland vegetation at Reedy Swamp (Goulburn wetlands), by the VEWH

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 (Figure 5.4.1). 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 ancient, iconic river rich with environmental, cultural 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 Water Holdings 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 South Australia.

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 from 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 the 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 revised Goulburn to Murray trade rule and operating rule is expected to be introduced for 2021-22.

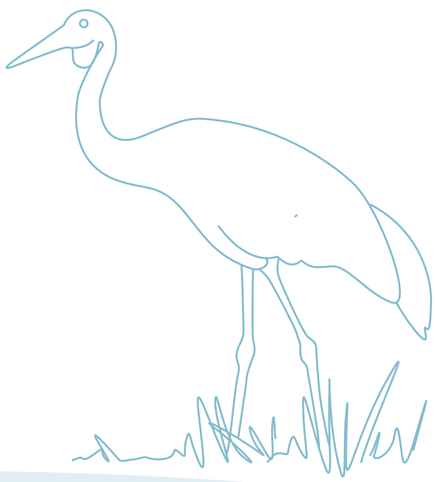
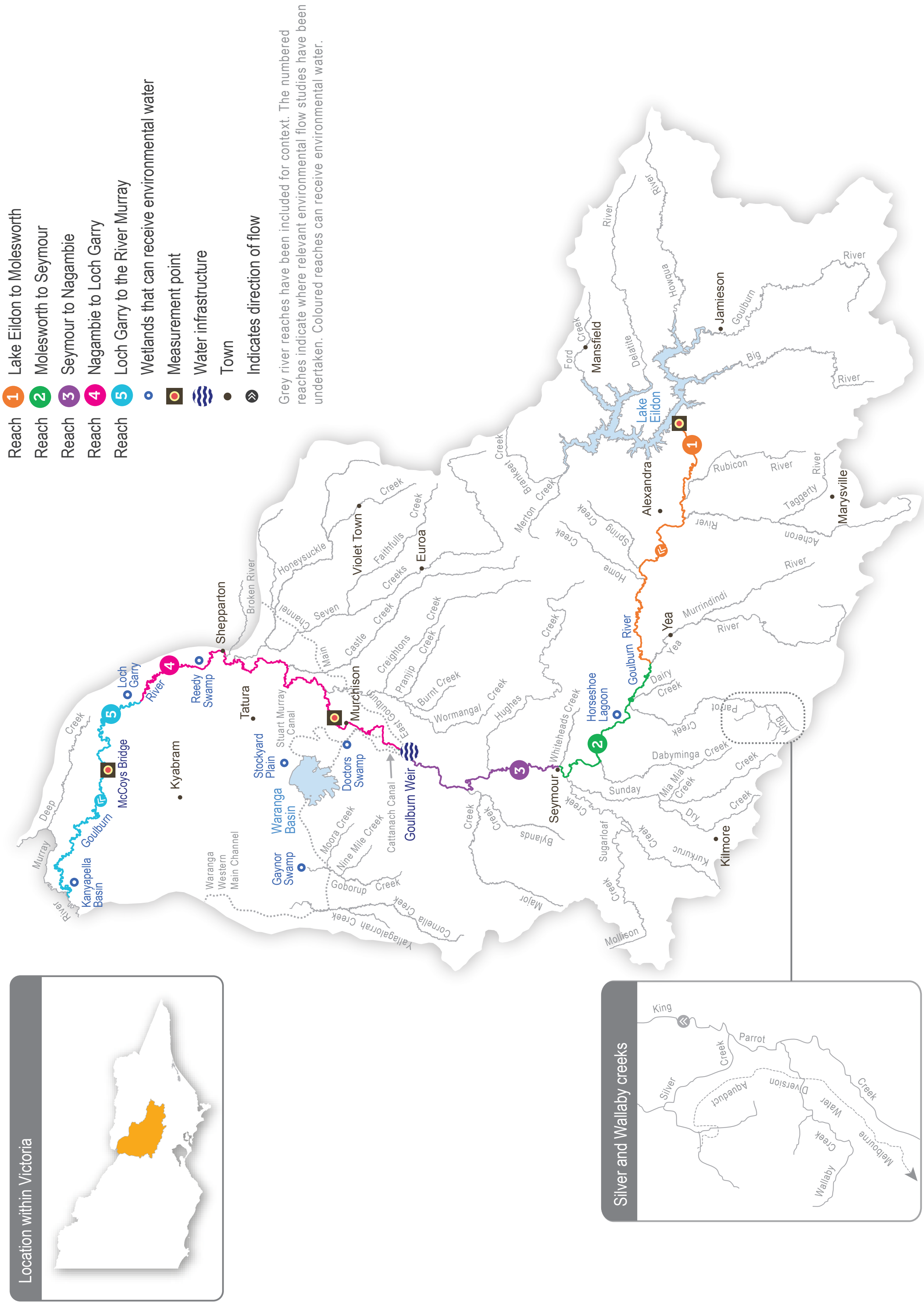


Figure 5.4.1 The Goulburn system



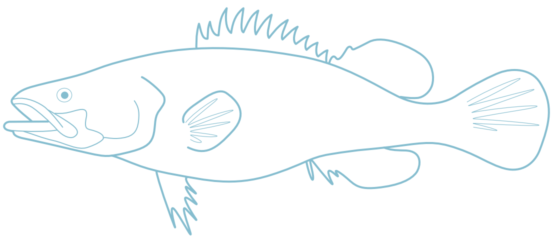
Environmental values

The Goulburn River and its tributaries support a range of native fish (including golden perch, silver perch, Murray cod, trout cod, Macquarie perch, freshwater catfish), turtles, platypus and rakali (water rats). 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 waterbugs 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 occur in lagoons connected to reach 3 of the Goulburn River. Citizen science monitoring programs indicate the mid-Goulburn River supports a strong population of platypus, which are now classified as vulnerable under Victoria's *Fauna and Flora Guarantee Act 1988*. Monitoring in recent years shows that environmental flows in the lower Goulburn River trigger golden perch and silver perch to spawn. However, the extent to which these spawning events contribute to populations locally and in the wider southern basin is unknown. Self-sustaining populations of Murray cod have been confirmed, and trout cod are extending their range in the lower Goulburn River.

Environmental watering objectives in the Goulburn River

Protect and increase populations of native fish
Maintain the form of the riverbank and channel, and a high diversity of river bed surfaces to support all stream life
Increase populations of platypus
Maintain populations of turtles
Provide sufficient rates of carbon and nutrient production and processing to support native fish and waterbug communities
Increase the abundance of 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 the Yorta Yorta Nation Aboriginal Corporation during the planning of environmental flows 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.

The Taungurung Land and Waters Council indicated there is alignment between planned environmental flows in the mid-Goulburn River, *Waring* and healing Country. Reach 1 baseflows and the winter and spring freshes will help protect the landscape and health of the land. These flows will help support the health of cultural values and landscapes, protecting intangible cultural heritage, valued species, traditional food and medicine plants. The flows will also help fulfil Caring for Country responsibilities and support investigations into rehabilitating degraded significant sites.

Taungurung has a special interest in the rehabilitation of floodplain wetlands associated with *Waring*, which are now largely disconnected from the main river channel due to the impacts of river flow regulation. Taungurung is currently assessing habitat condition at six of the disconnected wetlands, and their findings will inform future seasonal watering proposals and planning for water for the environment. Currently, Taungurung is working to enhance habitat conditions for native species in the area, and healthy Country assessments will provide important information about cultural objectives and indicators.

Yorta Yorta Nation Aboriginal Corporation indicated there is alignment between planned watering actions in the lower Goulburn River (*Kaiela*) (reaches 4 and 5) and the cultural and ecological values of the Yorta Yorta Peoples. A Yorta Yorta representative contributed to the recent *Kaiela (Lower Goulburn River) Environmental Flows Study 2020*, which shaped planning for environmental flows in the lower Goulburn River during 2021-22 and beyond. Through this consultation, Yorta Yorta and Goulburn Broken CMA have identified that environmental flows are critical for culturally important species of both plants and animals. Flows encouraging spawning activity, recession flows to alleviate slumping of culturally important sites (such as middens and scar trees) and flows with a focus on reviving streamside vegetation are important to sustain food, fibre, and medicine.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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 5.4.1 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

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, canoeing, fishing, gaming hunting and kayaking)
- riverside recreation and amenity (such as landholders and visitors)
- community events and tourism (such as paddling and boating businesses)
- socio-economic benefits (such as stock and domestic uses, irrigation diverters and water supply for settlements on the Goulburn River).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.4.1 with the following icon.

Watering planned to support angling activities

The Goulburn River provides numerous recreational and economic benefits. Environmental flows support native fish populations by providing fish passage and habitat and by encouraging fish migration and spawning, which in turn provides benefits for recreational anglers. Following community feedback, the timing of a targeted environmental flow in November/December is planned to reduce impacts on river access around peak fishing periods, benefitting anglers and local businesses.

Recent conditions

Rainfall in the Goulburn catchment was above the long-term average in winter and early spring 2020, but slightly below average in late spring and through summer. The high rainfall at the start of the year resulted in significant inflows to catchment storages, and allocations against high-reliability water shares in the Goulburn system reached 100 percent by mid-November. Sufficient water was available for the environment through carryover and new allocation to meet high-priority environmental flow requirements throughout the year.

Waranga Basin filled in early winter, and natural flows caused Goulburn Weir to spill throughout winter and early spring. There were few operational or consumptive water releases from Lake Eildon during this period, and water for the environment was used to maintain habitat for native fish and waterbugs in the reach immediately downstream of the reservoir. Water for the environment was used to slow the recession of spills at Goulburn Weir on three occasions in April, May and August 2020, to minimise erosion and reduce the risk of mass bank slumping. The largest natural flow event in August transported sediment and seed from mid-Goulburn tributaries and helped prime the system for an early spring fresh. Water for the environment was used in combination with unregulated flows to deliver an early spring fresh between September and October 2020, providing increased habitat for fish and macroinvertebrates. A late spring fresh was delivered in November 2020 to stimulate the spawning of golden perch. IVTs met or exceeded the recommended environmental flow rates in the lower Goulburn River from late November 2020 to April 2021. Water for the environment was used to deliver a fresh in April 2021, to help maintain the bank vegetation.

Deliveries of water for the environment were managed between an average and wet climate scenario during 2020-21, and all planned watering actions were achieved through natural events, IVTs or managed releases of water for the environment. Water for the environment delivered in the Goulburn River is reused at downstream sites along the Murray River, after a deduction for losses. In 2020-21, environmental flows that passed through the Goulburn River were used to support native fish objectives in Gunbower Creek, inundate wetlands in Gunbower Forest and the Hattah Lakes system and support ecological objectives in South Australia.

Recent monitoring suggests that rules restricting IVT flows to a maximum of 40 GL per month in summer are reducing the impacts to lower-bank vegetation and the erosion seen in previous years. Field monitoring following winter and spring freshes has reinforced the ecological benefits of these watering actions, especially when they are delivered in conjunction with natural inflows from upstream tributaries. Tributary inflows carry sediment, seeds and plant propagules that help banks in the lower Goulburn River recover. Fish monitoring confirmed that the late-spring fresh triggered the highest rate of golden perch spawning recorded in the lower Goulburn River in several years. It will be important to deliver targeted spring freshes and high flows in 2021-22, to support the continued recovery of bank vegetation and provide opportunities for more fish spawning and migration.

Scope of environmental watering

Table 5.4.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Goulburn River

Potential environmental watering action	Expected watering effects	Environmental objectives
Goulburn River reach 1		
Year-round low flow (400-1,000 ML/day in reach 1)	• Maintain habitat for small-bodied native fish • Scour fine sediment from the gravel bed and riffle substrate • Maintain adequate foraging habitat for platypus and reduce the risk of predation • Provide habitat and food for turtles • Maintain existing beds of in-channel vegetation • Wet and maintain riffles to provide habitat for biofilms and waterbugs	
Winter/spring fresh (one fresh of more than 5,000 ML/day for two days in reach 1 during July to September)	• Encourage female platypus to select a nesting burrow higher up the bank, to reduce the risk of higher flow later in the year flooding the burrow when juveniles are present	
Goulburn River reaches 4 and 5		
Year-round low flow (600-800 ML/day in reach 4 and 600-1,000 ML/day in reach five)	• 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 and littoral vegetation to provide habitat for fish and waterbugs and a substrate for biofilms to grow • Provide habitat and food for turtles • Maintain habitat for aquatic vegetation and water the root zone of low-bank vegetation • Vary flow within a specified range to encourage plankton production for food, disrupt biofilms and maintain water quality • Low, variable flow enables vegetation to establish to protect against notching and bank erosion	
Winter/autumn fresh (one fresh of more than 7,300 ML/day for two days in reaches 4 and 5 during July to August 2021 and May to June 2022)	• Provide organic matter and carbon (e.g. leaf litter) to the channel • Provide connectivity to off-channel habitats and through the river for fish dispersal and greater food resources • Scour bed sediments to maintain pools and change in-channel complexity to improve habitat • Provide cues for platypus to nest higher in the bank • Provide sediment and plant propagules from tributary inflows after large rain events, to encourage the establishment of new plants • Inundate and reduce terrestrial vegetation on low banks and trigger the recruitment of native, flood-tolerant streamside vegetation • Improve waterbug habitat and food availability by scouring fine sediments	
Pass a portion of natural tributary flows in the mid-Goulburn to reaches 4 and 5 when flows in reach 3 are above 4,000 ML/day (1,000- 5,000 ML/day in reaches 4 and 5 during May and October)	• Provide organic matter and carbon (e.g. leaf litter) to the channel • Transport and deposit seed, sediment and plant propagules on the riverbank	

Table 5.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Goulburn River *(continued)*

Early spring fresh (one fresh of up to 10,500 ML/ day with more than seven days above 7,300 ML/day during September and October in reaches 4 and 5)	• Provide organic matter and carbon (e.g. leaf litter) to the channel • Provide connectivity to off-channel habitats and through the river for fish dispersal and greater food resources • Scour bed sediments to maintain pools and change in-channel complexity for improved habitat • Increase soil moisture in banks to improve the condition of existing native vegetation • Provide sediment and plant propagules from tributary inflows after large rain events to encourage the establishment of new plants • Inundate and reduce terrestrial vegetation on low banks and trigger the recruitment of native flood-tolerant streamside vegetation • Improve waterbug habitat and food availability by scouring fine sediments and biofilms from hard substrates	
Late spring fresh (one fresh of more than 6,000 ML/ day for two days during November and December in reaches 4 and 5)	• Stimulate spawning of golden and silver perch • Scour bed sediments to maintain pools and change in-channel complexity for improved habitat • Improve waterbug habitat and food availability by scouring fine sediments and biofilms from hard substrates	
Autumn fresh (one fresh of more than 5,700 ML/ day for two days during March and May in reaches 4 and 5)	• Cue fish to move into and through the system to increase their abundance and dispersal • Scour bed sediments to maintain pools, and change in-channel complexity for improved habitat • Increase soil moisture in banks for existing vegetation maintenance	
Slow recession of 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 a rapid reduction in the water level • Transport and deposit seed, plant propagules and sediment on the riverbank • Minimise the risk of hypoxic blackwater after natural events	
Flows should not exceed 1,000 ML/day for six to eight weeks after an early spring fresh in reaches 4 and 5	• Protect littoral vegetation as habitat for small-bodied fish and macroinvertebrates • Allow recently germinated littoral, lower bank and semi-aquatic vegetation to become established	

Scenario planning

Table 5.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Providing year-round low flow in reach 1 of the mid-Goulburn River is a high priority under all climate scenarios, to maintain habitat for fish, platypus, turtles and waterbugs. This low flow also ensures in-stream vegetation remains inundated and persists through the non-irrigation season, when operational flows cease. 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 over summer and autumn in recent years. Providing year-round low flow in the lower Goulburn River is the highest priority under all scenarios, to provide habitat for fish and macroinvertebrates and help the lower bank 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, reduce the risk of bank slumping and provide a more natural flow pattern for native fish.

