Victorian Environmental Water Holder

Seasonal Watering Plan 2022-23

Cover image:
Wadawurrung women Melinda Kennedy (left) and Tammy Gilson (right), visited Moorabull *Yulluk* (Moorabool River) at Dogs Rocks in 2019, to welcome the release of 500 megalitres of water for the environment. Image by Kristen Lees, Corangamite CMA

Acknowledgement of Traditional Owners

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

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

The VEWH acknowledges the 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 Traditional Owners and Aboriginal knowledge systems are making to planning and managing water for the environment. We also recognise that this contribution is largely through frameworks and processes that have not been determined by Traditional Owners, and their 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 the environmental watering program.

Adequately recognising and strengthening the rights and agency of Traditional Owners in water management is essential for achieving self-determination and healthy waterways into the future. The VEWH will continue to actively support and enable this, within our power and capability.

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 to identify, and in some system sections have used, 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 our information to be exact, but we provide it in the spirit of acknowledging Traditional Owners past and present and their longstanding connection to Country.

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

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.

CORANGAMITE CMA

EAST GIPPSLAND CATCHMENT MANAGEMENT AUTHORITY

Glenelg Hopkins CMA

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

mallee catchment management authority

Melbourne Water

NORTH CENTRAL Catchment Management Authority *Connecting Rivers, Landscapes, People*

NORTH EAST CATCHMENT MANAGEMENT AUTHORITY

West Gippsland Catchment Management Authority

Wimmera CMA

Foreword

I am pleased to introduce the Victorian Environmental Water Holder's (VEWH's) *Seasonal Watering Plan 2022-23*, which outlines the scope of why, where and when water for the environment may be delivered over the next 12 months.

Our planning for the 2022-23 water year comes after relatively high rainfall, influenced by the ongoing La Niña weather pattern, which has resulted in good inflows into many storages, managed spill releases and natural flows across the Gippsland, central and northern regions, sometimes for prolonged periods. In 2022-23, the combination of available carryover, full storages and an average-to-wet climate outlook puts us in a good position to consolidate and build on environmental outcomes achieved last year in all regions. If above-average rainfall occurs, there may be prolonged periods of high flows in some systems. This will increase our ability to deliver the watering actions set out in this plan, potentially including some larger floodplain watering events.

In western Victoria, La Niña has had less effect. Water storages have remained in a similar position since 2019-20, and there are moderate water reserves available. Significant inflows over winter and spring are needed to boost allocations and deliver many of the watering actions set out in this plan. If water availability remains low, we will focus on delivering minimum flows to protect aquatic ecosystems.

Our evidence-based approach over the past decade, including the information from climate change forecasts, indicates that water for the environment will be increasingly required to support the health of rivers, wetlands and other waterways. 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.

Protecting our waterways and the plants and animals that rely on them provides benefits for all Victorians, now and in the future. The ecological benefits of water for the environment in Victoria are clear. Water for the environment is doing its job: it is doing its job well, and it is also helping the social and economic fabric of our communities.

Our water planning is underpinned by scientific understanding and local knowledge from across Victoria, including cultural and ecological knowledge shared by Traditional Owners. I thank Victoria's catchment management authorities and Melbourne Water that have consulted with communities when developing the watering proposals for the seasonal watering plan. I also thank the Traditional Owner organisations across Victoria that have contributed to the watering proposals and, in some cases, reviewed the seasonal watering plan. Managing water for the environment in collaboration with Traditional Owners can help realise cultural objectives and achieve better outcomes for the environment.

The VEWH will work with partner agencies and directly with Traditional Owners to support increased Traditional Owner influence in the environmental watering program and enable broader progress towards self-determination. We look forward to further discussions about supporting Traditional Owner objectives for Country emerging from *Water Is Life: Traditional Owner Access to Water Roadmap*, the refreshed *Victorian Waterway Management Strategy* and VEWH's own analysis regarding how we can realise opportunities in the short, medium and long terms.

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

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.

In this section…

1.1.1 Why do we need an environmental watering program?

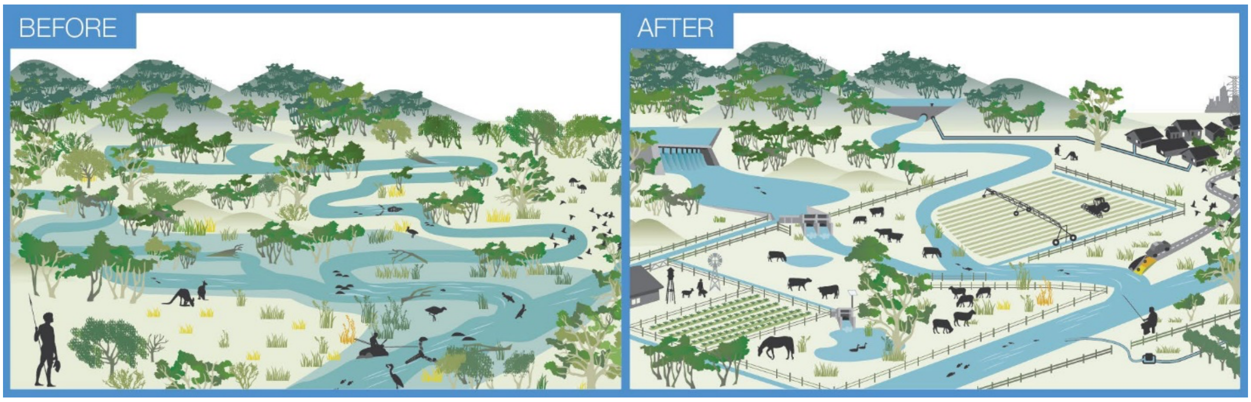
Many of Victoria's rivers and wetlands have been significantly modified, compared to how they were during the tens of thousands of years that Traditional Owners managed them. Water now flows differently through the landscape: it is captured in dams and weirs and diverted by infrastructure — pipelines,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



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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 describes 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 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 frequency, 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, delivery of water for the environment 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; maintain healthy Country for Aboriginal communities; and improve the quality of water available to irrigators.

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 Traditional Owners and 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 is committed to strengthening the role of Traditional Owners as program partners into the future.

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 for jointly managed parks) 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 water-delivery infrastructure (such as pumps, outlets, gates and channels) and public signage. Some delivery of water for the environment also occurs on private land, in partnership with landholders or corporations.

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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 help identify environmental values in each region and help monitor the success of delivery of water for the environment. Local communities make great use of their local rivers and wetlands, and they bring a wealth of cultural, economic, recreational and social perspectives to the program.

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

Citizen scientists are increasingly monitoring the outcomes of delivery of water for the environment. 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?

In many regions of Victoria, Traditional Owners work in partnership with local waterway managers to influence the planning and management of water for the environment. Program partners and Traditional Owners are working together to embed Traditional Owners' objectives, values, uses and knowledge in the management of environmental flows. More information is available in the regional overviews and system sections of this seasonal watering plan.

Under existing legislation, Aboriginal cultural values must be considered in the management of water for the environment. However, more can be done within the current framework to increase Traditional Owners' influence in the planning and management of water for the environment. The VEWH and its program partners will continue to identify and act on opportunities to do so.

1.1.6 How are we enabling self-determination for Traditional Owners in the management of water for the environment?

In the context of Treaty negotiations in Victoria and the Victorian Government's commitment to self-determination for First Nations, program partners in the environmental watering program are aware that structural changes — legislative, policy and/or governance changes — to how water is managed may be made in the future in recognition of Aboriginal water rights. Program partners have heard for many years that Traditional Owners want empowerment and agency in water management, and in many cases they want to manage water on Country on their own terms.

The VEWH acknowledges that existing frameworks and processes for the management of water on Country do not adequately provide opportunities for empowerment and agency of Traditional Owners. More can be done to enable self-determination within and beyond the program. The VEWH, in partnership with Traditional Owners, DELWP and other program partners, will play its part to better embed Traditional Owners' influence and participation in the environmental watering program and support Traditional Owners on the path to accessing water and managing water on Country on their own terms. Over time, we are aiming to move from a Traditional Owner 'inclusion' mindset to supporting more transformational reforms that enable self-determination for First Nations.

The VEWH has developed a position statement about working with Traditional Owners. Its main intent is to affirm our commitment to supporting self-determination for Traditional Owners within the environmental watering program and beyond and to communicate this to Traditional Owners across Victoria, program partners and stakeholders. The position statement outlines the steps that will be taken in the next few years to honour the statement's intent.

1.1.7 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 decisions about and outcomes of delivery of water for the environment
- 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.

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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.

1.1.8 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. They outline integrated waterway management actions and are a sub-strategy of regional catchment strategies.

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 the outcomes of delivery of water for the environment. These include invasive species control, streamside land management, sustainable agriculture practices, 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 used to deliver water for the environment to wetlands. Capacity limits associated with water-delivery 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 delivered, which significantly reduces the environmental outcomes that can be achieved.

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.

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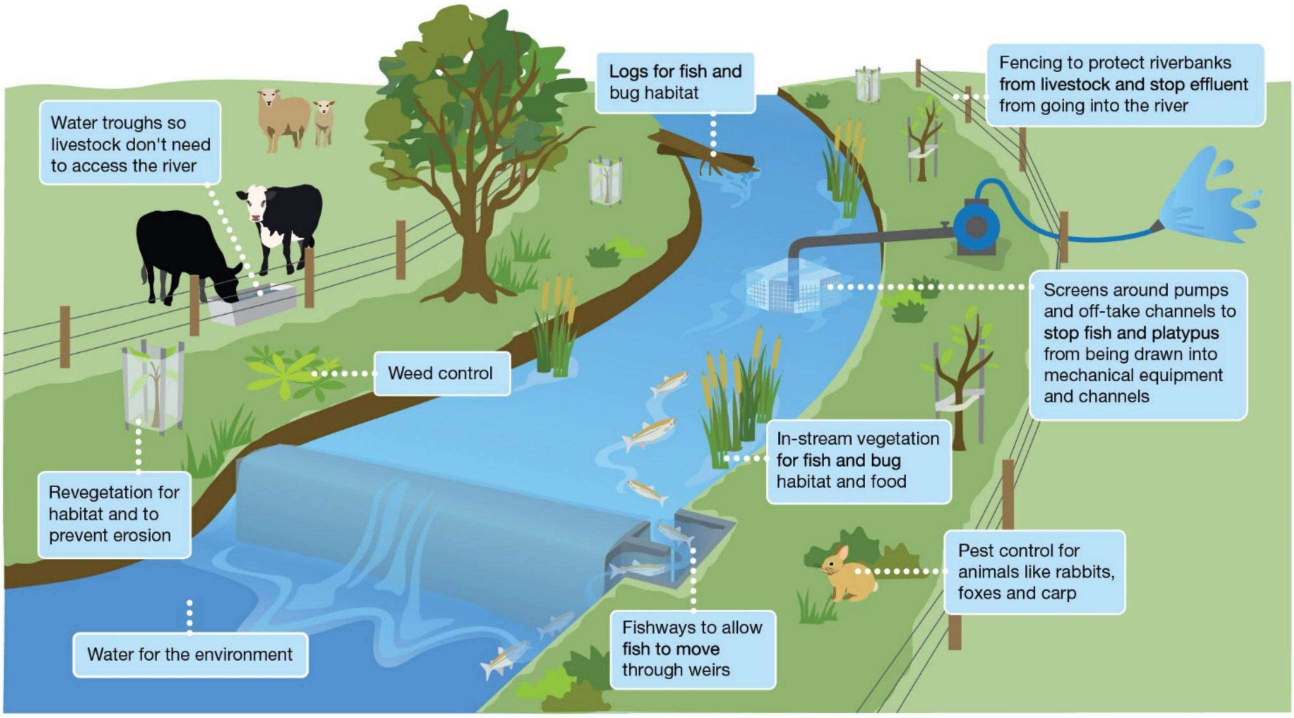
Figure 1.1.2 Example of complementary waterway management activities



1.1.9 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.

Observed and forecast changes to streamflows and extreme climatic events in Victoria threaten to reduce the availability of water for the environment, 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 investing in environmental works and measures that will allow better use of the VEWH's existing water at priority sites for the delivery of water for the environment. In some instances, the VEWH may supplement this investment using water trade revenue.

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 the 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.

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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 the delivery of water for the environment, 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 also 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 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 between 2016 and 2065 under a medium climate change scenario

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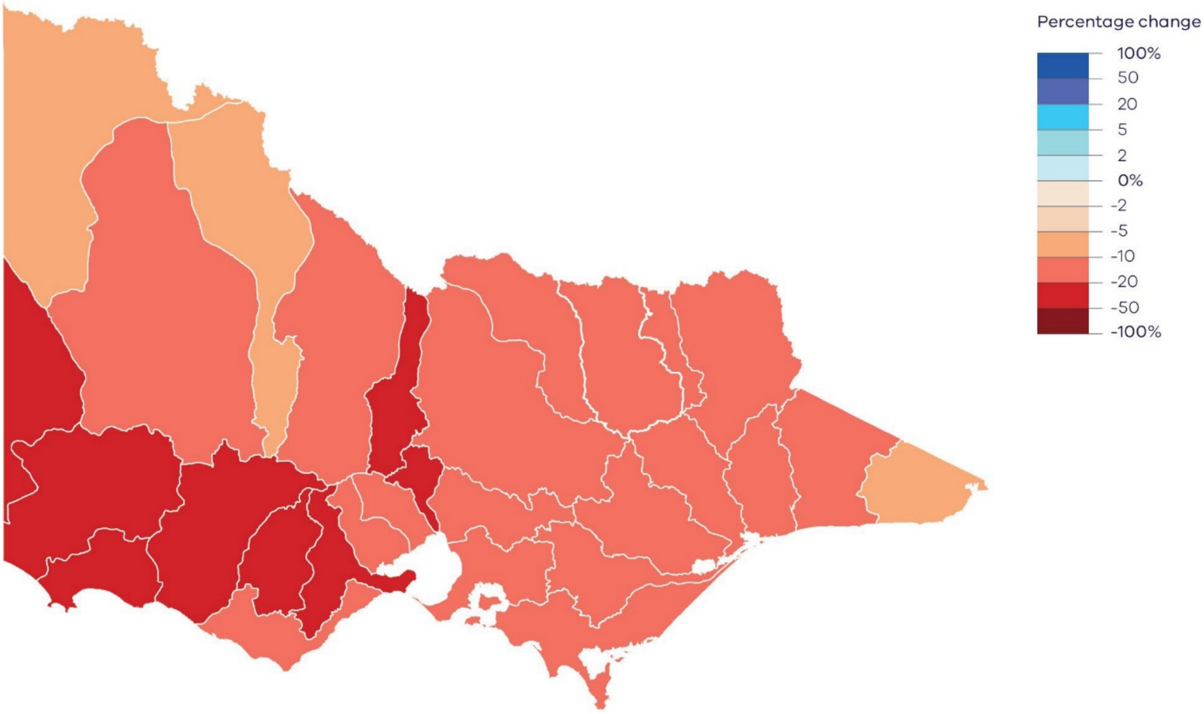
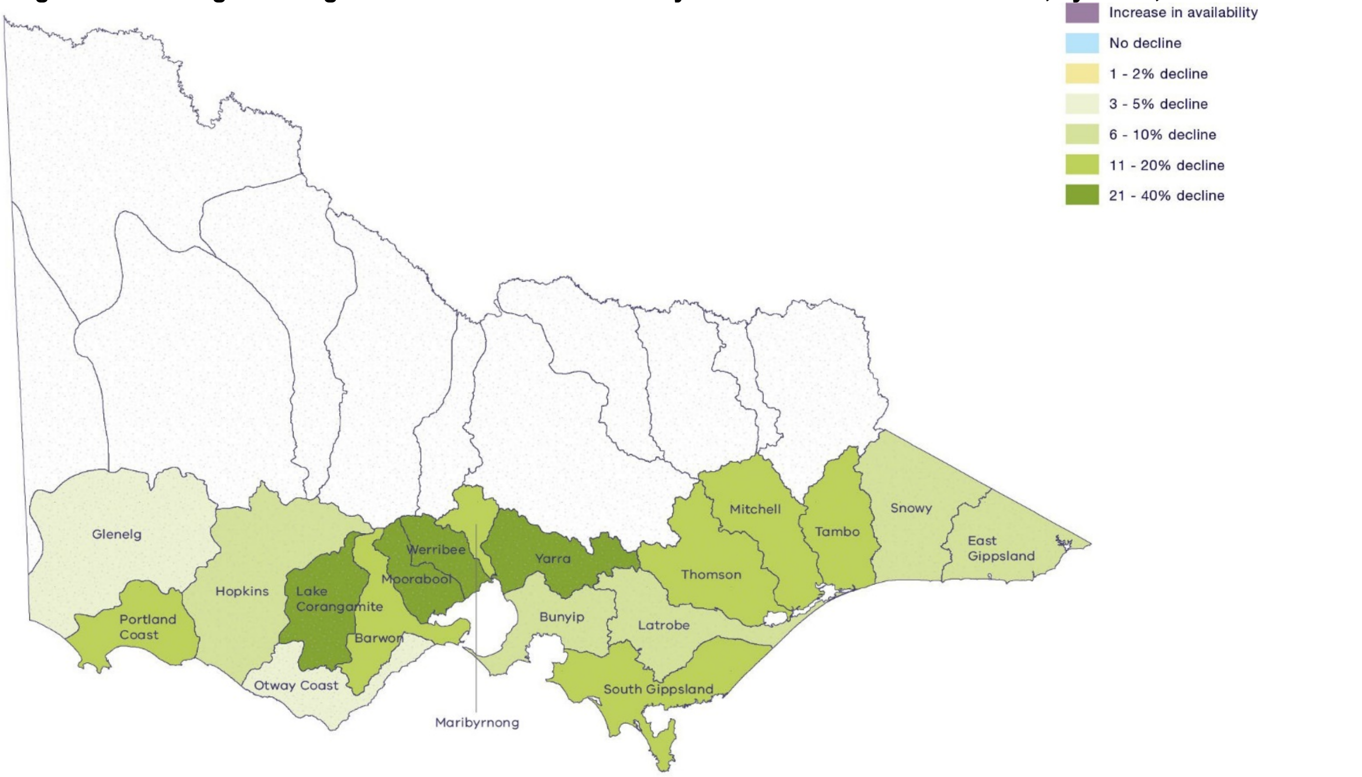


Source: Water for Victoria

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

1.1.10 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.

In addition to the DELWP-funded programs, 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 delivering water for the environment 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 selected 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 decisions about the delivery of water for the environment. 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 2007-08 and 2020-21. Sites with scores earlier 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.

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Figure 1.1.5 Environmental condition report card scores, the Living Murray program icon sites, 2006-07 to 2020-21

	Barmah-Millewa Forest	Gunbower Forest	Koondrook-Perricoota Forest	Hattah Lakes	Lindsay, Mulcra and Wallpolla islands	Chowilla floodplain	Lower Lakes, Coorong and Murray Mouth
2020-21	B	B	D	B	C	C	C
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 Most (75-100%) ecological objectives have been met	B More than half (50-74%) of the ecological objectives have been met	C Fewer than half (25-49%) of the ecological objectives have been met	D Few (0-24%) ecological objectives have been met	– Data not available		

1.1.11 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.

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1.2 The seasonal watering plan

The seasonal watering plan is a statewide plan that guides decisions about the delivery of water for the environment 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 description 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 plan and any variations are valid for the whole water year, which runs from 1 July to 30 June 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.

Subsequent sections of the seasonal watering plan include scenario planning text and tables that describe the potential watering actions that are likely to be delivered in each river and wetland system during the year under different climatic conditions.

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

Each year, waterway managers scope the potential actions to deliver water for the environment 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 are shown in Figure 1.2.1. More information about the strategies and plans shown in Figure 1.2.1 is available at vewh.vic.gov.au.

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Figure 1.2.1 Victorian environmental watering program planning framework

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

Key - Responsibilities

- Waterway managers
- VEWH
- Expert advisors

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

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1.2.3 Who contributes to the seasonal watering plan?

Stakeholder engagement about potential actions to deliver water for the environment 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[1], 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 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 the use of water for the environment that does not require a variation to the seasonal watering plan. These include:

- minor operational adjustments to specific actions to deliver water for the environment
- 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 actions to deliver water for the environment 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, 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.

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1 In the context of the Victorian Government commitment to self-determination for First Nations, partners in the environmental watering program are committed to strengthening the role of Traditional Owners as program partners into the future and supporting self-determination both within the program and beyond.

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 risks (including potential harm to Victoria's rivers, wetlands and floodplains) are appropriately managed.

1.3 Implementing the seasonal watering plan

The seasonal watering plan scopes potential delivery of water for the environment 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 decisions to deliver water for the environment?

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 action to deliver water for the environment
- the opportunity to deliver shared benefits (for example, for Traditional Owners' and recreational values).

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 which 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 decisions about the delivery of water for the environment, 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 actions to deliver water for the environment on its website at vewh.vic.gov.au.

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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 actions to deliver water for the environment.

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 actions to deliver water for the environment 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 to address emerging risks or changes in operating conditions or water availability. Withdrawing a seasonal watering statement or watering authorisation is done in consultation with the relevant environmental water holders, waterway manager and storage manager for that river or wetland system.

A waterway manager or storage manager may decide, in consultation with the VEWH, not to proceed with an action to deliver water for the environment 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 native plants and animals 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 actions to deliver water for the environment.

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.

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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.

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Figure 1.3.1 Criteria for prioritising actions to deliver water for the environment

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 actions to deliver water for the environment, 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.

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Waterway managers are best placed to advise about the extent and significance of an action to deliver water for the environment 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 action to deliver water for the environment.

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.

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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

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1.3.5 How are economic, recreational, social and Aboriginal cultural values and uses considered in decisions to deliver water for the environment?

By improving the health of rivers, wetlands and floodplains, delivery of water for the environment 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, maintain healthy Country for Aboriginal communities and improve the quality of water available to irrigators.

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 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 the disruption to users as much as possible.

It is important to acknowledge that many Traditional Owners are seeking reforms to existing government frameworks and processes for the management of water on Country. While existing legislation requires that Aboriginal cultural values and uses are considered in the planning and management of water for the environment, we recognise that Traditional Owners want greater empowerment and agency in water management. In many cases, Traditional Owners want to manage water on Country on their own terms.

Over time, program partners in the environmental watering program are moving from a Traditional Owner 'inclusion' mindset to supporting more transformational reforms that enable self-determination for First Nations.

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 risks that arise from the delivery of water for the environment; 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 delivering water for the environment. Program partners consider and reassess these and other potential risks as the season unfolds and planned watering actions are due to commence.

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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 delivering water for the environment

Type of risk	Example mitigating actions
Delivering water for the environment 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 delivering water for the environment	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 deliveries of water for the environment. 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.
Deliveries of water for the environment have 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 the outcomes of deliveries of water for the environment 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 deliveries of water for the environment to be taken at short notice.

Emergency watering procedure

Emergency actions to deliver water for the environment are typically one of 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 decisions to deliver water for the environment and to expedite requests for emergency seasonal watering statements.

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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 the water made available under these entitlements may be delivered.

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 of 1 April 2022, 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.

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

Table 1.4.1 Environmental entitlements held by the VEWH (as at 1 April 2022)

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	High reliability
		8,000[1]	Share of inflow
Macalister	Macalister River Environmental Entitlement 2010	12,461	High reliability
		6,230	Low reliability
Central region			
Yarra	Yarra Environmental Entitlement 2006[3]	17,000	High reliability
		55	Unregulated
Tarago	Tarago and Bunyip Rivers Environmental Entitlement 2009	3,000[1]	Share of inflow
Werribee	Water shares	734	High reliability
		361	Low reliability
	Werribee River Environmental Entitlement 2011[3]	n/a[1]	Share of inflow
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	High reliability
		1,000	Lower reliability

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System	Entitlement	Volume (ML)	Class of entitlement
Northern region			
Victorian Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	45,267	High reliability
		8,523	Low reliability
		49,000	Unregulated
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah-Millewa Forest Environmental Water Allocation	50,000	High reliability
		25,000	Low reliability
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	9,589	High reliability
		101,850	Low reliability
		34,300	Unregulated
	Bulk Entitlement (River Murray – Snowy Environmental Reserve) Conversion Order 2004	29,794	High reliability
	Environmental Entitlement (River Murray – NVIRP Stage 1) 2012	1,207[5]	High reliability
	Water shares – Snowy Environmental Reserve	14,671	High reliability
		6,423	Low reliability
	Water shares – the Living Murray program	12,267	High reliability
Goulburn	Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004	30,252	High reliability
		8,156	Low reliability
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625	High reliability
		156,980	Low reliability
	Environmental Entitlement (Goulburn System – Northern Victoria Irrigation Renewal Project (NVIRP) Stage 1) 2012	1,891[5]	High reliability
	Goulburn River Environmental Entitlement 2010	26,555	High reliability
		5,792	Low reliability
	Silver and Wallaby Creeks Environmental Entitlement 2006	n/a	Passing flow only
	Water shares – Snowy River Environmental Reserve	8,321	High reliability
		17,852	Low reliability
	Water shares – the Living Murray program	5,559	High reliability
Broken	Water shares	90	High reliability
		19	Low reliability
Campaspe	Campaspe River Environmental Entitlement 2013	20,652	High reliability
		2,966	Low reliability
	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126	High reliability
		5,048	Low reliability
Loddon	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005[3,4]	11,798	High reliability
		2,024	Low reliability
	Environmental Entitlement (Birch Creek – Bullarook System) 2009[3,4]	100	n/a[6]
	Water shares – Snowy River Environmental Reserve	470	High reliability

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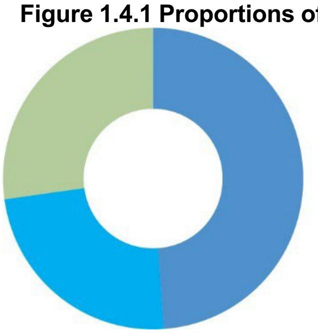
1 Water is accumulated continuously according to a share of inflows to these entitlements (i.e. Blue Rock 9.45%, Thomson 3.9%, Tarago 10.3%, Werribee 10.0%, Moorabool 11.9% and upper Barwon River 3.8%). This volume represents the maximum that can be stored at any time, except for Werribee because the 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 depends on 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 on 30 June 2021. 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 deliveries of water for the environment 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 deliveries of water for the environment 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 environmental 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 deliveries of water for the environment in Victoria.

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Table 1.4.2 Environmental water entitlement held in Victoria by the Commonwealth Environmental Water Holder, as of 28 February 2022

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	318,557	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

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 the delivering of water for the environment.

Other water sources

Water for the environment is not the only type of water that can support river, wetland and floodplain health. Waterway managers and environmental water holders, in consultation with storage managers, consider the potential for environmental watering objectives to be met by other sources of water. The timing of environmental releases can be coordinated with other sources of water to achieve greater 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.

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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 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 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 (that is, the process of buying, selling or exchanging rights to water) allows the VEWH to smooth out some of the variability in water availability across systems and years. A water trade can be a permanent transfer of ownership of a water entitlement or the transfer or sale of an annual water allocation. Permanent trades are subject to approval by the Minister for Water. The VEWH has not undertaken any permanent trades to date, but we commonly buy, sell or transfer annual allocations. For the purposes of the seasonal watering plan (that is, within this plan), the term trade refers to the purchase, sale or transfer of annual allocation.

The VEWH can trade water allocated to our entitlements by:

- making administrative water transfers between our entitlements
- making administrative water transfers with other water holders
- buying 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. 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, technical studies or strategic projects 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 by 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.

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.

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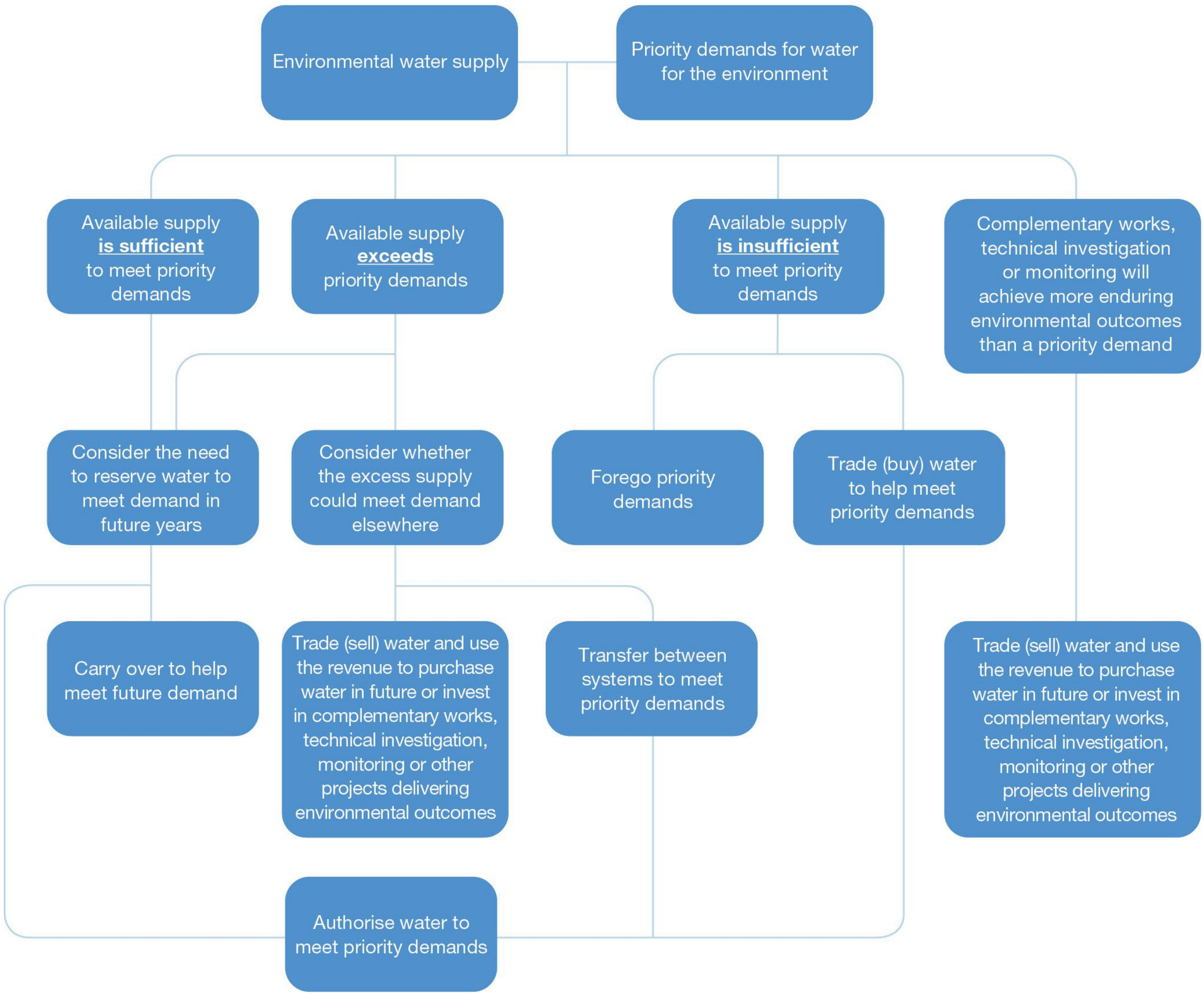
Figure 1.4.2 Key considerations guiding use, carryover and trade decisions



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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 delivering water for the environment
- 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
  - 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 deliveries of water for the environment**, which is a table of potential actions to deliver water for the environment in 2022-23, 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 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 actions to deliver water for the environment 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 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, 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.

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Figure 1.5.1 Example environmental objectives table

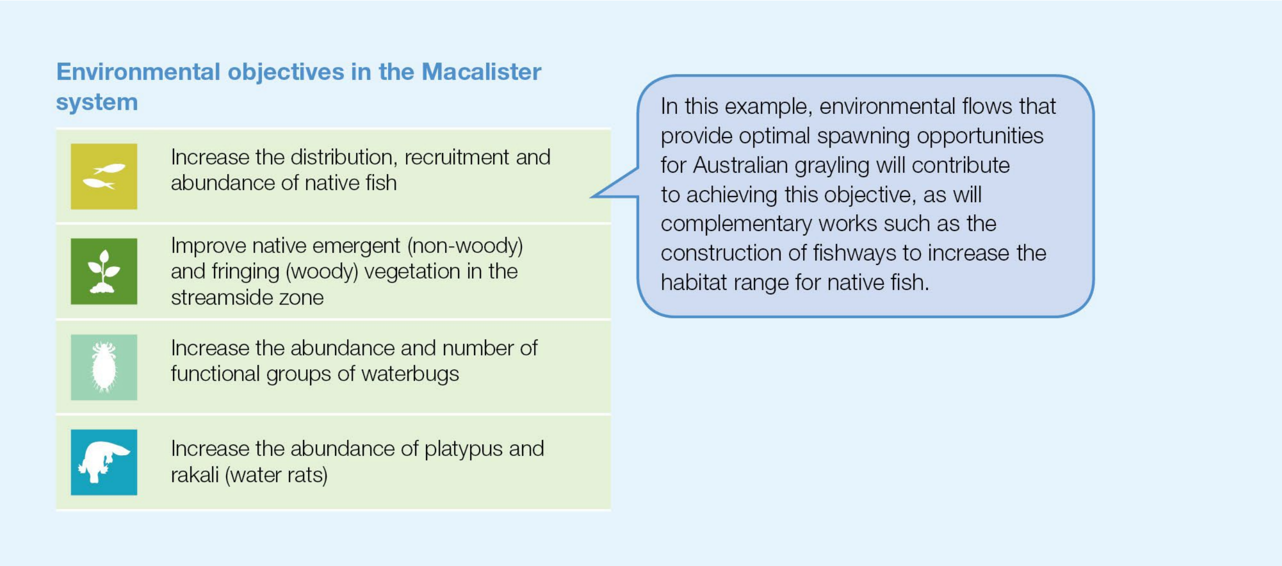

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Figure 1.5.2 Example potential actions to deliver water for the environment and objectives table

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.

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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.

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Section 2
Gippsland region

2.1 Gippsland region overview

The systems in the Gippsland region that can receive water from the VEWH's environmental entitlements are *Durt-Yowan* (Latrobe River), lower Latrobe wetlands, *Carran Carran* (Thomson River), Heyfield wetlands and *Wirn wirndook Yeerung* (Macalister River). 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, objectives, and planned actions for delivering water for the environment 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 have an intrinsic connection to Country that has endured for tens of thousands of years. This includes inherent rights and cultural obligations to Country and community.

The Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC), on behalf of the Gunaikurnai, 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 Victorian Government has entered into a recognition and settlement agreement with the Gunaikurnai. The recognition and settlement agreement, executed under the *Traditional Owner Settlement Act 2010*, affords the Gunaikurnai 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.

In the context of Treaty negotiations in Victoria and the Victorian Government's commitment to self-determination for First Nations, program partners in the environmental watering program are aware that structural changes (such as legislative, policy and governance changes) to how water is managed may be made in the future in recognition of Aboriginal water rights. Program partners have heard for many years that Traditional Owners want empowerment and agency in water management, and in many cases, they want to manage water on Country on their own terms.

Engagement

Seasonal watering proposals are informed by community and program partner engagement, including Traditional Owner engagement. Program partners and communities help to identify priorities and opportunities for the delivery of water for the environment in the coming year.

Longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flows studies), environmental water management plans and Traditional Owner Country plans (and associated documents) also inform seasonal watering proposals. These strategies, plans and technical reports collectively describe a range of environmental, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence actions and priorities for water for the environment.

The VEWH and its program partners consider cultural, social, economic and recreational values and uses of waterways when planning for water for the environment. Where possible, opportunities to support these values and uses are incorporated into watering decisions, provided they do not compromise environmental outcomes. Cultural, social, economic and recreational values considered for each system in the Gippsland region are presented in the system sections that follow.

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 planning process for water for the environment. Table 2.1.1 shows the IAP2 Spectrum categories and participation goals.

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

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

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

Table 2.1.2 shows the partners, stakeholder organisations and individuals with which West Gippsland CMA engaged when preparing the *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 also consulted for operational information as part of the development of all seasonal watering proposals by CMAs.