Delivering a winter/autumn fresh in reaches 4 and 5 is a high priority under dry, below average and average climate scenarios, to provide channel-forming processes that are required as often as possible to scour bed sediments and improve habitat. Water availability under a drought climate scenario would prevent delivery of a winter/autumn fresh, but it is expected to occur naturally under a wet climate scenario. In reach 1, a winter/autumn fresh is a high priority under all scenarios, to cue platypus to nest higher in the bank. Water for the environment will be used to deliver a winter/spring fresh in reach 1 under drought and wet climate scenarios, and water released from Lake Eildon for the winter fresh in reaches 4 and 5 will meet the reach 1 winter/spring fresh-flow target under dry and average climate scenarios.

Timing deliveries of water for the environment alongside large, natural-flow events will again be a focus for 2021-22. Passing these flows from the mid-Goulburn River to the lower Goulburn River to provide variability through winter and spring is a high priority under dry to wet climate scenarios. Tributary flows following high-rainfall events carry more plant seed, nutrients and sediments that are beneficial to the lower Goulburn River than water released from Lake Eildon does.

An early-spring fresh to prime the system and stimulate plant germination is a high priority under all climate scenarios. A late-spring fresh to trigger perch spawning is also a high priority under all scenarios, but this watering action will not be delivered if it is likely to impact the recovery of bank vegetation, and it will only be delivered under drought to below-average climate scenarios if sufficient water is available. If summer low-flow targets are met (that is, if IVTs are not too high), an autumn fresh will be delivered between March and May 2022, to maintain the bank vegetation and allow new seeds to germinate.

Carrying over water to meet minimum low-flow objectives from July 2022 to September 2023 is an important consideration under drought, dry and below-average climate scenarios.

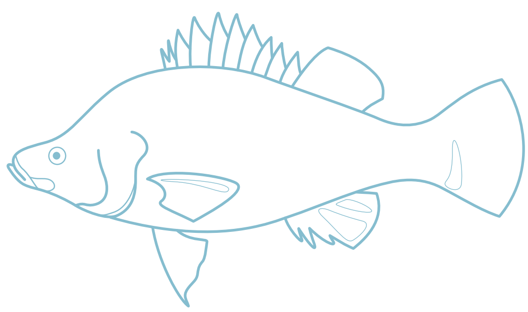


Table 5.4.2 outlines the potential environmental watering and expected water use for the Goulburn River under a range of planning scenarios

Expected river conditions	• Very few or no large natural-flow events • Blackwater could be an issue if there is a large rain event in the warmer months	• One to two short-duration, large, natural-flow events are likely to provide small winter/ spring freshes • Blackwater could be an issue if there is a large rain event in the warmer months	• Large natural-flow events are expected to provide some low flow for a few months from winter/ mid-spring and are likely to provide small winter/spring freshes • Blackwater could be an issue if there is a large rain event in the warmer months	• Large natural-flow events will provide low flow for most of the year and will likely provide winter/ spring freshes • Blackwater could be an issue if there is a large rain event in the warmer months	• Large natural-flow events will provide low flow and multiple overbank flow events in winter/spring
Predicted supply of water for the environment[1]	• 330 GL	• 431 GL	• 512 GL	• 590 GL	• 590 GL
Potential environmental watering – tier 1 (high priorities)[2]					
	• Year-round low flow • Winter/spring fresh	• Year-round low flow • Winter/spring fresh	• Year-round low flow • Winter/spring fresh	• Year-round low flow • Winter/spring fresh	• Year-round low flow • Winter/spring fresh

Table 5.4.2 outlines the potential environmental watering and expected water use for the Goulburn River under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Below average	Average	Wet
Goulburn River reaches 4 & 5					
Potential environmental watering – tier 1 (high priorities)[2]	**Tier 1a (can be achieved with predicted supply)**				
	• Year-round low flow • Early spring fresh • Autumn fresh (partial) • Recession flow management	• Year-round low flow • Winter/autumn fresh • Pass mid-Goulburn tributary flows • Early spring fresh • Autumn fresh • Recession flow management	• Year-round low flow • Winter/autumn fresh • Pass mid-Goulburn tributary flows • Early spring fresh • Autumn fresh • Recession flow management	• Year-round low flow • Winter/autumn fresh • Pass mid-Goulburn tributary flows • Early spring fresh • Late spring fresh • Autumn fresh • Recession flow management	• Year-round low flow • Winter/autumn fresh • Pass mid-Goulburn tributary flows • Early spring fresh • Late spring fresh • Autumn fresh • Recession flow management
	Tier 1b (supply deficit)				
	• Pass mid-Goulburn tributary flows • Late spring fresh	• Late spring fresh	• Late spring fresh	• N/A	
Possible volume of water for the environment required to achieve objectives	• 330,000 ML (tier 1) • 60,000 ML (tier 1b)	• 396,000 ML (tier 1) • 45,000 ML (tier 1b)	• 504,000 ML (tier 1) • 45,000 ML (tier 1b)	• 520,000 ML (tier 1)	• 458,000 ML (tier 1)
Priority carryover requirements	• 23,000 ML			• 0 ML	

1 When trading opportunities are available, additional allocations of water for the environment from the Murray River can be transferred 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.

5.4.2 Goulburn wetlands

System overview

Within the Goulburn Broken catchment, there are about 2,000 natural wetlands identified, but only six — Doctors Swamp, Gaynor Swamp, Horseshoe Lagoon, Kanyapella Basin, Loch Garry and Reedy Swamp — 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.

Doctors Swamp, Gaynor Swamp, Kanyapella Basin, Loch Garry and Reedy Swamp 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 Doctors Swamp, Gaynor Swamp, Kanyapella Basin, Loch Garry and Reedy 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.

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 feed on exposed mudflats at Gaynor Swamp is the red-necked avocet.

Horseshoe Lagoon is a paleochannel of the Goulburn River that has tall marsh, floodway pond herbland and floodplain streamside woodland vegetation communities. The lagoon supports numerous waterbird species and is home to three species of turtle including the Broad-shelled Turtle.

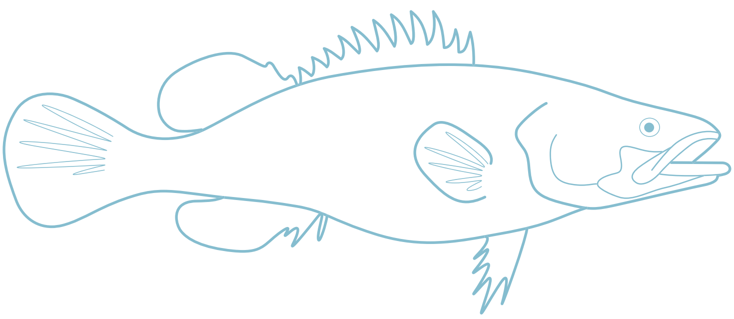
Kanyapella Basin is a shallow, freshwater marsh that provides habitat for numerous plant and animal species including the threatened intermediate egret. Historically, it has been a popular breeding site for ibis, heron and cormorants.

Loch Garry is a paleochannel 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.

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).

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 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



Traditional Owner cultural values and uses

Goulburn Broken CMA sought input from the Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation during the development of plans for water for the environment for the Goulburn wetlands. Both groups indicated 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.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

The Taungurung Land and Waters Council has been involved in planning for water for the environment at Gaynor Swamp and Horseshoe Lagoon. Healing Country and Healing Knowledge are key values outlined in the Cultural and Natural Resource Management Strategy, and they align closely with outcomes achieved with the delivery of water for the environment.

The first delivery of water for the environment to Horseshoe Lagoon in winter 2019 was celebrated by Taungurung women: the lagoon is a significant site and this was an excellent example of working together to protect cultural values and heal Country. The Taungurung water knowledge group Baan Ganalina (Guardians of Water) has worked closely with Goulburn Broken CMA, the VEWH and other partners to bring water back to the lagoon, to restore habitats and see birds and other animals return to the site. The Taungurung Land and Waters Council also participated in the development of the environmental water management plan for the site in 2019. In addition to this, the Taungurung Land and Waters Council has identified that water for the environment assists in:

- supporting the health of cultural values at the site by protecting intangible cultural heritage and valued species, traditional food and medicine plants
- exploring opportunities to reintroduce culturally informed management tools and practices
- supporting and securing access for Taungurung contemporary cultural practices and uses, teaching places, reconnection to Country and camping sites
- actively fulfilling Caring for Country responsibilities through restoring a more natural watering regime to degraded significant sites and rehabilitation of habitat for native species
- supporting contemporary Living Biocultural Knowledge exchange and integration through involvement in natural resource management decisions
- increasing Taungurung water literacy and understanding of conservation and water management within their Country
- increasing Taungurung internal capacity and confidence in water management following self-determination principles via engagement and joint management arrangements with Goulburn Broken CMA and Parks Victoria.

Taungurung has a special interest in the rehabilitation of floodplain wetlands associated with the Goulburn River (*Waring*), but which are now largely disconnected from the main river channel due to the impacts of river flow regulation. Taungurung Land and Waters Council is currently working on assessing habitat conditions at six of the disconnected wetlands. This process and their findings will inform future seasonal watering proposals and planning for water for the environment. Currently, Taungurung is working to enhance habitat conditions for native species in the area, and healthy Country assessments will provide important information about cultural objectives and indicators.

The Yorta Yorta Nation Aboriginal Corporation has been involved in planning for environmental flows at Doctors Swamp, Kanyapella Basin, Loch Garry and Reedy Swamp including by participating in the development of environmental water management plans for the sites.

- Yorta Yorta identified key cultural values at Doctors Swamp. Water for the environment supports *Nardoo* (a food source), native grasses, Old Man Weed (which has medicinal uses) and weaving (using sedges/rushes). Watering also supports a wide range of bird and animal species that provide a variety of cultural values.
- Kanyapella Basin plays an important role in Yorta Yorta's cultural and spiritual connections. It supports the health of cultural values in the landscape (such as Creation Story and traditional food and medicine plants). Before a delivery of environmental flows in winter 2020, Yorta Yorta Peoples conducted a cultural burn at the site, helping to enable direct delivery of the water and help the growth of Old Man Weed.
- Environmental flows delivered to Loch Garry in April 2020 initiated a resurgence of culturally important food, fibre and medicinal plants. Giant rush thrived, providing nesting opportunities for important bird species. The site is rich in cultural values identified by Yorta Yorta, with stone scatters, marked trees and significant sand hills in the higher elevations.

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:

- water-based recreation (such as canoeing)
- riverside recreation and amenity (such as birdwatching, camping, cycling, hiking, photography and walking)
- community events and tourism (such as community birdwatching events, the Nature Scripts Initiative and outdoor classroom learning).

Recent conditions

The Goulburn catchment received above-average rainfall in late winter and early spring 2020 but mostly below-average rainfall over the remainder of 2020-21. Monthly temperatures remained close to the long-term average throughout the year.

Large rain events between autumn and spring 2020 naturally filled or partially filled Doctors Swamp, Horseshoe Lagoon, Loch Garry and Reedy Swamp. Water for the environment was used to water Gaynor Swamp and Kanyapella Basin and to top up Horseshoe Lagoon as required during 2020-21.

Doctors Swamp filled naturally in autumn 2020 and received an additional top-up of water for the environment in May 2020. Water persisted in the deeper areas of the wetland until February 2021. Magpie geese and Sloane's froglet were recorded while it held water.

Gaynor Swamp received water for the environment in 2018 and was allowed to dry out during 2019-20. Water for the environment was used to re-fill the wetland in spring 2020, and subsequent monitoring indicated the watering event triggered flowering of the vulnerable-listed spiny lignum and cane grass and provided foraging habitat for brolga. Lewin's rail was also heard calling at the swamp, which was the first record of the species at this site.

Horseshoe Lagoon filled naturally in autumn 2020. A small volume of water for the environment was used to top up the wetland in September 2020, to protect the nests of eastern long-neck turtles, but unfortunately the nests were then raided by foxes. Additional protections will accompany future watering actions at the lagoon.

Kanyapella Basin was inundated with unregulated flows in 2011-12 and 2016-17, and it received its first delivery of water for the environment in winter 2020. The wetland held water for three months, supporting frogs and aquatic vegetation. Monitoring detected the rigid water-milfoil, which is listed under the *Environment Protection and Biodiversity Conservation Act 1999* and was last recorded at the site in 1982.

Loch Garry and Reedy Swamp filled naturally in April 2020, and water levels were maintained by further rain in late winter and early spring. These natural events meant that environmental watering actions planned for autumn 2021 were not required.

Environmental watering in the Goulburn wetlands in 2020-21 was undertaken in line with an average climate scenario, and all required planned watering actions were achieved.

Scope of environmental watering

Table 5.4.3 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.4.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Goulburn wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Doctors Swamp (partial fill in autumn 2022)	• Inundate the deeper and fringing margins of the swamp to wet and promote the condition and growth of the vegetation • Provide refuge habitat and breeding conditions for frogs • Support plant species used for Yorta Yorta traditional medicines and weaving at a significant cultural site	
Gaynor Swamp (fill in autumn 2022)	• Inundate to less than 1 m depth to promote conditions for vegetation growth and flowering, particularly of southern cane grass and spiny lignum and planted river red gum saplings • Provide nesting, breeding and feeding habitat for waterbirds, in particular for brolga	
Horseshoe Lagoon (partial fill or top-up as required in winter 2021)	• Inundate to the wetland margins to provide soil moisture to maintain wetland vegetation communities by supporting their growth and recruitment • Promote the growth of river swamp wallaby grass • Suppress the growth of weeds • Provide feeding and breeding habitat for turtle populations	
Kanyapella Basin (partial fill in winter 2021)	• Promote diverse vegetation communities to establish • Support the growth of rigid water-milfoil and river swamp wallaby grass populations • Support plant species used for Yorta Yorta traditional medicines and weaving at a significant cultural site	
Loch Garry (partial fill in spring 2021)	• Inundate deeper and fringing wetlands areas to promote and improve the growth of native wetland vegetation communities including threatened flora • Provide feeding and breeding habitat for frogs, turtles and waterbirds • Support plant species used for Yorta Yorta traditional medicines and weaving at a significant cultural site	
Reedy Swamp (fill in autumn 2022)	• Inundate to less than 1 m to promote the growth of and maintain native wetland vegetation • Provide refuge and feeding and breeding habitat for frogs • Support plant species used for Yorta Yorta traditional medicines and weaving at a significant cultural site	

Scenario planning

Table 5.4.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Proposed watering actions at Doctors Swamp, Gaynor Swamp, Horseshoe Lagoon, Loch Garry and Reedy Swamp are considered a high priority in 2021-22 under all climate scenarios. All of these wetlands filled naturally or with water for the environment in 2019-20 or 2020-21, and they are currently dry or drying. A short dry phase is beneficial at these wetlands for various ecological processes, but follow-up watering will be needed to consolidate and build on the benefits of recent watering actions.

Native wetland plants were actively planted at Gaynor Swamp and Horseshoe Lagoon in 2020-21, and follow-up watering is required in 2021-22 to ensure those plants survive and become established. The proposed watering actions at Loch Garry and Reedy Swamp are deferred actions from 2020-21, and they are needed in 2021-22 to avoid stressing the plants and animals that rely on those wetlands. Doctors Swamp was mostly dry by February 2021, and it is proposed to be filled in autumn 2022 after it has completed a year in a dry phase.

Watering Kanyapella Basin is considered a high priority under dry and average climate scenarios, to consolidate vegetation outcomes associated with water for the environment in 2020-21. This site would not naturally receive water as often as some of the other Goulburn wetlands, and it is therefore a lower priority under a drought scenario. Goulburn-Murray Water uses Kanyapella Basin as a flood-retarding basin, so deliberate environmental watering is not planned under a wet climate scenario.

Doctors Swamp and Horseshoe Lagoon are likely to fill naturally in 2021-22 under a wet climate scenario and Loch Garry may be used as a flood-retarding basin, but the other wetlands will need to be actively watered with water for the environment unless there is widespread flooding throughout the Goulburn catchment. The potential contribution from natural fills has been factored into the expected volume of water for the environment that will be required for the proposed watering actions in 2021-22.

No specific carryover volume has been identified for the Goulburn wetlands for 2022-23.

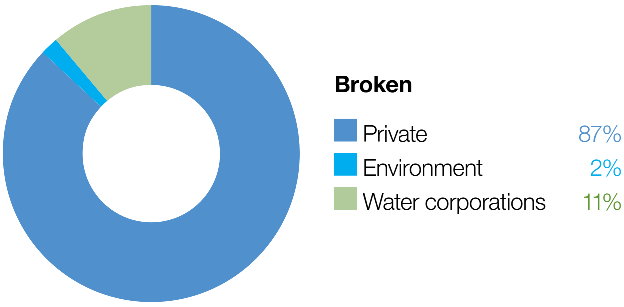
Table 5.4.4 Potential environmental watering for the Goulburn wetlands under a range of planning scenarios

Expected river conditions	• Catchment run-off and natural flow into the wetlands are highly unlikely	• Catchment run-off and natural flow into the wetlands are unlikely	• Some catchment run-off and natural flow into some wetlands are likely, particularly in winter/spring	• Catchment run-off and natural flow into the wetlands is likely to partially or completely fill them, particularly during winter/spring
Potential environmental watering – tier 1 (high priorities)[1]	• Doctors Swamp • Gaynor Swamp • Horseshoe Lagoon • Loch Garry • Reedy Swamp	• Doctors Swamp • Gaynor Swamp • Horseshoe Lagoon • Kanyapella Basin • Loch Garry • Reedy Swamp	• Doctors Swamp • Gaynor Swamp • Horseshoe Lagoon • Kanyapella Basin • Loch Garry • Reedy Swamp	• Doctors Swamp • Gaynor Swamp • Horseshoe Lagoon • Loch Garry • Reedy Swamp
Possible volume of water for the environment required to achieve objectives	• 3,220 ML (tier 1)	• 4,220 ML (tier 1)	• 4,020 ML (tier 1)	• 2,100 ML (tier 1)

1 Tier 1 potential environmental watering at the Goulburn wetlands is not classified into tier 1a and 1b, because the water available for use is shared across various systems and it is not possible to reliably estimate supply.

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



Proportion of water entitlements in the Broken basin held by private users, water corporations and environmental water holders on 30 June 2020.

Did you know...?

'The Broken River (and upper Broken Creek) hold many cultural values. Common reed contained within the slack water provides important material for tools, while also providing refuge for culturally important fish species (large and small-bodied). The river also has significant stands of old growth river red gum containing important habitat and exhibiting scars made from carving out canoes and coolamons.'
— *Yorta Yorta Nation Aboriginal Corporation*

Top: Broken Creek, by Goulburn Broken CMA
Above: Murray cod release, by Arthur Rylah Institute

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 (Figure 5.5.1). 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, although total annual flow is considerably less than natural. 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.

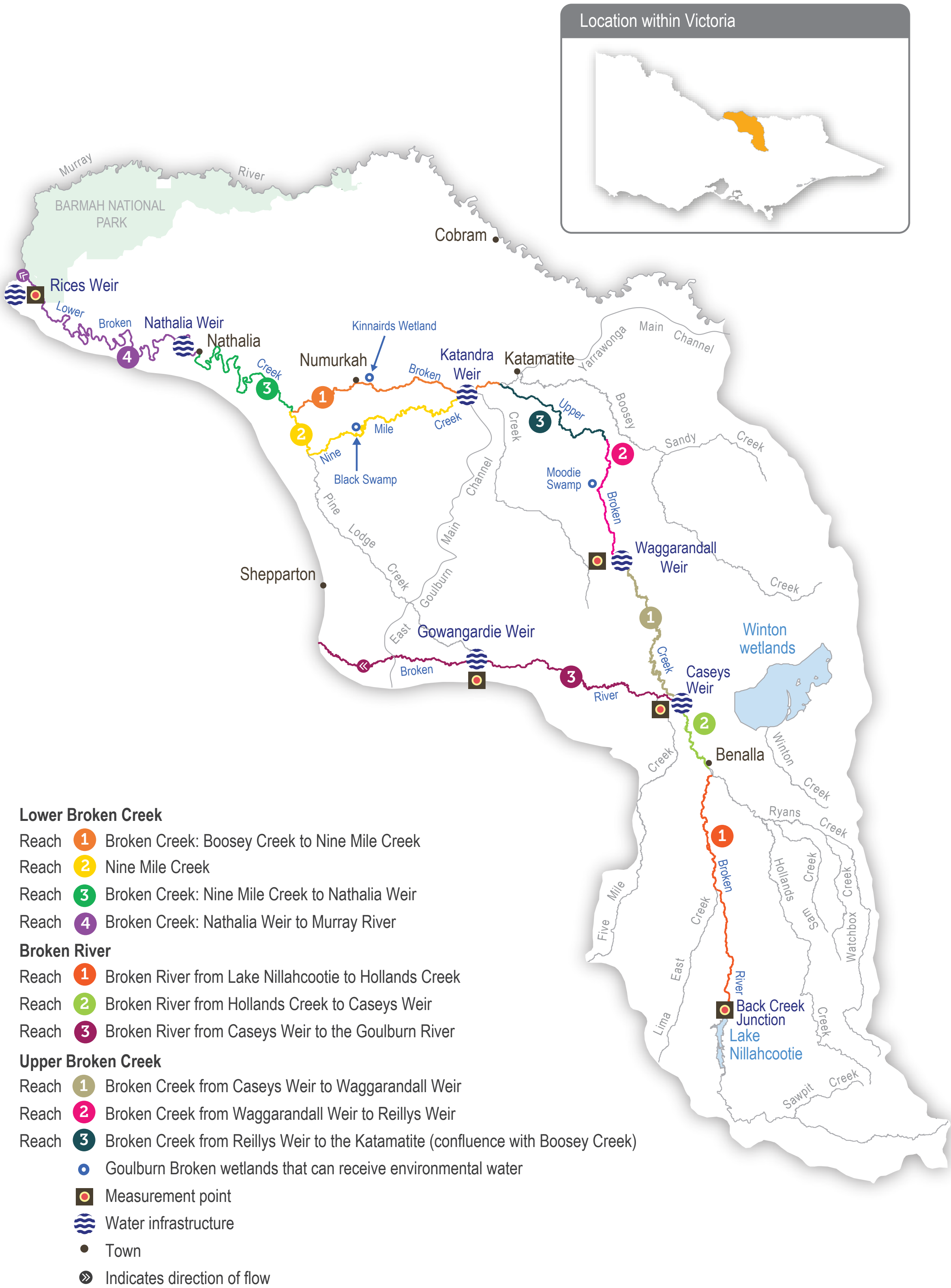
Upper Broken Creek is defined as the 89-km stretch of creek from the Broken River (at Caseys Weir) to the confluence with Boosey Creek near Katamatite. Upper Broken Creek flows across a flat, riverine plain and has naturally low run-off from its local catchment. It receives flood flows from the Broken River, although the frequency of these floods has been reduced by river regulation, 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. The flow below Waggarandall Weir is mainly influenced by rainfall and catchment run-off. 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 due to the small volume of Water Holdings in the Broken system. Environmental water holders can trade it into the Broken system from other trading zones subject to relevant limits and conditions, to meet critical environmental needs.

The bulk entitlement for the Broken system held by Goulburn-Murray Water stipulates that minimum environmental flows — also known as passing flows — are to be maintained in the Broken River when there are natural flows into the system. The bulk entitlement also allows Goulburn-Murray Water and the VEWH to agree to reduce minimum flows and to accumulate the unused volumes for later releases that will provide a greater environmental benefit. In recent years, passing flows have been reduced, accumulated and delivered to maintain low flow (on days when there are no passing flows due to no natural flow into the system) and for freshes in the Broken River. In 2020-21, accumulated passing flows were used to supplement the flow in upper Broken Creek for the first time. Accumulated passing flows are the first volumes lost when the storage spills. Environmental flows in upper Broken Creek are restricted by the volume of available supply, channel capacity and the need to avoid flooding low-lying, adjacent land.

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 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. 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.

Upper Broken Creek is dominated by unique box streamside vegetation and remnant plains grassy woodland. The creek and its streamside zone support 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.

Environmental watering objectives in the Broken River

Increase native fish populations
Turn over bed sediments and scour around large wood to maintain in-channel habitat diversity
Maintain platypus populations
Maintain in-stream vegetation
Maintain 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

Traditional Owners value implementing more natural flow regimes in the landscape's waterways and wetlands as a way of caring for Country, supporting culturally important plants and providing opportunities to practice culture. Goulburn Broken CMA consulted with the Yorta Yorta Nation Aboriginal Corporation for upper Broken Creek and the Broken River downstream of Benalla, and the Taungurung Land and Waters Council for the Broken River upstream of Benalla.

The Taungurung Land and Waters Council plan to assess cultural values and objectives for the Broken River through healthy Country assessments like Aboriginal Waterway Assessments. These will assist Taungurung Land and Waters Council to identify more specific cultural objectives for the system in future. Taungurung Land and Waters Council has been part of the Broken system advisory group meetings since 2018 and is continuing to work with Goulburn Broken CMA to identify cultural objectives and develop culturally informed recommendations for water for the environment in the Broken system. Water for the environment in the Broken system supports the health of cultural values and landscapes including intangible cultural heritage, valued species and traditional food and medicine plants.

The Yorta Yorta Nation Aboriginal Corporation advised that water for the environment in the Broken River and upper Broken Creek supported the following Yorta Yorta values:

- common reed contained within the slack water provides important material for tools, while also providing refuge for culturally important large and small-bodied fish species
- significant stands of old-growth river red gum containing important habitat and exhibiting scars made from carving-out canoes and coolamons.

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 canoeing, fishing, kayaking and swimming)
- riverside recreation (such as birdwatching, bushwalking, camping, duck hunting and picnicking)
- amenity: green spaces are important to the community for wellbeing and mental health
- community events and tourism (such as markets around Benalla Lake)
- socio-economic benefits (such as consumptive water; water for irrigation and stock and domestic use; and water to support terrestrial birds that help control agricultural pests).

Recent conditions

Rainfall and daily maximum temperatures across the Broken catchment in 2020-21 were close to the long-term average. Allocations against high-reliability water shares in the Broken system started the year at 17 percent and rose to 100 percent in October, due to consistent inflows that caused Lake Nillahcootie to fill and spill. Accumulated passing flows carried over from 2019-20 in the Broken River were used to supplement low flow on days when there was no passing flow in the Broken River and to deliver winter/spring low flow in upper Broken Creek before Lake Nillahcootie spilled.

While recent conditions in the Broken catchment aligned with an average climate, water for the environment was managed in the Broken system in line with a dry climate scenario during 2020-21. Due to low operational flows in upper Broken Creek, water for the environment was used to maintain low flow throughout the year in the creek, and there was insufficient water to deliver a fresh. Minimum low-flow targets in all reaches of the Broken River were largely met with a combination of operational releases, tributary inflows and the use of accumulated passing flows. There were several natural freshes between July and October 2020, but recommended summer and autumn freshes could not be delivered, due to limited environmental Water Holdings.

A combination of accumulated passing flows and water for the environment was used to maintain winter and spring low flow in upper Broken Creek until October when the banked passing flows were lost with the spill of Lake Nillahcootie. After October, water for the environment was used (with additional water traded into the system) to meet summer and autumn low flow in upper Broken Creek. This low flow maintained water quality within target levels, so additional summer and autumn freshes were not required.

Scope of environmental watering

Table 5.5.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

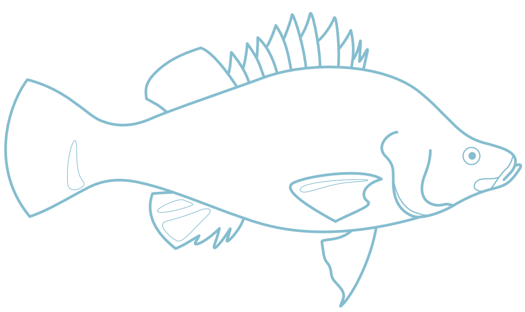


Table 5.5.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Broken River and upper Broken Creek

Winter low flow (1-10 ML/ day during June to August)	• Maintain aquatic habitat and connections between weir pools for native fish and platypus • Inundate benthic surfaces and large wood located in the bottom of the channel, which serves as habitat for waterbugs • Maintain water quality and oxygen levels for native fish, platypus and waterbugs	
Spring low flow (1-10 ML/ day during September to November)		
Summer low flow (1-5 ML/ day during December to February)		
Autumn low flow (1-5 ML/ day during March to May)		
Summer/autumn fresh (one fresh of 50-100 ML/ day for 10 days during December to May)	• Flush pools to improve their water quality and increase oxygen levels	
Winter low flow (15-30 ML/ day during June to August)	• Maintain habitat for in-stream and fringing vegetation, and prevent terrestrial vegetation from colonising the stream bed • Maintain riffles, pools and slackwater to provide diverse hydraulic habitat for native fish, aquatic plants, platypus and waterbugs • Maintain water quality and oxygen levels for native fish, platypus and waterbugs	
Spring low flow (15-30 ML/ day during September to November)		
Summer low flow (15-30 ML/day during December to May)		
Autumn low flow (15-30 ML/day during March to May)		
Summer/autumn fresh (one fresh of 400-500 ML/ day for two to five days during December to May)	• Scour sediments around large wood, turn over bed sediments, replenish biofilms and maintain macrophyte habitat • Provide flow cues to stimulate native fish to breed and migrate • Maintain longitudinal connectivity for native fish passage	

Scenario planning

Table 5.5.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

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 has no inflows from tributaries and is more reliant 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.

All potential watering actions in the Broken River and upper Broken Creek are required under all climate scenarios, but there is not enough water for the environment to meet most of the potential actions, and no allocations of water for he environment are expected for the Broken system in 2021-22 under a drought climate scenario. The VEWH may elect to trade water into the system to meet potential watering actions if there is a trade opportunity available.

The main objective of environmental flows for upper Broken Creek is to maintain low flow throughout the year, to maintain water quality and habitat for native fish, platypus, waterbugs and aquatic vegetation. Maintaining adequate flow during spring is particularly important to achieve ecological outcomes, because the native fish, platypus, waterbugs and vegetation are most active and productive at this time. The recommended spring low flow will provide adequate connectivity, habitat and water quality during the breeding seasons of fish and platypus. The small volume of water for the environment expected under a dry climate scenario should be used to deliver the recommended spring low flow, to maintain conditions for aquatic animals. Larger allocations of water for the environment under average and wet climate scenarios should be prioritised for summer low flow, to reduce the risk of poor water-quality outcomes during warmer weather.

Year-round low flow is needed to support the environmental objectives for the Broken River, but there is little capacity to do so with environmental water, especially under drought and dry climate scenarios. Operational deliveries and natural tributary inflows will likely meet a large proportion of the recommended flow in the Broken River under average and wet climate scenarios, but water for the environment may be used to supplement the recommended low flow or summer/autumn freshes if needed.

The small environmental entitlement in the Broken system will be prioritised for use in 2021-22, and no carryover target has been set for 2022-23.