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

External factors also influence engagement opportunities. COVID-19 restrictions restricted engagement efforts across Gippsland, reducing opportunities for face-to-face meetings with the community and Traditional Owners.

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)

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

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	Latrobe River	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	**IAP2 level: Involve** • Gippsland Water
	IAP2 level: Inform • Department of Environment, Land, Water and Planning • East Gippsland CMA • Victorian Fisheries Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • East Gippsland CMA • Victorian Fisheries Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Victorian Fisheries Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Victorian Fisheries Authority
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		**IAP2 level: Collaborate** • Arthur Rylah Institute	**IAP2 level: Collaborate** • Arthur Rylah Institute
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: Collaborate** • Gunaikurnai Land and Waters Aboriginal Corporation

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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 of 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 streambank vegetation and invasive species.

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

Examples of complementary programs that are likely to support environmental flows 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 the potential delivery of water for the environment in 2022-23 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 2022-23

Rainfall in the Gippsland region in 2021-22 was well above the long-term average for the second consecutive year, and temperatures were close to the long-term average. Widespread flooding occurred in June and November 2021, and major flooding occurred in Traralgon Creek, Tanjil River, Avon River, *Wirn wirndook Yeerung* (Macalister River) and *Carran Carran* (Thomson River) in June.

Delivery of water for the environment in rivers and wetlands within the West Gippsland CMA region was managed in line with a wet scenario during 2021-22, and all planned watering actions were achieved. Natural flows from spilling reservoirs and local catchment run-off met most of the planned watering actions during the year. Water for the environment was used to deliver several freshes in *Carran Carran* (Thomson River) and autumn/winter low flows and freshes in *Wirn wirndook Yeerung* (Macalister River) to support native fish migration and breeding, but was not needed in *Durt-Yowan* (Latrobe River); and there will likely be moderate-to-large carryover volumes for 2022-23. The three lower Latrobe wetlands (Sale Common, Dowd Morass and Heart Morass) received their first full flushing flows since 2010-11, and salinity levels in Lake Wellington remained low for a second consecutive year.

The Snowy River received its highest allocation of water for the environment since the Victorian Environmental Water Holder was established. The water was used to mimic seasonal snow melt patterns to enhance the river's ecological and physical conditions.

The Bureau of Meteorology forecasts above-average rainfall and above-average temperature for the Gippsland region during winter and spring 2022. With greater-than-average soil moisture and relatively high storage levels, the risk of flooding remains for the Gippsland region in the first half of 2022-23.

High storage levels and forecast wet conditions for the start of 2022-23 are likely to result in high allocations to environmental entitlements in the Gippsland systems. There will also be a moderate-to-large carryover of unused environmental allocation from 2021-22, and although some of the carryover may be lost if storages spill, the combination of high allocations and carryover means there will be sufficient supply to deliver planned watering actions under all climate scenarios during 2022-23.

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The approach to delivering water for the environment in the Gippsland region is to maintain enough flow in dry times to minimise stress on existing plant and animal populations and deliver larger flows in wetter conditions to enhance the condition of and increase recruitment in those populations. Wet conditions over the last two years have resulted in strong native fish recruitment in all of the Gippsland systems that receive water for the environment. While certain flows will be delivered at a lower magnitude under drier climate scenarios, the forecast high water availability means that delivery of water for the environment to consolidate the environmental gains of the last two years and to support additional recruitment where possible should still be possible under all scenarios in 2022-23. Efforts to boost migratory fish populations in the Latrobe, Thomson and Macalister rivers are particularly important to increase numbers across the broader Gippsland region and help recover populations in systems that were affected by the 2019-20 bushfires.

Delivery of water for the environment in the lower Latrobe wetlands in 2022-23 will also aim to consolidate and, where possible, improve the environmental gains of the last two years. This will involve keeping all three wetlands at least partially full under all climate scenarios and looking for opportunities to provide flushing flows if there are high flows through the lower Latrobe River.

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 2022 to April 2023 were endorsed by the Snowy Advisory Committee in March 2022. The agreed daily releases will not vary unless flows increase the risk of flooding downstream or operational constraints prevent delivery.

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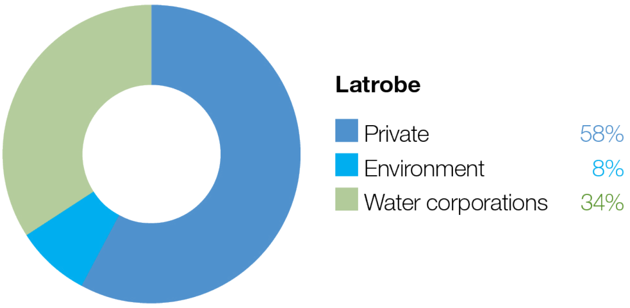
2.2 Latrobe system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

Proportions of water entitlements in the Latrobe basin held by private users, water corporations and environmental water holders on 30 June 2020



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

2.2.1 *Durt-Yowan* (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.

Durt-Yowan (Latrobe River) from Rosedale to the *Carran Carran* (Thomson River) confluence (reach 5) is the priority reach for delivering water for the environment because it contains endangered plant communities that have good potential for rehabilitation. Capacity constraints within reach 5 mean that some of the larger freshes required to meet environmental objectives in reaches 4, 5 and 6 cannot be delivered without flooding private land. Until this can be resolved, environmental flows will be managed to within-channel levels. Where possible, flows in *Durt-Yowan* (Latrobe River) are coordinated with freshes in *Carran Carran* (Thomson River) to meet targets for the Latrobe River estuary.

Options to deliver water for the environment to *Durt-Yowan* (Latrobe River) via the Tyers River may be investigated in 2022-23. 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.

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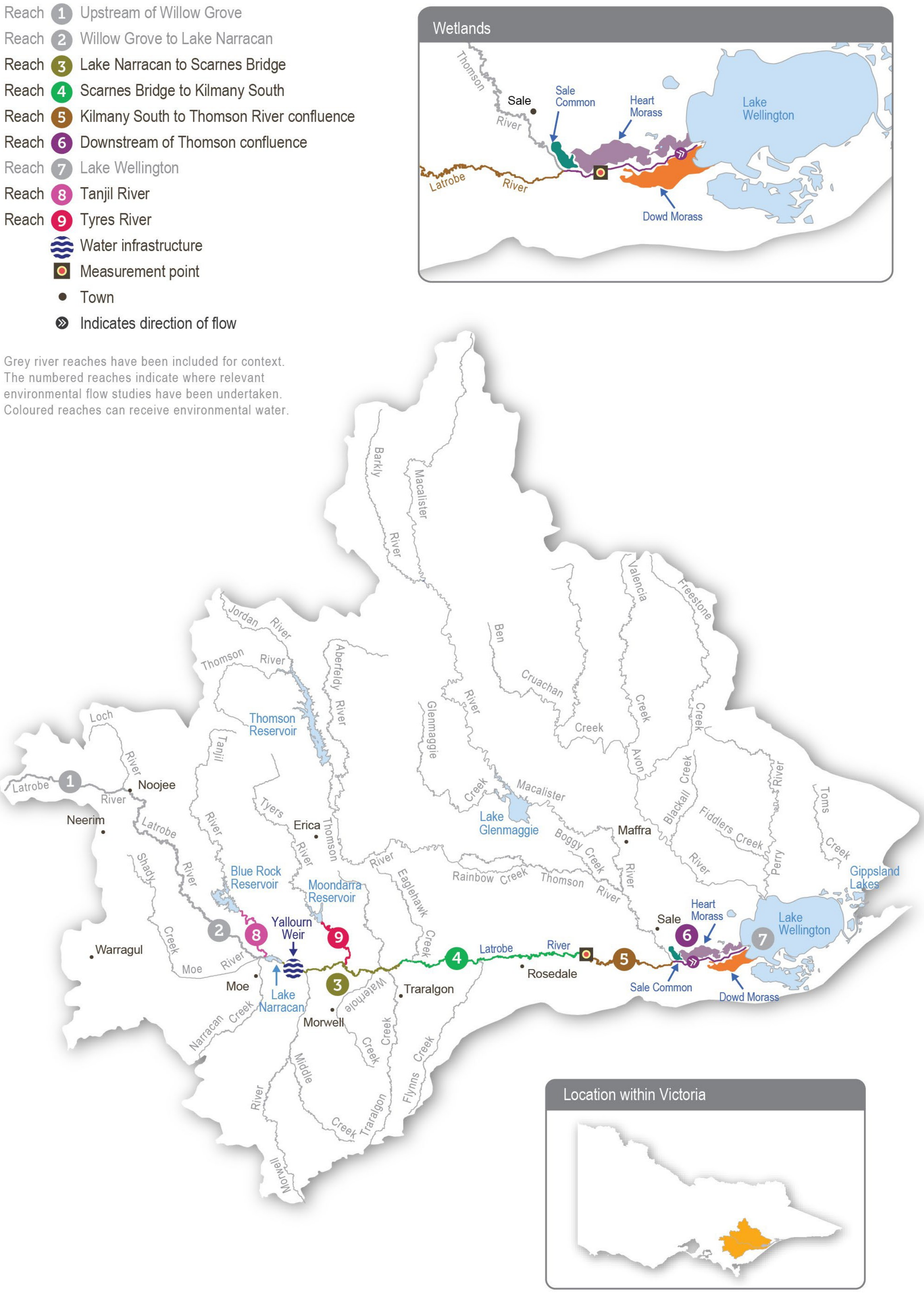
Figure 2.2.1 The Latrobe system



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Environmental values

The upper reaches of *Durt-Yowan* (Latrobe River) flow through state forest and are relatively intact and ecologically healthy. They have continuous stands of river red gums and intact streamside vegetation, and they support 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.

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

Icon	Environmental objectives in the 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 over 27,000 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. The Gunaikurnai see all of Country as interconnected with only separation between clan groups, not cultural landscapes of land, waterways, coasts, oceans and natural and cultural resources. The cultural landscape is dependent on culture and Aboriginal management.

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 Owners with traditional knowledge. Traditional Owners' guidance about objectives and values was received from GLaWAC via the Gunaikurnai Cultural Water Team. This engagement is planned to continue in the 2022-23 water year.

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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
  - implementation of cultural resource management
  - waterways as meeting places, pathways and boundaries
  - 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 the delivery of water for the environment 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 as 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 birdwatching)
- socioeconomic benefits (such as commercial fishing, tourism and improved water quality for domestic, irrigation and stock use).

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.

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

The *Durt-Yowan* (Latrobe River) catchment experienced above-average temperatures throughout most of 2021-22, and above-average rainfall during winter and spring resulted in several overbank flood events and sustained high flows for most of the year. A large rain event in June 2021 caused Blue Rock Reservoir to spill, resulting in widespread flooding in the lower reaches and the estuary, with a high flow peak of 34,000 ML/d recorded at Kilmany. Due to above-average inflows and only minor use of water for the environment since 2018-19, the full environmental entitlement was available at the start of the 2021-22 water year and was sustained throughout the season.

Water for the environment was managed in line with a wet climate scenario throughout 2021-22, and all planned watering actions were met or exceeded with natural flows for the second consecutive year. These natural flows provided several large flow events that are needed to support key ecological and geomorphological processes and cannot be delivered through managed releases of water for the environment. A flow constraint in reach 5 of *Durt-Yowan* (Latrobe River) currently limits the ability to deliver the full environmental water entitlement from Blue Rock Reservoir under average-to-wet conditions, and this is the third year in a row where all deliverable flow components required for *Durt-Yowan* (Latrobe River) have been achieved with high natural flows throughout winter and spring. This has helped freshen the Latrobe estuary and enhanced environmental outcomes in all reaches.

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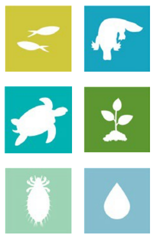
Flows over the past year have created the perfect conditions in the Latrobe estuary for fish breeding, with commercial eel fishers in the area observing estuary perch and Australian bass recruitment at a scale that many have never seen before. Fish surveys conducted in *Durt-Yowan* (Latrobe River) and its tributaries in early 2021 and 2022 detected many young-of-year tupong and Australian bass and a 25 percent reduction in the carp population since 2015. Fish ecologists from the Arthur Rylah Institute for Environmental Research advised that maintaining minimum low-flow targets throughout 2022-23 will continue to 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 2022-23, their expected watering effect (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 2022 and June 2023)	• Wet benches to maintain habitat, support the growth of emergent macrophyte vegetation and limit the encroachment of terrestrial vegetation • Maintain oxygen levels in pools and maintain sediment (sands and silts) in suspension to prevent pools from 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, scour algae from hard surfaces and clean fine sediment from substrates, including river blackfish nesting habitats 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 • provide longitudinal connectivity (including over benches for Australian grayling) for native fish, platypus and rakali (water rats)	

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Potential environmental watering action	Expected watering effects	Environmental objectives
Durt-Yowan **(Latrobe River) (targeting reach 6)**		
Summer/autumn estuary fresh(es) (one to three freshes of 2,200 ML/ day for seven to 10 days during December to May) *Note: this is a combined magnitude with Carran Carran (Thomson River) over the equivalent period; a contribution of at least 1,280 ML/ day from Carran Carran (Thomson River) is required.*	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	

Scenario planning

Table 2.2.2 outlines potential environmental watering and expected water use under a range of planning scenarios. The estimated water demands for planned watering actions presented in Table 2.2.2 do not account for potential unregulated flows. As seen in recent years, natural tributary inflows are likely to achieve many of the planned watering actions under wetter climate scenarios, so most or all of the tier 1a and tier 1b actions proposed for the Latrobe River under wet and possibly average scenarios should be achievable with the available supply.

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 2020-21 and 2021-22.

Most of the recommended flows are likely to be fully 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 can be lower under drought and dry climate scenarios, where the focus is on 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 may 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. Passing flows and natural inflows from unregulated tributaries are likely to provide some flow through the system during winter and spring. Water for the environment will only be used in winter or spring under drier climate scenarios if a lack of flow represents an immediate risk to aquatic fauna.

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. There may only be enough supply to deliver three summer/autumn freshes under a drought scenario, and at least one of these should be delivered for 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 (up to 10 days) may be coordinated with flows in *Carran Carran* (Thomson River) under dry, average and wet climate scenarios to meet environmental flow 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 2022-23 to help deliver critical watering actions in 2023-24. Natural inflows are likely to meet some of the planned watering actions under dry to wet climate scenarios in 2022-23 and result in some leftover water at the end of the year. This leftover water will help support potential watering actions in 2023-24, and no specified carryover target has been set or prioritised for those scenarios.

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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	• Small contributions to low flows from unregulated reaches and tributaries • Passing flows reduced, more likely over summer/autumn	• Possible spills from storages in spring, minor flood levels may occur • Some natural flows contributing to low flows and freshes • Passing flows may be reduced, more likely over summer	• Regular spills from storages in spring, and minor to moderate flood levels may occur • Natural flows and/or passing flows likely to meet low-flow requirements	• Large and frequent spills from storages, and moderate to major flood levels may occur • Natural flows and/or passing flows likely to meet low-flow requirements
Expected availability 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 (partially delivered) • Summer/autumn river freshes (two of lower duration, one of mid-duration [four days])	• Summer/autumn low flow • Summer/autumn river freshes (four of lower duration and two of mid-duration [three days]) • Replace one mid-duration summer/autumn river fresh with an estuary fresh, if conditions allow	• Winter/spring low flow (continuous) • Summer/autumn low flow • Summer/autumn river fresh (one of lower duration and three of 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 of lower duration and three of 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 (lower duration) • 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 (of lower duration)	• Winter/spring low flow (lower duration) • One additional summer/autumn estuary fresh	• N/A	
Potential environmental watering – tier 2 (additional priorities)	• N/A			

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Possible volume of water for the environment required to achieve objectives	• 16,200 ML (tier 1a) • 28,300 ML (tier 1b)	• 14,400-20,400 ML (tier 1a) • 13,400 ML (tier 1b)	• 7,400-27,200[1] ML (tier 1a)	• 8,600-15,200 ML (tier 1a)

Planning scenario	Drought	Dry	Average	Wet
Priority carryover requirements for 2023-24	• 2,500 ML	• 0 ML		

1 While the upper 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 an average scenario

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 the 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, including the musk duck.

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

Icon	Environmental 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 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)

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Traditional Owner cultural values and uses

The Lower Latrobe wetlands are a place of spiritual and cultural connection for the Gunaikurnai people. Over many thousands of years, customs and lore have been passed orally between generations about the cultural values and uses of the wetlands and their importance to all Gunaikurnai people. The wetlands are on the lands of the Brayakaulung clan of the Gunaikurnai.

For the Gunaikurnai, the overarching objective for the wetlands is to provide and maintain healthy Country. Healthy Country includes the importance of place and the health of the entire ecosystem, including maintaining water quality, controlling pest species and maintaining a natural, seasonal flow regime and overbank flood events.

Environmental objectives for the delivery of water for the environment for the lower Latrobe wetlands should take a cultural landscape approach.

Watering requirements to support cultural values and uses include:

- timing the delivery of water for the environment planned in partnership with the Gunaikurnai Land and Waters Corporation (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
- providing connectivity between reaches and onto floodplains and maintaining water quality to support cultural values and uses of significance to the Gunaikurnai.

The wetlands support many keystone species important to the Gunaikurnai, and *boran* (pelican) and *tuk* (musk duck) are the mother and father in the Gunaikurnai creation story. If *boran* and *tuk* are living and breeding at the wetlands, it is a sign Country is healthy. If they are not, flows should be provided to promote required habitat and ecosystem services.

Other birds are important for *woorngan* (hunting) and food, including *nalbong* (water hens), *gidai* (black swans), *boyangs* (eggs) and *koortgan* (ducks except for tuk). *Gidai* require submerged and softer emergent vegetation to make nest mounds, placing them on a small island or floating them in deeper water. *Gidai* breed in late winter to early spring after the water level rises. Actions that fill the large wetlands and support the growth of *loombrak* (water ribbon) and submerged aquatic plants will support *gidai*. Ensuring that the lower wetlands and floodplain depressions (for example, billabongs) receive freshwater flows in winter/spring will provide the conditions for submerged and emergent aquatic plants to grow and provide food and nesting materials for the waterbirds.

GLaWAC is developing a vision for the wetlands that aligns with GLaWAC's *Gunaikurnai Whole-of-Country Plan*. Key aspects of the vision include:

- **healthy Country:** reflecting the spiritual and cultural values of the Gunaikurnai custodians; healthy Country contributes to the well-being of the Gunaikurnai
- **water access:** access to water is crucial for many cultural values, including identity and relational values, future economic values and place values, among many others. Access to water, through ownership or management, means water made available to the Gunaikurnai on the Latrobe system and the Thomson system that provides freshwater to the wetlands. Every effort should be made to maintain freshwater-dependent values, which in turn deliver cultural values
- **cultural and economic use:** returning to cultural practices and Gunaikurnai-informed management at the lower Latrobe wetlands is key to returning to a more freshwater habitat for cultural uses and cultural species. It will also provide for water-based tourism, cultural education and ecotourism (camping) experiences
- **connection:** GLaWAC takes its responsibility very seriously to work closely with the people it represents on management decisions concerning Country and the health of Country. Gunaikurnai cultural obligations reflect Gunaikurnai views on healthy Country and, in turn, help the Gunaikurnai continue their ongoing connection to the land and waters of Country
- **climate change:** the Gunaikurnai have cared for Country for thousands upon thousands of years, through many cycles of climatic change, and they understand how to manage the landscape as it too changes. When cared for using traditional knowledge, Country can be healed. Mitigation of climate change factors affecting the lakes, rivers and other waterways of the lower Latrobe wetlands can be effective with resources and empowerment provided 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 legislative and policy commitments, including 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 their contribution and indicating progress towards deeper involvement.

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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 flows with Gunaikurnai outcomes in the lower Latrobe wetlands. In 2022-23, this is planned to include a jointly managed Gunaikurnai event to deliver water for the environment in Dowd Morass.

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)
- socioeconomic benefits (such as commercial eel and carp fishing).

Recent conditions

The Latrobe catchment experienced above-average temperatures throughout most of 2021-22 and above-average rainfall during early winter and throughout spring (in particular during November) 2021 for a second consecutive year. Significant flooding occurred in June 2021 and was followed by several smaller floods in late winter and spring. These floods, as well as other high-flow events in the Latrobe, Macalister and Thomson rivers, flushed the lower Latrobe wetlands for the first time since 2010-11, and salinity in Lake Wellington was at its lowest since 2004.

Environmental flows at the lower Latrobe wetlands were managed in line with a wet climate scenario in 2021-22. All planned watering actions were fully achieved with a combination of natural overbank flows and managed deliveries of water for the environment through inlet-regulating structures. It was the second consecutive year that all planned watering actions had been met, following relatively dry conditions in 2018-19 and 2019-20.

Routine monitoring at the wetlands detected improved water quality and vegetation condition at all sites as well as extensive growth of water-dependant eel grass, and there was evidence of successful breeding of green and golden bell frogs at Heart Morass. According to one anecdotal report, the level of frog breeding at Heart Morass was the highest in 30 years. More than 300 colonial waterbird nests, including royal spoonbills, little black cormorants, pied cormorants and Australian darter, were observed at Dowd Morass, making it the largest breeding event since the 2010-11 floods. Delivery of water for the environment in 2022-23 aims to build on the achievements of 2020-21 and 2021-22 and continue to enhance high-priority environmental values and support key ecohydrological functions.

Scope of environmental watering

Table 2.2.3 describes the potential environmental watering actions in 2022-23, their expected watering effect (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 2.2.3 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 August[1] with top-ups as required to maintain water depth of at least 0.3 m 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Fill (with top-ups as required during August to November to maintain a water depth of 0.4 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 0.5 m 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 2022 and April to June 2023[2])	• Provide seasonal variation in water depth throughout the wetland to support the growth and flowering of semi-aquatic plants • Wet vegetation and soils at middle elevations within the wetland to increase the abundance of waterbugs and other food resources for frogs, turtles and waterbirds • Provide connectivity between the river and wetlands and between wetlands, increasing available habitat for frogs and turtles • Support bird breeding (when delivered in spring/early summer following earlier fill) by maintaining wetted habitat around reed beds	
Fill (with top-ups as required to maintain water depth of 0.6 m AHD during August to November)	• Wet reed beds and deep water next to reedbeds to provide waterbird nesting habitat and 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
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 triggered3 if wetland overtopping appears likely; based on rising water levels at Lake Wellington (reaching or exceeding +0.5 m 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, create 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	
Partial fill (with top-ups as required to maintain a minimum water depth of 0.3 m AHD during August to December[1])	• 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 the 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 an 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 0.5 m AHD.

Scenario planning

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

The main priority for environmental flows at the lower Latrobe wetlands in 2022-23 will be 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 and 2021-22 to 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 the lower reaches of *Durt-Yowan* (Latrobe River) are suitable, and therefore the timing and extent of water delivery 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 compromises other planned wetting or partial drawdown events. Specific watering plans for each wetland under different climate scenarios are described below.

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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.

Providing a fill to 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.

The wetland will be allowed to draw down naturally over the warmer months, although there may be limited drawdown under average and wet climate scenarios. Facilitated drawdown (via opening regulator gates) is not proposed in 2022-23 unless it is deemed necessary, such as to control the excess proliferation of carp. If climatic conditions only allow a limited drawdown in 2022-23, the wetland may be actively drawn down in 2023-24 to facilitate nutrient cycling and other dry-phase ecosystem processes.

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. Top-ups would be provided as needed to support waterbird breeding and from April to June 2022 to prevent water levels from dropping below 0.3 m AHD and so increase available habitat for frogs and turtles by maintaining connectivity between the river and wetlands. A partial fill will support some vegetation outcomes and help maintain habitat and food for waterbirds, frogs and turtles. Achieving a complete fill at Dowd Morass is a lower priority in 2022-23, but it may occur naturally via overbank flows from *Durt-Yowan* (Latrobe River) in an average and wet climate scenario. A partial drawdown is planned in summer and autumn under drought and dry scenarios to support a wider range of wetland vegetation communities and facilitate carbon and nutrient cycles, but it may be limited under average and wet scenarios if there is significant local rainfall or high flows in *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. Heart Morass was fully flushed in 2021-22, which removed accumulated salt and sulphides and reduced the immediate risk of acid sulfate soils. Flushing flows are likely to occur again in 2022-23 under wet and possibly average climate scenarios, but they will not be delivered without a natural flood. The preferred watering strategy under drought and dry scenarios involves providing a partial fill to the wetland from winter to early summer and maintaining water levels above -0.3 m AHD for the rest of the year. The partial fill in winter and spring will support established wetland plant communities and provide additional habitat and food for frogs, turtles and waterbirds. The partial drawdown in summer and autumn will expose shoreline habitat to increase the diversity of vegetation communities, allow nutrient cycling and provide foraging habitat for shorebirds. Significant drawdown is unlikely under an average or wet climate scenario.

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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) is 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 is 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)
• Trigger-based fill or top-up to 0.5 m AHD (during December to January, if required)
• Partial drawdown (during December to March)</td><td>• Top-up (any time, following bird breeding)
• Fill (with top-ups as required during August to November)
• Partial fill (with top-ups as required)
• Trigger-based fill or top-up to 0.5 m AHD (during December to January, if required)
• Partial drawdown (during December to March)</td><td colspan="2">• Top-up (any time, following bird breeding)
• Fill (with top-ups as required during August to November)
• Trigger-based fill or top-up to 0.5 m AHD (during December to January, if required)
• Partial fill (with top-ups as required during December to June)
• Partial drawdown (during December to March) if triggered</td></tr>
<tr><td colspan="5">Dowd Morass</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</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 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 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 colspan="2">• Top-up (any time to permanently maintain water level above -0.3 m 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 -0.3 m AHD)
• Top-up (any time, following bird breeding)
• Fill and partial flushing flow (during July to November)</td></tr>
</table>

1 Potential environmental flows at the lower Latrobe wetlands are 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 -0.7 m AHD at *Durt-Yowan* (Latrobe River) at the Swing Bridge gauging station.

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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

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 delivery of water for the environment 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 4 a) and Rainbow Creek (reach 4b) (see Figure 2.3.1). Passing flows throughout the year are split two-thirds down reach 4 a 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 4 a) to support fish migration because Cowwarr Weir impedes fish movement through Rainbow Creek.

The Heyfield wetlands is a cluster of 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.

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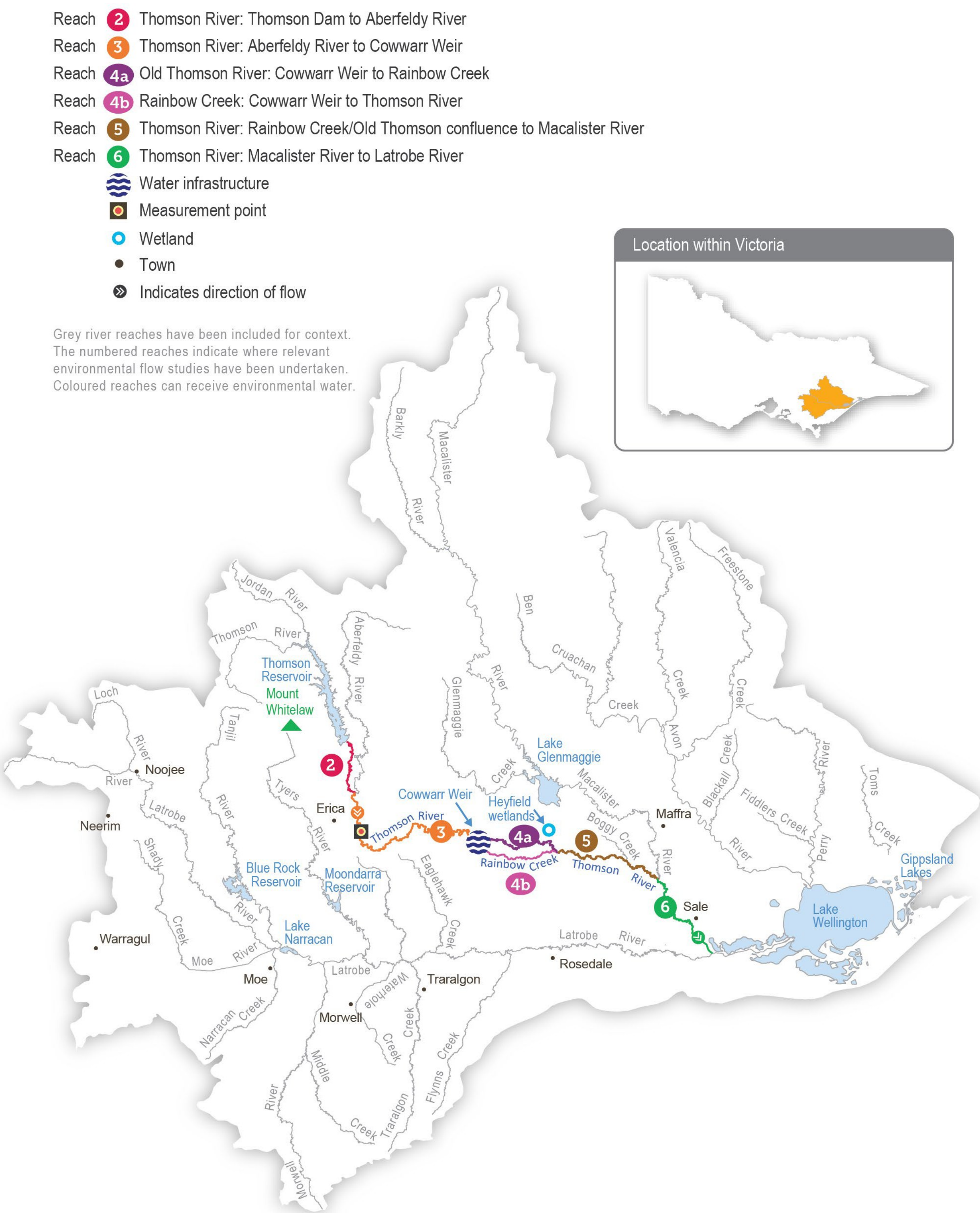
Figure 2.3.1 The Thomson system



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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 the Thomson River catchment. The vegetation is intact and in 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.

Environmental watering objectives in the Thomson system

Icon	Environmental 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 and promote the growth and establishment of semi-aquatic species (Heyfield wetlands) Enhance the resilience of semi-aquatic species (Heyfield wetlands)
	Maintain the natural invertebrate community
	Provide freshwater habitat for migratory and non-migratory wetland birds within the Gippsland Plains landscape
	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 over 27,000 years, including with the waterways in the Latrobe system, into which *Carran Carran* (Thomson River) feeds. For the Gunaikurnai as Traditional Owners, there are immense challenges to heal, protect and manage Country which has been drastically altered since colonisation. The Gunaikurnai see all of Country as interconnected with only separation between clans, not cultural landscapes of land, waterways, coasts, oceans and natural and cultural resources. The cultural landscape is dependent on culture and Aboriginal management.

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. 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 and GLaWAC membership of the newly formed Thomson and Latrobe Environmental Water Advisory Groups (EWAGs).

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GLaWAC cultural water officers have 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, most 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 deliveries of water for the environment 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.

West Gippsland CMA engaged with the GLaWAC Cultural Water Team on watering priorities for 2022-23.

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, events at the Heyfield wetlands and visitation by locals and non-locals)
- socioeconomic benefits (such as maintaining bankside vegetation and preventing erosion and the potential loss of private and public land).

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.

	Watering planned to support water sports activities (canoeing and kayaking)
	Watering planned to support peaks in visitation

Autumn, winter and spring freshes in *Carran Carran* (Thomson River) create ideal white water 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, a fresh that aims to cue the migration of Australian grayling and other native fish may be timed to coincide with recreation events or holiday periods when people take advantage of the white water rafting conditions. 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.

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Recent conditions

The Thomson River catchment had average to above-average rainfall and above-average temperatures throughout much of 2021-22. A significant rainfall event in June 2021 caused major flooding, with flow peaking at 74,000 ML/d upstream of Cowwarr Weir. Two other separate natural bankfull flows in spring also helped to achieve environmental objectives that cannot be achieved with managed releases of water for the environment. High rainfall throughout winter and spring boosted inflows to Thomson Reservoir and provided significant increases to allocations. Most 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.

Delivery of water for the environment in the Thomson system was managed according to a wet scenario in 2021-22, and all the high priority (tier 1) planned environmental flows were met. Natural flows from the Aberfeldy River helped to achieve or exceed environmental flow recommendations in reach 3 of the Thomson River throughout most of the year. Water for the environment was used during 2021-22 to deliver a spring fresh of 800 ML per day for seven days in late October to encourage the recruitment of juvenile migratory fish species, a summer fresh of 350 ML per day for seven days to maintain and support the growth of aquatic and fringing vegetation, and an autumn fresh of 800 ML per day for seven days to trigger the migration of adult and juvenile native fish. Significant rainfall across the catchment filled the Heyfield wetlands in winter, eliminating the need for planned environmental water deliveries. Water levels in the wetlands were maintained throughout spring, providing habitat for waterbirds, frogs and turtles.

Water for the environment that was not used in 2021-22 will be carried over to support watering actions in 2022-23 or beyond. However, Thomson Dam was 90 percent full in May 2022, and if high rainfall continues over winter and spring 2022, some of the carried-over water may be forfeited (in line with entitlement rules) if the dam operator needs to make spill releases.

The Thomson River catchment has had wetter-than-average conditions for the past two years, which have delivered many large flow events. Fish surveys conducted in the middle and lower reaches of the Thomson River have detected Australian grayling, river blackfish and the strong recruitment of tupong. These results highlight the importance of spring and autumn freshes, which support the spawning and recruitment of migratory native fish species. Tupong were also detected upstream of the newly constructed Horseshoe Bend fishway in 2021 and 2022, indicating fish are migrating upstream and using the fishway to access habitat in the upper reaches of the Thomson and Aberfeldy rivers.

Scope of environmental watering

Table 2.3.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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

Potential environmental watering action	Expected watering effects	Environmental objectives
***Carran Carran* (Thomson River) (targeting reach 3)**		
Winter/spring/autumn low flow (125-350 ML/day during July to November 2021 and April to June 2022)	• 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 are increased when delivered at greater 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 greater magnitudes) • Wet low-lying benches (when delivered at greater 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Spring fresh(es) (one to two freshes of 800-900 ML/day for five to seven days during September to November)	• 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 March)	• 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 • Prevent encroachment into the in-stream channel by invasive plants	
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 • Wet low-lying benches to prevent encroachment by invasive plants and enable vegetation zonation • 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
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 providing access to burrowing invertebrates	

Scenario planning

Table 2.3.2 outlines 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 than under average and wet scenarios. However, a large carryover from 2021-22 and forecast high allocations at the start of 2022-23 mean the available supply of water for the environment will likely be high under all climate scenarios, which may allow flows to be delivered at greater-than-normal rates under the dry and drought scenarios. The estimated water demands for planned watering actions presented in Table 2.3.2 do not account for potential unregulated flows. As seen in recent years, natural tributary inflows are likely to achieve many of the planned watering actions under wetter climate scenarios, and therefore, most or all of the tier 1a and tier 1b actions proposed for the Thomson River under wet and possibly average scenarios should be achievable with available supply.

Under all climate scenarios, the highest-priority watering actions for *Carran Carran* (Thomson River) are 800 ML per day freshes in autumn and spring (in October/November), 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, which have shown positive signs of recruitment over the last two years. These events are necessary every year under average and wet climate scenarios to ensure regular recruitment and to align with environmental cues in the broader landscape. They are generally less important in dry or drought scenarios, but they are considered important to deliver even under drier conditions in 2022-23 to consolidate recent population growth and to potentially supplement populations in east Gippsland that were affected by the 2019-20 bushfires. Where possible, the spring and autumn freshes may be timed to coincide with long weekends to provide additional recreational benefits for river users. Two autumn freshes will likely be delivered under all climate scenarios, but under drought and dry scenarios, 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 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 or dry 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 from December to March, and it is the minimum recommended flow between May and November. This flow magnitude is expected to be delivered with operational passing flows under all climate scenarios. Increasing the low-flow magnitude up to 350 ML per day between July and November and April to June is preferred under all climate scenarios, to improve outcomes for fringing and streamside vegetation. If water for the environment is limited under drier scenarios, the low flow may likely only be raised in July (to 300 ML per day) and May to June (to 230 ML per day) to help fish and platypus move throughout the reach at critical breeding and dispersal times.