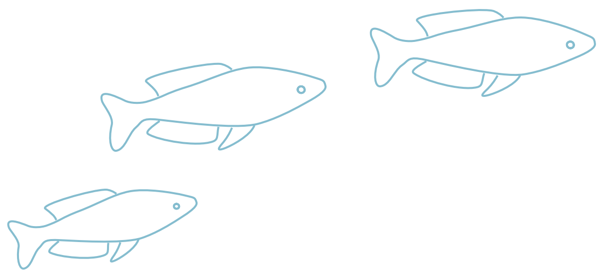
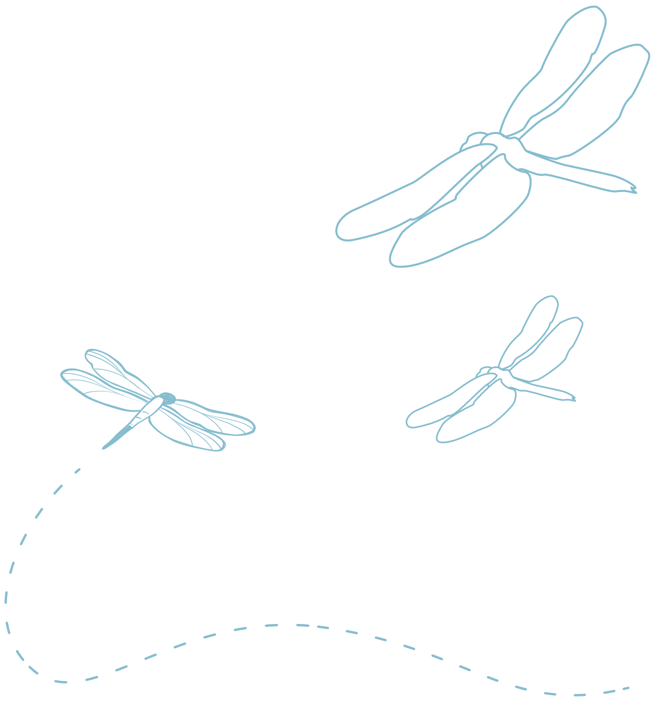


Table 5.5.2 Potential environmental watering for the Broken River and upper Broken Creek under a range of planning scenarios

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	• Low, unregulated flows 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	• High winter/spring flow in Broken River • Some natural winter/spring flow in upper Broken Creek	• High winter/spring flow in the Broken River • Winter/spring freshes in upper Broken Creek
Predicted supply of water for the environment	• 0 ML	• 226 ML	• 647 ML	• 647 ML
Potential environmental watering – tier 1 (high priorities)				
	• N/A	• Spring low flow (partial)	• Spring low flow • Summer low flow (partial)	• Spring low flow • Summer low flow (partial)
	• Winter low flow • Spring low flow • Summer low flow • Summer/autumn fresh (as required) • Autumn low flow	• Winter low flow • Spring low flow (remaining volume) • Summer low flow • Autumn low flow • Summer/autumn fresh (as required)	• Winter low flow • Summer low flow (remaining volume) • Autumn low flow • Summer/autumn fresh (as required)	• Winter low flow • Summer low flow (remaining volume) • Autumn low flow • Summer/autumn fresh (as required)
Potential environmental watering – tier 2 (additional priorities)	• N/A			

Table 5.5.2 Potential environmental watering for the Broken River and upper Broken Creek under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Average	Wet
Broken River (targeting reach 1, 2 and 3)				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• N/A		• Winter low flow • Spring low flow • Summer low flow • Autumn low flow	• Winter low flow • Spring low flow • Summer flow • Autumn low flow • Summer/autumn fresh
	Tier 1b (supply deficit)			
	• Winter low flow • Spring low flow • Summer low flow • Autumn low flow	• Winter low flow • Spring low flow • Summer low flow • Summer/autumn fresh • Autumn low flow	• Summer/autumn fresh	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 0 ML (tier 1a) • 6,676 ML (tier 1b)	• 226 ML (tier 1a) • 11,450 ML (tier 1b)	• 647 ML (tier 1a) • 7,791 ML (tier 1b)	• 647 ML (tier 1a) • 353 ML (tier 1b)



5.5.2 Lower Broken Creek

System overview

The Lower Broken Creek system is found with in Yorta Yorta country and their knowledge is evident throughout the landscape. 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 and little flow during the non-irrigation season. These modifications have changed the way native species use the creek and have introduced invasive species such as arrowhead (*Sagittaria graminea*). 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, encourage the growth of native plants, promote in-stream productivity, control water quality and flush the water fern azolla as necessary.

Regulated water is delivered to lower Broken Creek from the Goulburn and Murray systems via the irrigation channel network. Lower Broken Creek is operated separately from upper Broken Creek and Broken River, which are both supplied from Lake Nillahcootie on 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 flows 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 accumulations 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 — inter-valley transfers (IVTs) from the Goulburn to the Murray or Barmah Choke bypass flows — 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 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 Promote the cover and condition of native in-stream and littoral vegetation communities
Increase 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 the Yorta Yorta Nation Aboriginal Corporation (YYNAC) during the planning of deliveries of water for the environment in lower Broken Creek. The following cultural values were identified for lower Broken Creek.

"The Broken Creek holds many cultural values. Common reed contained within the slack water provides important material for tools whilst also providing refuge for culturally important fish species (large and small-bodied). The creek also has significant stands of old growth river red gum containing important habitat and exhibiting scars made from carving out canoes and coolamons" *(YYNAC, 4 March 2021).*

Yorta Yorta Nation Aboriginal Corporation continues to pursue their inherent rights to water for country to improve their spiritual, cultural, environmental, social and economic needs *Yorta Yorta Whole of Country Plan 2021-2030*, (YYNAC).

The environmental objectives in the lower Broken Creek seasonal watering proposal are supported by Yorta Yorta and align with their values of caring for Country. Flows have been specifically targeted to support in-stream vegetation and native fish, along with other aquatic biota. The Goulburn Broken CMA will continue to work with Yorta Yorta people to identify how the management of water for the environment can best support water for their country, enhancing cultural values.

Yorta Yorta Nation Aboriginal Corporation has raised concerns around flow regulation in all their waterways, which is having an impact on their country and cultural knowledge.

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, game hunting and kayaking)
- riverside recreation and amenity (such as aesthetic and amenity values that are particularly important for the community's mental health and wellbeing during dry periods, and passive recreation)
- socio-economic benefits (such as consumptive water users, Goulburn-Murray Water irrigators and diverters and Goulburn Valley Water customers).

Recent conditions

The Goulburn Broken region experienced average rainfall and above-average temperatures for most of 2020-21. Unregulated flow from upper Broken Creek provided minimal contribution to lower Broken Creek throughout the season, but inflows to Goulburn and Murray storages that supply lower Broken Creek saw high-reliability entitlements reach 100 percent allocation by November and February respectively.

Flow in lower Broken Creek was restricted during winter 2020-21 due to maintenance works on the Yarrawonga Main Channel and the East Goulburn Main Channel. The flow dropped below the recommended winter target of 40 ML per day in all reaches, and fishways were closed between May and June 2020 to maintain water levels in the weir pools. Extended high flows were delivered from the start of the irrigation season in August 2020, which helped flush accumulated azolla through the system. Water for the environment was used to deliver a fresh in September 2020, to cue native fish movement. This was followed by a period of stable, high flow to optimise available habitat during the Murray cod breeding season. IVTs from the Goulburn system, Barmah Choke bypass flows and other operational transfers to the Murray system maintained an average flow of about 380 ML per day (with peaks up to 540 ML per day) in lower Broken Creek from mid-November 2020 to early autumn 2021. Water for the environment was delivered in conjunction with operational deliveries from late March 2021, to maintain a flow of about 200 ML per day until the end of the irrigation season.

Deliveries of water for the environment in lower Broken Creek were managed in line with an average climate scenario during 2020-21. All planned environmental watering actions from spring 2020 until May 2021 were partially or fully achieved, but the inability to meet the minimum winter low-flow target for the second consecutive year has potentially compromised some environmental objectives for young-of-year fish and platypus. Any channel maintenance works that prevent the delivery of minimum low-flow targets outside the main irrigation season in 2021-22 will further compromise these environmental objectives.

There is little ecological monitoring in lower Broken Creek, but members of the Broken Environmental Water Advisory Group and other community members have reported a marked improvement in water quality since targeted deliveries of water for the environment started in 2010-11. There are also anecdotal reports of improvements to the native fish population. Higher flows associated with IVTs and Murray bypass deliveries help maintain oxygen levels in the creek, but their impact on bank health is a potential concern, and it is currently being investigated.

Scope of environmental watering

Table 5.5.3 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.5.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for lower Broken Creek

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter low flow (20-40 ML/day during May to August)[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 the cold in winter • Provide flowing-water habitat and avoid winter drying of weir pools for fish, vegetation, waterbugs, platypus and turtles • Maintain water over submerged aquatic plants, so they are protected from drying and frosting • Reduce the stagnation of weir pools and maintain suitable oxygen concentrations	
Spring/summer/autumn low flow (70-150 ML/day in reaches 1 and 2 and 200 to 250 ML/day in reaches 3 and 4 during July to May)	• Provide habitat for native fish, platypus, rakali, turtles and waterbugs • Support the movement and recruitment of fish • Mobilise azolla and maintain oxygen levels in summer	
Winter/spring fresh(es) (one to three freshes of 300-450 ML/day for one to two weeks during July to September)	• Flush and mobilise azolla if it has accumulated, to maintain water quality • Trigger the movement and spawning of fish • Encourage the germination and growth of littoral and in-stream vegetation	

1 This flow may be difficult to achieve when channel maintenance work is being completed. If maintenance work is required, waterway managers will work with the storage manager to minimise impacts where possible. Possible mitigation actions include adjusting weir pool levels ahead of planned maintenance work and scheduling works to minimise the duration of impacts on flow.

Scenario planning

Table 5.5.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The high degree of regulation in the lower Broken Creek system means flow patterns in the lower Broken and Nine Mile creeks is the same under most climate scenarios. Water for the environment in the lower Broken Creek system is primarily used to guard against reduced flow during the non-irrigation season.

The potential watering actions under all climate scenarios include maintaining flow above 40 ML per day outside the irrigation season, ameliorating sudden fluctuations in irrigation demand during the irrigation season and delivering spring freshes to trigger fish movement or flush excessive accumulations of azolla.

A carryover target of 5,000 ML applies under all climate scenarios, to ensure minimum low flow and also that a small fresh can be delivered in 2022-23.

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 flow in winter • No unregulated flow throughout the irrigation season (mid-August to May) • No diversion of unregulated Murray River flow available	• Some unregulated flow in winter • No unregulated flow throughout the irrigation season (mid-August to May) • No diversion of unregulated Murray River flow available	• Unregulated flow in winter/spring • Unregulated flow unlikely during October to May • Diversion of unregulated Murray River flow available during mid-August to October	• Unregulated flow in winter/spring • Unregulated flow unlikely during November to May • Diversion of unregulated Murray River flow available during mid-August to November
Potential environmental watering – tier 1 (high priorities)[1]	• Winter low flow • Spring/summer/autumn low flow • Winter/spring freshes			
Possible volume of water for the environment required to achieve objectives	• 45,000 ML			
Priority carryover requirements	• 5,000 ML			

1 Tier 1 potential environmental watering for the 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 allows them to receive environmental water: Black Swamp, Kinnairds Wetland and Moodie Swamp.

These wetlands are found on Yorta Yorta country, whose knowledge is evident throughout the landscape. 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, but the VEWH, waterway managers and storage managers adjust the timing and rate of environmental deliveries where possible to optimise environmental outcomes within current system constraints.

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

	Maintain or improve the cover, diversity, recruitment/regeneration and growth of native wetland plant species consistent with ecological vegetation class benchmarks Reduce the cover and diversity of exotic plant species Maintain populations of rigid 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 Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation during the planning of deliveries of water for the environment in the Broken system. Currently, water for the environment can only be delivered to Broken wetlands in Yorta Yorta Country.

The Yorta Yorta Nation Aboriginal Corporation and Goulburn Broken CMA are working to ensure that planned watering actions at Black Swamp, Kinnairds Wetland and Moodie Swamp align with the conservation and protection of cultural sites and allow for connection to Country and establishing strong linkages. The Yorta Yorta Nation Aboriginal Corporation has been involved in planning through online meetings and on-Country visits and by providing content for, reviewing and endorsing the Broken wetlands seasonal watering proposal.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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 5.5.5 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

Black Swamp, Kinnairds Wetland and Moodie Swamp have significant diversity within the landscape, multiple varieties of *Nardoo* (a food source), native grasses such as Old Man Weed, *sneezeweed*, (medicinal) and basket weaving sedges/rushes are in the area. The sites support a wide array of bird life and other animals that provide a variety of cultural values including for food and clothing. At Black Swamp, there is also evidence of cooking mounds around the perimeter.

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:

- water-based recreation (such as canoeing)
- riverside recreation and amenity (such as birdwatching, camping, picnicking, photography and walking)
- community events and tourism (such as Walk and Squawk)
- socio-economic benefits (such as tourism).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.5.5 with the following icon.

Watering planned to support waterbird-related recreational activities

Environmental flows will provide a winter/spring fill at Kinnairds Wetland, improving the growth of vegetation at the site and enhancing its amenity and aesthetics for locals and tourists. The fill will be timed to ensure conditions are optimal for 'Walk and Squawk', an event that aims to improve the community's understanding of the ecology, flora and fauna at the site.

Recent conditions

The Broken catchment had very high rainfall in autumn 2020, but rainfall and temperatures throughout 2020-21 were close to the long-term average.

Black Swamp and Kinnairds Wetland were partially filled using water for the environment in autumn 2020, and they held water for three and five months respectively. Moodie Swamp filled naturally in autumn 2020 and held water until November 2020. These watering events triggered the germination and growth of wetland plants at all three wetlands, and brolga were observed feeding and courting at Moodie Swamp during its wet phase.

All three wetlands are ephemeral systems that rely on wet and dry phases to support various ecological processes. No water for the environment was delivered to any of the Broken wetlands in 2020-21, to allow them to draw down and dry. Planned watering actions in 2021-22 will stimulate wet-phase processes and prevent wetland vegetation communities from exceeding their optimal dry-phase duration.

Scope of environmental watering

Table 5.5.5 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.5.5 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Broken wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Black Swamp (partial fill in winter/spring and top-up as required)	• Promote the growth of planted river red gum saplings and improve the condition of Red Gum Swamp Ecological Vegetation Class (EVC) vegetation including river swamp wallaby grass	
Kinnairds Wetland (fill in winter/spring)	• Promote the growth and improve the condition of Red Gum Swamp EVC and Plains Grassy Wetland EVC vegetation including rigid water-milfoil	
Moodie Swamp (fill in autumn and top-up as required)	• Promote the growth and improve the condition of Cane Grass Wetland EVC vegetation • Promote the growth of rigid water-milfoil • Provide feeding, nesting and breeding habitat for brolga and other waterbird species	

Scenario planning

Table 5.5.6 outlines the potential environmental watering and expected water use under a range of planning scenarios.

A partial fill of Black Swamp and a complete fill of Kinnairds Wetland in winter/spring are high priorities under all climate scenarios, because the vegetation communities at each site will have reached the end of their optimal dry phases. Without the proposed watering actions, the condition of Red Gum Swamp EVC at both sites and Plains Grassy Wetlands EVC at Kinnairds Wetland may decline.

The optimal dry-phase duration for Moodie Swamp is between 15 and 30 months. Filling the wetland in autumn 2022 is likely to benefit native vegetation and waterbirds, but the proposed watering action could be delayed until 2022-23 without causing significant environmental harm. Moodie Swamp may be opportunistically watered in autumn 2022 if water is available, to reduce the need to water it in 2022-23.

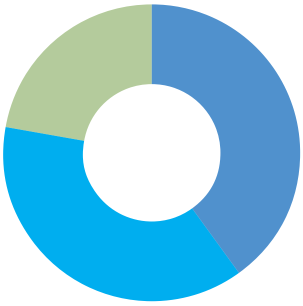
Table 5.5.6 Potential environmental watering for the Broken wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment run-off and natural flow into the wetlands are highly unlikely	• Catchment run-off and natural flow into the wetlands are unlikely	• Some catchment run-off and natural flow into some of the wetlands are likely, particularly in winter/spring	• Catchment run-off 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]	• Black Swamp • Kinnairds Wetland	• Black Swamp • Kinnairds Wetland	• Black Swamp • Kinnairds wetland	• Black Swamp • Kinnairds wetland
Potential environmental watering – tier 2 (additional priorities)	• Moodie Swamp	• Moodie Swamp	• Moodie Swamp	• Moodie Swamp
Possible volume of water for the environment required to achieve objectives	• 680 ML (tier 1) • 1,000 ML (tier 2)	• 680 ML (tier 1) • 1,000 ML (tier 2)	• 680 ML (tier 1) • 1,000 ML (tier 2)	• 0 ML (tier 1) • 700 ML (tier 2)

1 Tier 1 potential environmental watering at the Broken wetlands is not classified into tier 1a and 1b, because the water available for use is shared across various systems and it is not possible to reliably estimate supply.

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



Campaspe

Private	40%
Environment	38%
Water corporations	22%

Proportion of water entitlements in the Campaspe basin held by private users, water corporations and environmental water holders on 30 June 2020.

Did you know...?

Taungurung's Baan Ganalina Advisory Group and Dja Dja Wurrung's Kapa Gatjin Advisory Group recently completed an Aboriginal waterway assessment along the Campaspe River. This will help feed into future water management plans, and it highlights valuable ways to collaboratively work together to understand how environmental values and cultural values align.

Top: Campaspe River, by Arthur Rylah Institute
Above: Campaspe River aquatic vegetation, by the VEWH

The Campaspe system includes the Campaspe River and Coliban River.

5.6.1 Campaspe River

System overview

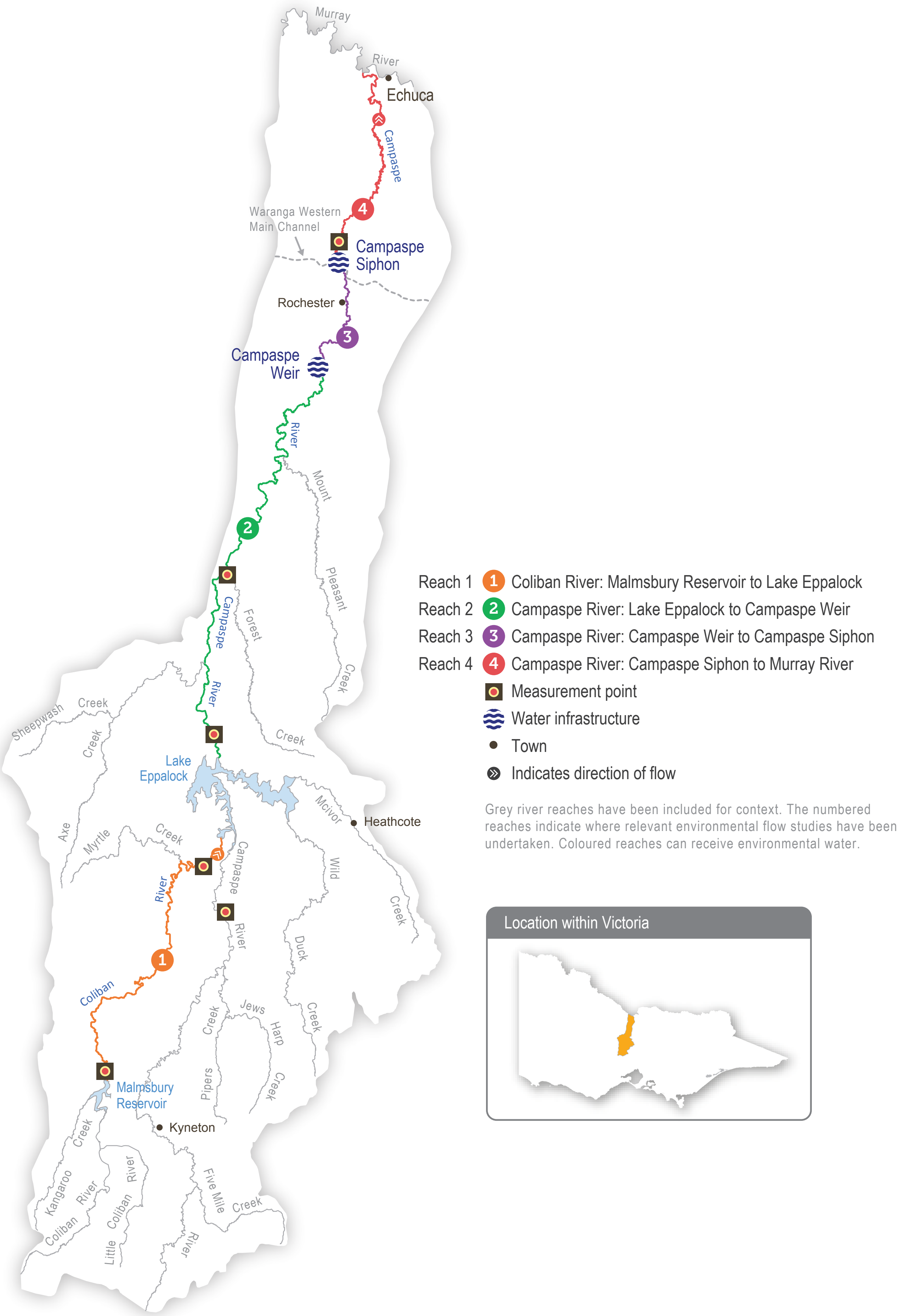
Natural inflows in the upper Campaspe River catchment are harvested into Lake Eppalock, which is located near the townships of Axedale and Heathcote. The main tributaries of the Campaspe River are the Coliban River, McIvor and Wild Duck creeks above Lake Eppalock and Mount Pleasant, Forest and Axe creeks below Lake Eppalock (Figure 5.6.1). 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 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 Campaspe 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 winter and 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 inter-valley transfers (IVTs) usually occur in summer and autumn and, depending on the rate of delivery, can either support or compromise environmental flows 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 recruiting streamside vegetation. Storage managers and the North Central 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.

Figure 5.6.1 The Campaspe system



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).

Environmental watering objectives in the Campaspe River

Protect and increase populations of native fish Facilitate recolonisation by native fish species that have been presumed lost
Protect the resident platypus population
Maintain adult river red gums and increase the recruitment of immature trees Maintain the extent and increase the diversity of streamside vegetation Increase the extent of in-stream aquatic plants
Increase the diversity and biomass of waterbugs
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 Nation Aboriginal Corporation to discuss how cultural values and uses can be supported by environmental water and the importance of Traditional Owner involvement in environmental water management. These discussions included:

- meetings between Dja Dja Wurrung Clans Aboriginal Corporation's Kapa Gatjin (water advisory) Group and North Central CMA. Kapa Gatjin expressed their aspirations and environmental objectives for the Campaspe River. Dja Dja Wurrung Traditional Owners have highlighted the significance of native fish, turtles, medicine plants and pest control.
- meetings between Taungurung Clan Aboriginal Corporation's Baan Ganalina Advisory Group and North Central CMA. Baan Ganalina have highlighted the importance of native fauna and identified the importance of overstorey, mid-layer and aquatic vegetation in creating healthy habitat and preventing flows that might erode or damage cultural sites.
- regular meetings between the Yorta Yorta Nation Aboriginal Corporation Consultation group and Goulburn Broken, North East and North Central CMAs, where the three CMAs and the Yorta Yorta representatives discussed CMA activities on Country. Yorta Yorta Traditional Owners have raised concerns regarding the impacts of groundwater extraction on river flows and gold mining in the Campaspe Valley, and support flows that will mitigate the impacts of consumptive water delivery over summer and provide conditions to improve habitat for platypus breeding.

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, fishing and water sports)
- riverside recreation and amenity (such as birdwatching, bushwalking, camping, cycling, duck hunting and picnicking)
- community events and tourism (such as visitors travelling to canoe and kayak on the river)
- socio-economic benefits (such as diversions for irrigation, domestic and stock uses, local and regional economic benefits from increased visitation, ecosystem services [such as carbon storage, groundwater recharge and water-quality regulation], lower salinity costs and blackwater and blue-green algae risks for landholders, and contributions to community enjoyment, health and recuperation).

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 the following 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 River where visitors can camp. Aysons Reserve is a very popular camping site near Elmore, and it draws hundreds of campers during the autumn school holiday period. Where possible, delivery of summer/autumn freshes will be timed to improve river conditions for campers and for water-related activities during peak visitation periods (such as the March and April long weekends).

Recent conditions

Rainfall in the Campaspe River region in 2020-21 was close to the long-term average, with above-average rainfall and catchment inflows in August 2020, October 2020 and January 2021. Temperatures were also close to average overall: November was exceptionally hot, but December and January were cooler than average. Allocations against high-reliability water shares in the Campaspe system were 32 percent at the start of 2020-21 and increased to 100 percent in October 2020.

Water for the environment was used to maintain low flow through winter and spring. There were two small natural freshes in July and August 2020, and unregulated flow during August and September was higher than the planned low flow. Water for the environment was used to deliver a fresh in September 2020. IVTs started in mid-November 2020 and kept flow above the recommended environmental flow throughout most of summer and autumn.

Deliveries of water for the environment in the Campaspe system in 2020-21 were managed in line with an average climate scenario. All planned watering actions for the year were largely met. Additional freshes to mitigate poor water quality were not required.

Scope of environmental watering

Table 5.6.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.6.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Campaspe River

Winter/spring low flow (50-200 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 from stratifying • Discourage terrestrial plants from 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	
Winter/spring freshes (two freshes of 1,000-1,800 ML/day for two to three days during June to November)	• Flush accumulated leaf litter from the 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, especially during the Murray cod nesting period • Encourage female platypus to select a nesting burrow higher up the bank, to reduce the risk of high flow later in the year flooding the burrow when juveniles are present	
Summer/autumn low flow (10-50 ML/day during December to May)	• Maintain slackwater habitats for zooplankton and nursery habitats for native fish • Maintain water depth and prevent stratification in deep pools in summer, to maintain habitat for native fish and platypus • Allow platypus to safely move between pools while foraging and ensure there is adequate food for lactating females	
Summer/autumn freshes (three freshes of 50-200 ML/day for one to three days during February to April)	• 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	
Year-round fresh (trigger-based, 5-200 ML/day, as required) *Triggers* • *oxygen levels are below 5 mg/L* • *air temperatures are above 28°* • *there are high water temperatures and/or low river flow*	• De-stratify pools and improve water quality (increase oxygen levels) along the river in reach 4, ensuring there is adequate oxygen to support aquatic animals (such as native fish and platypus)	

Scenario planning

Table 5.6.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The Campaspe River requires low flow and freshes throughout the year under all climate scenarios, but not all the recommended flows can be delivered with available supply under drought and dry to below-average climate scenarios. Under a drought scenario, available water will be used to deliver a summer/autumn low flow at the lower end of the recommended range. The summer/autumn low flow is the highest priority, because there is a high risk of poor water quality and critically low habitat availability in the warmer months. Delivering the low flow at the lower end of the recommended range will aim to maintain critical habitat to prevent significant loss of fish and platypus populations, but it will not support any breeding or improvement in environmental condition. Any additional water that is available under a drought scenario will be primarily used to deliver freshes if any of the poor water-quality triggers are met. Under a dry to below-average climate scenario, available water will be used to deliver as much of the recommended low flow and freshes as possible during summer and autumn, and a portion of the recommended winter/spring flow. The winter/spring fresh is particularly important under a dry to below-average scenario, to flush organic material from the banks and reduce the likelihood that this material could contribute to a hypoxic blackwater event if there is a high flow or fresh in summer. This fresh will be delivered in October if possible, to support Murray cod nesting.

Delivering the full range of recommended flows at the upper end of their range will be important under average and wet climate scenarios, to increase the quantity and quality of habitat to support native fish and platypus breeding and to improve the condition of in-stream and streamside vegetation.

The carryover target for 2022-23 is based on the volume required to deliver priority low flow during 2022-23 if there is a return to dry or drought conditions.

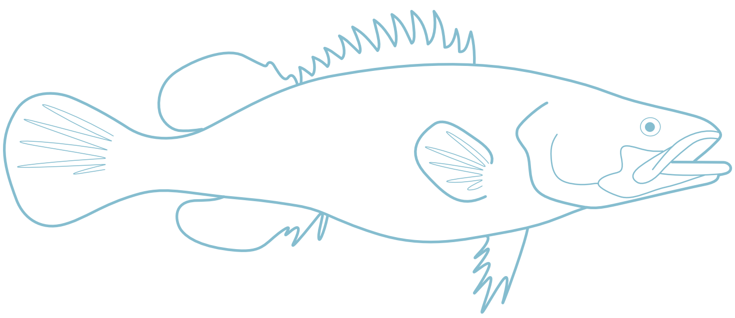


Table 5.6.2 Potential environmental watering for the Campaspe River under a range of planning scenarios

Expected river conditions	• Little to 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 • No expected spills from storage, except under extremely wet conditions
Predicted supply of water for the environment	• 7,500 ML	• 26,000 ML	• 27,300 ML
Potential environmental watering – tier 1 (high priorities)			
	• Summer/autumn low flow (low on the magnitude range)	• Winter/spring low flow (lower magnitude) • Winter/spring fresh (one fresh) • Summer/autumn low flow (high on the magnitude range) • Summer/autumn freshes (three freshes)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn low flow (high on the magnitude range) • Summer/autumn freshes (three freshes)
	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn freshes (three freshes) • Year-round fresh (if required)	• Winter/spring low flow (increased magnitude) • Winter/spring fresh (one fresh) • Year-round fresh (if required)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 5,400 ML (tier 1a) • 9,800 ML (tier 1b)	• 21,500 ML (tier 1a) • 7,000 ML (tier 1b)	• 26,100 ML (tier 1a)
Priority carryover requirements	• 5,500 ML		

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 reservoirs. An important distinction between the Coliban River and other regulated Victorian systems is the lack of irrigation demand that may be met by managed releases downstream of system storages. Flow in the river is influenced by the passing-flow entitlement, which depends on catchment inflows and major flood events in the catchment.

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 in the river between Malmsbury Reservoir and Lake Eppalock. A small volume of Commonwealth water for the environment is held in the system, but the high cost of delivery means there is no plan to use it in 2021-22.

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 the platypus population
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 streamside woody vegetation and facilitate recruitment
Maintain an adequate diversity and biomass of waterbugs, to break down dead organic matter and supply 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 the preservation of historical and contemporary cultural values including promoting a sense of place and spiritual connection.

The *Dja Dja Wurrung Country Plan 2014-2034* 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 Kapa Gatjin and North Central CMA have been working together to identify opportunities and sites where water for the environment can support the Dja Dja Wurrung's aspirations for the Coliban River.

Activities to further this work have been suspended due to COVID-19 restrictions, but it is anticipated that activities on Country will be undertaken as restrictions ease in 2021-22.

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, fishing and water sports)
- riverside recreation and amenity (such as birdwatching, bushwalking, camping and cycling)
- socio-economic benefits (such as diversions for domestic and stock uses, benefits to the local and regional economies from recreational activities, ecosystem services [such as carbon storage, groundwater recharge and water-quality regulation], lower salinity costs and blackwater and blue-green algae risks for landholders, and contributions to community enjoyment, health and recuperation).

Recent conditions

Total annual rainfall in the Coliban River catchment in 2020-21 was slightly above the long-term average, and the temperature was slightly cooler than average. August, October and January were significantly wetter-than-average months. November was hotter and dryer than average. Accumulated passing flows that make up the holdings of water for the environment were lost when Malmsbury Reservoir spilled in October 2020, but high rainfall in January 2021 allowed additional passing flows to be accumulated to replenish the supply for planned environmental flows.

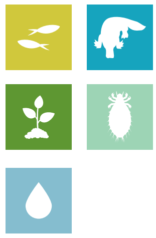
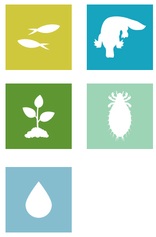
Passing flows, natural inflows and the managed release of accumulated passing flows maintained a continuous flow from Malmsbury Reservoir to Lake Eppalock throughout most of the year, and the summer cease-to-flow period at the downstream end of the reach was shorter than in previous years. High-rainfall events delivered moderate-sized freshes, and more variable flow in the lower reach in August, September and November 2020 and the October spill of Malmsbury Reservoir delivered a high flow through the whole system.

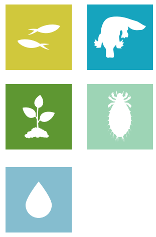
Releases of water for the environment in the Coliban River were delivered in line with an average climate scenario in 2020-21. One of the planned watering actions for the average scenario — the summer and autumn low flow — was partly achieved, while the summer and autumn fresh was not delivered. In particular, the wetter-than-average conditions provided additional flow in the system and helped maintain water quality, which meant summer/autumn low flows could be delivered continuously rather than as pulses.