The recommended water regime for the Heyfield wetlands is the same under all climate scenarios to help recently planted 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 run-off is likely to meet some or all of the recommended watering actions at the Heyfield wetlands under average and wet climate scenarios.

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).

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Passing flow and limited natural flow from Aberfeldy River and other tributaries contribute to low flow • A large volume of consumptive water is released from storage	• Passing flow and natural flow from Aberfeldy River and other tributaries contribute to low flow and some freshes • A moderate volume of consumptive water is released from storage	• Passing flow and natural flow from Aberfeldy River and other tributaries contribute to low flow and periods of high flow and freshes • A small volume of consumptive water is released from storage	• Natural flow from Aberfeldy River and other tributaries is expected to meet most low-flow requirements, provide large freshes and sustained high flow • Minimal volume of consumptive water released from storage
Expected availability of water for the environment	• 25,000-28,000 ML	• 28,000-31,000 ML	• 31,000-34,000 ML	• 34,000-37,000 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/autumn low flow (partially delivered: 300 ML/day in July 2022, 230 ML/day in June 2023 and 125 ML/day at other times) • Spring fresh (one fresh, of lower duration and magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, one at upper, one at lower magnitude) • Autumn freshes (two freshes, one of lower duration [in May])	• Winter/spring/autumn low flow (partially delivered: 300 ML/day in July 2022 and 230 ML/day in May to June 2023 and 125 ML/day at other times) • Spring fresh (one fresh, of longer duration but lower magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, one at upper, one at lower magnitude) • Autumn freshes (two freshes)	• Winter/spring/autumn low flow (partially delivered: 300 ML/day in July 2022 and 350 ML/d in May to June 2023 and 125 ML/day at other times) • Spring fresh (one fresh, of longer duration but lower magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, one at upper, one at lower magnitude) • Autumn freshes (two freshes)	• Winter/spring/autumn low flow (partially delivered: at 350 ML/day in July 2022 and April to June 2023 and 125 ML/day at other times) • Spring freshes (two freshes, of longer duration but lower magnitude) • Summer/autumn low flow • Summer/autumn freshes (two freshes, of upper magnitude and duration) • Autumn freshes (two freshes)

Planning scenario	Drought	Dry	Average	Wet
	Tier 1b (supply deficit)			
	• Winter/spring/ autumn low flow (at 350 ML/day during July to November 2022) • Spring freshes (two freshes [one replacing tier 1a fresh], delivered of longer duration and one additional spring fresh of longer duration and lower magnitude) • Autumn fresh (tier 1a fresh delivered of longer duration [in May])	• Winter/spring/ autumn low flow (at upper magnitude continuously) • Spring fresh (one additional fresh, of longer duration and lower magnitude)	• Winter/spring/ autumn low flow (at upper magnitude continuously) • Spring fresh (one additional fresh, of longer duration and lower magnitude) • Summer/autumn freshes (deliver both tier 1a freshes at upper magnitude)	• Winter/spring/ autumn low flow (at upper magnitude continuously) • Spring fresh (one tier 1a fresh at upper magnitude)
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Heyfield wetlands				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Fill (in August) • Top-ups (two, in September-December) • Partial drawdown (during December to February)			
	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	• 21,000 ML (tier 1a) • 22,500 (tier 1b)	• 26,000 ML (tier 1a) • 25,700 ML (tier 1b)	• 33,400 ML (tier 1a) • 21,200 ML (tier 1b)	• 43,500 ML[1] (tier 1a) • 14,600 ML (tier 1b)
Priority carryover requirements for 2023-24	• 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.

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2.4 Macalister system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

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 greater 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. Most irrigation water is diverted at Maffra Weir, and flow downstream of the weir is lower than natural year-round. 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 delivery of water for the environment for migratory fish objectives mainly focuses on reach 2. All other objectives apply to both reaches 1 and 2.

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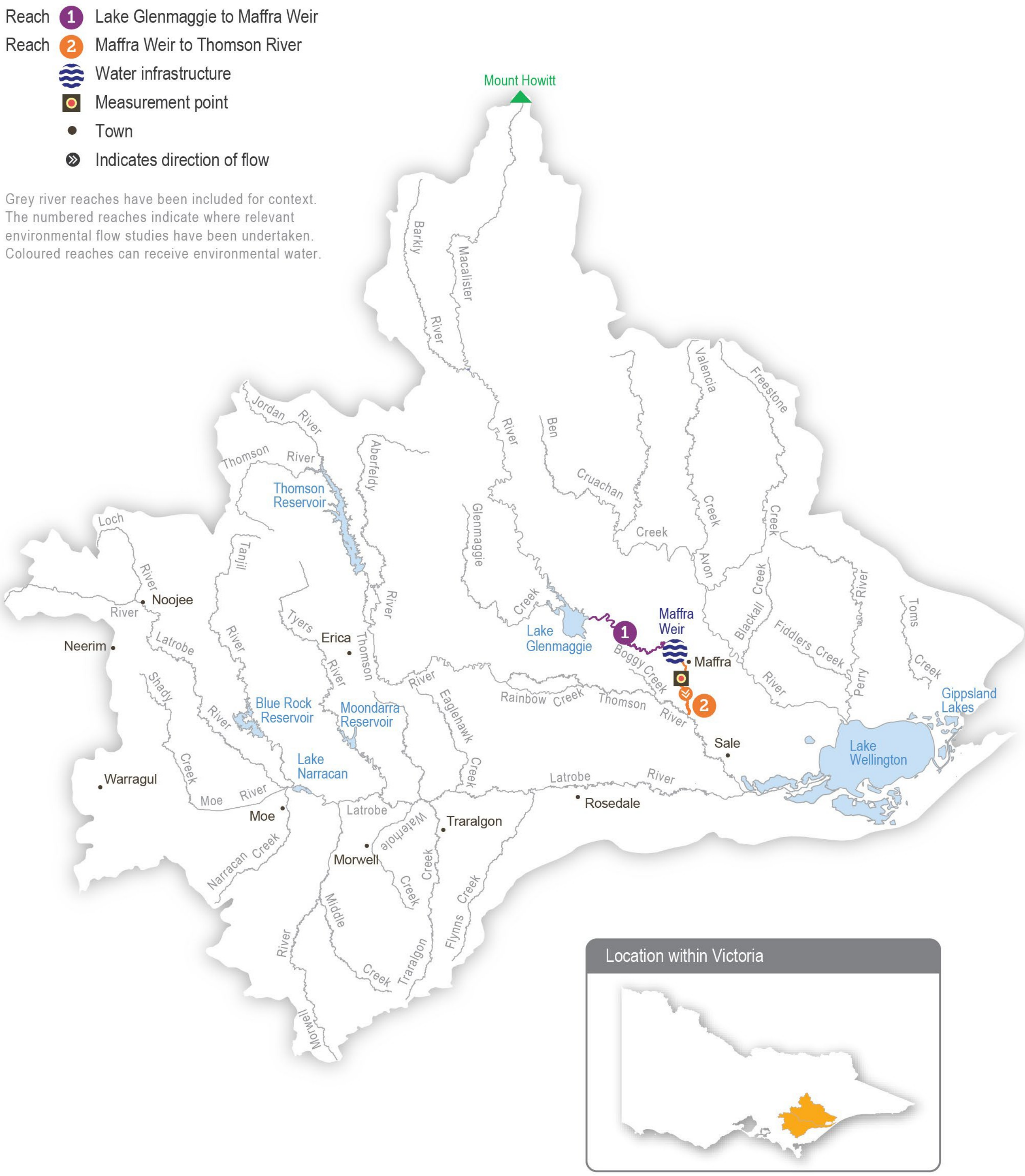
Figure 2.4.1 The Macalister system



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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 the Macalister system

Icon	Environmental objectives in the Macalister system
	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

Traditional Owner cultural values and uses

"Traditionally, the Macalister River is a very important river to the Gunaikurnai people. It is a pathway that connects from the Alps to the heart of Gippsland. It is a pathway to ceremonial grounds and a known, special men's place to Elders. Its traditional name is *Wirn wirndook Yeerung*, which translates to 'song of the male fairy wren'.

"*Yeerung* is the men's totem. This river has many cultural resources and extensive important sites along the whole system."

The Gunaikurnai have had a continued connection to Gunaikurnai Country for over 27,000 years, including with the waterways in the Latrobe system (into which *Wirn wirndook Yeerung* [Macalister River] feeds). For the Gunaikurnai as Traditional Owners, there are immense challenges to heal, protect and manage Country, which has been drastically altered since colonisation. The Gunaikurnai see all of Country as interconnected with only separation between clan groups, not cultural landscapes of land, waterways, coasts, oceans and natural and cultural resources. The cultural landscape is dependent on culture and Aboriginal management.

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.

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 to 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 in 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 have moved through the landscape along the waterways for thousands of years, sourcing food and plants along the way.

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From the perspective of the Gunaikurnai, 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.

Watering requirements to support cultural values and uses include:

- timing the delivery of water for the environment 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.

West Gippsland CMA engaged with the GLaWAC Cultural Water Team about watering priorities for 2022-23.

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)
- socioeconomic benefits (such as preventing erosion and the potential loss of private and public land).

Recent conditions

Rainfall and temperatures in the Macalister catchment were above average throughout most of 2021-22, with periods of very much above-average rainfall in spring 2021. It was the second consecutive year of naturally wet conditions. Strong inflows to Lake Glenmaggie in July 2021 saw the storage quickly fill and spill, and there were multiple bankfull flow events above 4,000 ML/d in reaches 1 and 2. Allocations of high-reliability water shares opened at 100 percent, and low-reliability water share allocations reached 100 percent by March 2022. Carryover from 2020-21 was lost when Lake Glenmaggie spilled, but there was a sufficient supply of water for the environment to meet planned demands.

Delivery of water for the environment in the Macalister system was managed according to a wet climate scenario throughout 2021-22. All planned watering actions for 2021-22 were met, mainly through a combination of natural and operation flows. Water for the environment is expected to be used to help deliver an autumn fresh to cue fish migration and facilitate fish passage.

Wet conditions throughout Gippsland in 2020 provided ideal breeding conditions for many native fish, and large numbers of young-of-year tupong were detected in the Macalister River in March 2021. Follow-up fish surveys in February 2022 also found large numbers of juvenile tupong and older fish, which indicates conditions in 2021 contributed to high survival rates and the second year of successful breeding. These results show that the Macalister River continues to provide important habitat for coastal migratory fish species within the Gippsland region.

Scope of environmental watering

Table 2.4.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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.

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Table 2.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Macalister system

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 2022 and June 2023)	• Provide permanent wetted habitat for waterbugs and maintain water depth over riffles to enable fish passage between local habitats • Provide sustained wetting of low-level benches to limit the encroachment of terrestrial vegetation	
Spring fresh (one fresh of 700 ML/day for five days during September to November)	• Cue the upstream migration of adult fish (e.g. short-headed lamprey) and the recruitment of juveniles (e.g. Australian grayling, tupong, common galaxias, Australian bass and short- and long-finned eels) from marine/ estuarine environments • Wet mid-level benches to water woody vegetation, limit the encroachment of terrestrial vegetation and facilitate the dispersal of emergent and fringing vegetation seeds and propagules throughout the reach	
Spring/summer fresh following spill (one fresh peaking at 1,500-1,800 ML/day for three to 10 days during September to December)	Shape the recession of a 1,500 ML/day or 3,000 ML/day spill to: • wet mid- and higher-level benches to water emergent and woody vegetation and move organic matter into the channel to transport food resources downstream • provide flow with sufficient shear stress to scour biofilms and flush fine sediment from pools and small gaps in the substrate to improve geomorphic habitat and food resources for waterbugs • 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 and short- and long-finned eels) from marine/ estuarine environments	
Spring/summer low flow (60-90 ML/day during September to February)	• Maintain the water depth in pools and hydraulic habitat for native fish • Maintain permanent wetted habitat in pools and riffles for waterbugs • Provide longitudinal connectivity for local movement of platypus and rakali (water rats), as well as protection from predation, access to food sources and maintenance of refuge habitats Note: 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.	
Trigger-based summer/ autumn low flow (40-60 ML/day for five to 13 days during December to May) *Trigger: extended periods of reduced passing flow or no flow being released from Lake Glenmaggie*	• 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	
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	

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Potential environmental watering action	Expected watering effects	Environmental objectives
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 • 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 Note: 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.	
Autumn/winter fresh (one fresh of 700 ML/day for five days during July to August 2022 or May to June 2023)	• 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.

Scenario planning

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

Providing year-round low flows to maintain habitat connectivity for aquatic animals in *Wirn wirndook Yeerung* (Macalister River) is the highest-priory watering action under all climate scenarios. Year-round operational passing flows of 60 ML per day will meet the minimum low-flow objectives for reach 2. Increasing flows to 90 ML per day has additional benefits for environmental values in reach 1 and is therefore preferred. It is expected to be achieved under all scenarios unless carryover from 2021-22 is lost due to managed spill releases, and it may cause a deficit in supply for the remaining priorities, which is possible under average and wet scenarios. If this occurs, increasing the magnitude to 90 ML per day will only be prioritised in November after the delivery of a spring fresh and during mid-April to mid-August, when water from the upper catchment is harvested to fill Lake Glenmaggie, and little to no consumptive orders on top of the operational passing flow are released downstream. Low flows delivered at the upper end of the recommended range aim to provide more habitat and food to help grow waterbug, fish and platypus populations and exclude terrestrial vegetation from the main channel.

Under a wet scenario, increasing the low flow to 300 ML per day during winter and spring is preferred to wet the lower benches over a sustained period. The estimated water demand for this action presented in Table 2.4.2 does not account for potential unregulated flows. As seen in recent years, natural tributary inflows are likely to achieve many of the planned watering actions under wetter climate scenarios, so most or all of the tier 1a and tier 1b actions proposed for the Macalister River under the wet scenario should be achievable with the available supply.

Under drought and dry climate scenarios, low inflows to Lake Glenmaggie may trigger reduced operational passing flows any time over summer and autumn. Maintaining low flows of at least 60 ML per day is the target under all scenarios, but if that cannot be achieved under drought or dry scenarios, water for the environment may be used to deliver trigger-based low flows of 40 ML per day for five to 13 days and then a summer/autumn fresh. This combination of actions aims to avoid a serious water-quality outcome and the loss of environmental values — regular water quality monitoring would occur if that was likely — while also conserving available supply. Additional summer/autumn freshes may be provided under average and wet climate scenarios.

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 be delivered in late autumn or winter to increase fish migration. These events are necessary every year under average and wet climate scenarios to ensure regular recruitment and align with environmental cues in the broader landscape. They are generally less important in dry our drought scenarios, but they are important

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to deliver even under drier conditions in 2022-23 to consolidate recent population growth and to potentially supplement populations in east Gippsland that were affected by the 2019-20 bushfires. Several other large freshes are recommended to slow the recession following spills from Lake Glenmaggie, but they are a lower priority and will likely be at least partly met by operational releases under most scenarios.

Under all climate scenarios, a minimum of 1,900 ML is prioritised for carryover into 2023-24 to meet critical early-season low-flow requirements in *Wirn wirndook Yeerung* (Macalister River).

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Limited natural flow; freshes or high flows are unlikely • Passing flows at Maffra Weir may be reduced	• Possible spills from Lake Glenmaggie in spring, minor flood levels may occur • Passing flows at Maffra Weir may be reduced	• Regular spills from Lake Glenmaggie in spring, minor to moderate flood levels may occur	• Large and frequent spills from Lake Glenmaggie, moderate to major flood levels may occur
Expected availability of water for the environment	• 21,700 ML	• 25,000 ML[1]	• 27,000 ML[1]	• 31,500 ML[1]
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Spring fresh (one fresh) • Spring/summer low flow (partial: delivered at upper magnitude in November only, following fresh) • Trigger-based summer/autumn low flow • Summer/autumn fresh (one fresh, of lower duration) • Autumn fresh (one fresh) • Autumn/winter low flow • Autumn/winter fresh (one fresh)	• Spring fresh (one fresh) • Spring/summer low flow • Trigger-based summer/autumn low flow • Summer/autumn fresh (one fresh, of lower duration) • Autumn fresh (one fresh) • Autumn/winter low flow • Autumn/winter fresh (one fresh)	• Spring fresh (one fresh) • Spring/summer low flow[2] • Spring/summer fresh following 1,500 ML/d spill (one fresh)[3] • Summer/autumn freshes (three freshes) • Autumn fresh (one fresh) • Autumn/winter low flow[2] • Autumn/winter fresh (one fresh)	• Spring fresh (one fresh) • Spring/summer low flow[2] • Spring/summer fresh following 3,000 ML/d spill (one fresh) • Summer/autumn freshes (three freshes) • Autumn fresh (one fresh) • Autumn/winter low flow[2] • Autumn/winter fresh (one fresh)
	Tier 1b (supply deficit)			
	• Spring/summer low flow (upper magnitude continuous)	• N/A		• Winter/spring low flow
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 18,200 ML (tier 1a) • 4,000 ML (tier 1b)	• 21,800 ML (tier 1a)	• 25,200 ML (tier 1a)	• 24,100 ML (tier 1a) • 28,800 ML (tier 1b)
Priority carryover requirements for 2023-24	• 1,900 ML			

1 Carryover from 2021-22 may be forfeited in the event of spill releases from Lake Glenmaggie.
2 Continuous delivery is a tier 1a action unless carryover is lost to spill. If this occurs, delivering the low flow at the upper magnitude is prioritised from July to August 2022, November 2022 and April to June 2023 (60 ML per day at other times).
3 Tier 1a action unless carryover lost to spill: this action will not be prioritised if there is insufficient supply.

2.5 Snowy system

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

Storage manager – Snowy Hydro Limited

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

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 the 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 and Environment plans environmental flows 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.

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. 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. Environmental releases aim to deliver an average of 212,000 ML per year, the equivalent to 21 percent of the average annual natural flows before the construction of the Jindabyne Dam.

Environmental values

Environmental values in the upper reaches and tributaries of the Snowy River include water-dependant plants and animals, including freshwater native fish (such as river blackfish and Australian grayling), platypus and frogs. 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.

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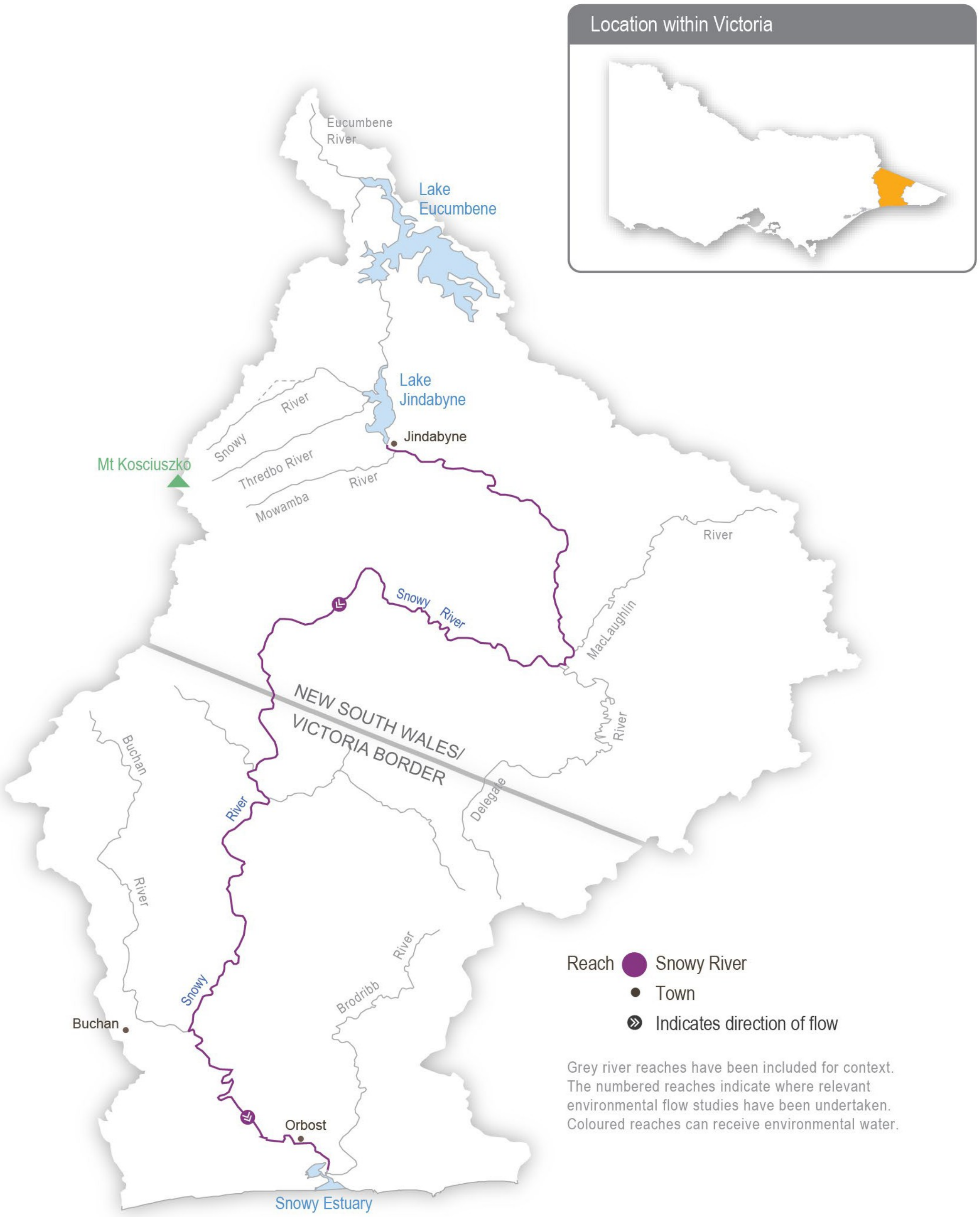
Figure 2.5.1 The Snowy system



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Recent conditions

Rainfall in the Snowy River catchment in 2021-22 was significantly above the long-term average, with some areas receiving their highest recorded monthly totals. Jindabyne Dam spilled in December 2021, and the storage manager made several airspace releases over subsequent months. These spills and natural inflows from downstream tributaries delivered regular floods in the lower Snowy River during the year. Flows peaked above 20,000 ML per day in the lower Snowy River several times during winter, spring, summer and autumn. The December flood peaked at 130,000 ML per day at Jarrahmond, near Orbost.

Water availability for environmental flows in the Snowy River is determined by allocations in the Murray, Goulburn, Loddon and Murrumbidgee rivers. In 2021-22, 209,577 ML[1] was allocated for environmental releases in the Snowy River system. This was the highest allocation since 2011 and more than twice the 2020-21 allocation of 91,176 ML.

The high allocation allowed river managers to deliver larger flows for longer durations than 2020-21. Five winter/spring high-flow events were released (one more than in 2020-21), and a flushing flow occurred in October 2021.

Environmental monitoring in the lower reaches of the Snowy River and its estuary over the last decade indicates that environmental flows are improving physical and ecological processes, increasing ecosystem productivity and improving 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, in-stream and riparian vegetation are beginning 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 2022-23 is 205,110 ML. That is one of the highest volumes of water for the environment ever available for the Snowy River.

Due to operating rules in the system, the daily flow regime that will be delivered in 2022-23 is pre-planned. The storage manager will make daily releases of varying magnitudes from Lake Jindabyne between May 2022 and April 2023 to mimic the typical flow patterns 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 a wet year in 2021-22, water availability for the environment will again allow for a large number of high-flow releases in 2022-23, which will aim to improve ecological conditions and build additional resilience into the system. The flow pattern is similar to previous years and mimics a snowmelt river, with greater flows during winter and spring. Five high-flow releases are scheduled between May and November 2022 to move sediment and improve in-stream habitat for native fish, platypus, frogs and waterbugs. The largest release is planned for October 2022. It has a target peak flow rate equivalent to 5,000 ML per day, which will be held for about eight hours to flush fine sediment and wet high benches and backwaters. Other peak flows will mimic winter rainfall and spring snowmelt events. Moderate-to-high flow rates will be sustained from the end of May to December 2022 to mix water in the estuary to benefit plants and fish (such as Australian bass). Lower flow rates will be maintained from January until the end of the water year in April 2023.

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

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1 The actual release volume that was delivered in 2021-22 may alter slightly due to accounting adjustments and will be verified in Snowy Hydro Limited's Annual Water Operating Plan.

Section 3
Central region

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 does not hold an environmental entitlement in the Maribyrnong system, but in some years, the VEWH purchases available allocation to allow delivery of water for the environment in selected reaches of the Maribyrnong system.

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

Traditional Owners in the central region

Traditional Owners in the central region have an intrinsic connection to Country that has endured for tens of thousands of years. This includes inherent rights and cultural obligations to Country and community.

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.

With the recent releases of the *Rivers of the Barwon (Barre Warre Yulluk) Action Plan*, the *Waterways of the West Action Plan* and the *Yarra Strategic Plan (Burndap Birrarung burndap umarkoo)*, the VEWH and waterway managers will work with Traditional Owners in these areas and other partners to embed the outcomes of these plans into the Victorian environmental watering program in coming years.

The VEWH is committed to playing our part in recognising waterways and their lands in the Barwon (*Parwan*), Moorabool (*Murrubul*), Werribee (*Wirrubi Yaluk*), Maribyrnong (*Mirrangbamurn*) and Yarra (*Birrarung*) catchments as living and integrated natural entities. We will support Traditional Owners to self-determine what this concept means to them and empower their voice in planning water for the environment. This aligns with the VEWH's position statement on working with Traditional Owners, which was released in late 2021.

In the context of Treaty negotiations in Victoria and the Victorian Government's commitment to self-determination for First Nations, program partners in the environmental watering program are aware that structural changes (such as legislative, policy and governance changes) to how water is managed may be made in the future in recognition of Aboriginal water rights. Program partners have heard for many years that Traditional Owners want empowerment and agency in water management and in many cases want to manage water on Country on their own terms.

Engagement

Seasonal watering proposals are informed by community and program partner engagement, including Traditional Owner engagement. Program partners and communities help to identify priorities and opportunities for the delivery of water for the environment in the coming year.

Longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flows studies), environmental water management plans and Traditional Owner Country plans (and associated documents) also inform seasonal watering proposals. These strategies, plans and technical reports collectively describe a range of environmental, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence environmental flows and priorities.

The VEWH and its program partners consider cultural, social, economic and recreational values and uses of waterways when planning for water for the environment. Where possible, opportunities to support these values and uses are incorporated into watering decisions, provided they do not compromise environmental outcomes. Cultural, social, economic and recreational values considered for each system in the central region are presented in the system sections that follow.

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 planning process for water for the environment. Table 3.1.1 shows the IAP2 Spectrum categories and participation goals.

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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.

The following tables show the partners, stakeholder organisations and individuals with which Melbourne Water and Corangamite CMA engaged about the Yarra, Tarago, Maribyrnong, Werribee, Moorabool and Barwon (upper Barwon River and lower Barwon 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 seasonal watering proposals by waterway managers.

The tables also show the level of engagement between these waterway managers and stakeholders in the environmental watering program in the central region, based on each manager's interpretation of the IAP2 Spectrum.

The level of engagement differs between organisations and between systems, depending on the availability, capacity or interest of stakeholders to participate, roles and responsibilities of organisations in managing a site or system, and potential interaction of proposed watering with other activities on the waterway. For example, a landholder on a waterway may only wish to be informed of what water deliveries are proposed, while another may wish to help inform the planning process. A government agency may collaborate in planning where it has a land management responsibility for one particular site but only need to be informed of plans for another site.

External factors also influence engagement opportunities. COVID-19 restrictions limited engagement with stakeholders to largely online interaction. For example, Melbourne Water offered stakeholders three different ways to engage with the planning process: an email with a link to a webpage providing information about the seasonal watering proposal, an invitation to an online interactive engagement session and a personal discussion via phone or email.

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 • Moorabool Catchment Landcare Group • 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

	Moorabool system	Upper Barwon River	Lower Barwon wetlands
Government agencies	**IAP2 level: Collaborate** • Barwon Water • Central Highlands Water • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water **IAP2 level: Consult** • Golden Plains Shire Council • Moorabool Shire Council	**IAP2 level: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning • Southern Rural Water **IAP2 level: Consult** • Colac Otway Shire Council	**IAP2 level: Collaborate** • Barwon Water • City of Greater Geelong • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water • Victorian Fisheries Authority
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: Inform** • Eastern Maar Aboriginal Corporation	**IAP2 level: Collaborate** • Wadawurrung Traditional Owners 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)

	Yarra system	Tarago system	Maribyrnong system	Werribee system
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 • Cardinia Environment Coalition • 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 Coordinator • Werribee Riverkeeper • Western Region Environment Centre

	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 • Greater Western Water • Melbourne Water (Service Delivery) • Southern Rural Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Greater Western Water • Melbourne Water (Service Delivery) • Southern Rural Water
	IAP2 level: Inform • Aboriginal Victoria • Banyule City Council • City of Boroondara • City of Melbourne • City of Whittlesea • 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 • Victorian Freshwater Fish Habitat & Flows Roundtable • 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 • Victorian Freshwater Fish Habitat & Flows Roundtable	**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

	Yarra system	Tarago system	Maribyrnong system	Werribee system
Local businesses	**IAP2 level: Inform** • Doon Reserve Caravan Park • East Coast Kayaking • Melbourne Adventure Hub • Sea Kayak Australia • 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
Recreational users	**IAP2 level: Inform** • Kirinari Kayak Club • Paddle Victoria • Patterson Lakes Canoe Club • Victorian Sea Kayak Club • VRFish • Whitehorse Canoe Club Inc.	**IAP2 level: Inform** • 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 • 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 • 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 • 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 • 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** • Bunurong Land Council Aboriginal Corporation	**IAP2 level: Consult** • Bunurong Land Council Aboriginal Corporation • Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation	**IAP2 level: Consult** • Bunurong Land Council Aboriginal Corporation • Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation	**IAP2 level: Consult** • Bunurong Land Council Aboriginal Corporation • Wadawurrung Traditional Owners Aboriginal Corporation • Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation

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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 of water for the environment in the central region will not be fully met without simultaneously addressing issues such as barriers to fish movement, high nutrient loads, loss of streambank vegetation and invasive species.

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

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

- works to protect and enhance streambanks along priority reaches, including willow removal, revegetation and fencing to exclude stock
- the Central and Gippsland Regional Sustainable Water Strategy (in development) will include complementary actions, including an update of the Werribee Diversion Weir. It is also expected to include actions to increase the security and reliability of the supply of water for the environment for all flow-stressed systems in the central region.

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 flows for 2022-23 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 2022-23

The rainfall across the central region varied between systems in 2021-22. Rainfall in the Tarago, Upper Barwon and Moorabool systems was close to the long-term average, while the Yarra, Werribee and Maribyrnong systems had above-average rainfall. This is the second consecutive year of average or above-average rainfall in the central region, and some reservoirs in all systems other than the Maribyrnong spilled during 2021-22. These spills and other natural inflows met many planned environmental flows in the Tarago, Yarra, Werribee, Moorabool and Upper Barwon systems and some planned watering actions in lower Jacksons Creek in the Maribyrnong system. The VEWH purchased water from licence holders in the Maribyrnong system to deliver environmental flows in Jacksons Creek.

The Bureau of Meteorology has forecast above-median rainfall and temperatures during autumn, winter and spring 2022 across the central region. With full or near-full storages in most systems from 2021-22 and a wet outlook for the start of 2022-23, most systems are likely to have significant water holdings. 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 environmental outcomes achieved over the last two years.

Further inflows to Rosslynne Reservoir in winter and spring 2022 are likely to create an opportunity to purchase water to deliver environmental flows in the Maribyrnong system, although outcomes in upper Jacksons Creek continue to be limited by infrastructure delivery constraints.

Options for delivering water for the environment in the Moorabool and Barwon systems in 2022-23 will be heavily influenced by local climatic conditions due to their smaller and more variable environmental allocations. Larger flows in the Moorabool and upper Barwon systems rely on significant contributions from local rainfall and are therefore only likely to be achieved under average or wet climatic conditions. Natural inflows will also have a significant bearing on low flows and freshes in the Moorabool and upper Barwon systems, and summer and autumn flows may need to be delivered at the lower end of their recommended range to conserve available environmental supply if those seasons are dry. Delivery of water for the environment 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 drawdown in summer/autumn should be possible under all climate scenarios if river levels allow.

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3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

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 Gorge 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. Reach 6 is also a priority in summer and autumn to manage poor water quality upstream of Dights Falls, as flow targets in reach 5 may not be sufficient. Water for the environment delivered to reaches 2 and 5 will help meet flow targets in other reaches.

Plenty River rises from the slopes of Mount 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 in the coming years.

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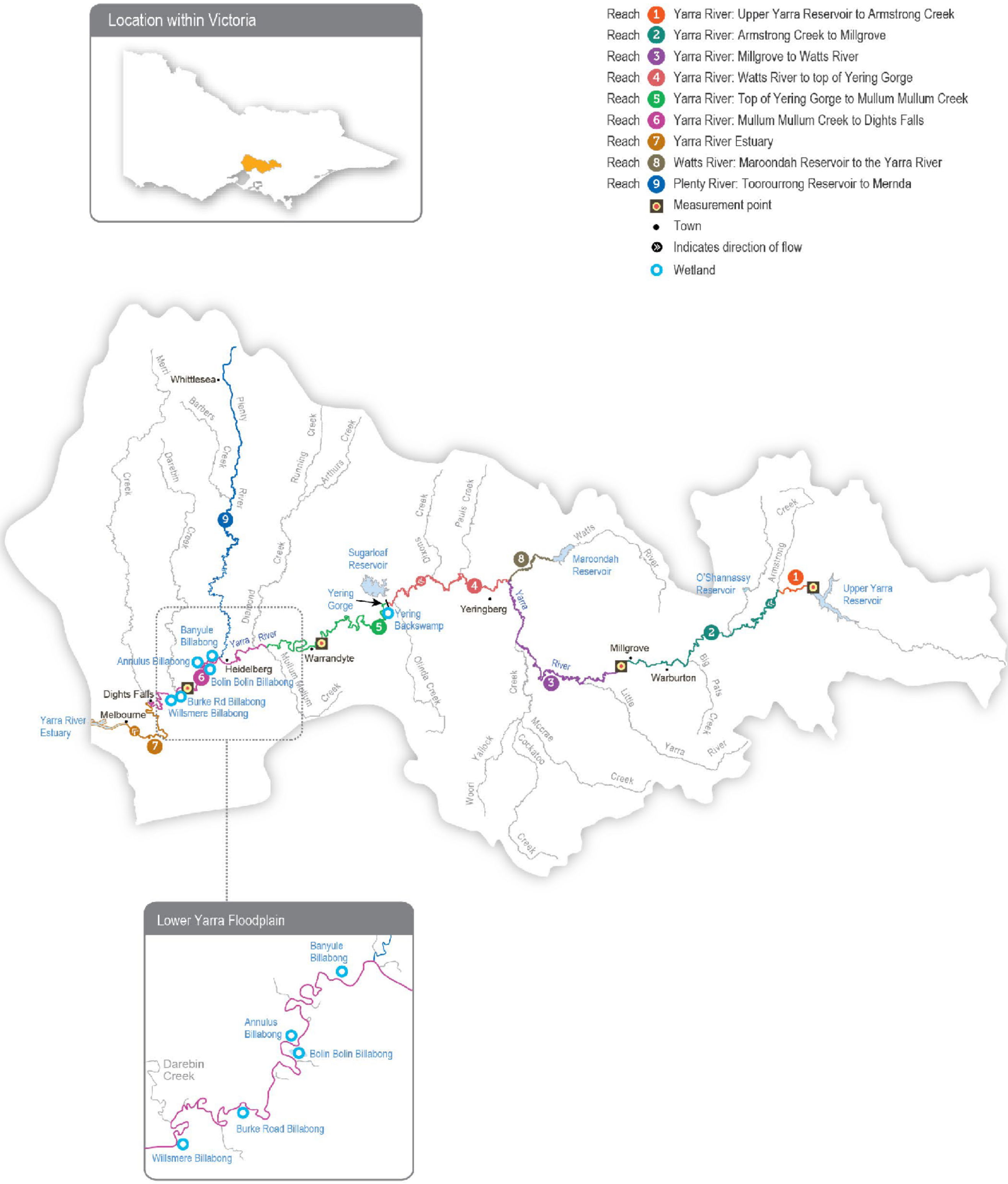
Figure 3.2.1 The Yarra system



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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 they have good-quality streamside and aquatic vegetation. The middle and lower reaches of *Birrarung* (Yarra River) (reaches 4-6) flow through forested gorges, cleared floodplains and some highly-urbanised areas, and they 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 flows objectives in the Yarra system

Icon	Environmental objectives in the Yarra system
	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
	Maintain native streamside and aquatic vegetation on the riverbank and in the channels Increase the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows on the floodplain and billabongs
	Provide wetted habitat area for waterbirds
	Maintain the diversity and increase the abundance 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

Traditional Owner cultural values and uses

Melbourne Water is working with the Registered Aboriginal Parties within the Yarra system — the Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation, the Bunurong Land Council Aboriginal Corporation and the Taungurung Land and Waters Council Aboriginal Corporation — to develop and strengthen relationships with them and to increase Traditional Owners' involvement in the planning and delivery of water for the environment. As of May 2022, three overarching partnership agreements were being drafted that will frame relations and obligations with the organisations. The intent is for Traditional Owners to be active partners in the planning, delivery and monitoring of all works and deliveries of water for the environment associated with *Birrarung* (Yarra River), the Plenty River and Yarra billabongs, including the environmental watering program.