Scope of environmental watering

Table 5.6.3 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.6.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Coliban River

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring low flow (2.5 to 25 ML/day during June to November)	• Maintain a connected river that allows small-bodied native fish and platypus to disperse throughout the river • Increase wet areas for native aquatic and streamside plants, while limiting terrestrial species encroaching the river channel • Increase flow to mix water in pools, to prevent stagnation and a decline in water quality • Increase the wetted area for habitat for waterbugs	
Winter/spring fresh (one fresh of up to160 ML/day for three to five days during June to November)	• Maintain up to 65 cm water depth between pools, so native fish can disperse throughout the river and colonise sites • Encourage female platypus to select a nesting burrow higher up the bank, to reduce the risk of a higher flow later in the year flooding the burrow when juveniles are present • Increased the wetted river perimeter for fringing and edge vegetation • Increase the wetted river perimeter to increase habitat for waterbugs • Flush organic matter to reduce the risk of declining water quality in summer	
Summer/autumn low flow (four to 10 ML/day during December to May)	• Maintain 3-6 cm water depth between pools for native fish movement, and maintain river pool depth • Wet the channel to maintain in-stream aquatic and fringing vegetation • Maintain aquatic habitat that supports waterbugs, native fish and platypus • Maintain water quality including oxygen levels	

Summer/autumn freshes (two freshes of 25 to 160 ML/day for three to five days during December to May)	• Maintain the water depth through riffle-run habitats of 8-20 cm for 25-50 ML/day event to maintain water quality and habitat for waterbugs
	• Maintain water depth through riffle-run habitats of 45-61 cm for a 160 ML/day event to:
	  • increase the water depth to facilitate the movement of fish and platypus
	  • clean sediment and biofilms from river substrates
	  • wet the benches and low banks to promote the growth and recruitment of fringing vegetation
		

Pulsed summer/autumn low flow (five to 15 ML/day for 14 days during December to May, trigger-based) *Triggers:* • *oxygen level is below 5 mg/L* • *water temperature is above 28 °* • *there are low or cease-to-flow river conditions*	• Improve water quality including oxygen levels • Maintain refuge habitat for aquatic animals, including fish and platypus	

Scenario planning

Table 5.6.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The potential environmental watering actions required for the Coliban River are the same under all climate scenarios, but the magnitude of the low flow and the magnitude and duration of freshes vary across the scenarios. By lowering the magnitude, duration and frequency, water can be delivered for more environmental flows and for longer, to help prevent water-quality events and support platypus populations. With more water available to deliver larger flows, more environmental objectives can be achieved.

The highest-priority watering action in the Coliban River is the low flow in summer and autumn, to provide sufficient depth for native fish movement and aquatic habitats for fish, platypus and waterbugs. Releases of water for the environment in summer and autumn help maintain water quality (especially when oxygen levels are low) and maintain pools in the upper reaches for platypus. Passing flows that were banked but not used in 2020-21 will be carried over and used to help maintain continuous low-flow targets under all climate scenarios in 2021-22. If the continuous flow cannot be maintained, shorter, pulsed flows will be delivered to maintain refuge habitats. Where possible, summer and autumn freshes will be delivered, to facilitate fish and platypus movement and support fringing vegetation. Such a fresh is most important in March to April, to support juvenile platypus dispersal and reduce predation.

Accumulated passing flows will be set aside to cover high-priority summer and autumn low flow in 2022-23. The carryover target under all climate scenarios is 720 ML, but the actual carryover will depend on accumulated passing flows through the year, the potential watering actions delivered and the climatic outlook for the following year. Setting aside water for next year is a priority, once the low flow and at least one summer/autumn fresh have been delivered.

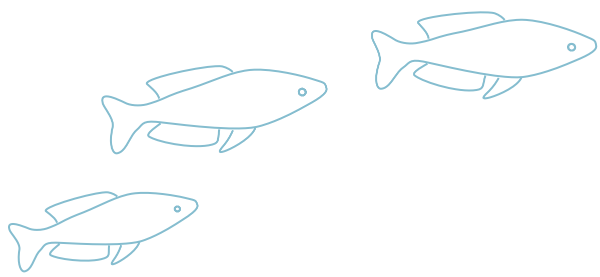
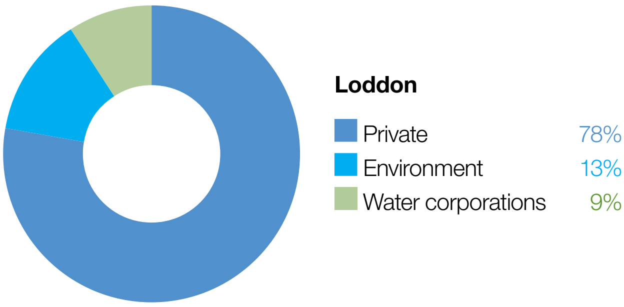


Table 5.6.4 Potential environmental watering for the Coliban River under a range of planning scenarios

Planning scenario	Drought	Dry	Average and Wet
Expected river conditions	• Little to no natural flow	• Some natural flow	• Some natural flow
Predicted supply of water for the environment	• 1,800 ML	• 2,100 ML	• 2,900 ML
Coliban River (targeting reach 1)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow (lower magnitude in the range) • Summer/autumn low flow (lower magnitude in the range) • Summer/autumn fresh (one fresh) • Pulsed summer/autumn low flow (trigger-based)	• Winter/spring low flow (lower magnitude in the range) • Summer/autumn low flow (lower magnitude in the range) • Summer/autumn fresh (one fresh)	• Winter/spring low flow (lower magnitude in the range) • Summer/autumn low flow (lower magnitude in the range) • Summer/autumn fresh (one fresh)
	Tier 1b (supply deficit)		
	• Winter/spring low flow • Summer/autumn low flow (higher magnitude) • Summer/autumn fresh (one fresh)	• Winter/spring low flow (higher magnitude in the range) • Winter/spring fresh (one fresh) • Summer/autumn low flow (higher magnitude in the range) • Summer/autumn fresh (one fresh)	• Winter/spring low flow (higher magnitude in the range) • Winter/spring fresh (one fresh) • Summer/autumn low flow (higher magnitude in the range) • Summer/autumn fresh (one fresh)
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 1,740 ML (tier 1a) • 3,000 ML (tier 1b)	• 1,980 ML (tier 1a) • 4,400 ML (tier 1b)	• 2,300 ML (tier 1a) • 5,500 ML (tier 1b)
Priority carryover requirements	• Accumulate passing flows for 2022-23 (720 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



Proportion of water entitlements in the Loddon basin held by private users, water corporations and environmental water holders on 30 June 2020.

Did you know...?

Lake Boort is a highly significant area for Dja Dja Wurrung. The floodplain contains some of the highest densities of scarred trees in the world as well as 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).

Top: Loddon River at Kerang, by the VEWH
Above: Ducks at Lake Meran, by Kevin Mah, North Central CMA

The Loddon system includes the Loddon River system (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 (Figure 5.7.1). 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 Laanecoorie Reservoir 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, restrict flow reliability and create barriers to aquatic animal movement throughout the river – impacting the ability to achieve outcomes for native fish and possibly platypus.

Environmental values

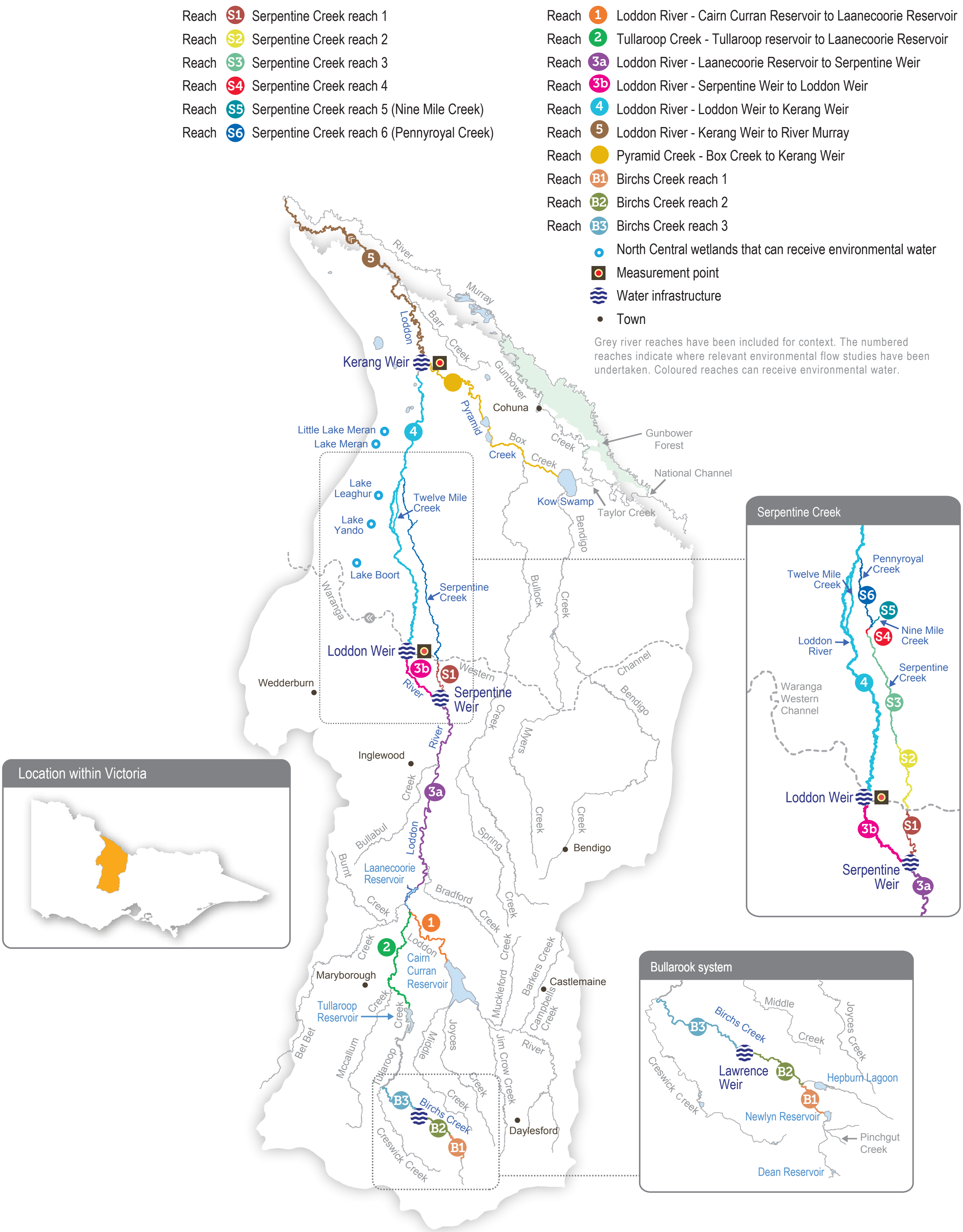
The Loddon River system supports platypus, rakali (water rats) and several species of native fish (such as Murray cod, golden perch, silver perch, river blackfish and Murray-Darling rainbowfish). Streamside vegetation varies in condition depending on the recent water regime, the extent of clearing and historic and current land management practices. The areas that remain 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 water for the environment 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 productive and dynamic food webs Maintain/increase the diversity and abundance of biofilms
Maintain the condition of streamside and floodplain vegetation Maintain and increase the extent of in-stream vegetation
Maintain/increase the diversity and abundance of waterbugs and waterbug functional feeding groups
Maintain water quality, to support aquatic animals and minimise the occurrence of blackwater events

Traditional Owner cultural values and uses

In planning for environmental flows in the Loddon River system, Dja Dja Wurrung, Barapa Barapa and Wemba Wamba and North Central CMA have considered how environmental flows in the Loddon system can be managed to support their respective values and uses.

Environmental water management assists with preservation of historical and contemporary values held highly by the Dja Dja Wurrung. This includes promoting a sense of place and spiritual connection. The Kapa Gatjin and North Central CMA have been working together to identify opportunities and sites where water for the environment can support the Dja Dja Wurrung's aspirations for the Loddon River.

The Barapa Barapa and Wemba Wamba 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.

In early 2021, the Barapa Barapa Wemba Wamba Water for Country Steering Committee joined North Central CMA staff on Country to discuss the cultural values of the river and floodplain and how environmental water can contribute to achieving cultural objectives. The Steering Committee members emphasised the importance of supporting fish populations, particularly Murray cod and golden perch. The Traditional Owners also identified evidence of occupation such as clay balls and mussel shells in Sheepwash Creek, supporting similar observations in the Pennyroyal Creek-Bannacher Creek network on a previous field visit and providing evidence that environmental flows can help the distribution and health of plants and tubers for food and medicine.

These values will be supported in 2021-22 through flows that are designed to support food and fibre species of cultural value and to facilitate cultural activities.

Barapa Barapa Traditional Owners have also communicated their cultural objectives for the Loddon River and other waterways in the Barapa Barapa Healthy Country Plan. Objectives that relate to the Loddon River system include:

- all wetlands surrounding the Murray River, Gunbower Forest, Loddon River and associated lakes have good plant life and healthy native fish (cod and yellow belly), mussels and turtle populations by 2033
- by 2033, the Murray, Gunbower, Loddon and associated lakes will have enough water. Water quality is improving and water is clear for most of the year in good years
- Barapa people are actively involved in water management
- reduce the number of major fish and plant deaths from toxic blackwater events to improve water quality.

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 fishing, powered and non-powered boating, water skiing and water sports)
- riverside recreation and amenity (such as birdwatching, bushwalking, camping and cycling)
- community events and tourism (such as water skiing competitions at Bridgewater and associated visitation)
- socio-economic benefits (such as diverters for domestic and stock uses, local and regional economic benefits from increased visitation and ecosystem services [such as carbon storage, groundwater recharge and nutrient recycling]).

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 the following icon.

Watering planned to support water sports activities (e.g. water skiing)

If possible, North Central CMA will work with Goulburn-Murray Water to manage the delivery of low flow rates and the timing of freshes over summer/autumn, to support optimum conditions for annual water skiing competitions at Bridgewater weir pool, where possible.

Recent conditions

Despite dry conditions in July, rainfall and temperatures in the Loddon catchment were close to the long-term average throughout most of 2020-21. Inflows to major storages in autumn 2020 resulted in opening season allocations of 35 percent for high-reliability water shares in the Loddon and Goulburn systems, which was higher than the previous year. Allocations increased regularly through spring and reached 100 percent in mid-November. No low-reliability water share allocation was issued in 2020-21.

A small natural fresh occurred in September 2020 and again in February 2021, but otherwise there were relatively few natural high-flow events in the Loddon River system in 2020-21. Low flow was delivered to all reaches throughout the year using mandated passing flows, environmental water or a combination of both. Water for the environment was used to deliver spring freshes in the Loddon River, Serpentine Creek and Pyramid Creek. The Loddon River and Pyramid Creek freshes were coordinated to provide a higher flow at Kerang Weir, to cue native fish to move into the system from the Murray River. Water for the environment was also used to deliver two summer/autumn freshes in the Loddon River; a third summer/autumn fresh occurred naturally in February.

In 2020-21, water for the environment in the Loddon system was managed initially in line with a dry climate scenario, shifting to an average climate scenario from spring onwards. Most planned watering actions for the Loddon River and Pyramid Creek were achieved. The only event that was not delivered to these systems was a higher autumn flow that aimed to facilitate platypus and native fish migration. The lack of this flow is not considered a major problem, because a large autumn flow occurred naturally in April 2020. The potential flooding of private land at the end of Serpentine Creek prevented the delivery of planned summer/autumn freshes, and the winter/spring low flow in Serpentine Creek was delivered at less than the recommended magnitude at times during 2020-21. The North Central CMA, storage manager and the VEWH will undertake to resolve this issue in 2021-22 to allow a wider range of watering actions to be delivered in future.

Results of fish monitoring surveys conducted by the Arthur Rylah Institute as part of the Victorian Environmental Flows Monitoring and Assessment Program in 2020-21 indicated that native fish are moving and using fishways in response to medium-to-high environmental flows in the Loddon system. This information resulted in the recommended low-flow magnitude in Pyramid Creek and the lower Loddon River increasing, compared to previous years.

Scope of environmental watering

Table 5.7.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.7.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Loddon River system

Potential environmental watering action	Expected watering effects	Environmental objectives
Loddon River (targeting reach 4)		
Winter/spring low flow (50-100 ML/day during June to November)[1]	• Increase the water depth for fish, platypus and rakali (water rat) dispersal (especially for male juvenile platypus to colonise new breeding territory in winter) and to provide foraging habitat • Prevent silt and fine sediment settling on submerged wood and other hard surfaces • Inundate a variety of habitats, to increase the growth of biofilms and support waterbug productivity • Water the native fringing bank vegetation, to support seed germination and growth and prevent the encroachment of exotic terrestrial plants in the river channel	
Winter/spring high flow (one high flow of 450 ML/day for six to 10 days during August to November)	• Provide sufficient velocity to 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 • Wet the banks 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)	• 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 • Wet the banks and shallow riffles, to support the growth of in-stream and fringing non-woody vegetation	
Summer/autumn freshes (three to four[2] freshes of 50-100 ML/day for three days during December to May)	• Increase the water level, to promote seed germination and the growth of fringing emergent macrophytes • Increase connectivity between deep pools to promote the local movement of fish and to prompt the dispersal of juvenile platypus in autumn • Generate sufficient force to flush fine sediment and old biofilms from submerged wood and other hard surfaces, promoting the growth of new biofilms and increasing waterbug productivity • Freshen water quality and reoxygenate pools	

Table 5.7.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Loddon River system *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Autumn high flow (one high flow of 400 ML/day for six days[3] during March to May)	• Trigger and facilitate the upstream movement of golden perch, silver perch and Murray cod older than one year • Facilitate the dispersal of juvenile platypus • Generate sufficient force to flush fine sediment and old biofilms from submerged wood and other hard surfaces, promoting the growth of new biofilms and increasing waterbug productivity	
Serpentine Creek (targeting reach 1)[4]		
Winter/spring low flow (20-50 ML/day[5] during June to November)	• Maintain habitat for native fish and facilitate movement for aquatic animals • 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 maintain the diversity of fringing vegetation • Provide a sufficient depth of water and variability of flow to maintain microbial biofilms	
Winter/spring fresh (one fresh of 40-150 ML/day[5] for two days during August to November)	• Maintain the channel form and scour pools (an augmented response is expected when delivered at 120-150 ML/day) • Provide connectivity for fish and waterbugs to access different habitat areas, supporting a diversity of functional feeding groups • Transport organic matter that has accumulated in the channel, to increase the breakdown of organic matter in winter/spring and reduce the risk of a hypoxic blackwater event in summer (an augmented response is expected when delivered at 120-150 ML/day) • Encourage female platypus to select nesting burrows higher up the bank (when delivered at 120-150 ML/day) to reduce the risk of higher flow later in the year flooding burrows when juveniles are present	
Summer/autumn low flow (10-20 ML/day[5] during December to May)	• 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)	

Table 5.7.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Loddon River system *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn freshes (three freshes of 40 ML/day[5] for two days during December to May)	• Maintain the channel form by inundating benches • Generate sufficient force to flush fine sediment and old biofilms from submerged wood and other hard surfaces, to increase productivity and replenish the food supply for aquatic animals • Transport organic matter that has accumulated in the channel providing carbon and nutrients downstream • Provide flow variability to maintain the diversity of fringing vegetation such as emergent macrophytes • Freshen water quality by diluting salt and re-oxygenate pools	
Pyramid Creek (targeting Box Creek regulator) and lower Loddon River (targeting Kerang Weir)		
Year-round low flow (90-300 ML/day at Box Creek regulator)	• Maintain connectivity between pools and provide habitat for aquatic animals • 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	
Winter/spring high flow (one high flow of 700 ML/day at Kerang Weir for 10 days)[6]	• Trigger the migration, spawning and recruitment of native fish species including Murray cod • Maintain connectivity between habitats and improve water quality • Provide sufficient energy to flush accumulated sediment from pools and substrates	
Autumn high flow (one high flow of 700 ML/day[7] at Kerang Weir for six days[3] during March to April)[6]	• Trigger and 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 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.

2 A fourth summer/autumn fresh may be delivered under drought or dry climate scenarios. The recommended magnitude and duration may be increased if needed, to prevent a decline in oxygen levels.

3 The peak magnitude of this event is planned to be delivered for six days, but there is an extended, 10-day ramp-down period.

4 Flow in Serpentine Creek may be allowed to either return to the Loddon River or continue down Pennyroyal and Bannacher creeks or Nine Mile Creek with the agreement of landholders.

5 Flow delivered from Serpentine Weir may be restricted to manage end-of-system outfalls, to avoid third-party impacts, until an alternate solution is determined.

6 Winter/spring and autumn freshes are planned to occur at the same time in the Loddon River and Pyramid Creek, with the peak timed to meet at Kerang Weir. 700 ML/day is the total combined target at Kerang Weir.

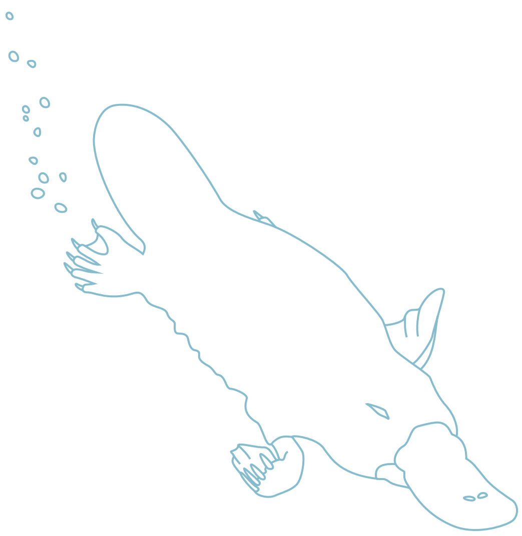
7 The autumn high flow may be delivered at a reduced rate under seasonal or operational conditions, which could heighten the risk of third-party impacts.

Scenario planning

Table 5.7.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

In the Loddon River, delivery of three summer/autumn freshes and continuous low flow year-round is a high priority under all climate scenarios, to freshen water quality and maintain connectivity throughout the system for aquatic animals. Flows will likely be delivered at the lower end of the recommended range under drought and dry conditions, to conserve supply. Lower-magnitude flows will aim to prevent critical harm to aquatic plants and animals rather than improve their condition, and either a temporary increase in low-flow magnitude or an additional fresh may need to be delivered during very low-flow periods to manage water quality. Some contingency water has been factored into estimated demands under a drought climate scenario, to provide these additional deliveries if needed.

Under the drought climate scenario, winter/spring low flow in the Loddon River may be reduced to 50 ML per day — prescribed passing flows from May to October are 77 ML per day — to accumulate a portion of the passing flows to supplement flows in summer and autumn when there are higher risks of poor water quality and cease-to-flow events. Under a dry climate scenario, the winter/spring low flow will likely be delivered at the passing-flow rate, and, while the upper magnitude is preferred, this may also be the rate delivered under an average climate scenario, to reserve supply for high-priority demands in the Boort wetlands system. If additional water becomes available or a wet scenario occurs, water for the environment may be used to increase winter/spring low flow to 100 ML per day, to improve the condition of vegetation higher up the bank.



Coordinated winter/spring high flow in the Loddon River and Pyramid Creek is a high priority under all climate scenarios (and may be achieved with natural flow under wet conditions) to trigger the upstream movement of native fish from the Murray system for feeding and breeding as well as remove accumulated organic matter on the banks and benches. The duration of these events may be reduced to six days, which is sufficient to trigger a moderate fish response, under a drought or dry climate scenario, to conserve supply. A similar-sized event in autumn is recommended for average and wet climate scenarios, but it is a lower priority under drought and dry climate scenarios, because such a flow is not required every year and a large natural event occurred in autumn 2020. It is also more important to deliver the autumn high flow in average and wet years, because there are likely to be more fish moving in the Murray River that can detect and respond to the flow cue.

The other high-priority flow for Pyramid Creek is the low flow. Modelling after fish surveys conducted by the Arthur Rylah Institute indicates that maintaining a low-flow magnitude of at least 200 ML per day throughout the year will be most beneficial for supporting native fish populations in Pyramid Creek. This flow is needed under all climate scenarios, to maintain habitat for native fish and other aquatic animals, especially during the non-irrigation season. Operational deliveries maintain water in Pyramid Creek during the irrigation season, but these deliveries cease between May and August, and without water for the environment during this period there is unlikely to be enough flow to support fish populations.

In Serpentine Creek, the main priority will be to maintain low flow throughout the year to provide habitat for native fish, waterbugs, rakali (water rats) and platypus and to deliver freshes to improve water quality, allow fish and platypus movement and improve the condition of streamside vegetation. Flow will likely be delivered at the lower end of the recommended range under drought and dry climate scenarios, to conserve available supply.

Carryover of 2,000 to 4,430 ML is prioritised into 2022-23 under drought and dry climate scenarios. This water will help meet early-season, low-flow demands in all waterways.

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 (and none in reach 4) • Reduced passing flows in autumn/ winter possible	• Small inflows from unregulated reaches and tributaries of the Loddon River contributing to low flow, consumptive water deliveries in the irrigation season (but not in reach 4)	• Natural flow will provide low flow and multiple freshes, most likely in winter/ spring • Consumptive water deliveries in the irrigation season (but not in reach 4) • No spill likely	• Spills from Loddon system storages will provide extended-duration high flow and overbank flow most likely in late winter/spring
Predicted supply of water for the environment[1]	• 15,269[2] ML	• 18,037 ML	• 21,124 ML	• 21,124 ML
Loddon River (targeting reach 4)				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Winter/spring low flow (delivered at lower magnitude[3]) • Winter/spring high flow (one high flow, delivered at lower duration) • Summer/autumn low flow (delivered at lower magnitude[4]) • Summer/autumn freshes (three to four freshes[5])	• Winter/spring low flow (delivered at passing-flow rate) • Winter/spring high flow (one high flow, delivered at lower duration) • Summer/autumn low flow (delivered at lower magnitude[4]) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (delivered at passing-flow rate) • Winter/spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes)	• Winter/spring low flow • Winter/spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow)
	Tier 1b (supply deficit)			
	• N/A[6]	• Winter/spring low flow delivered at higher magnitude • Summer/autumn low flow (delivered at higher magnitude)	• Winter/spring low flow (delivered at upper magnitude) • Autumn high flow (one high flow)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A			

Table 5.7.2 Potential environmental watering for the Loddon River system under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Average	Wet
Serpentine Creek				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Winter/spring low flow (lower magnitude) • Winter/spring fresh (one fresh, at lower magnitude) • Summer/autumn low flow (lower magnitude) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (lower magnitude) • Winter/spring freshes (three freshes) • Summer/autumn low flow (lower magnitude) • Summer/autumn freshes (three freshes)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn freshes (three freshes)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)			
	• Tier 1a winter/spring fresh delivered at higher magnitude • Summer/autumn low flow delivered at higher magnitude	• Winter/spring low flow delivered at higher magnitude • Summer/autumn low flow delivered at higher magnitude	• N/A	
Potential environmental watering – tier 2 (additional priorities)	• N/A			

Table 5.7.2 Potential environmental watering for the Loddon River system under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Average	Wet
Pyramid Creek and Loddon River (reach 5)				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Year-round low flow • Winter/spring high flow (one high flow)		• Year-round low flow • Winter/spring high flow (one high flow) • Autumn high flow (one high flow)	
	Tier 1b (supply deficit)			
	• N/A			
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	**Loddon River (reach 4) and Serpentine Creek**			
	• 3,656-7,436 ML (tier 1a) • 0-7,749 ML (tier 1b) • 0 ML (tier 2)	• 9,937 ML (tier 1a) • 4,209 ML (tier 1b) • 0 ML (tier 2)	• 14,446 ML (tier 1a) • 8,609 ML (tier 1b) • 0 ML (tier 2)	• 11,320 ML (tier 1a) • 0 ML (tier 1b) • 0 ML (tier 2)
	Pyramid Creek and lower Loddon River (reach 5)[7]			
	• 4,000 ML (tier 1a) • 0 ML (tier 1b) • 0 ML (tier 2)		• 6,000 ML (tier 1a) • 0 ML (tier 1b) • 0 ML (tier 2)	
Priority carryover requirements	• 4,430 ML	• 2,000 ML	• 0 ML	

1 Loddon system entitlements are shared between the Loddon River system and the Boort wetlands. Expected availability is used to meet demands in both systems.

2 Under a drought scenario, the VEWH may request a reduction in passing-flow volume at Loddon Weir and accumulate the savings for use at other times of the year. The combined volume in Cairn Curran and Tullaroop reservoirs must exceed 60,000 ML, in order to enable passing-flows savings.

3 Delivering at a lower magnitude would accumulate passing-flow savings if the combined volume in storage exceeds 60,000 ML. If the volume in storage is less than 60,000 ML, the winter/spring passing-flow rate reverts to the summer passing-flow rate, and the demand for this event increases. Depending on when this occurs, this action may move from tier 1a to tier 1b.

4 The low-flow magnitude may be increased if needed, to prevent a decline in oxygen levels.

5 A fourth summer/autumn fresh may be delivered (and the recommended magnitude and duration may be increased) if required, to prevent a decline in oxygen levels.

6 Unless reduced passing flows over winter/spring are triggered (which occurs if the combined volume in storage is less than 60,000 ML), which would result in a far greater demand for achieving winter/spring low flows.

7 Each environmental watering event in Pyramid Creek has an estimated demand of 2,000 ML for underwriting losses associated with delivering consumptive water en route to downstream locations via Pyramid Creek. Actual demand for each event is expected to be a much lower 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 not currently 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 on the fringes of the wetlands
- 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 Wemba Wamba 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.

The *Dja Dja Wurrung Country Plan 2014-2034* 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.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. 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 5.7.3 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

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

The Dja Dja Wurrung clan (family group) the Yung Balug are preparing a water management plan for Lake Boort, the connected wetland Lake Lyndger and the Kinypanial Creek (a branch of the Loddon River), as part of the larger Djandak, Gatjin and Wi (Land, Water and Fire) Healthy Country Planning project which they are conducting with the support of Djandak, the commercial arm of Dja Dja Wurrung Clans Aboriginal Corporation. North Central CMA has committed to asking the Yung Balug family group for informed consent for the watering actions proposed for Boort in 2021-22 while moving towards self-determined management in the long term.

A key priority for Barapa Barapa and Wemba Wamba 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 has tested the revegetation DST and also aims to incorporate cultural aspirations into revegetation outcomes. Barapa Barapa and Wemba Wamba Traditional Owners were involved in physical planting, plant selection and site selection for the project, and decisions around water for the environment at these wetlands have been able to support the DST project by delivering the watering requirements of the revegetation, resulting in a positive vegetation response and enabling monitoring to be completed by Barapa Barapa.

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 fishing and water sports)
- riverside recreation and amenity (such as birdwatching, camping and duck hunting)
- community events and tourism (such as attracting locals and visitors for birdwatching and hunting)
- socio-economic benefits (such as aesthetic benefits for landholders who are interested in learning about the ecological values of wetlands, diverters for domestic and stock use and irrigation, and ecosystem services like groundwater recharge, flood mitigation, nutrient treatment and carbon storage).

Recent conditions

Rainfall in the Boort wetlands catchment was variable throughout 2020-21, but average rainfall and temperatures were experienced through most of the year. There were no natural flows into wetlands, with managed released required to achieve all environmental watering priorities. Inflows to major storages in autumn 2020 resulted in opening season allocations of 35 percent for high-reliability water shares in the Loddon and Goulburn systems (both systems influence available Water Holdings for the Boort wetlands), which was higher than in the previous year. Allocations increased regularly through spring and hit 100 percent in mid-November. No low-reliability water share allocation was issued in 2020-21.

Water for the environment at the Boort wetlands was managed in line with the average climate scenario in 2020-21. A partial fill was provided to Lake Yando in spring, followed by a top-up in summer/autumn to support observations of waterbird breeding. Top-ups were provided to Lake Meran in December, February and April to maintain the water level within a critical range that provides habitat for aquatic animals while enabling the growth of herbland vegetation on the wetland fringe. A planned spring fill of Lake Leaghur was deferred, due to channel upgrade works. A priming fill was delivered in autumn 2021 ahead of a planned fill in winter/spring 2021, which is a high priority to ensure the condition and composition of wetland plant communities at Lake Leaghur do not decline.