Increasing the involvement of Traditional Owners in environmental water planning and management and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework and the 2016 *Water for Victoria*, 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 their contribution and indicating progress towards deeper involvement.

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

There are many places of tangible and intangible cultural significance for the Wurundjeri Woi wurrung people on the lower *Birrarung* 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 the Wurundjeri Woi wurrung people.

Watering of Annulus, Banyule and Bolin Bolin billabongs is aligned with the aspirations of Wurundjeri Woi wurrung Elders. The Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation's Narrap Team is the Wurundjeri Woi wurrung natural resource management team and is active in the planning, delivery and monitoring of all works on the lower Yarra (*Birrarung*) floodplain. The Narrap Team continues to monitor associated environmental values (such as vegetation, eels and water quality). Watering also aligns with a landscape-scale approach for billabong watering in the lower *Birrarung*, which has been developed in consultation with Wurundjeri Woi wurrung people.

A vegetation monitoring and water-quality monitoring project is continuing 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 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 2021-22, and similar work will likely be undertaken in 2022-23. The Narrap Team is also undertaking weed control and revegetation at Annulus Billabong and Bolin Bolin Billabong.

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 birdwatching, camping, picnicking, cycling, running and walking)
- community events and tourism (such as the Moomba Festival and the Inflatable Regatta)
- socioeconomic benefits (such as for diverters for irrigation, stock needs and domestic use: water levels and water quality can rely on the delivery of water for the environment, particularly in summer).

Recent conditions

Rainfall in the *Birrarung* (Yarra River) catchment in 2021-22 was above the long-term average, and tributary inflows significantly contributed to flow in *Birrarung* (Yarra River) and the Plenty River throughout the year. Maroondah Reservoir, O'Shannassy Reservoir and Yan Yean Reservoir all spilled for prolonged periods during the year. Natural flow events frequently exceeded in-channel flow targets during winter and spring, with the largest event reaching about 3,700 ML per day at Millgrove (reach 2) and about 7,400 ML per day at Warrandyte (reach 5) in October. Maintenance work at Upper Yarra Reservoir required operational releases to *Birrarung* (Yarra River) during October to November 2021. 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. Ecological monitoring downstream of the Upper Yarra Dam was undertaken in 2021, and follow-up monitoring will take place in 2022 to study the effects of the operational releases. This was undertaken with members of the Narrap Team, and the continuing presence of populations of river blackfish was noted.

Water for the environment was managed in line with the wet scenario throughout 2021-22. Natural rain events, combined with larger-than-normal inflows from the O'Shannassy River and operational releases from the Upper Yarra and Maroondah reservoirs, achieved most of the planned watering actions in the Yarra River for 2021-22. Natural rain events inundated many of the *Birrarung* (Yarra River) billabongs during the year. Water for the environment was used to help meet winter/spring high flow, winter fresh and summer fresh requirements in the *Birrarung* (Yarra River). In the Plenty River, natural rain events achieved most of the high-priority planned watering actions, but a faulty release pipe at Yan Yean Reservoir prevented any opportunity to supplement natural flows with water for the environment. Melbourne Water will undertake maintenance during 2022-23 and review opportunities for environmental flow releases in the Plenty River in 2023-24.

Yering Backswamp has received water for the environment annually since 2013. The site was inundated naturally in June, September and October 2021, and it was allowed to gradually dry out by February 2022 in accordance with the site's management plan. Annulus Billabong received water for the environment for the first time from October to December 2020, and it was filled again in September 2021 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 local visitors. Bolin Bolin Billabong was filled in 2017 with a combination of natural overbank flows and water for the environment, which were delivered via a temporary pump. It filled again naturally in 2018, 2020 and on three occasions in 2021. Bolin Bolin Billabong was then drawn down over the summer months of 2021-22. Vegetation monitoring has detected a decrease in the cover and diversity of exotic plant species within Bolin Bolin Billabong since 2017. The inlet between the river and the billabong was modified in March 2022 to better facilitate the long-term delivery of water for the environment.

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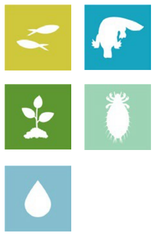
Birdlife Australia conducted bird surveys at four Yarra billabongs in 2021-22. The surveys aimed to compare bird responses at watered and dry billabongs, but Yering Backswamp, Spadonis Billabong, and some parts of *Birrarung* Billabong naturally filled and prevented a direct comparison. The surveys still provided useful information about how birds are using the Yarra billabongs. Initial results indicate that some species respond very quickly to environmental flows, with a family of day-old wood ducks observed at Annulus Billabong only one week after watering commenced. Other notable observations include nankeen night-heron at Annulus Billabong and buff-banded rail at *Birrarung* Billabong.

Melbourne Water has installed real-time water-quality monitoring instruments in Birrarung (Yarra River) at Millgrove and upgraded the water-quality monitoring buoy in the lower reaches of the river. These complement the other four water-quality monitoring stations along Birrarung (Yarra River) and will help inform decisions about the delivery of water for the environment.

Scope of environmental watering

Table 3.2.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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 3.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Yarra system

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: 80-350 ML/day Reach 5: 350-750 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 freshes (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)	
Winter/spring high flow (one high flow for 14 days during August to 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 Reach 6: 300-450 ML/ day	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish, waterbugs and platypus	

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn freshes (three freshes for two 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	
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	
Yarra billabongs		
Annulus Billabong (partially fill in winter/ spring)	• Wet the wetland bed to support the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows • Provide habitat for frogs, waterbirds, waterbugs and eels	
Bolin Bolin Billabong (partially fill in winter/ spring)	• Wet the deepest part of the wetland to about 200 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 (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	
Banyule Billabong (fill in spring/summer)	• Wet the wetland bed to support the growth of aquatic and semi-aquatic vegetation • Inundate the wetland to prevent the encroachment of terrestrial vegetation • Provide habitat for native fish, frogs and waterbirds	
Burke Road Billabong (fill in spring/summer)	• Wet the wetland bed to support the growth of aquatic and semi-aquatic vegetation • Inundate the wetland to prevent the encroachment of terrestrial vegetation • Provide habitat for frogs and waterbirds	

Scenario planning

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

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 2021-22 will provide sufficient supply for most required watering actions in 2022-23, 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 providing high flows at critical times to support the migration and breeding requirements of native fish. Summer/autumn low flows and freshes, a winter/spring high flow and winter/spring low flows and freshes are

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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.

Winter/spring high flows are required at least once every two years to support Macquarie perch breeding and the upstream migration of Australian grayling and tupong. The recommended winter/spring high flow for *Birrarung* (Yarra River) has only been met twice since 2017-18, and it is therefore a high priority under all scenarios in 2022-23. Autumn high flows are required in at least two of every three years to support Australian grayling breeding, and they are the lowest tier 1 priority action under average and dry scenarios for 2022-23 because they have been delivered in the two previous years. Ensuring priority carryover requirements into 2022-23 means there may not be enough water to deliver the autumn high flow under dry and average scenarios. Autumn high flows are still a priority under wet conditions because other environmental cues and resources will likely favour strong native fish recruitment.

Melbourne Water is delivering a landscape-scale approach to watering floodplain billabongs that considers the ecosystem services different billabongs provide, as well as which billabongs need to be watered at any given time to support regionally important plant and animal populations. 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. Ensuring some billabongs are inundated at any given time is necessary to provide habitat for waterbirds and frogs, including some species that are rare or threatened.

Melbourne Water's landscape assessment has identified watering at Yering Backswamp, Bolin Bolin Billabong, Annulus Billabong, Banyule Billabong and Burke Road Billabong as high priorities under all scenarios in 2022-23. These wetlands are ephemeral — they have a wet then dry cycle — except for the deep section in Bolin Bolin Billabong, which aims to be kept permanently inundated. The proposed watering will maintain their preferred wet-dry frequency, which will help support native vegetation communities and provide food and potential breeding opportunities for frogs and waterbirds when they are inundated. If all billabongs miss out on a natural inflow, which is possible under a dry scenario, resources may limit Melbourne Water from actively watering all sites in spring and summer.

A target carryover volume of between 10,350 and 12,000 ML (depending on the climate scenario) has been determined to supplement natural flows and deliver the highest-priority flows in 2023-24.

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

Planning scenario	Dry	Average	Wet
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	• 41,400 ML		

Planning scenario	Dry	Average	Wet
***Birrarung* (Yarra River) (targeting reach 2 and 5)**			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow • Winter/spring freshes (two freshes) • Winter/spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Targeted billabong watering (Annulus, Bolin Bolin, Yering, Banyule, Bourke Road)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Winter/spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Targeted billabong watering (Annulus, Bolin Bolin, Yering, Banyule, Bourke Road)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Winter/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, Banyule, Bourke Road)
	Tier 1b (supply deficit)		
	• Autumn high flow (one high flow)	• Autumn high flow (one high flow)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 25,650 ML (tier 1a) • 11,600 ML (tier 1b)	• 25,850 ML (tier 1a) • 8,800 ML (tier 1b)	• 25,250 ML (tier 1a)
Priority carryover requirements	• 12,000 ML	• 10,350 ML	• 12,000 ML

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3.3 Tarago system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

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 and Bunyip Rivers Environmental Entitlement 2009* 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 contribute toward meeting the minimum low-flow requirements in summer/autumn and winter/spring, but they are less than the recommended minimum flows. Passing flows do not provide any of the freshes or greater 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.

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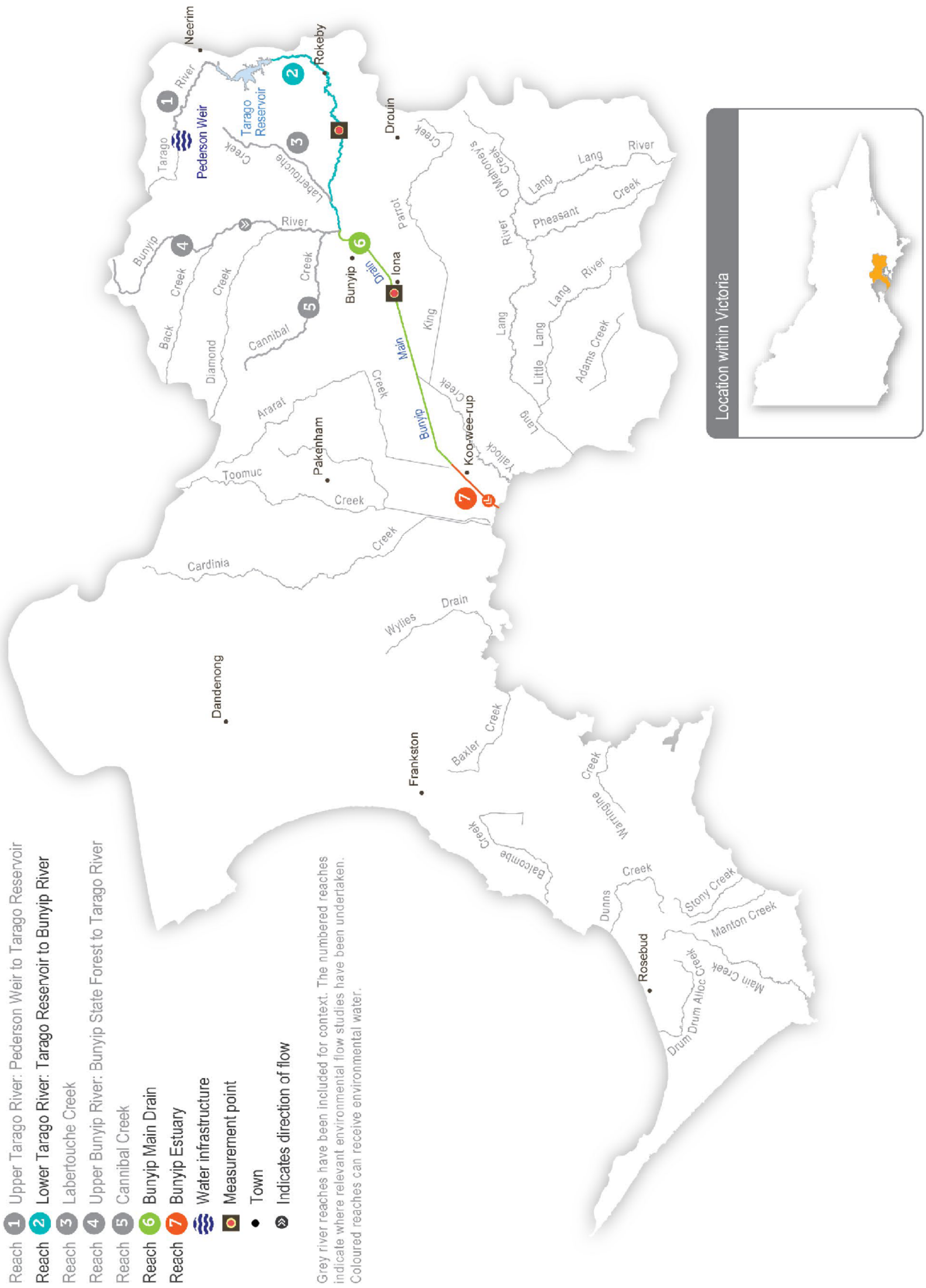
Figure 3.3.1 The Tarago system



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Environmental values

The Tarago system contains several significant and threatened native animal and plant 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, tupong, short-finned eels and mountain galaxias. The lower catchment (reach 6) has been highly modified, but it still contains patches of remnant vegetation and is a key migration pathway for Australian grayling. It also has healthy platypus populations.

Environmental watering objectives in the Tarago system

Icon	Environmental objectives in the Tarago system
	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 is working with the Registered Aboriginal Parties within the Tarago system — the Bunurong Land Council Aboriginal Corporation, the Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation and the Gunaikurnai Land and Waters Aboriginal Corporation — to develop and strengthen relationships with them and to increase Traditional Owners' involvement in the planning and delivery of water for the environment. As of May 2022, three overarching partnership agreements were being drafted that will frame relations and obligations with the organisations. The intent is for Traditional Owners to be active partners in the planning, delivery and monitoring of all works and deliveries of water for the environment associated with the Tarago and Bunyip rivers, including the environmental watering program.

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

Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation is interested in undertaking a program of work to determine cultural values and uses in the Tarago River 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:

- water-based recreation (such as fishing and swimming)
- riverside recreation and amenity (such as cycling, camping, caravanning, short- and long-term visiting and walking)
- community events and tourism (such as visiting and residing in the Glen Cromie Caravan Park)
- socioeconomic benefits (such as for diverters for irrigation, stock needs and domestic use: water levels and water quality can rely on the delivery of water for the environment, particularly in summer).

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.

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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 2023, so visitors and long-term residents of the Glen Cromie Caravan Park can enjoy the additional flows in the river.

Recent conditions

The mean temperatures in the Tarago River catchment during 2021-22 were above the long-term average. Rainfall was close to the long-term average, except during spring and January, which were wetter than average. This follows wetter-than-average conditions in 2020-21. The Tarago Reservoir continually spilled from March 2021 to January 2022, and a combination of high tributary inflows and reservoir spills caused minor flooding in the Tarago River during October 2021, which connected with many streamside billabongs. The VEWH held 100 percent or more[2] of its entitlement volume in Tarago Reservoir (3,000 ML share of storage) from the beginning of the water year (July 2021), and inflows to the reservoir quickly replenished the VEWH's supply whenever it was used throughout the year.

Water for the environment was managed in line with a wet climate scenario throughout 2021-22 as a response to the frequent reservoir spills. All watering actions planned for winter and spring of 2021 in the Tarago River were fully achieved from natural tributary flows and spills from Tarago Reservoir. Water for the environment was used to deliver summer/autumn freshes in January and February 2022 and an autumn high flow in March.

Since 2019, scientists have used passive integrated transponder (PIT) tag readers to track the movement of migratory fish in response to environmental flows in the Tarago. The results from tracking highlight the importance of high flows to support the migration and spawning patterns of Australian grayling, tupong and short-finned eel. The PIT tag readers also allow managers to adaptively manage flows during the season. For example, in 2021, waterway managers cancelled a planned flow to trigger the movement of fish because PIT tag readers indicated that fish had already responded to natural high flows. Cancelling the planned flow conserved water for the environment for other high-priority watering actions later in the year.

Scope of environmental watering

Table 3.3.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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 3.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Tarago system

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 • Mix pools to maintain water quality and increase habitat for fish and macroinvertebrates during wetter months	
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, including eel and tupong • Wet the banks and low benches to maintain the fringing aquatic vegetation	

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2 In agreement with Melbourne Water and other entitlement holders in the Tarago system, VEWH is allowed to store its share of inflows to Tarago Reservoir in unused airspace when the VEWH's capacity share of 3,000 ML is full.

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 greater flow later in the year flooding the burrow when juveniles are present	
Summer/autumn low flow (20 ML/day [or natural] during December to May)	• Maintain adequate depth through riffles to support waterbugs and allow access to habitats for fish and platypus • Maintain adequate foraging habitat in pools for fish and platypus • Maintain water quality (especially oxygen concentration) in pools	
Summer/autumn fresh(es) (four 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)	• Cue the downstream migration and spawning of diadromous fish (e.g. Australian grayling) • Assist the dispersal of juvenile platypus	

Scenario planning

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

The Tarago River requires similar watering actions every year, although the magnitude of low flows and the frequency of high flows will naturally be less under a dry climate scenario than under a wet or average climate scenario. Natural catchment inflows, mandated passing flows and reservoir spills will meet many of the required watering actions and provide natural flow variation throughout the year, especially under a wet climate scenario. Water for the environment will be used where possible to deliver critical flow components that are not met by other means.

Under a dry climate scenario, water for the environment will likely be used to deliver summer/autumn freshes and top up low flows to maintain water quality and adequate habitat for native fish and platypus. Melbourne Water will monitor water levels and water quality throughout the year and adjust releases as necessary to limit stress on existing plants and animals. There is unlikely to be enough supply under a dry scenario to deliver spring high flows to cue the upstream migration of Australian grayling from the estuary to the river, deliver autumn high flows for Australian grayling movement and spawning or help platypus select breeding burrows. The inability to deliver high flows is a low risk in dry years because fish and platypus will naturally have lower breeding rates. The risk is lower than normal in 2022-23 because the Tarago system has had multiple, large flow events and good breeding conditions during the last two to three years.

Under average and wet conditions, natural inflows will likely provide a greater proportion of the recommended low flows throughout the year, and the larger supply of water for the environment will potentially be used to deliver more freshes to improve the condition and size of native fish and platypus populations. Delivering two winter/spring freshes is a priority under average and wet climate scenarios to consolidate recent environmental gains by creating more opportunities for fish movement, boosting biofilm and macroinvertebrate productivity and improving the growth and survival of new fringing vegetation. Delivering an autumn high flow to cue Australian grayling migration and spawning is always a high priority under a wet climate scenario to optimise natural breeding success. Australian grayling require suitable breeding conditions about two out of every three years. Given the Tarago River has had high autumn flows (and Australian grayling recruitment) in each of the last two years, delivering an autumn high flow is a lower priority in 2022-23 under dry and average climate scenarios if the supply of water for the environment is insufficient.

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As a minimum, 1,000 ML should be carried over into 2023-24 to ensure critical summer and autumn low flows and freshes can be delivered if the climate becomes very dry and there is low allocation.

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

Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflow • Some reduction in 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	• 3,000 ML	• 3,500 ML	• 4,500 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow (partially achieved) • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn freshes (four freshes)	• Winter/spring low flow (partially achieved) • Winter/spring freshes (two freshes) • Summer/autumn low flow • Summer/autumn freshes (four freshes)	• Winter/spring low flow (partially achieved) • Winter/spring freshes (two freshes) • Summer/autumn low flow • Summer/autumn freshes (five freshes) • Autumn high flow (one high flow)
	Tier 1b (supply deficit)		
	• Winter/spring low flow • Spring high flow (one high flow) • Autumn high flow (one high flow)	• Winter/spring low flow • Spring high flow (one high flow) • Summer/autumn fresh (one fresh) • Autumn high flow (one high flow)	• Winter/spring low flow • Spring high flow (one high flow)
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 1,850 (tier 1a) • 5,900 ML (tier 1b)	• 2,450 ML (tier 1a) • 5,150 ML (tier 1b)	• 3,450 ML (tier 1a) • 2,900 ML (tier 1b)
Priority carryover requirements	• 1,000 ML		

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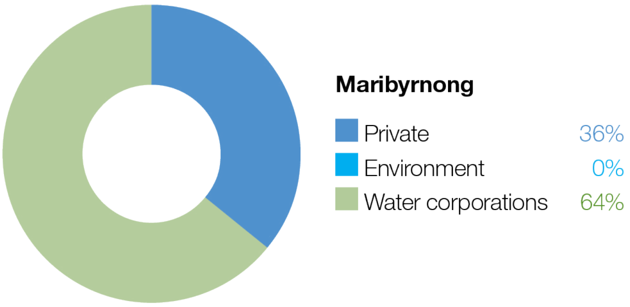
3.4 Maribyrnong system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Not applicable

Proportions of water entitlements in the Maribyrnong system held by private users, water corporations and environmental water holders on 30 June 2020



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 maximum release capacity of 20 ML per day under ideal conditions, 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, delivery of water for the environment to reaches 6 and 7 shown in Figure 3.4.1). Jacksons Creek is a known groundwater-dependent ecosystem on the national *Groundwater Dependent Ecosystems Atlas*. This means ecological components in the system rely on groundwater for at least some period of time.

The VEWH does not hold an environmental entitlement in the Maribyrnong system, and it relies on opportunistic, temporary trade to meet demands. Melbourne Water (as diversion manager) 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, is subject to water availability in the bulk entitlement and storage capacity, and only occurs with the agreement of all parties involved.

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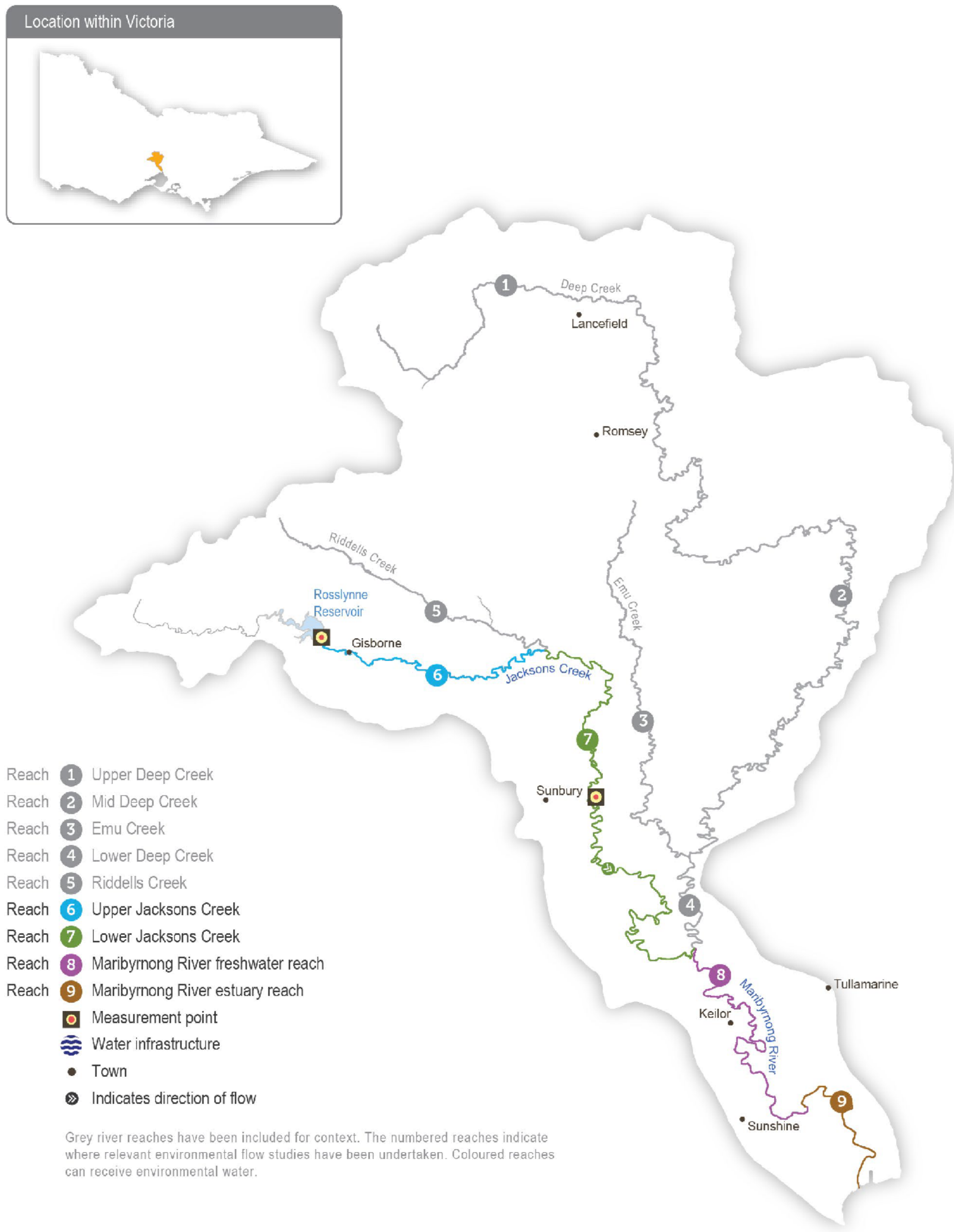
Figure 3.4.1 The Maribyrnong system



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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 of the Maribyrnong system.

Environmental watering objectives in the Maribyrnong system

Icon	Environmental objectives in the Maribyrnong system
	Protect and increase populations of native small-bodied fish
	Maintain or increase platypus populations
	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 is working with the Registered Aboriginal Parties within the Maribyrnong system — the Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation and the Bunurong Land Council Aboriginal Corporation — to develop overarching partnership agreements to frame relations and obligations between them to strengthen relationships and increase Traditional Owners' involvement in the planning and delivery of water for the environment. The intent is for Traditional Owners to be active partners in the planning, delivery and monitoring of all works and deliveries of water for the environment associated with *Mirrangbamurn* (Maribyrnong River), including the environmental watering program.

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.

Recent conditions

The Maribyrnong catchment had above-average rainfall during 2021-22, leading to high soil moisture and the largest tributary inflows to reaches downstream of Rosslynne Reservoir for more than five years. Inflows to Rosslynne Reservoir were also above average during 2021-22, and the storage reached 66 percent capacity in early February 2022. Tributary inflows provided good flow conditions in lower Jacksons Creek (reach 7) and the Maribyrnong River, but Rosslynne Reservoir harvested inflows from higher in the catchment and restricted flow through reach 6.

The VEWH purchased 314.5 ML of unused allocation from licence holders in the Maribyrnong system to provide environmental flows to Jacksons Creek in summer/autumn 2021-22.

Water for the environment was managed under a wet climate scenario during 2021-22 in the Maribyrnong system. Planned watering actions were met by natural flows in lower Jacksons Creek (reach 7), and managed releases from Rosslynne Reservoir partially met planned watering actions in upper Jacksons Creek (reach 6). Target low-flow magnitudes were met in upper Jacksons Creek for most of the critical summer/autumn period, and five freshes were also delivered. However, the water delivery infrastructure at Rosslynne Reservoir limits releases to a maximum of 15 ML per day, which makes it impossible to fully deliver the recommended summer/autumn fresh.

The target magnitude for winter/spring low flows and summer/autumn freshes has been reduced from 40 ML per day to 15 ML per day in this year's plan to reflect the flows that can be realistically delivered. These flows are smaller than the system requires for good environmental health, and the expected effects associated with those watering actions have been modified accordingly. The smaller flows are not expected to improve the condition of streamside vegetation or grow native fish and

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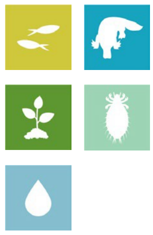
platypus populations. However, they will help to maintain habitat for existing populations and reduce the risk of poor water-quality incidents and are therefore still necessary. Melbourne Water will continue to work with the reservoir operator and relevant government agencies to improve water delivery capacity from Rosslynne Reservoir.

Scope of environmental watering

Table 3.4.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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 (15 ML/day during June to November)	• Maintain depth in pools and riffles to provide habitat for small-bodied native fish, platypus and waterbugs • Prevent terrestrial vegetation encroachment	
Summer/autumn low flow (4-6 ML/day during December to May)	• Maintain pool habitat availability for small-bodied fish and platypus during low-flow periods • Maintain a > 0.1 m median depth over riffles to provide macroinvertebrate habitat and inundate in-stream vegetation. • Maintain continuous flow to limit pool stratification and maintain water quality	
Summer/autumn freshes (five freshes of 15 ML/ day for four days every 4-6 weeks during December to May)	• Increase depth over riffle to provide local movement of small-bodied native fish and platypus during the low flow period • Maintain habitat and food resources for waterbugs • Flush pools to maintain water quality	

Scenario planning

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

There is no permanent environmental entitlement in the Maribyrnong system, so water for the environment can only be delivered in 2022-23 if other entitlement holders are willing to sell some of their annual allocations to the VEWH.

Adequate low flows throughout the year and summer/autumn freshes are a high priority under all climate scenarios to maintain habitat for native fish and platypus and to prevent incidences of poor water quality. Local catchment run-off, tributary inflows and groundwater contributions are likely to meet and exceed these flow requirements in lower Jacksons Creek (reach 7) under average and wet climate scenarios. However, mandated passing flows and water for the environment will be needed to achieve these watering actions in upper Jacksons Creek (reach 6) under all climate scenarios and in lower Jacksons Creek (reach 7) under a dry climate scenario.

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

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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 Jacksons Creek	• Unregulated flows meet some objectives • Passing flows may meet several low-flow objectives • Groundwater contributions provide baseflow in Jacksons Creek	• Unregulated flows meet most objectives • Passing flows may meet most low-flow objectives • Groundwater contributions provide baseflow in Jacksons Creek
Expected availability of water for the environment	• There is no environmental entitlement in the Maribyrnong system. Water will need to be traded with willing irrigators to support tier 1b watering actions		
Maribyrnong system (targeting reach 6)			
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 (three freshes)		
Possible volume of water for the environment required to achieve objectives	• 2,400 ML		
Priority carryover requirements for 2023-24	• N/A: the VEWH is unable to carry over water in the Maribyrnong system to support multi-year planning		

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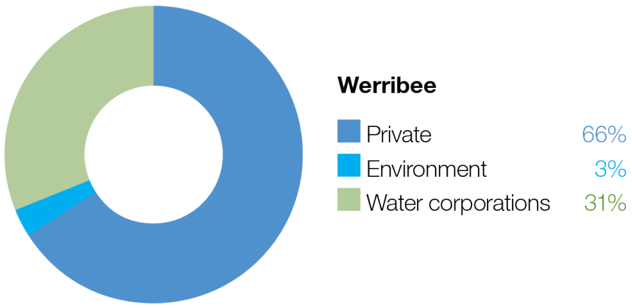
3.5 Werribee system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

Proportions of water entitlements in the Werribee basin held by private users, water corporations and environmental water holders on 30 June 2020



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 flows that target environmental objectives in reach 9 and the estuary are delivered from Melton Reservoir and therefore also benefit 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).

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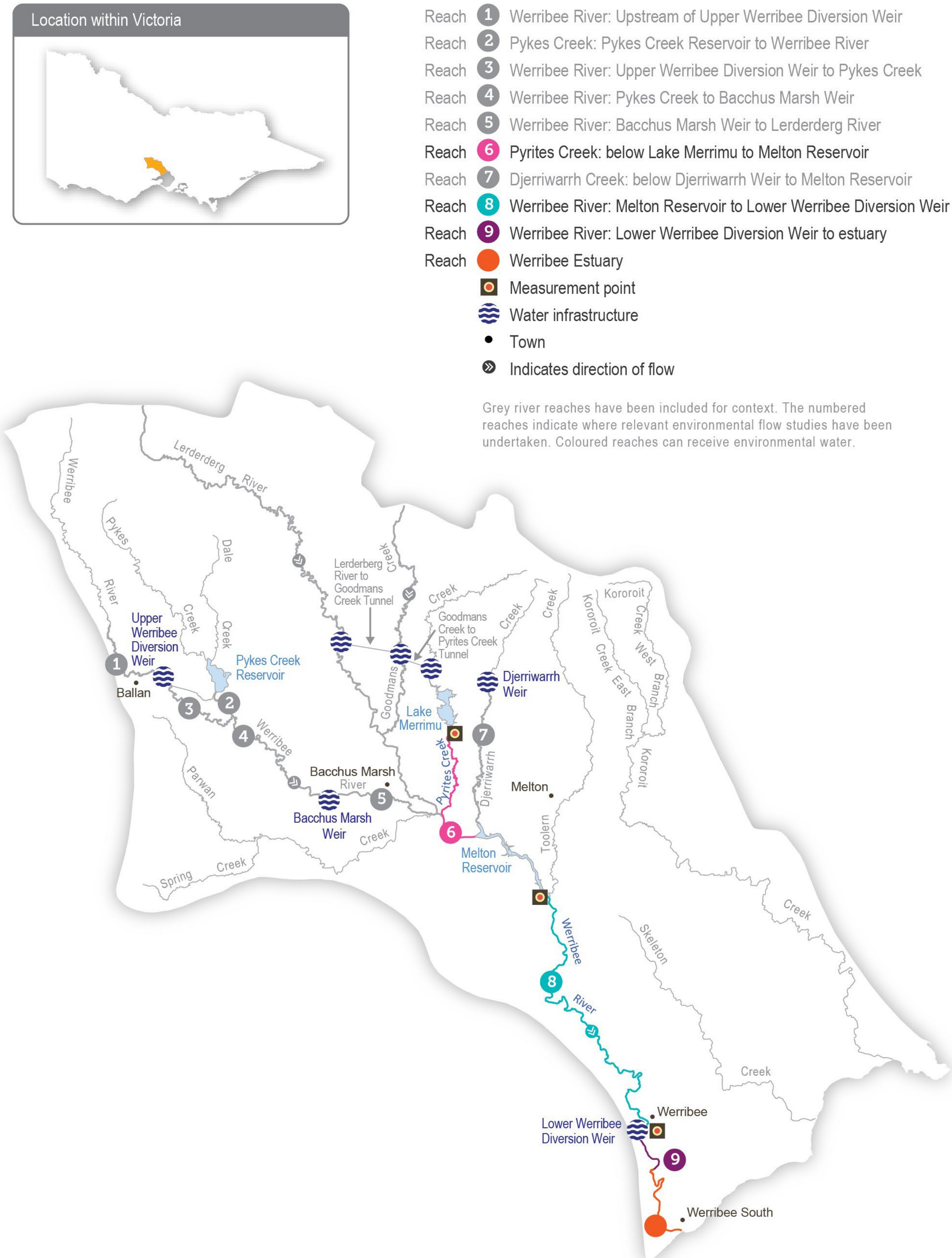
Figure 3.5.1 The Werribee system



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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 *Wirribi Yaluk* (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 and estuarine fish species (such as black bream).

Environmental watering objectives in the Werribee system

Icon	Environmental 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 help break down dead organic matter and support the river's food chain
	Maintain oxygen and salinity levels in pools

Traditional Owner cultural values and uses

Melbourne Water is working with the Registered Aboriginal Parties within the Werribee system — the Wadawurrung Traditional Owners Aboriginal Corporation, the Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation and the Bunurong Land Council Aboriginal Corporation — to develop overarching partnership agreements to frame relations and obligations between them to strengthen relationships and increase Traditional Owners' involvement in the planning and delivery of water for the environment. The intent is for Traditional Owners to be active partners in the planning, delivery and monitoring of all works and deliveries of water for the environment associated with *Wirribi Yaluk* (Werribee River), including the environmental watering program.

There are more opportunities emerging for Melbourne Water and the VEWH to work with Traditional Owner groups to identify and better integrate cultural values and their flow requirements into the environmental watering program on an ongoing basis. All three Registered Aboriginal Parties are involved in the upper Werribee River (*Wirribi Yaluk*) environmental flow study, which is due to be completed in 2022-23.

The Wadawurrung Traditional Owners Aboriginal Corporation has reviewed the environmental values for the *Wirribi Yaluk* system and has identified environmental values that also have cultural significance to Wadawurrung Traditional Owners, which the table below shows. However, further work is required to understand how potential watering actions can directly improve these cultural values.

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	

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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 from urban cooling (such as camping, walking, cycling and picnicking)
- community events and tourism (such as Werribee Zoo).

Recent conditions

The Werribee system experienced wetter-than-average conditions throughout most of 2021-22. The second consecutive year of above-average rainfall meant Pykes Creek Reservoir and Melton Reservoir both spilled through most of winter and spring and into early summer. Allocations against both high- and low-reliability water shares in Melton Reservoir reached 100 percent by early January 2022. Lake Merrimu had above-average inflows, resulting in the highest volume available under the Werribee River environmental entitlement since 2016-17.

Spills from Melton Reservoir between 10 June and 25 December 2021 provided noteworthy flows through reaches 8 and 9 (including bankfull flows in November 2021) and the Werribee River estuary. Despite wet conditions, Pyrites Creek did not have substantial natural inflows in 2021-22 because most flow was harvested in Lake Merrimu, where storage peaked at 82 percent capacity in December 2021, the highest recording since late 2013.

Water-quality-monitoring equipment was installed at Cobbledicks Ford in reach 8 and was upgraded in the *Wirribi Yaluk* (Werribee River) estuary. The data collected will be used to predict potential algal blooms and inform the delivery of water for the environment to mitigate blooms.

Water for the environment was managed in the Werribee system in accordance with a wet climate scenario in 2021-22. Most planned watering actions were fully achieved through a combination of natural flows, environmental water deliveries and operational flows. In Pyrites Creek, water for the environment was used to deliver four spring freshes and three spring/summer high flows and to maintain low flows to the end of December. In the Werribee River, water for the environment was used to deliver two spring/summer freshes. Passing flows below the Werribee Diversion Weir met the low-flow watering actions during late summer, autumn and winter.

The only planned watering action that was not fully achieved was a summer fresh in the lower Werribee River. Water for the environment was ordered and released from Melton Reservoir to deliver a fresh in late January, but the order was cut short due to operational requirements. Natural freshes before and after the planned event are likely to have met the environmental objectives on this occasion. Melbourne Water, Southern Rural Water and the VEWH are collaborating to reduce the likelihood of similar operational constraints affecting future environmental water orders.

Scope of environmental watering

Table 3.5.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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 (2 ML/day [or natural] during June to December)	• Provide sufficient water depth to provide riffle habitat for macroinvertebrates, native fish and frogs within the stream channel • Provide sufficient water depth to support the growth of flood-tolerant vegetation within the stream channel • Provide sufficient water depth to allow for native fish to move between pools	

Potential environmental watering action	Expected watering effects	Environmental objectives
Spring fresh(es) (three to four freshes of 30-40 ML/day for two days during September to December)	• Drown terrestrial plants 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 freshes of 70-130 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 At 130 ML/day, the effects above plus: • inundation of the full width of the channel and high backwaters to flush accumulated organic matter and promote the growth and recruitment of streamside vegetation	
Lower Werribee River (reaches 8, 9 and estuary)		
Winter/spring low flow (81 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) (two to four freshes of 350 ML/day for three days during June to October)	• Support the growth and recruitment of water-dependent streamside vegetation • Flush silt and scour biofilms and algae from substrates on the stream bed and maintain pools and channel dimensions • Provide movement cues and enough 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn fresh(es) (three to five freshes of 137-215 ML/day for one to 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 • 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 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. Recommended watering actions through reach 6 do not vary significantly between scenarios due to a need to move environmental water to Melton Reservoir to support outcomes in the lower reaches and because the reach is so reliant on releases to maintain any flow. However, the extent to which planned watering actions can be met will vary under each climate scenario. Under a dry scenario, there is unlikely to be enough water for the environment to deliver all required watering actions, so available supply will be prioritised for low flows to maintain enough pool and riffle habitat to allow existing fish, macroinvertebrate and aquatic vegetation communities to persist. Under average and wet conditions, environmental allocations will increase, and a larger proportion of required flows will likely be met by natural inflows. These two factors mean water for the environment can be used under average and wet conditions to deliver additional freshes and high flows to achieve geomorphological objectives, improve the condition of in-stream and streamside vegetation and help grow populations of native fish and frogs.

The lower *Wirribi Yaluk* (Werribee River) relies 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 run-off, including stormwater from urbanised areas of Werribee, provide larger flows, especially in wet years. Passing flows and operational deliveries for irrigation customers are expected to partially meet low-flow requirements in lower *Wirribi Yaluk* (Werribee River) under all climate scenarios. Water for the environment will therefore primarily be used to deliver summer/autumn freshes to manage water quality and control potential algal blooms. Winter/spring freshes will be used to support the movement and recruitment of native fish and platypus and to support streamside vegetation. More freshes will be able to be delivered under average and wet scenarios than under a dry scenario.

Under all scenarios, a minimum of 400 ML is planned to be carried over to ensure high-priority flows can be delivered to Pyrites Creek (reach 6) and lower *Wirribi Yaluk* (Werribee River) in 2023-24. Maintaining sufficient carryover in both Lake Merrimu and Melton Reservoir will be prioritised over the delivery of tier 1b potential watering actions 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	• Regulated flow conditions below Melton Reservoir year round • Minimal passing flows to reach 6, possible operational water transfers during summer • Consumptive releases out of storage into reach 8 in summer/autumn	• Some spills from Melton Reservoir in winter/spring and periods of unregulated flows in 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	• Regular large spills from Melton Reservoir in winter/spring and lengthy periods of unregulated flows in 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

Planning scenario	Dry	Average	Wet
Expected availability of water for the environment	• 2,690 ML	• 3,250 ML	• > 3,750 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) • Spring/summer high flow (one event)	• Winter/spring/summer low flow • Spring freshes (three freshes) • Spring/summer high flows (two events)	
	Tier 1b (supply deficit)		
	• Spring fresh (one fresh)	• Spring fresh (one fresh) • Spring/summer high flow (one event)	
Werribee River (targeting reach 9 and estuary)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	Summer/autumn freshes (three freshes)	• Summer/autumn freshes (five freshes)	• Winter/spring fresh (one fresh) • Summer/autumn freshes (five freshes)
	Tier 1b (supply deficit)		
	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow	• Winter/spring low flow • Winter/spring freshes (four freshes) • Summer/autumn low flow	• Winter/spring low flow • Winter/spring freshes (three freshes) • Summer/autumn low flow
Possible volume of water for the environment required to achieve objectives	• 1,750 ML (tier 1a) • 17,950 ML (tier 1b)	• 2,550 ML (tier 1a) • 19,400 ML (tier 1b)	• 3,100 ML (tier 1a) • 18,850 ML (tier 1b)
Priority carryover requirements for 2023-24	• 400 ML		

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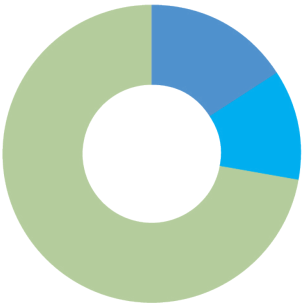
3.6 Moorabool system

Waterway manager – Corangamite Catchment Management Authority

Storage manager – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder

Proportions of water entitlements in the Moorabool system held by private users, water corporations and environmental water holders on 30 June 2020



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). The Moorabool catchment is highly regulated 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 3 a 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 operational and environmental releases, 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. Water use is limited by both inflows to the reservoir and by a use cap specified in the entitlement. The priority reaches for deliveries of water for the environment are between Lal Lal Reservoir and She Oaks Weir (reaches 3 a and 3b, as shown in Figure 3.6.1), as that is where the small amount of available water can have the most benefit. 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.

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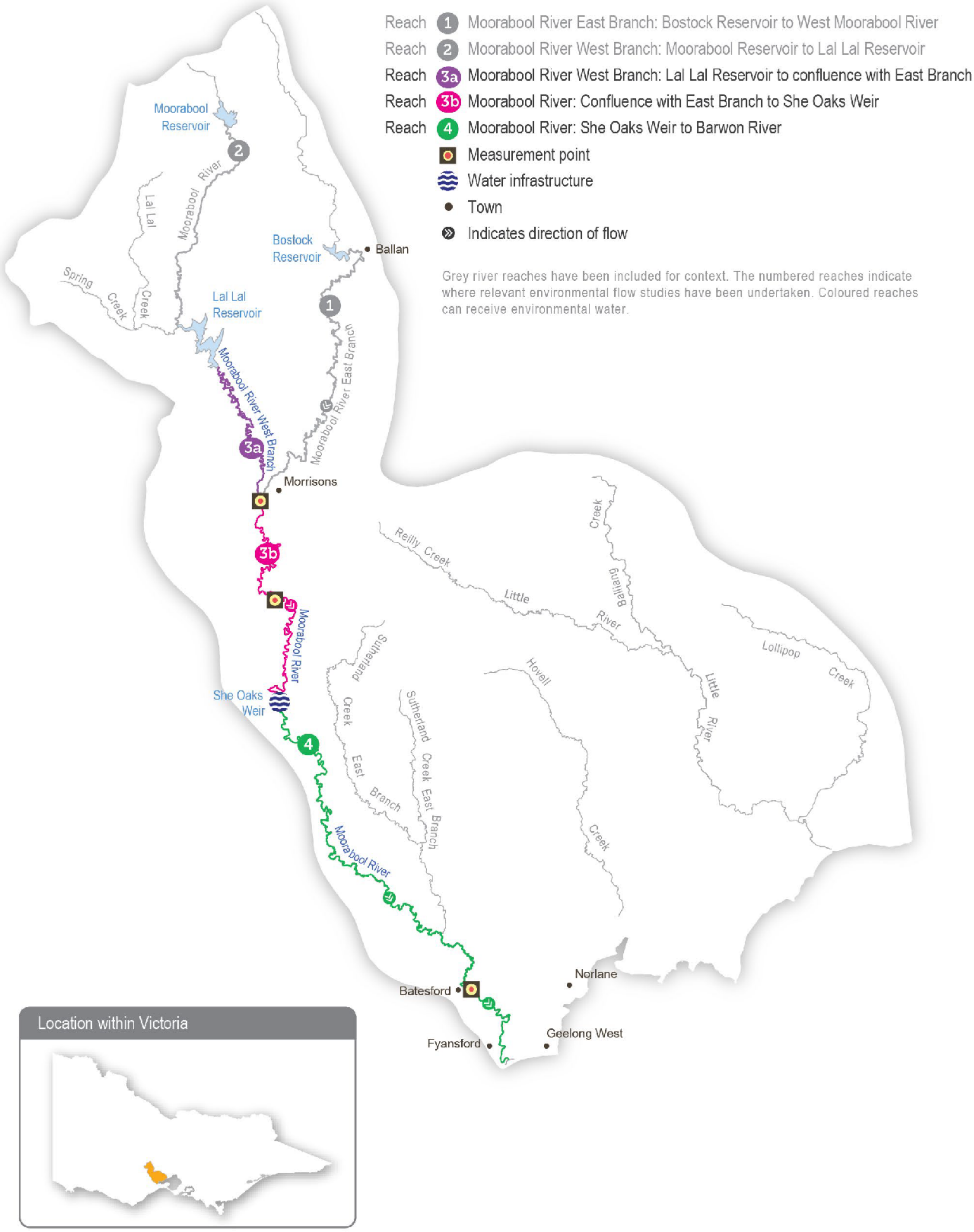
Figure 3.6.1 The Moorabool system



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Environmental values

Moorabool Yulluk (Moorabool River) is a highly flow-stressed system, but it retains 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 the Moorabool system

Icon	Environmental objectives in the Moorabool system
	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 and place high cultural value on *Moorabool Yulluk* (Moorabool River). The Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) is a key partner in advocating for additional water recovery to help support environmental outcomes and cultural water objectives.

In 2020, the WTOAC 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.

In 2019, the WTOAC 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 *Wad-dirring/peridak* (platypus), *Buniya* (eels), *Turrpurt* (tupong), *Ware-up* (river blackfish), *Tark* (common reed) and *Bal-yun* (cumbungi) which are traditional sources of food, materials and medicines
- waterway confluences and deep pools, which are places for meeting, ceremonies, trade and marking clan boundaries.

The WTOAC may partner with Corangamite CMA to coordinate the delivery of summer/autumn fresh events and some winter/spring fresh events to coincide with cultural events. This can support significant cultural values and species for the lead-up to or duration of an event.

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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
- socioeconomic benefits (such as for diverters for stock needs and domestic use: water levels and water quality can rely on the delivery of water for the environment, particularly in summer).

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 catchment varied throughout 2021-22 and was slightly above the long-term average. Wet conditions in 2020-21 caused Lal Lal Reservoir to fill, and further catchment inflows caused it to spill between early August and December 2021. Reservoir spills and local run-off downstream of the reservoir met many of the recommended high flows that are needed to grow aquatic plant and animal populations but cannot be delivered with managed environmental water due to various system constraints. The full reservoirs also boosted environmental water allocations and will support deliveries for the next three years.

The delivery of water for the environment in the Moorabool system was managed according to an average climate scenario during 2021-22, and all planned actions under that scenario were fully achieved. Natural flows met all planned watering actions during winter and spring. Water for the environment was used to deliver planned low flows and freshes throughout summer and autumn.

Scope of environmental watering

Table 3.6.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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.

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Table 3.6.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Moorabool system

Potential environmental watering action	Expected watering effects	Environmental objectives
Moorabool River (targeting reach 3a)		
Winter/spring low flow (5-60 ML/day during June to November)	• Maintain in-stream vegetation • Maintain connectivity and allow fish and platypus movement through the reach • Reduce intrusion by terrestrial vegetation into the stream bed	
Winter/spring freshes (three freshes, 80-90 ML/day for five to 10 days during May 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 (5-40 ML/day during December to May)	• Maintain refuge pools and riffle habitat for fish, waterbugs and platypus and submerged aquatic vegetation and allow movement through the reach • Maintain water quality for aquatic life by reducing periods of low oxygen, high temperature and high electrical conductivity	
Summer/autumn freshes (two to three freshes, 30-80 ML/day for five days during December to May)	One small fresh at 30-60 ML/day to: • maintain pool and riffle habitat and the condition of streamside vegetation, water fringing marginal zone vegetation and promote recruitment • allow fish movement through the reach Freshes at 60-80 ML/day to: • 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 plants and animals by reducing periods of low oxygen, high water temperature and salinity	

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Scenario planning

Table 3.6.2 outlines 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 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 to ensure connecting flows are maintained for as long as possible. Water for the environment may be added to operational transfers at times to increase flow variability downstream of Lal Lal Reservoir and to maintain some flow in the reaches downstream of She Oaks Weir once operational water is diverted. Even with these proposed watering actions, sections of the Moorabool River are likely to cease flowing under a dry or drought scenario, which will reduce environmental condition and the size of plant and animal populations.

Under average and wet climate scenarios, most of the recommended flows are expected to be provided through a combination of natural flows, passing flows and operational releases, which will mean water for the environment can be used to deliver additional freshes at any time of year to improve environmental conditions and increase populations of native plants and animals. Delivering a 60 ML per day fresh for five days in autumn will be a high priority under all climate scenarios to trigger Australian grayling migration and spawning. 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 2021-22 but not in 2020-21. They are needed in 2022-23 to help the population recover from past dry periods and provide a buffer in case there is a return to drier conditions in 2023-24.

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

The use of water for the environment in the Moorabool system is capped at 7,500 ML over three years. Under these rules, only 2,500 ML can be used in 2022-23, and full storages mean there is sufficient supply to support environmental flows until at least 2024-25.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Little rainfall with no inflow to Lal Lal Reservoir • Regular periods of no flow	• Below-average rainfall and inflow to Lal Lal Reservoir • Cease-to-flow events	• Average rainfall and moderate inflows to Lal Lal Reservoir, especially during winter and spring • Low flow over summer and high peaks in winter months	• Lal Lal Reservoir is likely to fill and spill • Continuous flow year-round • Overbank conditions in some parts during winter/spring
Expected availability of water for the environment	• 2,500 ML	• 2,500 ML	• 2,500 ML	• 2,500 ML
Moorabool River (targeting reach 3a)				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Winter/spring low flow (partial) • Summer/autumn low flow (partial) • Summer/autumn fresh (one fresh of 60 ML/day)	• Winter/spring low flow (partial) • Winter/spring fresh (one fresh) • Summer/autumn low flow (partial) • Summer/autumn fresh (one fresh of 60 ML/day)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow (partial) • Summer/autumn fresh (one fresh of 30-60 ML/day and two freshes of 60 ML/day)	• Winter/spring low flow • Winter/spring freshes (three freshes) • Summer/autumn low flow • Summer/autumn fresh (one fresh of 30-60 ML/day and two of 60 ML/day)
	Tier 1b (supply deficit)			
	• Winter/spring freshes (two freshes)	• Winter/spring fresh (one fresh)	• Winter/spring freshes (two freshes)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring low flow (delivered at upper magnitude) • Summer/ autumn low flow (delivered at upper magnitude) • Summer/ autumn freshes (three freshes, delivered at upper magnitude)	• Winter/spring low flow (delivered at upper magnitude) • Winter/spring freshes (two freshes) • Summer/ autumn low flow (delivered at upper magnitude) • Summer/ autumn freshes (three freshes, delivered at upper magnitude)	• Winter/spring freshes (three freshes) • Summer/ autumn low flow (delivered at upper magnitude) • Summer/ autumn freshes (three freshes, delivered at upper magnitude)	• Summer/ autumn freshes (three freshes, delivered at upper magnitude)
Possible volume of water for the environment required to achieve objectives	• 2,243 ML (tier 1a) • 1,130 ML (tier 1b) • 15,055 ML (tier 2)	• 2,508 ML (tier 1a) • 565 ML (tier 1b) • 15,055 ML (tier 2)	• 2,510 (tier 1a) • 990 ML (tier 1b) • 14,900 ML (tier 2)	• 780 (tier 1a) • 0 ML (tier 1b) • 9,300 ML (tier 2)
Priority carryover requirements for 2023-24	• The environmental entitlement for the Moorabool system caps use at 7,500 ML over three years. Use in 2022-23 will be capped at 2,500 ML, which will leave sufficient allocation to support watering actions in 2023-24 and 2024-25			

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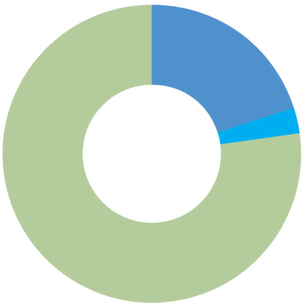
3.7 Barwon system

Waterway manager – Corangamite Catchment Management Authority

Storage manager– Barwon Water

Environmental water holder – Victorian Environmental Water Holder

Proportions of water entitlements in the Barwon basin held by private users, water corporations and environmental water holders on 30 June 2020



The Barwon system (Figure 3.7.1) includes the upper Barwon River and lower Barwon wetlands.

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

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

3.7.1 Upper Barwon River

System overview

Flows in the upper Barwon River are regulated by the operation of the West Barwon Reservoir. 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. When the reservoir is above 40,000 ML, all natural flows are passed down the east branch between January and March. Flood spills from the reservoir, and natural inflows from unregulated and regulated tributaries add to the passing flows in the west branch. Regulated and unregulated tributaries add to passing flows in the east branch.

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.

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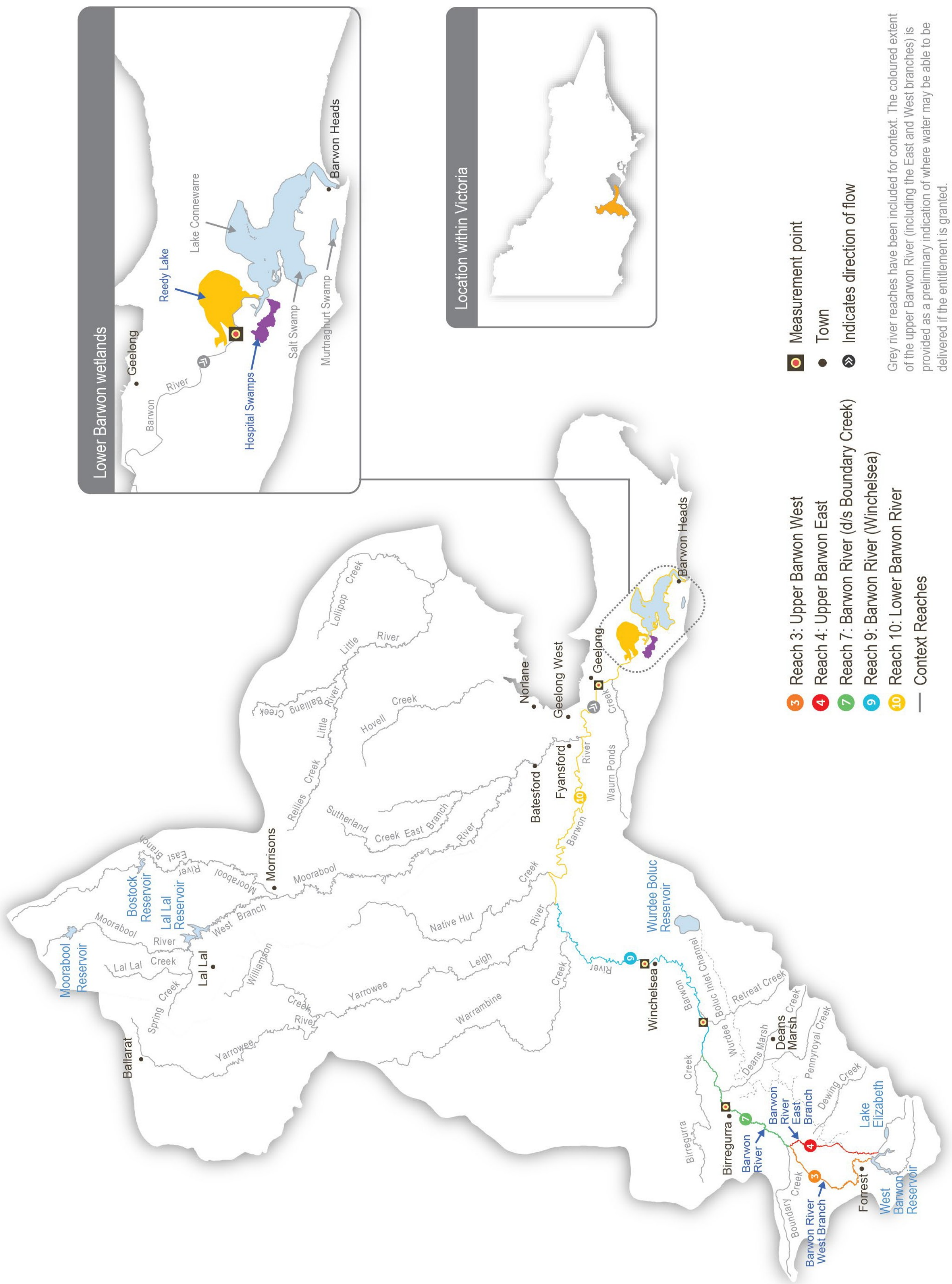
Figure 3.7.1 The Barwon system



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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.

Environmental watering objectives in the upper Barwon River

Icon	Environmental 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 (EMAC) 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 EMAC 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.

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

Both the EMAC and WTOAC have formal plans for how to heal Country in the region, and Corangamite CMA continues to work with them to identify cultural values aligned with the seasonal watering plan process.

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, kayaking, swimming and fishing, particularly for river blackfish)
- riverside recreation and amenity (such as birdwatching, camping and walking)
- socioeconomic benefits (such as for diverters for stock needs and domestic use: water levels and water quality can rely on the delivery of water for the environment, particularly in summer).

Recent conditions

Rainfall in the upper Barwon catchment in 2021-22 was slightly above the long-term average. The West Barwon Reservoir spilled for more than three months from July 2021, and the reservoir remained above 90 percent capacity throughout the year.

Water for the environment in the upper Barwon River system was managed according to an average climate scenario throughout 2021-22. All planned watering actions in the east branch were fully met through a combination of passing flows and natural flow events. Passing flows and natural flows also met most of the planned watering actions in the west branch. Water

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for the environment was used to maintain target summer/autumn low flows in the west branch when needed. Water for the environment was not delivered in the east branch during 2021-22.

Scope of environmental watering

Table 3.7.1 describes the potential environmental watering actions in 2022-23, their expected watering effect (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

Potential environmental watering action	Expected watering effects	Environmental objectives
Upper Barwon River (targeting reach 3 – west branch)		
Winter/spring low flow (20-30 ML/day during June to November)	• 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 (3-30 ML/day during December to May)	• 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	
Upper Barwon River (targeting reach 4 – east branch)		
Winter/spring low flow (1-9 ML/day during June to November)	• Maintain connectivity and an adequate water depth in the channel and 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 during December to May)	• 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 ML/day for two days during December to May)	• 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 the lower bank • Provide minimum velocity to mix and flush pools	

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Scenario planning

Table 3.7.2 outlines 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. However, high carryover volumes from 2021-22 and the forecast of high allocations mean that the volume of water available to support environmental flows in the upper Barwon system in 2022-23 will be greater than in previous years under all climate scenarios.

Planned watering actions for the upper Barwon River are derived from recommendations in the upper Barwon River Environmental Flows Study. The Corangamite CMA is aware that many of the flow magnitudes recommended in the environmental flows study cannot be delivered without inundating private land, so the planned watering actions presented in Table 3.7.1 are deliberately less than the known channel capacity constraints. Also, water levels will be monitored during any planned delivery of water for the environment in 2022-23, especially if significant rain is forecast, so that release rates can be promptly adjusted to avoid affecting streamside landholders. The flow rates presented in Table 3.7.1 are expected to provide a lower environmental benefit than the full environmental flow recommendations. The Corangamite CMA will continue to work with relevant agencies and landholders to investigate options that will allow some of the recommended environmental flows to be delivered closer to their target magnitude in future without affecting private land.

Under all climate scenarios, water for the environment will be used to maintain a continuous flow in the east and west branches during summer and autumn. Delivery of water for the environment in the east branch is prioritised over the west branch when supply is limited because the east branch has greater environmental values and relatively small flows in the east branch have the potential to deliver significant environmental outcomes. In the east branch, the priority will be to deliver summer/autumn low flows under all climate scenarios and summer/autumn freshes under dry, average and wet scenarios. The summer/autumn freshes will help to improve water quality and provide opportunities for fish and platypus to disperse throughout the system, breed and take advantage of increased food and habitat under wet and average climatic conditions.

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. The summer and autumn low flows in the west branch can be of greater magnitudes, as presented in Table 3.7.1, under average and wet climate scenarios to achieve better outcomes for fish, platypus and vegetation. Any remaining water for the environment under an average or wet climate scenario will be used to supplement winter and spring low flows in the east and west branches and flows further downstream. Winter and spring freshes in reaches 3 and 4 are essential for the system, but due to channel choke points from willow and glyceria and channel capacity and delivery constraints, these are not planned to be delivered by water for the environment and are not included in this seasonal watering plan.

The tier 1a and 1b watering actions presented 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.

The carryover reserve for the upper Barwon River is 500 ML for 2023-24.

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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	• Disconnected pools • Cease-to-flow events • Deteriorating water quality	• Disconnected pools during summer and autumn • Cease-to-flow events	• Low flow in summer and autumn • Peak flow in winter and spring	• Continuous flow throughout the year • Reservoir spills are likely, especially during winter and spring
Expected availability of water for the environment	• 1,500 ML	• 2,000 ML	• 2,500 ML	• 3,000 ML
Upper Barwon River (targeting reach 3 – west branch)				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Summer/autumn low flow (partial)	• Summer/autumn low flow (partial)	• Summer/autumn low flow (partial)	• Summer/autumn low flow
	Tier 1b (supply deficit)			
	• Winter/spring low flow • Summer/ autumn low flow (delivered at upper magnitude)	• Winter/spring low flow • Summer/ autumn low flow (delivered at upper magnitude)	• Winter/spring low flow • Summer/ autumn low flow (delivered at upper magnitude)	• Winter/spring low flow
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Upper Barwon River (targeting reach 4 – 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 freshes (two freshes)	• 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	• Winter/spring low flow	• Winter/spring low flow	• Winter/spring low flow
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 1,464 (tier 1a) • 7,602 ML (tier 1b)	• 1,947 (tier 1a) • 6,697 ML (tier 1b)	• 2,513 (tier 1a) • 4,305 ML (tier 1b)	• 2,986 (tier 1a) • 2,896 ML (tier 1b)
Priority carryover requirements for 2023-24	• 500 ML			

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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. The 2020 Wadawurrung Country Plan, *Paleert Tjaara Dja – let's make Country good together 2020-2030* 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.

Following a four-year (2016-17 to 2019-20) watering regime trial at Reedy Lake, the Lower Barwon Review in 2020 proposed to implement the long-term flow recommendations with a seasonally adaptive approach, avoiding complete dry-out years. At Reedy Lake, this means having the wetland full one out of four years and a partial drawdown in summer and autumn three out of four years. The review's recommendations informed 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.

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Environmental watering objectives in the lower Barwon wetlands

Icon	Environmental 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
	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 colonisation of tall reed in low-lying areas and increase open-water habitat Provide varying water levels and conditions to promote soil salinisation and support the persistence and growth of threatened, salt-dependent ecological vegetation communities
	Provide suitable feeding and breeding habitat for waterbirds, including mudflats 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 inflows to remove accumulated salts Maintain surface water and groundwater interactions Improve soil health and enable the weathering of heavy metals in vegetation-covered fringing soils

Traditional Owner cultural values and uses

Corangamite CMA worked with Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) during the development of plans to deliver water for the environment 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 WTOAC is a member of the Lower Barwon Community Advisory Committee. It has reviewed how its aspirations and plans for Country have been represented in the planning process for the lower Barwon wetlands and has provided a letter of endorsement for Corangamite CMA's 2022-23 seasonal watering proposal.

The WTOAC has 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.

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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 cultural, social, economic and recreational values 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 — providing a fill to 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)
- wetlands recreation and amenity (such as birdwatching and spending time outdoors)
- community events and tourism (such as community events and Traditional Owner events)
- socioeconomic 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 Barwon catchment during 2021-22 was slightly above the long-term average. The West Barwon Reservoir and Lal Lal Reservoir both spilled during the year, and these events, combined with natural inflows downstream of the storages, generated high flows in the lower Barwon River that inundated the lower Barwon wetlands several times in winter and spring.

Water for the environment in the lower Barwon wetlands was managed according to an average climate scenario throughout 2021-22. Both wetlands filled in winter and spring. Levels in Reedy Lake drew down slightly through evaporation and reduced inflows from Barwon River in December. Planned actions to actively draw down Reedy Lake during summer and autumn were timed to avoid disturbing nesting waterbirds, but the lake did not reach its target drawdown level due to wet conditions.

Hospital Swamps started drawing down through evaporation in December and reached its target drawdown level in March. The inlet from the Barwon River to Hospital Swamps was opened in May to start a wetland fill.

Scope of environmental watering

Table 3.7.3 describes the potential environmental watering actions in 2022-23, their expected watering effect (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.

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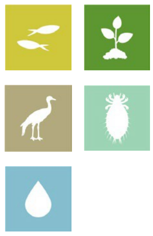
Table 3.7.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the lower Barwon wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Reedy Lake		
Autumn/winter/spring fill (April to November) and top-ups as required (year-round) (targeting 0.8 m 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 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 decomposition of organic matter	
Summer/autumn drawdown (December to May) (targeting 0.3 m 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 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 (April to November) and top up as required (year-round) (targeting 0.5 m 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 • Increase freshwater to dilute salt in the soil and surface water over winter • Inundate outer edges and margins to initiate growth and maintain the condition of important wetland vegetation communities	
Summer/autumn drawdown (December to May) (targeting 0.1-0.3 m AHD)	• Lower the water level by natural evaporation and assisted drawdown (if required and as informed by waterbird monitoring if available) to dry out wetland fringing vegetation and expose mudflats and margins to support the feeding of wading/migratory waterbirds and frogs • Manage reed colonisation of low-lying areas by allowing drying and saline groundwater intrusion to reduce growth • Support 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	

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Scenario planning

Table 3.7.4 outlines 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 wetlands may be topped up when required after the fill period while awaiting expert advice to commence drawing down.