Scope of environmental watering

Table 5.7.3 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.7.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Boort wetlands

Lake Boort (partial fill in autumn)	• Prime the wetland for spring watering in 2022-23 by breaking the dormancy of aquatic vegetation propagules so they can grow and reproduce • Grow zooplankton and waterbug communities to provide winter feeding conditions for waterbirds and frogs • Reduce the volume of water required to fill the wetland in spring 2022-23 • Support the growth of culturally significant plants on the wetland fringe including spiny flat sedge and river red gum	
Lake Meran (fill in winter/ spring)	• Wet soils around the wetland fringe that have been dry for the last two seasons, to encourage a boom in zooplankton and macroinvertebrate productivity enhancing food resources for waterbirds and turtles • Provide moisture to maintain mature trees in the intermittent swampy woodland on the wetland fringe • Provide deep, open water to maintain refuges for freshwater turtles (in particular Murray River turtles), support the feeding of deep-water foraging waterbirds and support the breeding of colonial nesting birds	
Lake Meran (top-ups, as required to maintain water level between 77.3 m Australian Height Datum [AHD] and 77.8 m 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	
Lake Leaghur (fill in winter/ spring)	• Increase water depth around 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 increased habitat area and grow zooplankton and waterbug communities to provide food resources for frogs and waterbirds	
Lake Leaghur (top-up, if triggered by waterbird breeding)	• Maintain shallow-water habitat under tree canopies to ensure adequate food resources for nesting waterbirds and their chicks	

Scenario planning

Table 5.7.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Delivering a fill to Lake Leaghur in late winter/early spring is a high priority under all climate scenarios. A priming fill was completed in autumn 2021 in preparation for this event. The minimum recommended filling regime for Lake Leaghur requires two fill events every 10 years. Lake Leaghur last filled in 2010-11 and vegetation communities at the lake are at risk of exceeding their maximum dry interval tolerance. Filling Lake Leaghur will also provide alternative habitat for waterbirds, given Lake Yando is currently drawing down. There is likely to be enough supply in the Loddon system to fill Lake Leaghur under dry to average climate scenarios, but there may not be enough supply under a drought scenario. Additional top-ups may be required at Lake Leaghur to support waterbird breeding if it occurs. Waterbird breeding is more likely to occur in average or wet climate scenarios.

Watering Lake Meran is also a high priority in 2021-22. The recommended (optimum) water regime for Lake Meran is to fill once every five years and maintain the fill for eight to 10 months, then draw down to 77.80 m AHD and maintain it at a level between 77.30 m AHD and 77.80 m AHD for two years before re-starting the cycle. Lake Meran last filled in 2016 (year one) with natural flows, was allowed to draw down between year two (2017-18) and year three (2018-19), and it has received top-ups of water for the environment since year four (2019-20) to maintain water levels within the target range of 77.30 AHD to 77.80 m AHD. The lake is due to be filled again in year six (2021-22) under the optimum regime, but it can withstand top-ups at the lower level until 2023-24 under its minimum recommended filling regime. Filling the lake before 2023-24 is preferred where possible, so a fill in 2021-22 is a high priority under an average and wet climate scenario. Filling Lake Meran is always subject to water availability, trade restrictions and delivery capacity constraints in the channel system. Under a drought climate scenario or if there is not enough available supply to fill Lake Meran under average and dry climate scenarios, it will be necessary to deliver smaller top-ups to prevent the water level from dropping below 77.30 m AHD.

Lake Boort is due to be filled in 2022-23, and a partial fill in autumn 2022 is highly recommended to prime the wetland and stimulate some ecological processes before the larger watering event. A partial fill in 2021-22 will likely improve the environmental outcomes from the subsequent filling event and also reduce the total volume of water that will need to be delivered in 2022-23. The partial fill may occur naturally under a wet climate scenario, or it could be delivered with available environmental water. Based on current estimates, there may not be enough available supply to partially fill Lake Boort under drought to average climate scenarios, but the watering action may proceed if water becomes available.

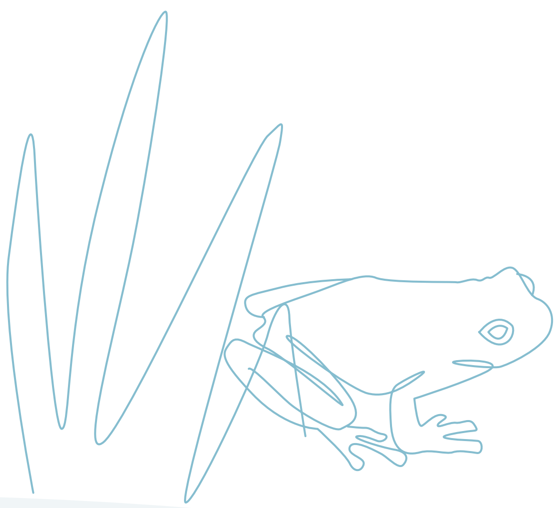


Table 5.7.4 Potential environmental watering for the Boort wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected conditions	• No natural inflow to wetlands	• Minimal natural inflow to wetlands from local catchment run-off possible	• Periods of high flow combined with localised catchment contributions, which are expected to provide minor inflow to wetlands	• Extended durations of high flow and overbank flow from creeks and flood runners, which fill most wetlands
Predicted supply of water for the environment[1]	• 3,403-7,183 ML	• 6,100 ML	• 6,678 ML[2]	• 9,804 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Lake Meran (top-ups)	• Lake Meran (top-ups) • Lake Leaghur (fill) • Lake Leaghur (top-up, if triggered)	• Lake Meran (top-ups) • Lake Leaghur (fill) • Lake Leaghur (top-up, if triggered)	• Lake Boort (partial fill) • Lake Meran (fill) • Lake Leaghur (fill) • Lake Leaghur (top-up, if triggered)
	Tier 1b (supply deficit)			
	• Lake Boort (partial fill) • Lake Leaghur (fill) • Lake Leaghur (top-up, if triggered)	• Lake Boort (partial fill)	• Lake Boort (partial fill) • Lake Meran (fill [instead of top-ups])	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A	• Lake Meran (fill [instead of top-ups])	• N/A	
Possible volume of water for the environment required to achieve objectives	• 2,500 ML (tier 1a) • 7,200 ML (tier 1b) • 0 ML (tier 2)	• 4,900 ML (tier 1a) • 4,500 ML (tier 1b) • 3,500[3] ML (tier 2)	• 4,900 ML (tier 1a) • 8,000[3] ML (tier 1b) • 0 ML (tier 2)	• 12,800[4] ML (tier 1a) • 0 ML (tier 1b) • 0 ML (tier 2)

1 Loddon system entitlements are shared between the Loddon River system and the Boort wetlands. The expected availability referenced in this table is an estimate of remaining supply after the Loddon River tier 1a demands and critical carryover requirements have been removed.

2 Large increases in tier 1a demands in the Loddon River system under average conditions will likely result in the available supply for the Boort wetlands being similar to the dry scenario.

3 Demand for Lake Meran is in addition to tier 1a.

4 While the demand is in excess of available supply, it is expected that some of the fill events will be at least partially met with natural inflows under a wet climate scenario.

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. The VEWH holds water for the environment in Newlyn Reservoir, but there is no water held in Hepburn Lagoon.

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 improved in-stream vegetation and populations of small-bodied fish.

Environmental watering objectives in Birchs Creek

Increase the population and diversity of small- and medium-bodied native fish including river blackfish, mountain galaxias, flat-headed gudgeon and Australian smelt
Maintain the breeding population of platypus and increase the number of individuals to improve the population's resilience to future droughts and floods Provide surplus juvenile platypus that can disperse 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 2014-2034* 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 fishing)
- riverside recreation and amenity (such as cycling and walking, diversion for domestic and stock use and improving amenity at key community spaces like Anderson's Mill).

Recent conditions

Although July rainfall was well-below average, near-average rainfall was observed during late winter to early summer, and January rainfall was well above average. Water for the environment allocated in December 2019 was carried into the 2020-21 water year, but it was lost due to regular spills at Newlyn Reservoir throughout winter and spring 2020. The full 100 ML allocation was again received on 1 December 2020.

Regular storage spills and contributions from groundwater led to all of the winter and spring flow requirements for Birchs Creek being met or exceeded. Low flow and freshes over summer and autumn were met with a combination of natural flow from summer storms and groundwater baseflow, as well as consumptive releases in reaches 1 and 2. No additional freshes were required in Birchs Creek in 2020-21, so the allocation from December 2020 will be carried over to support watering actions in 2021-22.

Scope of environmental watering

Table 5.7.5 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects 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 effects.

Table 5.7.5 Potential environmental watering actions, expected watering effects and associated environmental objectives for Birchs Creek

Potential environmental watering action	Expected watering effects	Environmental objectives
Birchs Creek (targeting reach 3)		
Winter/spring fresh (one fresh of 27 ML/day for three days during June to November)	• Maintain and support the growth and germination of streamside vegetation by increasing soil moisture and depositing sediment on the bank and benches • Scour old biofilms and organic matter that has accumulated in the channel, and cycle nutrients throughout the creek • Wet benches and banks, to increase habitat and refuge for small fish • Improve water quality by freshening refuge pools and provide connectivity between pools for fish and platypus movement	
Summer/autumn freshes (three freshes of 10 ML/day for three days during December to May)	• Increase the water depth, to maintain and support seed germination and 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.

The entitlement for water for the environment in Birchs Creek is primarily used to deliver winter/spring freshes and summer/autumn freshes if they are not met by the natural flow or consumptive water deliveries. The volume of available water for the environment is not sufficient to deliver any of the other recommended environmental flows in the system. The Birchs Creek Environmental Water Advisory Group has advised that it is better to use the available water to deliver recommended freshes in full, rather than a small proportion of recommended low flows.

Winter/spring freshes are important to cycle nutrients throughout the system and wet higher channel features to increase connectivity between types of habitat for aquatic animals. Summer/autumn freshes are needed to maintain water quality in the warmer months and ensure pools do not dry out. Both these watering actions are important and if required and where allocation allows, summer/autumn freshes may be prioritised to avoid critical loss of environmental values in the system, especially when considering this system can quickly shift climate scenarios in the warmer months.

Table 5.7.6 Potential environmental watering for Birchs Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average and Wet
Expected river conditions	• Reservoir spill unlikely • Flow 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 are certain in winter/spring • Some natural flow through summer/autumn • Groundwater contributes to baseflow throughout the year
Predicted supply of water for the environment	• 100 ML (2020 carryover)	• 100-200 ML (2020 carryover and possible 2021 allocation)	• 100 ML (2021 allocation)[1]
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring fresh (one fresh, at lower duration)	• Winter/spring fresh (one fresh) • Summer/autumn freshes (three freshes)	• Winter/spring fresh (one fresh) • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)		
	• Summer/autumn freshes (three freshes)	• N/A	
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 100 (tier 1a) • 100 ML (tier 1b) • 0 ML (tier 2)	• 200 ML (tier 1a) • 0 ML (tier 1b) • 0 ML (tier 2)	• 100 (tier 1a) • 0 ML (tier 1b) • 0 ML (tier 2)
Priority carryover requirements	• If the 100 ML allocation is received on 1 December 2021 and Birchs Creek is in good condition over summer/autumn, carry over 100 ML allocation into 2022-23 for use by 30 November 2022		

1 Under an average or wet scenario, it is likely that Newlyn Reservoir will spill before 30 November 2021, losing the 100 ML carryover from December 2020.

Vegetation Gunbower Forest, by North Central CMA

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 that 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 flow – A flow of sufficient size to reach the top of the riverbank, with little flow spilling onto the floodplain.

Biodiversity – The variety or abundance of plant and animal species in a particular habitat or environment.

Biofilm – A slimy film of bacteria, other microbes and organic materials that covers 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 levels of dissolved oxygen, which can stress or kill fish and other animals that breathe underwater.

Brackish water – Water that is moderately salty but not as salty as seawater. 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 – The 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 Commonwealth Environmental Water Holder.

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.

Deficit in supply – The insufficiency of the volume of available environmental water — the supply — to meet identified environmental watering requirements: the demand.

Drawdown – Water released from a dam or reservoir at the end of the irrigation season for the purposes of its operation and/or maintenance.

Ecological vegetation class – A component of a vegetation classification system, this is a group of vegetation communities based on floristic, structural and ecological features.

En route (water) – 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, that is used to inform decisions about the management and allocation of water resources.

Environmental objectives – Measurable target outcomes 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 setting 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.

Expected watering effect – The physical, chemical, biological or behavioural effect expected from a potential environmental watering action. Each potential environmental watering action will have one or more expected watering effects.

Fishway – A series of pools built like steps to enable fish to travel through a waterway, dam or waterfall.

Fledging – The stage in a young bird's life from birth until it can fly.

Flow component – A component of a river system's flow regime that can be described by its magnitude, timing, frequency and duration (for example, cease-to-flow and overbank flow).

Fresh – A small or short-duration, peak-flow event that exceeds the baseflow and lasts for a few days.

Geomorphology – The scientific study of landforms and the processes that shape them.

Groundwater – Water held underground in the soil or in pores and crevices in rock.

Headwater – A tributary stream of a river close to or forming part of its source.

Headworks system – A system including various storage infrastructure (such as reservoirs and diversion weirs) to enable connection of multiple waterways.

Heritage river – A river listed under the *Heritage Rivers Act 1992* and part of a river and river catchment area in Victoria that has significant nature conservation, recreation, scenic or cultural heritage attributes.

High-reliability entitlement – A legally recognised, secure entitlement to a defined share of water. The 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 transfer – The transfer of water between river systems to meet demands as a result of water trade between river systems.

Irrigation release – 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 flow – A relatively stable, sustained and low flow in a river, generally being its minimum natural level.

Low-reliability entitlement – A legally recognised, secure entitlement to a defined share of water. The full allocation of a low-reliability entitlement is expected only in some years.

Macroinvertebrate – An animal without a backbone and that can be seen with the naked eye including a worm, snail, mite, bug, beetle, dragonfly and freshwater crayfish. It is also to as a waterbug.

Macrophyte – An aquatic plant that is either emergent (growing out of the water, for example phragmites), submergent (growing under the water, for example ribbon weed) or floating (for example floating pondweed).

Managed release – A release of water for the environment that 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 post-contact settlement, it went from about 1995 to 2012.

Operational release – A release made from a major storage to enable the water distribution system to operate or to make water available to consumptive water users.

Overbank flow – 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 flow – Water released from a storage to operate a river and distribution system (often to help deliver water for environmental or consumptive uses) and to maintain environmental values and other community benefits. The volume of a passing flow is generally determined by inflows to the storage.

Permanent trade – The transfer of ownership of a water share or licence.

Potential environmental watering action – An environmental flow component that has been identified for a particular system in a particular year.

Program partners – Are those organisations with a responsibility for delivering some part of the environmental watering program. It includes waterway managers, storage managers, land managers, environmental water holders. In some areas, Traditional Owners, scientists and community members may also be program partners.

Pulse – A gradual build in the flow of water, typically to replicate the most-suitable conditions for water species (such as for fish to travel and spawn).

Ramsar-listed wetland – A wetland listed as internationally significant under the Convention on Wetlands of International Importance 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 catchment. It provides a single regional planning document for waterways in the area.

Remnant vegetation – Patches of native trees, shrubs and grasses remaining after disturbance.

Return flow – A flow delivered for environmental purposes and then returned to the downstream system to be reused for other purposes. A returned flow may be captured and stored downstream for later reuse, although most commonly it remains 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 on 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 that occurs when a freshwater river flows directly into saltwater.

Seasonal watering plan – The VEWH's annual operational document, that 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 that is 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.

Stakeholders – Are those organisations or individuals with a keen interest in the environmental watering program, who are engaged by one of the program partners during planning, delivery or reporting.

Storage manager – An organisation 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 – The transfer of a seasonal allocation.

Terrestrial vegetation – Land-based plants.

The Living Murray program – The intergovernmental program that holds an average of 500,000 ML of water for the environment a year for use at six iconic sites along the Murray River.

Tier 1 – Potential environmental watering actions that are required this year to achieve intended environmental objectives, given current environmental conditions and the planned environmental watering strategies under each climate scenario.

Tier 1a – The subset of tier 1 watering actions that the waterway manager proposes to deliver with predicted supply under each climate scenario.

Tier 1b – The subset of tier 1 watering actions that the waterway manager does not expect to be able to deliver if available supply is exhausted on tier 1a actions.

Tier 2 – Potential watering actions that are generally not required every year to achieve intended environmental objectives but are needed over the long-term. At the time of developing a seasonal watering plan, tier 2 potential watering actions are not considered necessary to deliver in the current year under specific climate scenarios, but they are likely to be needed in coming years and may be delivered in the current year if environmental conditions change or to take advantage of operational circumstances.

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 flow – A natural streamflow that cannot be captured in a major reservoir or storage.

Victorian Environmental Water Holder (VEWH) – The 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.

Waterway – A river, wetland, creek, floodplain, estuary or other body of water.

6.3 Contact details

For further information about the *Seasonal Watering Plan 2021-22*, 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.com.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

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VICTORIA State Government