The 2012 FLOWS study for the lower Barwon wetlands and the 2020 Lower Barwon Review recommend a four-year watering cycle for Reedy Lake: fill the wetland in autumn/winter/spring every year and having low water levels during summer in three out of four years to facilitate partial drying. For the last three years, Reedy Lake has not achieved a full drawdown, and it is a priority for 2022-23 under all scenarios to achieve it. Drawdowns at Reedy Lake and Hospital Swamps support waterbird and frog breeding and provide muddy margins for migratory shorebirds that actively forage in mudflats during summer and early autumn before returning to the Northern Hemisphere. The planned summer/autumn drawdown will be delayed if there is significant waterbird breeding. 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 flow from the Barwon River in winter/spring • Disconnection between wetlands and the Barwon River for a long period • Natural drawdown may begin earlier than planned	• Some natural inflow from the Barwon River in winter/spring • More gradual lowering of water levels during drawdown	• Overbank flow from the Barwon River is likely to fill the wetlands • Stormwater inflow and local rain/run-off will provide regular top-ups • Extensive drying of the wetland is unlikely
Reedy Lake			
Potential environmental watering	• Reedy Lake fill and top-up (as required) • Reedy Lake drawdown • Hospital Swamps fill and top-up (as required) • Hospital Swamps drawdown	• Reedy Lake fill and top-up (as required) • Reedy Lake drawdown • Hospital Swamps fill and top-up (as required) • Hospital Swamps drawdown	• Reedy Lake fill and top-up (as required) • Reedy Lake drawdown • Hospital Swamps fill and top-up (as required) • Hospital Swamps drawdown
Hospital Swamps			
Potential environmental watering	• Hospital Swamps fill and top-up (as required) • Hospital Swamps drawdown	• Hospital Swamps fill and top-up (as required) • Hospital Swamps drawdown	• Hospital Swamps fill and top-up (as required) • Hospital Swamps drawdown

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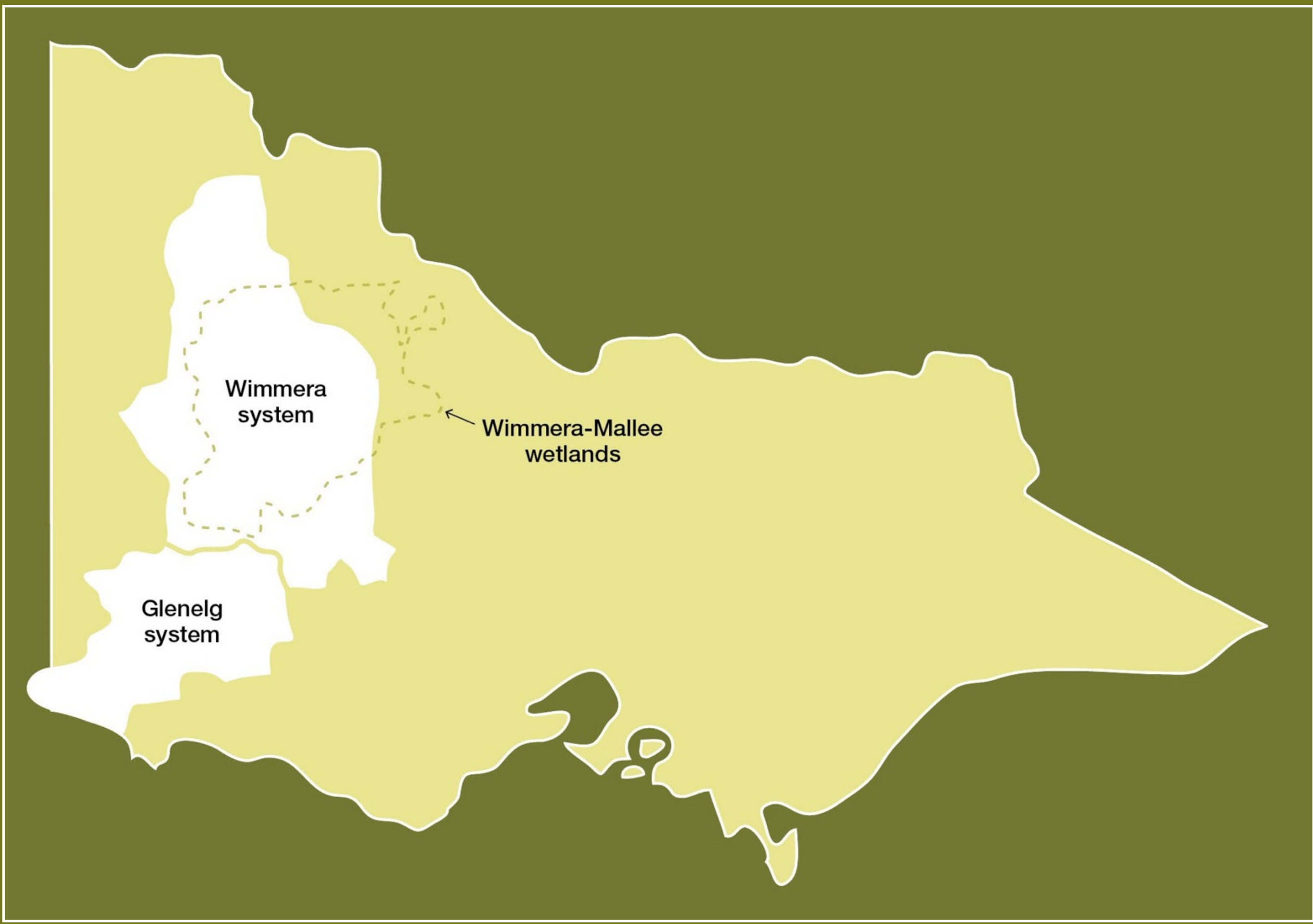
Section 4
Western region



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 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, 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 have intrinsic connections to Country that have endured for tens of thousands of years. These include inherent rights and cultural obligations to Country and community.

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) currently works in partnership with the South East Aboriginal Focus Group (SEAFG) who as First Nations from the South East of South Australia have ancestral connections across Bunganditj/Boandik Country from the Limestone Coast region in South Australia to the western parts of the Glenelg River catchment in Victoria. The SEAFG ancestral connections include Tanganekald (Southern Clans), Tatiara/Ngarkat, Meintangk/Moandik/Mootatunga/Thangal, Potaruwutij/Pinejunga, Wichantunga/Wattunga and Bunganditj/Boandik.

The SEAFG has had some engagement around Victorian water initiatives, including the 2009 Western Region Sustainable Water Strategy, the 2013 Wimmera Waterway Strategy and increased engagement through Burrandies in the Glenelg Cultural Flows discussions starting around 2017.

The Burrandies Corporation seeks to:

- Build relationships between First Nation groups through current and future engagement opportunities
- Investigate and implement reconnection of traditional/historic inland flow paths from Piccannine Ponds to the Glenelg River inlet.

Some parts of the Wimmera-Mallee wetlands area are on Barapa Barapa Country.

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.

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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.

In the context of Treaty negotiations in Victoria and the Victorian Government's commitment to self-determination for First Nations, program partners in the environmental watering program are aware that structural changes (such as legislative, policy and governance changes) to how water is managed may be made in the future in recognition of Aboriginal water rights. Program partners have heard for many years that Traditional Owners want empowerment and agency in water management, and in many cases, they want to manage water on Country on their own terms.

Engagement

Seasonal watering proposals are informed by community and program partner engagement, including Traditional Owner engagement. Program partners and communities help to identify priorities and opportunities for the delivery of water for the environment in the coming year.

Longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flows studies), environmental water management plans and Traditional Owner Country plans (and associated documents) also inform seasonal watering proposals. These strategies, plans and technical reports collectively describe a range of environmental, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence environmental flows and priorities.

The VEWH and its program partners consider cultural, social, economic and recreational values and uses of waterways when planning for the delivery of water for the environment. Where possible, opportunities to support these values and uses are incorporated into watering decisions, provided they do not compromise environmental outcomes. Cultural, social, economic and recreational values considered for each system in the western region are presented in the system sections that follow.

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 planning process for water for the environment. Table 4.1.1 shows the IAP2 Spectrum categories and participation goals.

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

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

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

Tables 4.1.2, 4.1.3 and 4.1.4 show the partners, stakeholder organisations and individuals with which Glenelg Hopkins CMA, Mallee CMA, North Central CMA and Wimmera CMA engaged when preparing 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 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, roles and responsibilities of organisations in managing a site or system, and potential interaction of proposed watering with other activities on the waterway. For example, in the 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 to the region's economy, tourism and environment. 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.

External factors also influence engagement opportunities. COVID-19 restrictions reduced opportunities across the western region for face-to-face meetings with the community and Traditional Owners.

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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** • Department of Environment, Land, Water and Planning • GWMWater • Natural Resources South East (South Australia) • Parks Victoria • Victorian Fisheries Authority • Wimmera CMA
	IAP2 level: Inform • Limestone Coast Landscape Board
Landholders/farmers	**IAP2 level: Collaborate** • Individual landholders
Local businesses	**IAP2 level: Inform** • Balmoral Bush Nursing Centre • Balmoral Local Post Office • Glenelg River Boat Cruises • Harrow Discovery Centre • Nelson Boat and Canoe Hire • Nelson River Cruises • Paestan Canoe Hire • Vickery Bros (sand extraction)
Recreational users	**IAP2 level: Consult** • Balmoral District Angling Club • Casterton Angling Society Inc. • Dartmoor Angling Club • Individual anglers • Kayakers • Southwest Victoria fishing reports • Vic Bream Classics (organisers and participants) • VRFish
	IAP2 level: Inform • Individual anglers
Traditional Owners	**IAP2 level: Collaborate** • Barengi Gadjin Land Council • Burrandies Aboriginal Corporation • Gunditj Mirring Traditional Owners Aboriginal Corporation

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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)

Partner/stakeholder	Wimmera system
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 • Field and Game • 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

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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 • Curyo-Watchupga 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 • Wimmera CMA
	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
	IAP2 level: Consult • Wimmera-Mallee Pipeline Environmental Water Advisory Group (North Central CMA)
Local businesses	**IAP2 level: Inform** • Ouyen Lake Project • Wimmera Mallee Tourism

Partner/stakeholder	Wimmera-Mallee wetlands
Recreational users	**IAP2 level: Consult** • Natimuk & District Field & Game Inc.
	IAP2 level: Inform • Recreational users in the local community
Traditional Owners	**IAP2 level: Collaborate** • Barapa Barapa Nation Aboriginal Corporation • 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 of 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 streambank 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 CMA on-ground works programs likely to support environmental flows outcomes in the western region include:

- 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
- sand management, removal of excess bedload sand 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 flows outcomes
- restoration of complex habitat for native fish by installing large wood in reach 2 of the Glenelg River using red gum trunks and root balls
- 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 flows for 2022-23 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

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Seasonal outlook 2022-23

Rainfall in 2021-22 was close to the long-term average across much of the western region, although inflows to system storages were below the long-term average for the fifth consecutive year. In the Glenelg River, tributary inflows downstream of Rocklands Reservoir, natural baseflow and regulated passing flow maintained river connectivity throughout most of the year.Water for the environment was used to supplement summer low flow where needed and to deliver two summer freshes in reaches 1 and 2. In the Wimmera system, natural inflows delivered unregulated flow through the length of the Wimmera River from June to late December, which was the longest period of unregulated flow since 2016. A large rainfall event in early November caused flow at Glenorchy to increase to 300-400 ML per day and triggered golden perch and silver perch spawning. Water for the environment was used to maintain drought refuges in the MacKenzie River, Burnt Creek and lower Mount William Creek throughout summer and autumn.

Water storages across the Wimmera-Mallee System Headworks were collectively at 31 percent capacity at the start of 2021-22. They rose to 44 percent in November 2021 and dropped back to 32 percent capacity at the end of April 2022. The *Wimmera and Glenelg Rivers Environmental Entitlement 2010* received 59 percent allocation in May 2022. This allocation, combined with carryover, meant 49,210 ML of water for the environment was available in 2021-22. The CEWH did not receive any allocation in the Wimmera system for the fifth year in a row, and its carryover from previous years was exhausted in 2019-20.

Long-range rainfall forecasts from the Bureau of Meteorology for May to July 2022 indicate a 35 percent to 55 percent chance of falls exceeding the median rainfall across the catchment. Falls in the Grampians are expected to be below the median, which would result in low inflows to storage during this period. The storage manager has indicated that entitlement holders will receive low allocations in 2022-23 under all but wet climate scenarios and are unlikely to receive full allocations under a wet scenario. VEWH is expecting to hold approximately 23,000 ML carryover against the Wimmera and Glenelg rivers environmental entitlement on 1 July 2022. This will be a combination of water held back when seasonal watering statements were issued to CMAs, planned actions that were met by natural flows and savings CMAs have made through the efficient use of water throughout the year. The Wimmera-Mallee wetlands received only one percent allocation by 4 May 2022 for the 2021-22 water year. Watering actions in the Wimmera-Mallee wetlands were met by carryover from previous years, and about 300 ML will be carried over to support wetland watering in 2022-23.

Annual allocations against the Wimmera and Glenelg rivers environmental entitlement alone have been less than the minimum volume needed to deliver planned watering actions in both rivers for the last four years, and carryover has been essential in helping to maintain environmental values across the western region. Unless inflows to catchment storages are significantly above average, allocations in 2022-23 are likely to be less than the total environmental demand for the year; therefore, carryover will again be prioritised to help support watering actions in 2023-24. The VEWH, in consultation with the Glenelg Hopkins and Wimmera CMAs, have agreed to prioritise between 14,000 ML and 28,000 ML for carryover at the end of 2022-23 under drought to average climate scenarios. If it is wet, then the target carryover volume may increase with water availability, boosting available supply and securing watering actions for future dry years. The VEWH will consult with the Wimmera and Glenelg Hopkins CMAs during the season and set a final target when there is sufficient information to do so. Protecting these carryover volumes is a priority, and it will influence allocation volumes and authorised watering actions in each system during 2022-23.

The Wimmera-Mallee Pipeline wetland environmental entitlement is not expected to receive any allocation in 2022-23 under any of the drought to average climate scenarios. Therefore, all wetland watering in 2022-23 is expected to rely on carryover from 2021-22. The planned watering actions for the wetlands in 2022-23 are expected to use up to 119 ML, which will leave about 117 ML to support watering actions in future years if dry conditions continue. The current supply for the Wimmera-Mallee wetlands will only allow essential watering actions to the end of 2023-24 without new allocations.

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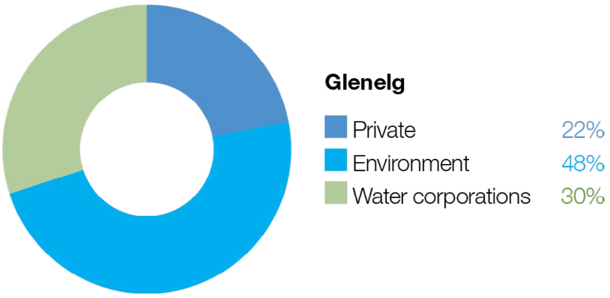
4.2 Glenelg system

Waterway manager – Glenelg Hopkins Catchment Management Authority

Storage manager – GWMWater

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

Proportions of water entitlements in the Wimmera-Mallee System Headworks held by private users, water corporations and environmental water holders on 30 June 2020



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

System overview

Bochara-Bogara-Pawur **(Glenelg River) rises in the Gariwerd (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 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. Glenelg Hopkins CMA is investigating the influence of water for the environment on the Glenelg River estuary, which is listed as a heritage river reach and a site of international significance under the Ramsar Convention.

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Figure 4.2.1 The Glenelg system

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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 system

Icon	Environmental objectives in the Glenelg system
	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

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 the 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, ring trees, stone structures, middens and rock paintings) 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 delivering water for the environment 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 ceremonial and on-Country gatherings along the river, including at Casterton and Nelson.

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The Glenelg River Yarns website (glenelgriveryarns.com.au) was launched in late 2021 as part of the Glenelg River Cultural Flows project. The website shares cultural values and stories on a virtual tour and welcomes all visitors to Country.

Figure 4.2.2 Glenelg River Environmental Flow Seasonal Calendar

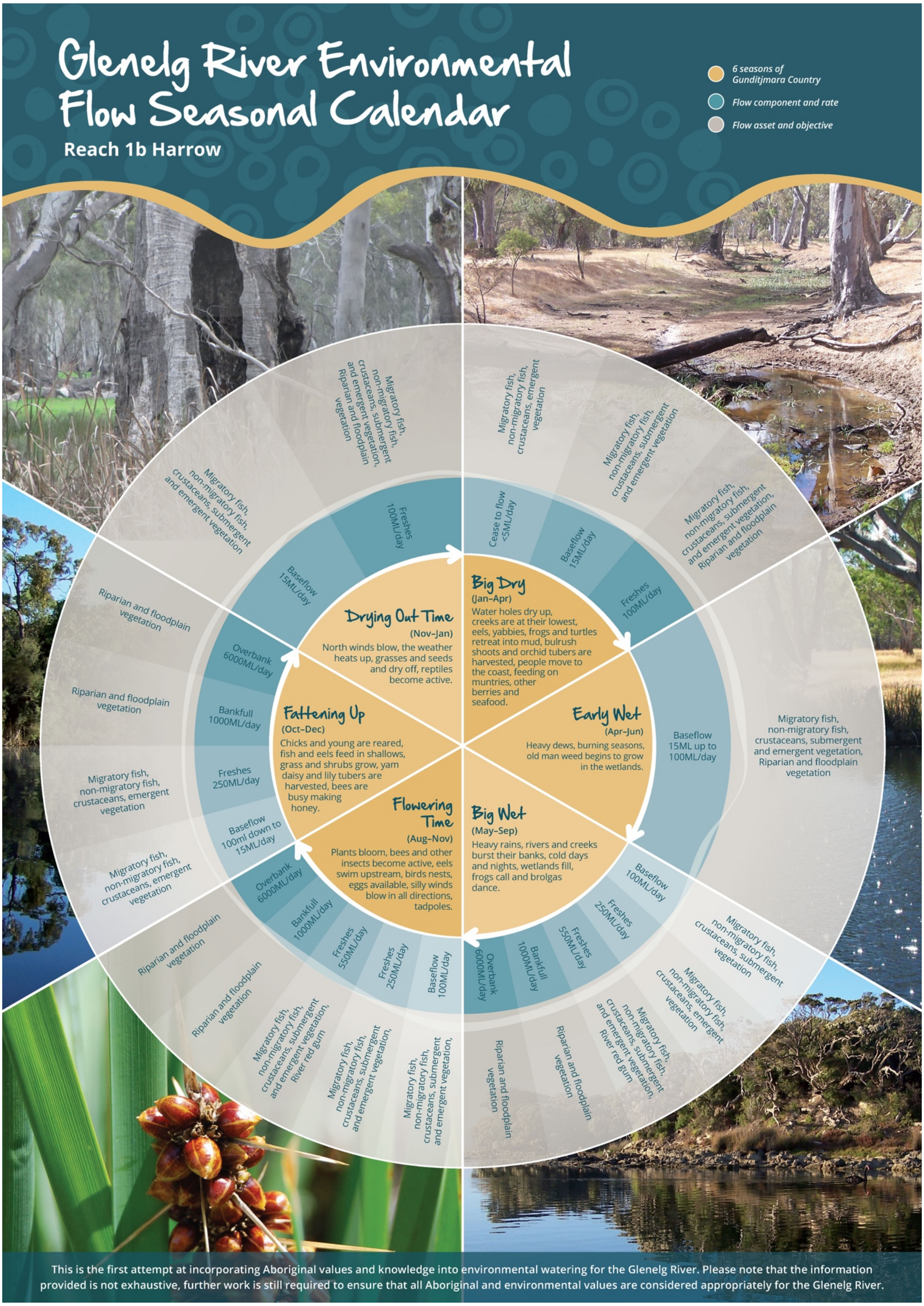

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Figure 4.2.2 describes the six seasons of Gunditjmara Country, and it was produced by the Gunditj Mirring Traditional Owners Aboriginal Corporation. The northern part of the river upstream of the Harrow area is in Jadawadjali Country, and the south-western part of the system is in Boandik Country. The calendar describes the six seasons alongside flow components for reach 1b of the Glenelg River — from 5-Mile Outlet to Chetwynd River — and aligns them with corresponding watering effects and objectives. 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 Owners' 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 environmental flow recommendations and scenario planning in future years.

Increasing the involvement of Traditional Owners in the planning and management of environmental flows and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* 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 their contribution and indicating progress towards deeper involvement.

	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 match, which is an important cultural event on the 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)
- socioeconomic benefits (such as for diverters for stock needs and domestic use: water levels and water quality can rely on the delivery of water for the environment, particularly in summer).

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 improve 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.

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Recent conditions

Rainfall in the Glenelg catchment in 2021-22 was close to the long-term average, and consistent 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 below the long-term average. Low storage levels at the beginning of the season coupled with limited inflows to storages meant allocations to the *Wimmera and Glenelg Rivers Environmental Entitlement 2010* only reached 59 percent by early May 2022. Summer rain events provided natural freshes in the system, contributing to the maintenance of river connectivity throughout the season. Large natural flows during August peaked at 1,598 ML per day in reach 1b and 1,859 ML per day in reach 2, providing natural connections between the river and some low-lying floodplain areas.

The Glenelg system was managed under a dry climate scenario through 2021-22, with an emphasis on conserving water for carryover. Most planned watering actions were at least partially achieved through a combination of natural flows, managed passing flows and water for the environment, although results varied between reaches. Water for the environment was used to supplement summer/autumn low flows and summer/autumn freshes, particularly in reach 1b and reach 2. Flow targets were largely met in reach 1b and reach 3, which had significant inflows from local tributaries and received the most water for the environment. Most flow targets were also met in reach 2, although the natural freshes in summer and autumn were relatively small.

Small releases from Rocklands Reservoir wall outlet have little effect on downstream reaches. To conserve water in dry conditions, most water for the environment is released from Five Mile Outlet to optimise outcomes in reach 1b and reach 2. In 2020-21, water for the environment was used to supplement the natural baseflow in reach 1a to help maintain a continuous flow between Rocklands Reservoir and the estuary throughout the year. The preferred flow targets for reach 1a were generally not met due to Rocklands Reservoir affecting the natural inflow through this reach. The flow through reach 1a likely prevented significant environmental harm, but larger flows will be needed in coming years to improve environmental outcomes in that part of the river. Good flow during 2021-22 has allowed the maintenance of connection from Rocklands Reservoir to the estuary at Nelson. This flow has supported a diverse range of healthy habitats and provided beneficial dispersal opportunities required by native plants and animals throughout the Glenelg system.

Scope of environmental watering

Table 4.2.1 describes the potential environmental watering actions in 2022-23, 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 system

Potential environmental watering action	Expected watering effects	Environmental objectives
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[1])		
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	

Potential environmental watering action	Expected watering effects	Environmental objectives
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[1])	• 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 greater 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[1])		
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)		

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 the fish and waterbug habitat • Wet emergent vegetation on the lower banks to improve its condition and prevent the encroachment of terrestrial species • Flush pools to improve water quality and lower temperatures • Provide sufficient flow to allow native fish and platypus to access habitat	
Summer/autumn fresh(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[1])		
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)		

1 See Figure 4.2.2: *Glenelg River Environmental Flow Seasonal Calendar*.

Scenario planning

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

The strategy for delivering environmental flows in the Glenelg River has been developed to protect the most significant environmental values within the system and to make the best use of available water. As a result, there are some notable differences in watering priorities between reaches under each climate scenario.

Under a drought or very dry climate scenario, there will be limited water for the environment, and because the catchment will be relatively dry, deliveries will only influence conditions in the reaches close to the release point. Under these scenarios, most of the available water for the environment will be used to deliver summer/autumn low flows from Five Mile Outlet at the top of reach 1b to maintain a continuous flow between that point and Casterton, where the flow can be sustained by tributary inflows. Under a drought scenario, a low flow in reach 2 will likely be delivered at less than the recommended magnitude to conserve the available resource, but it should be possible to deliver the recommended low flow under a very dry scenario.

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These continuous flows will be essential to maintaining native fish and platypus populations that have recovered since the Millennium Drought.

Small volumes of water for the environment will also be used under drought or very dry conditions to deliver summer/autumn freshes to reach 1a. These flows will aim to top up key refuge pools to help small-bodied fish, macroinvertebrates and some aquatic vegetation persist in reach 1a, but they will not maintain a continuous flow through that reach. Natural inflows and cooler temperatures are likely to maintain a connecting flow through most of the system during winter and spring, even under a drought or very dry scenario, so no environmental flows are planned for those seasons.

If more water is available under dry, average and wet climate scenarios, it will be used to deliver summer/autumn freshes to as many reaches as possible and to provide a continuous flow through reach 1a to grow populations of native plants and animals. These freshes would wet streamside vegetation and provide more opportunities for fish and platypus to move through the system and increase their access to food and alternative habitats. Natural inflows under average and wet climate scenarios would deliver larger baseflows, and water for the environment may be delivered on top of these to achieve recommended low-flow magnitudes in some seasons to boost ecosystem productivity.

If more water becomes available, the next priorities under all scenarios will be to deliver winter/spring low flow and winter/spring freshes in all reaches. These flows 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 2023-24 water year is a priority under all scenarios for the *Wimmera and Glenelg Rivers Environmental Entitlement 2010*. Carryover is vital to ensure there is sufficient water to deliver the highest-priority flows during summer and autumn 2023-24 if there are low allocations during the year. A range of scenarios has been discussed for carryover targets under the entitlement. The VEWH will consult with the Wimmera and Glenelg Hopkins CMAs during the season and set a final target when there is sufficient information to do so. The target carryover volume for 30 June 2023 will be based on use during 2022-23, environmental conditions and seasonal outlooks for 2023-24.

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

Planning scenario	Drought	Very dry	Dry	Average	Wet
Expected river conditions	• No 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[1]	• 25,400 ML	• 32,300 ML	• 43,500 ML	• 54,600 ML	• 64,800 ML
Glenelg River (targeting reach 1a)					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• Summer/ autumn freshes (two freshes)	• 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)
	Tier 1b (supply deficit)				
	• Winter/spring low flow • Summer/ autumn low flow	• Winter/spring low flow • Summer/ autumn low flow • Summer/ autumn fresh (one additional fresh)	• Winter/spring low flow	• N/A	

Planning scenario	Drought	Very dry	Dry	Average	Wet
Glenelg River (targeting reach 1b)					
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 (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 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 2)					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• Summer/ autumn low flow (partial delivery)	• Summer/ autumn low flow	• 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 low flow (full delivery) • 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 freshes (two freshes)	• Winter/spring low flow • Winter/spring freshes (three freshes)	• Winter/spring low flow • Winter/spring freshes (five freshes)

Planning scenario	Drought	Very dry	Dry	Average	Wet
Glenelg River (targeting reach 3)					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• N/A			• Summer/ autumn freshes (two freshes)	• Summer/ autumn low flow • Summer/ autumn freshes (two 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 fresh (one fresh)	• Winter/spring low flow • Summer/ autumn low flow • Summer/ autumn freshes (two freshes)	• Winter/spring low flow • Summer/ autumn low flow	• Winter/spring low flow
Possible volume of water for the environment required to achieve objectives	• 6,962 ML (tier 1a) • 47,430 ML (tier 1b)	• 7,962 ML (tier 1a) • 44,528 ML (tier 1b)	• 11,440 ML (tier 1a) • 38,979 ML (tier 1b)	• 16,460 ML (tier 1a) • 38,183 ML (tier 1b)	• 21,327 ML (tier 1a) • 25,778 ML (tier 1b)
Priority carryover requirements[1]	• 14,000 ML	• 19,000 ML	• 23,000 ML	• 28,000 ML	• 32,000 ML

1 Volume applies to the shared Wimmera and Glenelg Rivers Environmental Entitlement 2010.

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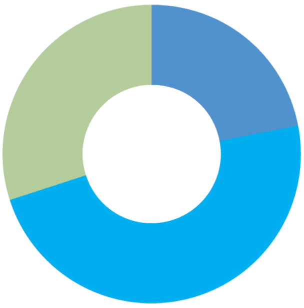
4.3 Wimmera system

Waterway manager – Wimmera Catchment Management Authority

Storage manager – GWMWater

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

Proportions of water entitlements in the Wimmera-Mallee System Headworks held by private users, water corporations and environmental water holders on 30 June 2020



Wimmera

Private	22%
Environment	48%
Water corporations	30%

The Wimmera-Mallee System Headworks captures run-off 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.

System overview

Barringgi Gadyin **(Wimmera River) rises in the Pyrenees Ranges 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 — Bungalally Creek and the Wimmera River below Mount William Creek — can receive water for the environment. In exceptionally wet periods, Lake Hindmarsh will overflow into Outlet Creek and on to Lake Albacutya, an internationally recognised Ramsar-listed wetland. There are numerous wetlands beyond Lake Albacutya 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 flow 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.

Two wetlands in the Wimmera system are also included in the environmental watering program.

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 run-off 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 the 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.

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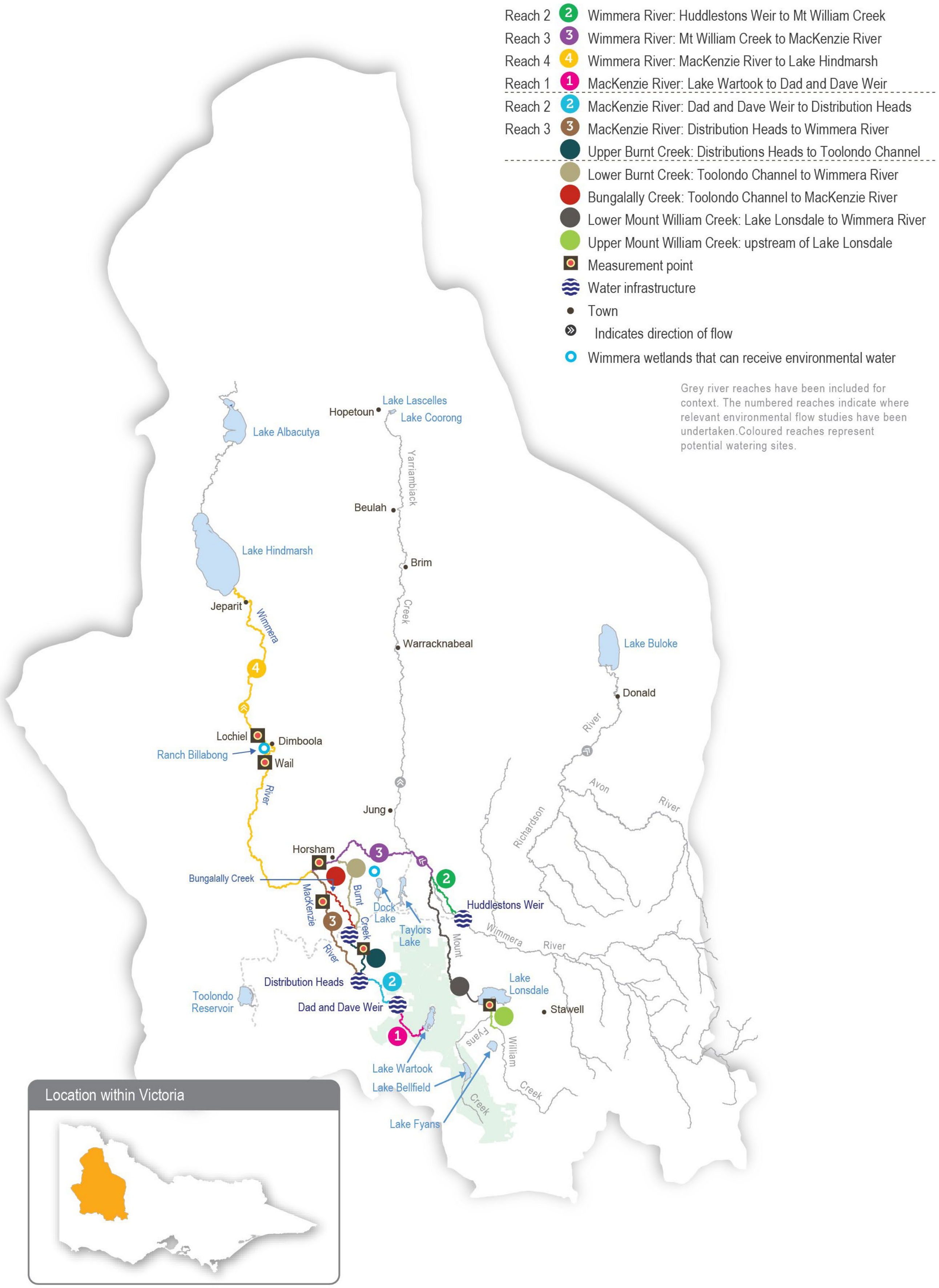
Figure 4.3.1 The Wimmera system



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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 confirmed 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, 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 flows) and provide refuge for these populations.

Vegetation along Burnt and Bungalally creeks provides habitat corridors for terrestrial wildlife. Upper Burnt Creek contains an important native fish community and a population of threatened western swamp crayfish, which is also becoming established in lower Burnt Creek. Mount William Creek supports regionally important populations of obscure galaxias, 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 system

Icon	Environmental objectives in the Wimmera system
	Protect and increase populations of native fish, including one of Victoria's few self-sustaining populations of freshwater catfish
	Maintain the frog population by providing feeding and breeding habitat
	Maintain channel capacity and diversity 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 Nations, 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 the planning and management of environmental flows and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* and in some cases, agreements under the *Traditional Owner Settlement Act 2010*.

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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 their contribution and indicating progress towards deeper involvement.

	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 Nations, work in partnership to provide Aboriginal environmental outcomes at Ranch Billabong. The delivery of water for the environment at Ranch Billabong aims to return to a more natural flooding regime, restore indigenous plant species (such as old man weed and sneezeweed) 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 in each of the last four years: 2018, 2019, 2020 and 2021. 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 has controlled weed species and enhanced accessibility by building walking tracks and culvert crossings around the billabong. More projects are planned for the future. 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 supporting small business, including chartered river cruises, pop-up food vendor caravans and general visitation)
- socioeconomic benefits (such as for diverters for irrigation, stock needs and domestic use: water levels and water quality can rely on the delivery of water for the environment, particularly in summer).

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 and above-average temperatures during 2021-22. This follows a run of four very dry years for the region. Consistent rainfall from the start of winter 2021 delivered unregulated flows from the upper catchment between June and December, which was the longest continuous period of unregulated flows in the Wimmera system since 2016. Inflows to storages to the end of January 2022 totalled 73,340 ML. This was slightly more than in recent years, but it did not significantly boost storage levels across the whole Wimmera-Mallee System Headworks. The exception was Lake Wartook, where storage levels increased to their highest level since 2017, so drought contingency plans were not required for the first time since 2018. The *Wimmera and Glenelg Rivers Environmental Entitlement 2010* received 59 percent allocation to May 2022. The CEWH did not receive any allocation in the Wimmera system for the fifth year in a row, and carryover from previous years was exhausted in 2019-20.

The Wimmera system was managed in line with a dry climate scenario through 2021-22, with an emphasis on conserving water for carryover given low storage levels. All planned watering actions for the Wimmera River and Burnt Creek were largely met during 2021-22. Passing flows from Huddleston's Weir delivered most of the required winter/spring low flows and small freshes that connected the length of the Wimmera River. A rain event in November 2021 generated a short pulse of 300-400 ML per day at Glenorchy, which reportedly triggered spawning behaviour by golden perch and silver perch downstream

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of Horsham Weir. Unregulated flow met most of the planned water requirements in Burnt Creek through winter and spring, and water for the environment was used to maintain refuge habitats in the system from December onwards. Water for the environment was also used to meet planned watering actions in Ranch Billabong.

Planned watering actions in the MacKenzie River and Mount William Creek were only partially met in 2021-22 due to the limited availability of water for the environment in Lake Wartook and poor water quality in Lake Lonsdale. Water for the environment was used to deliver a minimum flow to maintain refuge pools in the MacKenzie River through summer and autumn, and accumulated passing flows were delivered from Lake Lonsdale to top up refuge pools in Lower Mount William Creek from February 2022. The inability to achieve planned watering actions in certain reaches increases the stress on environmental values in much of the Wimmera system. Without significant and sustained natural flows and increased allocations to environmental flow entitlements, the risks to environmental values in the Wimmera system will remain very high.

Scope of environmental watering

Table 4.3.1 describes the potential environmental watering actions in 2022-23, 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

Potential environmental watering action	Expected watering effects	Environmental objectives
Wimmera River (reach 4)		
Winter/spring low flow (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 four 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	
Medium winter/spring fresh(es) (one to three freshes of 200 ML/ day for one to three days during June to November)	• Provide variable flow during the high-flow season for fish movement • Provide flow variability to maintain water quality and diversity of fish habitats • Wet lower benches, entrain organic debris and maintain habitat for waterbugs and fish	
Summer/autumn low flow (15 ML/day or natural during December to May)	• Maintain edge habitats in deeper pools and in-stream habitat to support native fish populations and waterbugs • Maintain soil moisture for streamside vegetation and near-permanent inundated stream channel for aquatic vegetation and prevent the growth of terrestrial plants in the stream bed	
Summer/autumn fresh(es) (one to three freshes of 70 ML/day for two to seven 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
MacKenzie River (reach 3)		
Winter/spring low flow (10 ML/day or natural)	• Maintain edge habitats and deeper pools and runs for waterbugs and platypus • 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	
Winter/spring fresh(es) (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	
Summer/autumn low flow (10 ML/day or natural)	• Maintain edge habitats and deeper pools and runs for waterbugs and platypus • 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	
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		
Winter/spring low flow (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	
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	
Summer/autumn low flow (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	
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	

Potential environmental watering action	Expected watering effects	Environmental objectives
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 fresh (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	
Upper Mount William Creek		
Top-up of pools (summer/autumn)	• Maintain edge and shallow-water habitat for native fish and waterbugs • Maintain water quality	
Lower Mount William Creek		
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	
Dock Lake		
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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Ranch Billabong		
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 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 specific ecological objectives in the different rivers and creeks. If dry conditions continue in the Wimmera system, the nature of deliveries of water for the environment 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, Bungalally Creek and Burnt Creek (that rely on water from Lake Wartook and Moora Moora Reservoir) and for lower Mount William Creek (which relies on water from Lake Lonsdale).

Wimmera River

The highest-priority potential watering actions in the Wimmera River under all climate scenarios are winter/spring and summer/autumn low flows. These actions are vital to maintaining water levels and water quality in refuge pool habitat for native fish. Under the driest scenarios, low flows will be delivered intermittently and at lower magnitudes due to low water availability. The primary objective under drought and very dry conditions will be to minimise the loss of aquatic plants and animals. In a dry scenario, there should be enough water to deliver low flows for part of each season and some small freshes to mitigate elevated salinity and maintain the current condition of native fish populations. Under average and wet climate scenarios, there should be enough environmental flow and natural catchment flow to deliver continuous low flow throughout each season, as well as some larger, longer-duration freshes to boost 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 River. Such flows are vital to protect populations of native fish, platypus and crayfish that have re-established since the Millennium Drought. Under drought to dry scenarios, low flows will be delivered for as long as possible, and freshes may be delivered at less than the target magnitudes to maintain critical habitats while conserving water. Under average and wet conditions, water for the environment will be used to increase flowing habitat in both systems and deliver more frequent freshes in the MacKenzie River, to improve the health of aquatic and emergent vegetation and native fish communities. 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, thereby growing the populations and increasing their genetic diversity. Watering actions for reach 3 of the MacKenzie River typically provide suitable flows to meet objectives in reach 2, but if extremely dry conditions prevent deliveries to reach 3, then small volumes will be delivered in reach 2 to support populations of sensitive species, including river blackfish.

A bankfull flow may be delivered to Bungalally Creek and Burnt Creek under average and wet climate scenarios to improve the health of streamside vegetation. This flow can only be delivered during periods of high flow throughout the system, so it is not considered under drier climate scenarios.

Mount William Creek

Poor water quality (in particular high salinity levels) and low water availability in Lake Lonsdale are likely to prevent the achievement of most recommended watering actions in lower Mount William Creek under drought and very dry climate scenarios. Any available water under these scenarios will be used to deliver low flows for as long as possible and small freshes to the section of lower Mount William Creek near the lake outlet. Water from Lake Fyans may be used 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 affected by multiple years of below-average flow and extended cease-to-flow conditions.

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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 flow objectives for Dock Lake require large volumes of water that can only be achieved with significant contributions from natural events, so delivering water for the environment is only a priority at Dock Lake under wet conditions.

Reserving water for carryover into the 2023-24 water year is a priority under all scenarios. Carryover is vital to ensure sufficient water to deliver the highest-priority flows during summer and autumn 2023-24 if there are low allocations during the year. A range of scenarios has been discussed for carryover targets under the Wimmera and Glenelg rivers environmental entitlement. The VEWH will consult with the Wimmera and Glenelg Hopkins CMAs during the season and set a final target when there is sufficient information to do so. The target carryover volume for 30 June 2023 will be based on use during 2022-23, environmental conditions and seasonal outlooks for 2023-24.

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

Planning scenario	Drought	Very dry	Dry	Average	Wet
Expected river conditions	• Infrequent, unregulated flow for reach 2 of the MacKenzie River, upper Burnt Creek and lower Mt William Creek • Regulated releases provide flows at other times and locations	• Periodic, unregulated flow for reach 2 of the MacKenzie River, upper Burnt Creek and lower Mt William Creek • Regulated releases provide flows at other times and locations	• Periodic, unregulated flow for reach 2 of the MacKenzie River, upper Burnt Creek and lower Mt William Creek • Regulated releases provide flows at other times and locations, apart from modest passing flow	• Regular, unregulated flow for reach 2 of the MacKenzie River, upper Burnt Creek and lower Mt William Creek • Reasonable passing flow and unregulated releases for the Wimmera River and lower Mt William Creek • Regulated releases provide flows at other times and locations	• Regular, unregulated flow for reach 2 of the MacKenzie River, upper Burnt Creek and lower Mt William Creek • Frequent passing flow and unregulated releases for the Wimmera River and lower Mt William Creek • Regulated releases provide flows at other times and locations
Predicted supply of water for the environment[1]	• 25,400 ML	• 32,300 ML	• 43,500 ML	• 54,600 ML	• 64,800 ML

Planning scenario	Drought	Very dry	Dry	Average	Wet
Wimmera River (targeting reach 4)					
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 (one month) • Summer/ autumn low flow (two months)	• Winter/spring low flow (two months) • Small winter/ spring fresh (one fresh) • Summer/ autumn low flow (three months) • Summer/ autumn freshes (two freshes)	• Winter/spring low flow (four months) • Small winter/ spring freshes (three freshes) • Summer/ autumn low flow (four months) • Summer/ autumn freshes (two freshes)	• Winter/spring low flow (four months) • Small winter/ spring freshes (three freshes) • Medium winter/ spring freshes (two freshes) • Summer/ autumn low flow (four months) • Summer/ autumn freshes (three freshes)
	Tier 1b (supply deficit)				
	• Winter/spring low flow (increased duration) • Small winter/ spring fresh (one fresh) • Summer/ autumn low flow (increased duration) • Summer/ autumn fresh (one fresh)	• Winter/spring low flow (increased duration) • Small winter/ spring fresh (one fresh) • Summer/ autumn low flow (increased duration) • Summer/ autumn fresh (one fresh)	• Winter/spring low flow (increased duration) • Small winter/ spring freshes (three freshes) • Medium winter/ spring freshes (two freshes) • Summer/ autumn low flow (increased duration)	• Winter/spring low flow (increased duration) • Small winter/ spring freshes (five freshes) • Medium winter/ spring freshes (two freshes) • Summer/ autumn low flow (increased duration)	• Winter/spring low flow (increased duration) • Small winter/ spring freshes (two freshes) • Medium winter/ spring fresh (one fresh) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (two freshes)

Planning scenario	Drought	Very dry	Dry	Average	Wet
MacKenzie River (targeting reach 3)[2]					
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)	• Winter/spring low flow (two months) • Summer/ autumn low flow (one month) • Summer/ autumn freshes (four freshes)	• Winter/spring low flow (two months) • Summer/ autumn low flow (two months) • Summer/ autumn freshes (four freshes)	• Winter/spring low flow (four months) • Winter/spring fresh (one fresh) • Summer/ autumn low flow (four months)	• Winter/spring low flow (four months) • Winter/spring fresh (one fresh) • Summer/ autumn low flow (four months) • Summer/ autumn fresh (one fresh)
	Tier 1b (supply deficit)				
	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (three freshes, full magnitude)	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (three freshes, full magnitude)	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (three freshes, full magnitude)	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (four freshes)	• Winter/spring low flow (increased duration) • Winter/spring freshes (five freshes) • Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (four freshes)

Planning scenario	Drought	Very dry	Dry	Average	Wet
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 (four months)	• Winter/spring low flow (one month) • Summer/ autumn low flow (four months)	• Winter/spring low flow (one month) • Summer/ autumn low flow (four months)	• Winter/spring low flow • Winter/spring freshes (five freshes, small) • Summer/ autumn low flow (four months)	• Winter/spring low flow • Winter/spring freshes (five freshes, small) • Summer/ autumn low flow (four months)
	Tier 1b (supply deficit)				
	• 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)	• Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (three freshes)	• Summer/ autumn low flow (increased duration) • Summer/ autumn freshes (three freshes)

Planning scenario	Drought	Very dry	Dry	Average	Wet
Lower Burnt Creek					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• N/A			• Bankfull fresh	
Bungalally Creek					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• N/A			• Bankfull fresh	
Upper Mount William Creek					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• Top-ups				
Lower Mount William Creek					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• N/A			• Year-round low flow • Summer/ autumn freshes (three freshes)	• Year-round low flow • Winter/spring fresh (one fresh) • Summer/ autumn freshes (three freshes)
Potential environmental watering – tier 1 (high priorities)	**Tier 1b (supply deficit)**				
	• Year-round low flow • Summer/ autumn freshes (three freshes)	• Year-round low flow • Summer/ autumn freshes (three freshes)	• Year-round low flow • Summer/ autumn freshes (three freshes)	• Year-round low flow (increased duration) • Summer/ autumn freshes (increased duration)	• Year-round low flow (increased duration) • Winter/spring freshes (four freshes) • Summer/ autumn freshes (increased duration)
Dock Lake					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**				
	• N/A				• Winter/spring Partial fill

Planning scenario	Drought	Very dry	Dry	Average	Wet
Ranch Billabong					
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)** • Top-ups (winter/spring and summer/autumn) (one winter and one autumn top-up after drawing down if needed)				
Possible volume of water for the environment required to achieve objectives	• 6,990 ML (tier 1a) • 29,560 ML (tier 1b)	• 7,990 ML (tier 1a) • 28,560 ML (tier 1b)	• 11,490 ML (tier 1a) • 26,440 ML (tier 1b)	• 16,490 ML (tier 1a) • 21,370 ML (tier 1b)	• 21,490 ML (tier 1a) • 24,570 ML (tier 1b)
Priority carryover requirements[1]	• 14,000 ML	• 19,000 ML	• 23,000 ML	• 28,000 ML	• 32,000 ML

1 Volume applies to the shared *Wimmera and Glenelg Rivers Environmental Entitlement 2010*.
2 Potential watering actions ta rgeting reach 3 of the MacKenzie River will also benefit reach 2.

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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

System overview

The Wimmera-Mallee wetlands include 52 sites on public and private land spread across north-west Victoria (Figure 4.4.1). From the early 20th century 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 largely agricultural 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.

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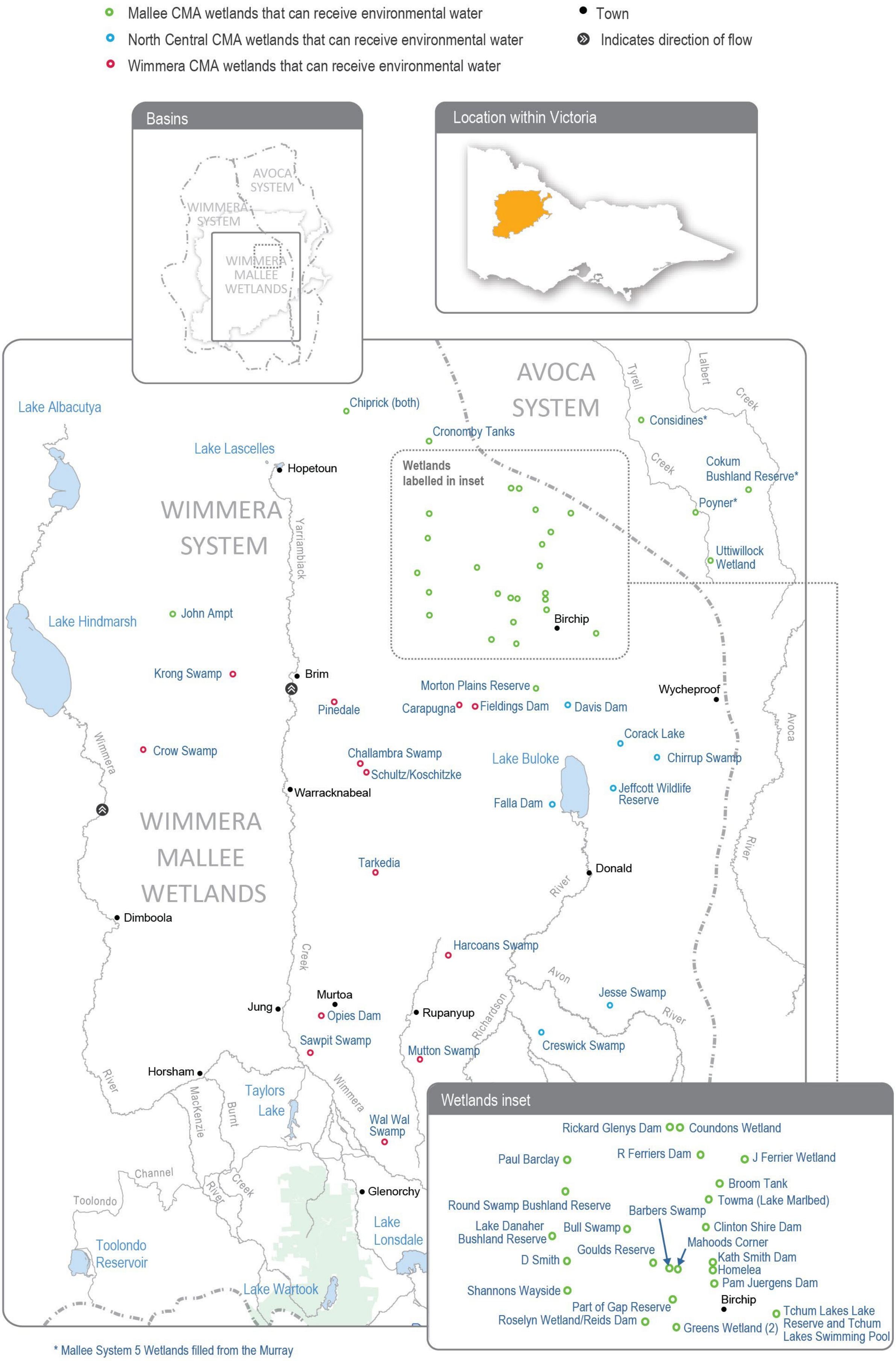
Figure 4.4.1 The Wimmera-Mallee wetlands



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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 support native waterbird populations, including brolgas, egrets, blue-billed ducks, freckled ducks, Australian painted snipes and glossy ibis. The vulnerable growling grass frog, turtles and many other native animals may use the wetlands as drought refuges and drinking holes. Rare and vulnerable vegetation species (such as spiny lignum, ridged water-milfoil, chariot wheels and cane grass (*Eragrostis australasica*)) are also present in some wetlands.

Environmental watering objectives in the Wimmera-Mallee wetlands

Icon	Environmental 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

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 Barapa Barapa Traditional Owners and other Traditional Owner groups represented by the Barengi Gadjin Land Council and the Dja Dja Wurrung Clans Aboriginal Corporation (trading as DJAARA). 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 peoples.

In recent years, Barengi Gadjin Land Council Aboriginal Water Officers and Wimmera CMA have undertaken monitoring at Sawpit Swamp, Wal Wal Swamp, Carapugna and Mutton Swamp helping to understand environmental flow deliveries and values at the sites.

Barengi Gadjin Land Council and North Central CMA have discussed opportunities for projects that facilitate reconnection with and healing of Country. Recent meetings have highlighted several areas where collaboration is possible including on-Country events and revegetation projects. In 2022, Barengi Gadjin Land Council and North Central CMA are intending to undertake cultural values assessments at the Wimmera Mallee Pipeline wetland sites.

The Barengi Gadjin Land Council has discussed the significance of the wetlands and their aspiration to undertake work at these sites in future, and 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 (pers. comm. Barengi Gadjin Land Council, April 2021).

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Further discussions with Barengi Gadjin Land Council are forthcoming regarding the cultural values and uses in and around the Wimmera Mallee Pipeline wetlands (within the Mallee catchment), with an onsite visit planned for May 2022 (during the drafting of this plan).

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 2021-22, but inflows to storages in the Wimmera-Mallee System Headworks were low and did little to replenish storage levels that have been depleted by five consecutive dry years. The Wimmera-Mallee Pipeline wetland environmental entitlement received a one percent allocation as at early May 2022 for the 2021-22 water year. All deliveries of water for the environment to the wetlands in 2021-22 were supplied with water carried over from previous years.

Deliveries of water for the environment to the Wimmera-Mallee wetlands during 2021-22 were made in line with a drought climate scenario. Watering objectives for 2021-22 were almost all achieved through planned watering actions, which were achieved at 37 out of 39 target wetlands during the year. Some wetlands received water once during the season, while others received additional top-ups to maintain their water-dependent values. The only target wetlands not watered were Krong Swamp and Opie's Dam in the Wimmera CMA region.

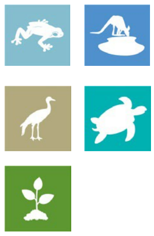
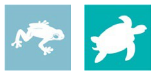
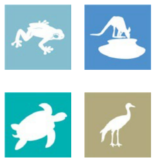
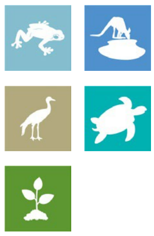
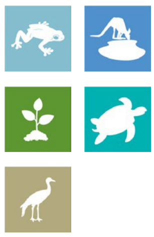
Incidental surveys at the Wimmera-Mallee wetlands found that water for the environment provided watering, feeding and breeding habitat for many animals (such as eastern long-necked turtles, frogs, yabbies, rainbow bee-eaters, ducks, grebes and other water and woodland birds and terrestrial species). Many wetlands had a noticeable new growth of aquatic and semi-aquatic plants, including nardoo, water-milfoil, water ribbons and cane grass. Fringing plant species, including black box, chariot wheels (a nationally threatened forb species) and lignum had new canopy growth and greater abundance at some watered wetlands. If dry conditions continue in 2022-23, 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

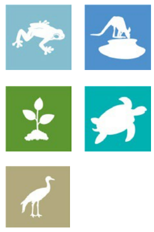
Table 4.4.1 describes the potential environmental watering actions in 2022-23, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

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

Potential environmental watering action	Expected watering effects	Environmental objectives
Mallee wetlands		
Barbers Swamp Bull Swamp Goulds Reserve Homelea 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Cokum Bushland Reserve	• 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	
Part of Gap Reserve		
Rickard Glenys Dam		
Broom Tank	• 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	
Clinton Shire Dam		
Greens Wetland		
J Ferrier Wetland		
Considines	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs and turtles	
Cronomby Tanks		
Newer Swamp	• Stimulate the growth of aquatic and fringing vegetation and allow the plants, including black box and lignum, to complete their life cycles	
Chiprick	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbirds, turtles and terrestrial species	
Coundons Wetland		
D Smith Wetland		
John Ampt		
Kath Smith Dam		
Mahoods Corner		
Pam Juergens Dam		
Paul Barclay		
Poyner		
R Ferriers Dam		
Shannons Wayside		
Roselyn 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	
Uttiwillock Wetland		
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	

Potential environmental watering action	Expected watering effects	Environmental objectives
North central wetlands		
Chirrup Swamp	• Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, waterbirds and turtles	
Corack Lake	• Provide a permanent water source for refuge and nursery habitat for turtles and frogs • Maintain varying depths of water to support aquatic and fringing plants' life cycles • Maintain varying depths of water to support a variety of feeding habitats for waterbirds	
Creswick Swamp	• Maintain varying depths of water to support the life cycle of aquatic plants • 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 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 the deeper pool section of the wetland for refuge and to support feeding and breeding opportunities for waterbirds and terrestrial species • Provide a semi-permanent water source to support refuge and feeding and breeding opportunities for frogs and to support feeding and breeding opportunities for waterbirds and terrestrial species • Maintain varying depths of water to support the life cycles of aquatic and fringing plants	
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 deep water in the spring • Stimulate aquatic and fringing vegetation growth in winter/spring	
Jeffcott Wildlife Reserve	• Maintain a minimum depth of water to support the life cycles of aquatic plants • Provide a permanent water source for refuge and to support feeding and breeding opportunities for frogs, 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	
Wimmera wetlands		

Potential environmental watering action	Expected watering effects	Environmental objectives
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/Koschitzke		
Tarkedia Dam		
Wal Wal Swamp		

Scenario planning

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

The potential watering actions for 2022-23 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 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 that supplies the wetlands in the Wimmera-Mallee wetland system are 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 2023-24 water year will be a priority under all scenarios to ensure sufficient water is available to support critical environmental demands in 2023-24 and beyond. The volume carried over against the Wimmera-Mallee Pipeline wetlands environmental entitlement will be decided in consultation with the North Central, Mallee and Wimmera CMAs during the year. It will be based on use during 2022-23, climactic conditions and seasonal allocation outlooks for 2023-24.

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

Planning scenario	Drought	Dry	Average	Wet
Predicted supply of water for the environment	• 256 ML	• 273 ML	• 566 ML	• 1,375 ML

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 1 (high priorities)	• Barbers Swamp • Broom Tank • Bull Swamp (Bulls Swamp) • Carapugna • Challambra Swamp • Chiprick (both) • Chirrup Swamp • Clinton Shire Dam • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland (2) • Harcoans Swamp • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • Kath Smith Dam • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp (Round Swamp) • Opies Dam • Pam Juergens Dam • Part of Gap Reserve (Stephen Smith Dam) • Pinedale • Poyner • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/ Reids • Dam Schultz/ Koschitzke	• Barbers Swamp • Broom Tank • Bull Swamp (Bulls Swamp) • Carapugna • Challambra Swamp • Chiprick (both) • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland (2) • Harcoans Swamp • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp (Round Swamp) • Opies Dam • Pam Juergens Dam • Part of Gap Reserve (Stephen Smith Dam) • Paul Barclay • Pinedale • Poyner • R Ferriers Dam • Rickard Glenys Dam	• Barbers Swamp • Broom Tank • Bull Swamp (Bulls Swamp) • Carapugna • Challambra Swamp • Chiprick (both) • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland (2) • Harcoans Swamp • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp (Round Swamp) • Opies Dam • Pam Juergens Dam • Part of Gap Reserve (Stephen Smith Dam) • Paul Barclay • Pinedale • Poyner • R Ferriers Dam • Rickard Glenys Dam	• Barbers Swamp • Broom Tank • Bull Swamp (Bulls Swamp) • Carapugna • Challambra Swamp • Chiprick (both) • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve • Considines • Corack Lake • Coundons Wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland (2) • Harcoans Swamp • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp (Round Swamp) • Opies Dam • Pam Juergens Dam • Part of Gap Reserve (Stephen Smith Dam) • Paul Barclay • Pinedale • Poyner • R Ferriers Dam • Rickard Glenys Dam

Planning scenario	Drought	Dry	Average	Wet
	• Shannons Wayside • Tarkedia Dam Tchum • Lakes Lake Reserve (North Lake - wetland) • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp	• Roselyn Wetland/ Reids Dam • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - wetland) • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp	• Roselyn Wetland/ Reids Dam • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - wetland) • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp	• Roselyn Wetland/ Reids Dam • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - wetland) • Towma (Lake Marlbed) • Uttiwillock Wetland • Wal Wal Swamp
Possible volume of water for the environment required to achieve objectives	• 119 ML	• 156 ML	• 213 ML	• 279 ML

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Section 5
Northern region

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, 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 have an intrinsic connection to Country that has endured for tens of thousands of years. This includes inherent rights and cultural obligations to Country and community.

The Traditional Owner groups in and around northern Victoria include Barapa Barapa, Bangerang, Duduroa/Dhudhuroa, Latji Latji, Ngintait, Nyeri Nyeri, Taungurung, Tati Tati, Wadi Wadi, Wamba Wemba, Waywurru, Weki Weki, Yorta Yorta and Yaithmathang. The Dja Dja Wurrung Clans Aboriginal Corporation (trading as DJAARA), 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, DJAARA entered into a recognition and settlement agreement under the *Traditional Owner Settlement Act 2010* in Victoria. Under the agreement, DJAARA has rights to access and use water for traditional purposes. This agreement also requires traditional ecological knowledge be incorporated into planning and policy decisions. DJAARA is continually building capacity to provide greater, more meaningful input into seasonal watering plans and to play a greater role in the administering of environmental water.

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 2020, the *Barmah National Park Joint Management Plan*, prepared by the Yorta Yorta Traditional Owner Land Management Board, was publicly released. The plan guides the strategic management of Barmah National Park over the next 10 years.

In 2020, the Victorian Government and the Taungurung Land and Waters Council Aboriginal Corporation and Taungurung Traditional Owner group entered a recognition and settlement agreement (signed in 2018), under the *Traditional Owner Settlement Act 2010*.

In the context of Treaty negotiations in Victoria and the Victorian Government commitment to self-determination for First Nations, program partners in the environmental watering program are aware that structural changes to how water is managed (e.g. legislative, policy and/or governance changes) may be made in the future in recognition of Aboriginal water rights. Program partners have been hearing for many years that Traditional Owners want empowerment and agency in water management, and in many cases want to manage water on Country on their own terms.

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Engagement

Seasonal watering proposals are informed by community and program partner engagement, including Traditional Owner engagement. Program partners and communities help to identify priorities and opportunities for the delivery of water for the environment for the coming year.

Longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flows studies), environmental water management plans and Traditional Owner Country Plans (and associated documents) also inform seasonal watering proposals. These strategies, plans and technical reports collectively describe a range of environmental, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence priorities for and the delivery of water for the environment.

The VEWH and its program partners consider cultural, social, economic and recreational values and uses of waterways when planning to deliver water for the environment. Where possible, opportunities to support these values and uses are incorporated into watering decisions, provided they do not compromise environmental outcomes. Cultural, social, economic, and recreational values considered for each system in the northern region are presented in the system sections that follow.

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 planning process for water for the environment. 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 each waterway manager has engaged when preparing seasonal watering proposals for the waterways under their authority. 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 seasonal watering proposals by CMAs.

The tables also show the level of engagement between waterway managers and stakeholders of the environmental watering program in the northern region based on their interpretation of the IAP2 Spectrum.

The level of engagement differs between organisations and between systems, depending on the availability, capacity or interest of stakeholders to participate, roles and responsibilities of organisations in managing a site or system, and potential interaction of proposed watering with other activities on the waterway. For example, 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 to a greater extent than it does with other local governments in areas that receive environmental flows but do not have direct responsibilities.

External factors also influence engagement opportunities. COVID-19 restrictions restricted engagement efforts across the northern region, reducing opportunities for face-to-face meetings with the community and Traditional Owners.

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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 Broken Wetland Advisory Group members • Goulburn Murray Landcare • Goulburn Valley Environment Group • Turtles Australia	**IAP2 level: Consult** • Goulburn Valley Environment Group	**IAP2 level: Consult** • Goulburn Murray Landcare Network • Goulburn Valley Environment Group • Turtles Australia	**IAP2 level: Consult** • Goulburn Murray Landcare Network • Goulburn Valley Environment Group • Turtles Australia	**IAP2 level: Consult** • Goulburn Valley Environment Group **IAP2 level: Inform** • Broken Boosey Conservation Management Network • Broken Creek Field Naturalists Club • Goulburn Murray Landcare Network	**IAP2 level: Involve** • Goulburn Valley Environment Group **IAP2 level: Inform** • Broken Boosey Conservation Management Network • Broken Creek Field Naturalists Club • Goulburn Murray Landcare Network

	Barmah Forest	Goulburn system	Goulburn wetlands	Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
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 • NSW National Parks and Wildlife Service • Parks Victoria	**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 • Victorian Fisheries Authority	**IAP2 level: Inform** • Victorian Fisheries Authority	**IAP2 level: Inform** • Victorian Fisheries Authority	**IAP2 level: Inform** • Victorian Fisheries Authority	**IAP2 level: Inform** • Victorian Fisheries Authority	**IAP2 level: Inform** • Moira Shire Council • Victorian Fisheries Authority
Landholders/farmers	**IAP2 level: Consult** • None in Victoria (NSW consults with Bullatale Creek landholders)	**IAP2 level: Consult** • 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: Involve** • Individual landholders who are on the Broken Environmental Water Advisory Group	**IAP2 level: Involve** • Individual landholders who are on the Broken Environmental Water Advisory Group

	Barmah Forest	Goulburn system	Goulburn wetlands	Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
Local businesses	**IAP2 level: Consult** • Trellys Fishing and Hunting	**IAP2 level: Consult** • Local ecotourism operator • Trellys Fishing and Hunting	**IAP2 level: Consult** • Trellys Fishing and Hunting	**IAP2 level: Consult** • Trellys Fishing and Hunting		
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: Involve** • Individual community members on the Broken Environmental Water Advisory Group **IAP2 level: Inform** • Nathalia Angling Club • Numurkah Fishing Club
Technical experts		**IAP2 level: Consult** • Goulburn to Murray Trade Rule Review Scientific Advisory Panel • Scientific leads from the CEWO Monitoring, Evaluation and Research Program – Goulburn River	**IAP2 level: Consult** • Arthur Rylah Institute • Rakali Consulting • Scientists and consultants on the Goulburn Broken Wetland Technical Reference Group • Water's Edge Consulting	**IAP2 level: Consult** • Arthur Rylah Institute • Rakali Consulting • Scientists and consultants on the Goulburn Broken Wetland Technical Reference Group • Water's Edge Consulting		
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: Involve** • Taungurung Land and Waters Council • Yorta Yorta Nation Aboriginal Corporation

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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)

	Hattah Lakes	Lower Murray wetlands	Lindsay, Mulcra and Wallpolla islands
Community groups and environment groups	**IAP2 level: Consult** • Mallee CMA Land and Water Advisory Committee • Mallee Conservation and Landcare Group • Mid-Murray Field Naturalists • OzFish Unlimited	**IAP2 level: Inform** • Lindsay Point Landcare Group • Millewa-Carwarp Landcare Group **IAP2 level: Consult** • OzFish Unlimited • Mallee CMA Land and Water Advisory Committee	**IAP2 level: Inform** • Lindsay Point Landcare Group • Millewa-Carwarp Landcare Group **IAP2 level: Consult** • OzFish Unlimited • Mallee CMA Land and Water Advisory Committee
Government agencies	**IAP2 level: Collaborate** • Parks Victoria	**IAP2 level: Collaborate** • Lower Murray Water • NSW Department of Planning, Industry and Environment • Parks Victoria	**IAP2 level: Collaborate** • NSW Department of Planning, Industry and Environment • Parks Victoria
	IAP2 level: Involve • Lower Murray Water – Victorian Murray Floodplain Restoration Project Team	**IAP2 level: Involve** • Victorian Murray Floodplain Restoration Project Team	**IAP2 level: Involve** • Lower Murray Water – Victorian Murray Floodplain Restoration Project Team
	IAP2 level: Consult • Goulburn-Murray Water		**IAP2 level: Consult** • SA Water
	IAP2 level: Inform • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Mildura Rural City Council • Murray-Darling Basin Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Mildura Rural City Council • Swan Hill Rural City Council	**IAP2 level: Inform** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Mildura Rural City Council • Murray-Darling Basin Authority • Victorian Fisheries Authority

	Hattah Lakes	Lower Murray wetlands	Lindsay, Mulcra and Wallpolla islands
Landholders/farmers	**IAP2 level: Inform** • Landholders and farmers who live around the Hattah Lakes	**IAP2 level: Collaborate** • Landholders and farmers who live around the lakes Powell and Carpul • Landholders and farmers who live around Robertson Creek and Wetland **IAP2 level: Inform** • Landholders and farmers who live around Heywood Lake and Little Lake Heywood • Neighbouring landholders • Landholders and farmers who live around Nyah Floodplain	**IAP2 level: Inform** • Lindsay Point irrigators • Neighbouring landholder
Local businesses	**IAP2 level: Inform** • Hattah Lakes Store • Mallee Tours • Mildura Visitor Information and Booking Centre • Murray Offroad Adventures • Victorian Apiarists' Association (Sunraysia branch) • Visit Mildura • Wildside Outdoors	**IAP2 level: Inform** • Mallee Tours • Mildura Visitor Information and Booking Centre • Murray Offroad Adventures • Victorian Apiarists' Association (Sunraysia branch) • Visit Mildura • Wildside Outdoors	**IAP2 level: Inform** • Lake Cullulleraine Store • Mallee Tours • Mildura Visitor Information and Booking Centre • Murray Offroad Adventures • Victorian Apiarists' Association (Sunraysia branch) • Visit Mildura • Wildside Outdoors
Recreational users	**IAP2 level: Inform** • BirdLife Mildura • Mildura 4WD Club • Sunraysia Bushwalkers Inc.	**IAP2 level: Inform** • BirdLife Mildura • Cabarita Community Inc. • Mildura 4WD club • Sunraysia Bushwalkers Inc.	**IAP2 level: Inform** • BirdLife Mildura • Mildura 4WD Club • Sunraysia Bushwalkers Inc.
Traditional Owners	**IAP2 level: Involve** • Traditional Owners, Elders and community members having connections with the Hattah Lakes region	**IAP2 level: Involve** • First People of the Millewa-Mallee Aboriginal Corporation • Traditional Owners, Elders and community members having connections with sites across the Murray wetlands region	**IAP2 level: Involve** • First People of the Millewa-Mallee Aboriginal Corporation • Local Aboriginal community

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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)

	Gunbower Creek and Forest	Central Murray wetlands	Campaspe system	Coliban River	Loddon system (including Boort wetlands)	Birchs Creek	Guttrum Forest
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** • Ashbourne Landcare • Echuca Moama Landcare Group • Strathallan Family Landcare	**IAP2 level: Consult** • Malmsbury and District Landcare Group	**IAP2 level: Inform** • Birdlife Australia • Little Lake Boort Management Committee • Turtles Australia • Water for Wetlands		

	Gunbower Creek and Forest	Central Murray wetlands	Campaspe system	Coliban River	Loddon system (including Boort wetlands)	Birchs Creek	Guttrum Forest
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 • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Parks Victoria	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Coliban Water • Commonwealth Environmental Water Office	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Parks Victoria	**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 • NSW Forests • Parks Victoria • VicForests
	IAP2 level: Inform • Campaspe Shire Council • Gannawarra Shire Council • Victorian Fisheries Authority	**IAP2 level: Inform** • Victorian Fisheries Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Game Management Authority • Victorian Fisheries Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Game Management Authority • Victorian Fisheries Authority	**IAP2 level: Inform** • Victorian Fisheries Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning • Parks Victoria • Victorian Fisheries Authority	**IAP2 level: Inform** • Victorian Fisheries Authority

	Gunbower Creek and Forest	Central Murray wetlands	Campaspe system	Coliban River	Loddon system (including Boort wetlands)	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 landholders and community members	**IAP2 level: Inform** • Coliban Water's Rural Advisory Group • Individual landholders and community members	**IAP2 level: Inform** • Individual landholders and community members	**IAP2 level: Inform** • Individual landholders and community members	**IAP2 level: Inform** • Adjacent landholders/local community
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** • Field and Game • Boort Angling Club	**IAP2 level: Inform** • VRFish	
Technical experts	**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists	**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists	**IAP2 level: Collaborate** • Arthur Rylah Institute		**IAP2 level: Collaborate** • Arthur Rylah Institute • Vegetation, fish and bird ecologists		**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: Collaborate** • Barapa Barapa Traditional Owners • Wamba Wemba Traditional Owners • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Dja Dja Wurrung Clans Aboriginal Corporation • Taungurung Land and Waters Council **IAP2 level: Inform** • 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 • Wamba Wemba Traditional Owners	**IAP2 level: Consult** • Dja Dja Wurrung Clans Aboriginal Corporation	**IAP2 level: Collaborate** • Barapa Barapa Traditional Owners • Wamba Wemba Traditional Owners

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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 Department Sandhurst Diocese Limited
Technical experts	**IAP2 level: Involve** • Arthur Rylah Institute
Traditional Owners	**IAP2 level: Collaborate** • Bangerang Aboriginal Corporation • 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 of 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, bank erosion 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.

The following are examples of complementary programs that are likely to support environmental flow outcomes in the northern region.

A strategic action plan to protect floodplain marshes in Barmah Forest is being implemented. The plan identifies management actions to address key threats to the delicate floodplain vegetation. Specific actions include removing feral horses and other invasive animals and controlling invasive plants. Parks Victoria and the Yorta Yorta Nations jointly manage Barmah National Park.

Construction of fishways at Koondrook and Cohuna weirs in Gunbower Creek was completed in winter 2021, to provide migration opportunities for species such as the iconic Murray cod. These works complement fish screens that were installed in Gunbower Creek to reduce the number of native fish lost to irrigation channels.

Restoration of Australasian bittern habitat through revegetation of tall marsh vegetation communities is continuing in Guttrum Forest. Planting will coincide with a planned delivery of water for the environment to help tall marsh become established.

Plantings of native aquatic plants in lower Broken Creek are helping 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, see 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 flows for 2022-23 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

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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 flows 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 Planning and Environment.

What is River Murray Unregulated Flows (RMUF)?

River Murray Unregulated Flows (RMUF) is the remaining unregulated water in the Murray system once Victoria and New South Wales have exercised their rights to use unregulated flows. Unregulated flow events are formally declared by the Murray-Darling Basin Authority when there is more water in the river than is needed to meet demands or can be captured in storage at the time. The use of RMUF is coordinated by the Southern Connected Basin Environmental Watering Committee for environmental outcomes.

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.

Planning

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, turtles, 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 2022-23' on pages XX) 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). The Southern Connected Basin Environmental Watering Committee publish its annual operational scenarios for environmental flow coordination in the Murray River. 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.

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Delivery coordination and monitoring

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 Dam 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.

To assess the effectiveness of landscape-scale responses to environmental flows, the Southern Connected Basin Environmental Watering Committee developed the *River Murray Channel Monitoring Plan 2021-22 to 2025-26*. The plan focuses on productivity and fish indicators to inform the management of environmental flows. This monitoring complements site-based monitoring programs across the Murray system.

Water holder partnerships and collaboration

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 supports environmental objectives along the Murray system in Victoria, NSW and South Australia. The Southern Connected Basin Environmental Watering Committee recommends how the Living Murray allocation, RMIF and RMUF should be coordinated and used.

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 the Commonwealth's environmental Water Holdings to meet Victorian environmental flow objectives is included in relevant system sections in the following pages of this plan.

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, the 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 icon sites.

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 values 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 flows. Participants developed a statement on the use of water for the environment, and in April 2022, a Murray Lower Darling Rivers Indigenous Nations gathering started to refresh the statement for 2022-23.

The statement is yet to be finalised. When it is, it will be published on the VEWH website subject to approval by Traditional Owners.

The statement will be used to guide environmental flow planning for the 2022-23 water year, particularly through the Southern Connected Basin Environmental Watering Committee. The committee will work hand-in-hand with existing, site-based First Nations planning and delivery of water for the environment along the Murray. There is more information about this in the Traditional Owner cultural values and uses explanations in the following system sections.

Seasonal outlook 2022-23

Rainfall across most of northern Victoria in 2021-22 was close to or above the long-term average, and it was much greater than average in the north-east, especially in the upper Murray catchment. Mean maximum temperatures were average in the east and above average in the west of the region.

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Wet conditions through winter/spring caused Hume Dam to spill on multiple occasions and delivered frequent, small-to-medium-sized, unregulated flow events in the Murray River. Most Victorian tributaries (such as the Goulburn River) had small, unregulated flow events in winter/spring, although the Campaspe River downstream of Lake Eppalock largely missed out. The Murrumbidgee and lower Darling rivers in New South Wales were also wetter than usual, and they contributed significant flow to the Murray system. The combination of unregulated flows downstream of Hume Dam and inflows from Victorian and New South Wales tributaries created the largest and most sustained high flow in the Murray River since 2016, especially downstream of the Murray–Murrumbidgee junction. Water for the environment was delivered to rivers and wetlands across the region to help achieve watering actions needed to support native plants and animals under average to wet climate scenarios.

Due to prolonged, unregulated flows in the Murray River, very few inter-valley transfers (IVTs) were delivered from the Goulburn system during summer and autumn in 2021-22. This resulted in lower flows during the hotter months (which is a more natural situation), and it allowed some recovery of bank vegetation that has been damaged by high IVT flows in recent years. Ongoing limits on the delivery of IVTs to protect the environment are needed for the recovery of bank vegetation and protection of the banks to continue. The Victorian Government is reviewing and developing the Goulburn to Murray trade and operating rules to deliver IVTs while protecting the environment.

The climate outlook for June to August 2022 indicates there is a greater than 80 probability of exceeding median rainfall, while temperatures are more likely to be at or below the median. Above-median rainfall in responsive catchments during winter is likely to result in unregulated flow events in some systems. Environmental flows to rivers and floodplains may be delivered before, during or after unregulated flows to improve environmental outcomes.

The allocation outlook for 2022-23 provided by the Northern Victoria Resource Manager on 16 May 2022 indicated opening allocations at or above 52 percent for high-reliability water shares in the Murray, Goulburn/Loddon and Campaspe systems, and the manager predicted reaching 100 percent by mid-October under average to wet scenarios. The smaller Broken and Bullarook systems have less water in reserve, and they are more reliant on catchment conditions during winter/spring 2022 for increases. While carried-over water is less important than in recent years due to greater opening allocations in the larger systems, it is still needed to ensure sufficient early-season water is available to meet winter and early-spring demands. There is a relatively high risk of carryover being lost to spill in 2022-23, especially in the Victorian Murray system.

The high water availability forecast for 2022-23 means critical actions, including some larger floodplain watering events, can occur regardless of the climatic conditions. While some Murray floodplains received water in 2021-22, some parts of the floodplain have not been inundated since 2016-17. The permanent and semi-permanent wetlands of Gunbower Forest and the lakes within Hattah have received water for the environment in recent years, but the remainder of the floodplain has missed out. Gunbower Forest floodplain watering is planned to commence in June 2022 and continue into 2022-23, while water levels in the Hattah Lakes may be topped-up to target vegetation communities slightly higher on the floodplain. The higher parts of Barmah Forest that have remained dry in recent years are above current operational flow constraints, and they can only be watered by large, unregulated flow events.

The number of wetlands across northern Victoria likely to receive water for the environment in 2022-23 will depend on climatic conditions. More wetlands will be watered under average and wet scenarios to respond to ecological cues in the landscape (for example, waterbird breeding). Wetlands that are not likely to exceed their dry tolerance interval may not receive water under dry or drought scenarios. Some wetlands will be deliberately allowed to draw down and dry to support important dry-phase ecological processes unless they are inundated by a natural flood. High water availability means planned actions for rivers can be delivered under most scenarios, which should help to consolidate the environmental benefits of recent wet conditions and build resilience ahead of the next dry period.

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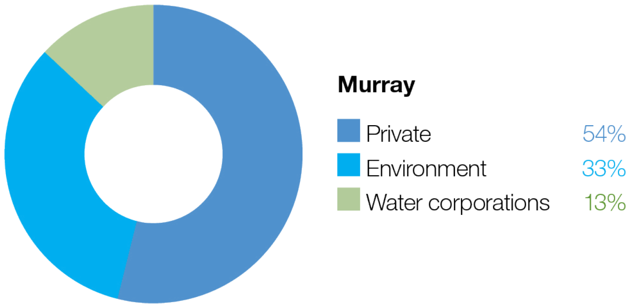
5.2 Victorian Murray system

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 and Water NSW

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

Proportions of water entitlements in the Victorian Murray system held by private users, water corporations and environmental water holders on 30 June 2020



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 North East, 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 the 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.

Victorian Murray system water availability

In 2021-22, allocations against high-reliability water shares reached 52 percent in August and 100 percent in October. Low-reliability water shares began receiving allocations in December and reached their full allocations in February. This is the first time Murray seasonal determinations reached maximum availability since the introduction of the current entitlement products in 2007. Spills from Hume Dam resulted in the deduction of most spillable carryover from 2020-21, as of 11 May 2022.

Prolonged periods of declared unregulated flow conditions in the Murray River enabled access to unregulated components of environmental entitlements and access to River Murray Unregulated Flows (RMUF). Victorian unregulated entitlements were primarily used to meet Murray floodplain demands at Gunbower, Hattah and the Lindsay Mulcra Wallpolla islands icon sites in spring, while RMUF was used for Murray River channel (Hume to the Coorong) water actions agreed by the Southern Connected Basin Environmental Watering Committee (SCBEWC). The strong resource position allowed the Barmah-Millewa Forest Environmental Water Account to be repaid much earlier in the year than normal, and it was used in combination with other holdings to meet Barmah-Millewa Forest demands in late winter and spring.

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Significant volumes were released from the Snowy system to the Murray system in 2021-22, which is likely to result in additional River Murray Increased Flows (RMIF) being available in the Murray system in May 2022. SCBEWC has the first option on RMIF, and it accepted 112,000 ML that it can use to meet Murray demands from June 2022 onwards and/or carry over into 2022-23.

Total water availability for the environment was high in 2021-22, with sufficient supply to meet planned Victorian Murray system demands and carryover needs for 2022-23. The high water availability allowed the VEWH to sell up to 12,000 ML of its allocation in autumn.

This summary covers water availability for all of the waterway systems described in section 5.2.

5.2.1 Upper Murray wetlands

System overview

The upper Murray wetlands are located on the Murray River floodplain between Lake Hume and Lake Mulwala. The wetland system includes the Ryans Lagoon wetland complex, which has two main lagoons: Ryans Lagoon 1 and Ryans Lagoon 2.

This is the first year the upper Murray wetlands have been included in the VEWH's seasonal watering plan and the first time water for the environment is planned to be delivered to the Ryans Lagoon wetland complex. The Ryans Lagoon wetland complex is a network of wetlands positioned downstream of the Lake Hume water storage and upstream of the Kiewa River confluence with the Murray River.

Flows into the complex are mainly influenced by regulated releases from Lake Hume, which travel via Ryans Creek, an anabranch of the Murray River. The complex begins to fill from Ryans Floodway when flows in the Murray River exceed 23,000 ML per day, but flows above 26,000 ML per day for extended periods are needed to completely fill both lagoons. High unregulated flows that move across the Kiewa River floodplain during wet conditions can also inundate the site. Since 2014, the maximum regulated flow from Lake Hume has reduced from 25,000 ML per day to less than 20,000 ML per day. These changes have greatly reduced the frequency of watering at Ryans Lagoon, which currently only fills if large, unregulated flows are released from Lake Hume or the reservoir spills.

Temporary pumps will be used to deliver water for the environment to restore the ecological health of the complex by providing a wetting and drying regime that is closer to the natural flow regime that existed before the regulation of the Murray River. Water can be pumped into Ryans Lagoon from the Ryans Lagoon floodway, which carries water when the flow in the Murray River exceeds 8,000 ML per day.

North East CMA is investigating options to improve watering regimes at other wetlands along the upper Murray floodplain.

Environmental values

North East CMA's *North East Waterway Strategy* recognises the Ryans Lagoon wetland complex as a high-value wetland complex, and it is listed as a nationally significant wetland in the *Directory of Important Wetlands in Australia*. The complex provides habitat for species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* and the Victorian *Flora and Fauna Guarantee Act 1988*, including seven bird, three fish and one perennial plant species. Ecological surveys conducted at the site since 1975 have recorded 250 species of waterbugs and 29 species of waterbirds, including the Australian white ibis, great egret and rufous night heron. The complex also supports native wetland vegetation types that are expected to improve in condition once a seasonally aligned, more variable watering regime is re-instated.

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Environmental watering objectives in the upper Murray wetlands

Icon	Environmental objectives in the upper Murray wetlands
	Restore carbon and nutrient cycling within the wetlands to increase ecosystem productivity
	Increase habitat for native fish and increase their population
	Increase the extent of fringing and aquatic vegetation
	Provide feeding habitat for a range of waterbird species
	Increase the abundance and diversity of waterbugs to support aquatic food webs

Traditional Owner cultural values and uses

Traditional Owners have lived for tens of thousands of years on the upper Murray floodplain. Wetlands in the region have immense cultural value to Traditional Owners, including those represented by the Dalka Warra Mittung Aboriginal Corporation, the Dhudhuroa Waywurru Nations Aboriginal Corporation and the Duduroa Dhargal Aboriginal Corporation.

North East CMA is building relationships with each corporation, and it aims to support Traditional Owners' input to planned environmental flows at the Ryans Lagoon wetland complex in the coming years. In the long term, North East CMA aims to support the defined objectives of Traditional Owners for the complex and Traditional Owners' obligations to Country more broadly.

Traditional Owners from Duduroa Dhargal Aboriginal Corporation have expressed an interest in developing a cultural plan for the Ryans Lagoon wetland complex. They have also communicated that they have little internal capacity or time to do so at present.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.1, North East CMA considered how environmental flows could support values and uses, including:

- water-based recreation (such as fishing)
- waterway recreation and amenity (such as birdwatching and camping)
- community events and tourism (such as visitation by schools, Landcare groups and other community groups)
- socio-economic benefits (such as incidental visitation to local towns and businesses).

Recent conditions

The upper Murray wetlands experienced above-average rainfall and temperatures for most of 2021-22. Inflows to Hume Dam were above average, and the storage reached 100 percent capacity in early spring for the first time since 2016. Additional water was released periodically from Hume Dam from September 2021 to create airspace and manage flood risk. These releases generated a peak flow in the Murray River below the dam of 33,000 ML per day in late November, which filled Ryans Lagoon 1 and partially filled Ryans Lagoon 2. This was the first time the site had received flows since 2016.

The desired watering regime for the wetland complex is to fill in spring each year and allow a partial drawdown over summer and autumn. The deeper parts of each lagoon are expected to retain permanent water that will support native fish populations, and the variable wetting and drying of the lagoons' shorelines will improve the condition and diversity of wetland plant communities and promote carbon and nutrient cycling. The desired watering regime for the Ryans Lagoon wetland complex has only been achieved once in the past 10 years: in 2016-17. Flows that entered the complex between 2012-14 and again in 2021-22 were insufficient to completely fill both lagoons. An ecological assessment in 2019 found the wetland complex to be in moderate-to-good condition but rated the flow regime as poor. Natural flows that partially filled the wetlands in 2021-22 are expected to have improved the overall condition of the complex. However, annual, temporary pumping to the site in future years will aim to reinstate a more natural water regime, to significantly improve ecological outcomes.

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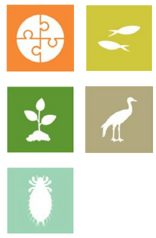
Scope of environmental watering

Table 5.2.1 describes the potential environmental watering actions in 2022-23, 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 5.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the upper Murray wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Ryans Lagoon 1 and Ryans Lagoon 2 (fill in spring)	• Mobilise carbon and nutrients within the wetlands to support wetland processes • Maintain permanent, deep, open-water habitat that supports food resources for waterbirds and native fish • Inundate wetland margins to provide refuge and feeding habitat for small- and large-bodied native fish • Increase soil moisture to promote the growth of fringing vegetation and the surrounding river red gum community • Inundate beds of aquatic and semi-aquatic vegetation to stimulate growth and increase their extent • Prevent the encroachment of river red gum saplings into deep areas of the wetland • Inundate wetland margins to provide habitat for waterbugs and foraging opportunities for waterbirds	

Scenario planning

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

Ryans Lagoon 1 and Ryans Lagoon 2 would have naturally filled every year before the river was regulated, so watering in spring is a high priority under all climate scenarios. Water for the environment (delivered via temporary pumps) will likely be needed to fill both lagoons under drought, dry and average climate scenarios. High unregulated flows and natural floods are likely to inundate the wetlands under a wet climate scenario, and water for the environment will only be used under a wet scenario to top up water levels in each lagoon if they do not fill naturally.

Table 5.2.2 Potential environmental watering for the upper Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flow below Hume Dam • Regulated flow from Hume Dam is likely to connect the Ryans Lagoon floodway to allow pumping into Ryans Lagoon 1 and Ryans Lagoon 2	• Unregulated flow is unlikely below Hume Dam • Regulated flow from Hume Dam will connect the Ryans Lagoon floodway to allow pumping into Ryans Lagoon 1 and Ryans Lagoon 2	• Periods of unregulated flow below Hume Dam • Regulated and unregulated flow from Hume Dam and/or flow from the Kiewa River will connect the Ryans Lagoon floodway to allow pumping into Ryans Lagoon 1 and Ryans Lagoon 2	• Regular periods of unregulated flows below Hume Dam and from the Kiewa River may provide partial inundation to Ryans Lagoon 1 and Ryans Lagoon 2
Expected availability of water for the environment	• 170 ML			
Potential environmental watering – tier 1 (high priorities)	• Ryans Lagoon 1 and 2 (fill in spring)			

Planning scenario	Drought	Dry	Average	Wet
Possible volume of water for the environment required to achieve objectives	• 170 ML (tier 1a)			• 0-170 ML (tier 1a)

5.2.2 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), is listed in the *Directory of Important Wetlands in Australia*, and it 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 29,305 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 used 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 magnitude of environmental flows that can be delivered to the forests. The Yorta Yorta People see this narrow part of *Dhungulla* as a culturally significant creation story, and it provides ecosystem services both from a culturally and environmentally significant viewpoint. The name 'Barmah Choke' is culturally inappropriate for the Yorta Yorta, and it is seen as a negative way to view their traditional lands and waters. Yorta Yorta People may refer to this as the 'Pama Narrows', or more simply 'The Narrows'.

Before the river was regulated, Barmah-Millewa Forest was regularly flooded with high flows from rainfall and snowmelt in winter and spring. These regular floods shaped a rich, productive forest environment. The construction and operation of Hume Dam 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 Narrows 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 it 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 now 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 to simulate natural conditions. 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.

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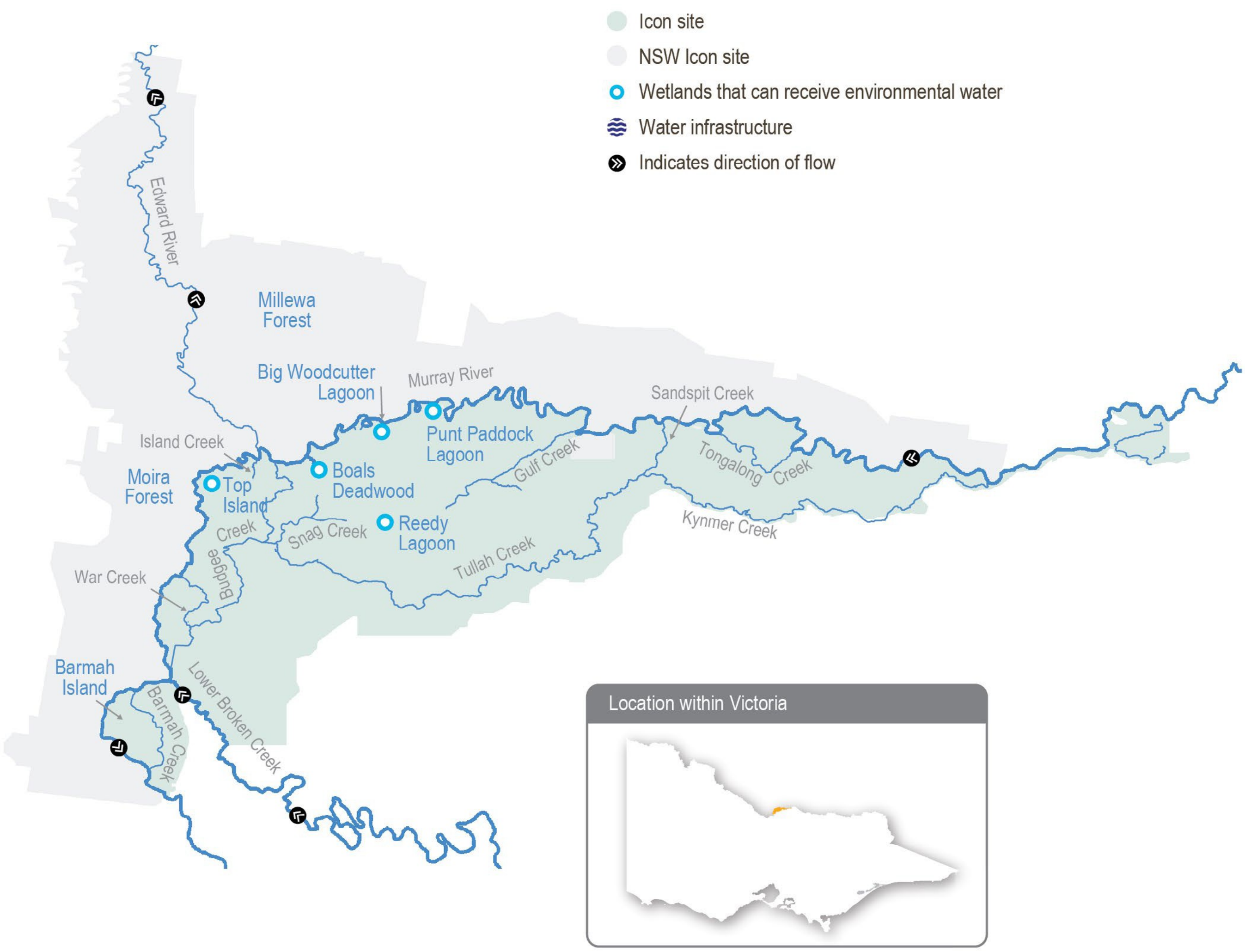
Figure 5.2.1 Barmah Forest



Environmental values

The Barmah-Millewa Forest is the largest river red gum forest in Australia and the most intact freshwater floodplain system along the Murray River. The forest supports important floodplain vegetation communities, including the threatened Moira grass plains and is a significant feeding and breeding site for waterbirds, including bitterns, ibis, egrets, spoonbills and night herons. Significant populations of native fish, frogs and turtles also live in the forest's waterways. Barmah Forest is known to support 74 plant and animal species protected under state and national legislation.

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Environmental watering objectives in the Barmah Forest

Icon	Environmental 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

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 with Parks Victoria under a Traditional Owner Land Management Agreement with the State of Victoria. Goulburn Broken CMA met with the Yorta Yorta Nation Aboriginal Corporation during the environmental flows planning process to obtain input and feedback about planned deliveries of water for the environment in Barmah Forest. Yorta Yorta Traditional Owners developed the *Yorta Yorta Whole-Of-Country Plan 2021-2030*, and they were involved in developing the *Joint Management Plan for Barmah National Park*. Both plans have informed planned watering actions. Ongoing interaction on land and water management at Barmah also occurs through the Living Murray Indigenous Partnerships Program.

Yorta Yorta values are more than 'stones and bones'. They encompass an inherent and living connection to land (*woka*), water (*wala*) and caring for Country.

Examples of Yorta Yorta cultural values and uses in Barmah Forest that are supported through water for the environment delivery include:

- maintaining refuges, which protect turtles, 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)
- improving the health of 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 healthy Country.

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Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.3, Goulburn Broken CMA considered how environmental flows could support values and uses, including:

- water-based recreation (such as boating, fishing, kayaking and canoeing)
- riverside recreation and amenity (such as birdwatching, picnicking, photography, camping and the general physical, mental and social benefits of communing with nature)
- community events and tourism (such as boat tours)
- socio-economic benefits (such as for apiarists and irrigation diverters).

Recent conditions

La Niña events generally result in above-average rainfall years, but back-to-back events in 2020-21 and 2021-22 have resulted in near-average rainfall years for Barmah Forest (as measured at Echuca). Maximum temperatures were also about average for both years.

While local rainfall is important for the forest, upstream Murray River and tributary flows (such as from the Ovens and Kiewa rivers) provide the natural, overbank floods that the forest needs. Rainfall in the Ovens and Kiewa catchments was about average to above average during 2021-22, resulting in some minor, unregulated events during winter and spring. Rainfall in the upper Murray above Hume Dam was above average to very much above average during 2021-22, which resulted in Hume Dam filling and multiple spills — managed high releases — from the storage. These flows combined to deliver four flood peaks of 30,000 to 45,000 ML per day downstream of Yarrawonga Weir during winter and spring 2021, with the largest event in September. While important for the health of the forest, the 2021-22 events were relatively small, inundating about 45 percent of the Barmah Forest floodplain. For context, the wet spring of 2016 resulted in a peak flow of about 180,000 ML per day downstream of Yarrawonga Weir, which inundated an estimated 98 percent of the forest floodplain.

In 2021-22, allocations against high-reliability water shares reached 52 percent in August and 100 percent in October. Low-reliability water shares began receiving allocations in December and reached their full allocations in February. This is the first time Murray seasonal determinations reached maximum availability since the introduction of the current entitlement products in 2007. Spills from Hume Dam resulted in the deduction of most spillable carryover from 2020-21. Section 5.2 has more information about the resource position of water for the environment in the Victorian Murray system during 2021-22.

Water for the environment in Barmah Forest was delivered in line with the average climate scenario in 2021-22. All planned deliveries for the year were fully or partially met, noting autumn-winter (May to June 2022) flows in the Murray River channel are planned but were yet to be delivered at the time of preparing this publication.

Water for the environment was delivered within operational limits to fill in gaps between natural events. Specific actions included maintaining a flow just below 3 m at Tocumwal (about 15,000 ML per day downstream of Yarrawonga Weir) throughout spring and managing recession flows back to below channel capacity in summer. Having a gradual flow recession during December is essential for native fish to move from the floodplain to the river channel without being stranded in forest anabranches. Fish movement was monitored during the recession flow, and the results will be used to inform the magnitude and timing of similar actions in spring 2022-23 and beyond.

Regulators that control flow between the Murray River and Barmah Forest are closed during summer and autumn to prevent high deliveries to downstream irrigation customers from inundating the forest when it would normally be drying. The exception is where water for the environment is diverted into individual wetlands within the forest (such as Boals Deadwood) to improve the success of any waterbird breeding events that may have been triggered by the forest's inundation in spring. High summer rainfall in the upper Murray catchment triggered some small spills from Hume Dam, and the Barmah Forest regulators were partially opened to reduce the flooding risk to public and private infrastructure. The unseasonal re-wetting of parts of the Barmah floodplain caused some low-oxygen blackwater to develop and flow into the Murray and Edwards rivers. The impact was minor, and no fish deaths were recorded.

A wet climate forecast for winter 2022 on the back of the above-average conditions in 2021-22 resulted in a potential opportunity to commence connecting the forest and the river earlier in winter than in recent years. Increased autumn-winter low flows are planned for June 2022.

Scope of environmental watering

Table 5.2.3 describes the potential environmental watering actions in 2022-23, 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.

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Table 5.2.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Barmah Forest

Potential environmental watering action	Expected watering effect(s)	Environmental objective(s)
Winter/spring forest low flow to various waterways in Barmah Forest (variable flow rates and duration during July to November 2022 and June 2023)	• 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 throughflow	
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 prevent Murray cod from abandoning their nests, 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 22oC 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	
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)	• Inundate open plains to sufficient depth and for sufficient 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	

Potential environmental watering action	Expected watering effect(s)	Environmental objective(s)
Autumn/winter low flow in the Murray River (1,800-12,000 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 5.2.4 outlines 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 through winter and spring. Flow control structures are used to direct water from the Murray River channel into the forest. The same structures facilitate the later return of most of that water back to the river, transporting carbon and nutrients for use downstream. Current flow constraints mean water will be biased towards Barmah Forest in 2022-23, aiming to meet depth and duration targets for wetlands. These arrangements alternate between Barmah and Millewa forests each year.

Demands for water for the environment in Barmah Forest vary significantly in response to seasonal conditions. Variable winter/spring low flow and spring/summer freshes are required under all scenarios. The variable winter/spring low flow aims 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 variation in the Murray River. The spring/summer freshes are achieved by providing variations in the flow rate in the Murray River below Yarrawonga Weir that trigger the spawning of silver perch.

Under drought and dry conditions, potential environmental flows will primarily aim to maintain water levels and water quality in refuge habitats within the forest to sustain fish and turtle populations. Actions to achieve these objectives require relatively small volumes of water to be directed into the forest, and they are unlikely to return much water to the Murray River for downstream use.

The winter/spring/summer low flow in the Murray River channel will 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 Narrows. 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 unregulated flooding events. Specific actions under the average or wet scenarios may include extending the duration of unregulated flooding to increase the vigour and resilience of wetland communities (such as Moira grass plains) 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 Dam targeting specific flow rates downstream of Yarrawonga Weir and managed using 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 2022-23 is desirable to help floodplain vegetation flower, set seed and recruit. Some floodplain inundation will occur when the flow downstream of Yarrawonga exceeds about 9,500 ML per day. However, a greater flow will inundate more of the floodplain to a greater depth and therefore deliver a better outcome for floodplain vegetation and also benefit native fish, frogs, 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.

Regulators may be used to divert water to selected wetlands under various scenarios to support any significant waterbird breeding that is triggered by spring inundation.

Spring wetting of floodplain marshes will provide environmental benefits under all climate scenarios in 2022-23. It is a high priority under dry to wet scenarios but would only be delivered in certain circumstances under the drought scenario. For example, the size of a multi-site environmental watering action supporting whole-of-River-Murray and/or downstream environmental objectives during winter and spring may increase flow through Barmah Forest. This may be possible in 2022-23 as water availability in the Murray system is forecast to be high, even under a drought scenario. Another possibility is 'piggybacking' operational transfers from Hume Dam with water for the environment. The volume of water for the environment required to achieve the floodplain marsh flow objectives under the drought climate scenario depends on demands for multi-site environmental events or operational transfers, and it is therefore not estimated in Table 5.2.4 below.

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Table 5.2.4 Potential environmental watering for the Barmah Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flow periods are unlikely • Flow in the Murray River will remain within the channel all year	• Some small, unregulated flow in late winter/spring • Low chance of overbank flow in late winter/spring	• Likely chance of small-to-medium unregulated flow in winter/spring • Likely chance of overbank flow in winter/spring	• High probability of moderate to large unregulated flow in winter/spring • Expected large overbank flow
Potential environmental watering – tier 1 (high priorities)[1]	• Winter/spring forest low flow • Spring/summer fresh(es) (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 fresh(es) (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	• Winter/spring forest low flow • Winter/spring/ summer low flow • Spring/summer fresh(es) (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 fresh(es) (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	• N/A		
Possible volume of water for the environment required to achieve objectives[2]	• 8,500 ML (tier 1)	• 550,000 ML (tier 1)	• 200,000 ML (tier 1)	• 130,000 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 sites.

5.2.3 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).

Gunbower Forest, which covers 19,450 ha, 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 have 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 12 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.

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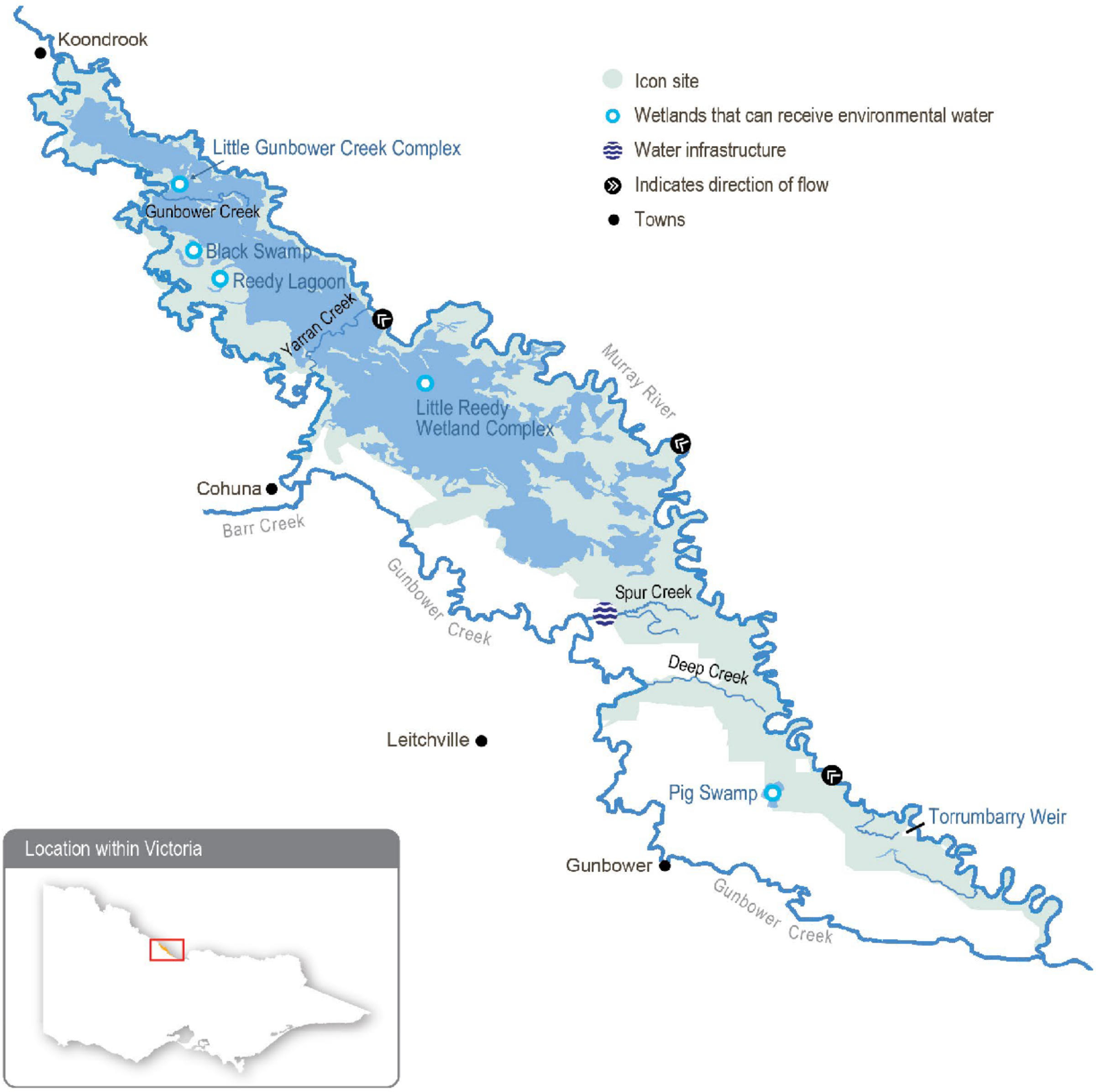
The Living Murray environmental works program in the middle and lower forest was completed in 2013. The works allow up to 4,500 ha of the wetlands and floodplain to be watered with considerably less water than would be required if the watering infrastructure was not in place. The works enable efficient watering through Gunbower Creek and the forest to maintain the 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 animals to move between habitats and support critical ecosystem functions (such as carbon exchange).

Figure 5.2.2 Gunbower Creek and Forest



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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 home to vulnerable and endangered plants and animals, including river swamp wallaby grass, wavy marshwort, Murray-Darling rainbowfish and eastern great and intermediate egrets. Gunbower Forest 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

Icon	Environmental 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
	Increase the diversity and abundance of native frog species within the forest
	Maintain the population of freshwater turtles by providing suitable feeding, breeding and refuge habitat
	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

Traditional Owner cultural values and uses

The Barapa Barapa are the Traditional Owners in the middle and lower area of Gunbower Forest, and the Yorta Yorta are the Traditional Owners in the upper Gunbower Forest.

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.

Yorta Yorta custodians and 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.

Yorta Yorta and Barapa Barapa Traditional Owners have provided feedback on watering priorities for 2022-23 in Gunbower Forest.

Increasing the involvement of Traditional Owners in the planning and management of environmental flows and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* 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 their contribution and indicating progress towards deeper involvement.

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

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Barapa Barapa Traditional Owners have been working in partnership with 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 evolved to also include Wamba Wemba Traditional Owners and continues to have a focus on Gunbower Forest.

Barapa Barapa Wamba Wemba Water For Country project members identified a range of opportunities for 2022-23 watering to support cultural values, which Table 5.2.5 shows.

Table 5.2.5 Cultural values and uses at Gunbower Forest as identified by the Barapa Barapa Wamba Wemba Water For Country project

Value/use	How the value/use will be considered by environmental flows in 2022-23
Cultural plants, cultural practices	• Water in wetlands and on the floodplain from deliveries of water for the environment 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 Hipwell channel in 2022-23 will support cultural plants that Barapa Barapa Traditional Owners value and provide opportunities for cultural practices to continue. • The amount of cultural resources available is linked to the scale of watering that can be achieved. Floodplain watering via the Hipwell channel 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) that elicit a good vegetation response and can support wetland and forest fauna. • Deliveries of water for the environment will ensure water is present on the floodplain and in high-priority wetlands regardless of whether there is flooding. This will provide refuge habitat for forest fauna, and the delivery 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 done by delivering the Hipwell channel environmental watering event to build on outcomes achieved by the lower landscape watering in 2022.
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. Deliveries of water for the environment result 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, but the changed watering regime since regulation and climate change 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 the delivery of water to the floodplain. The lower landscape regulators can target small areas of river red gum, and the Hipwell channel watering planned in 2022-23 will inundate large areas of river red gum and potentially suppress black box encroachment within the flood footprint.

Value/use	How the value/use will be considered by environmental flows in 2022-23
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 2022. • 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 deliveries of water for the environment will be communicated to Traditional Owners so cultural opportunities can be realised.
Cultural resources	• Barapa Barapa Traditional Owners have expressed that the ongoing survival of fish populations is important as a food resource. Wetland fish populations persisting in the Gunbower Forest wetlands following the 2021 watering event will be supported by the large-scale Hipwell channel watering event, ensuring a resident fish population persists across multiple years.

The Barapa Barapa Wamba Wemba 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, which Table 5.2.6 shows. These objectives are considered in conjunction with the environmental objectives and expected watering effects for the potential environmental flows shown in Table 5.2.7.

Planning for water for the environment in 2022-23 included a field visit to Gunbower Forest in early 2022. The discussion during the field visit focused on the current condition of the forest, particularly around the wetlands and the dry river red gum forest, and how the 2022-23 watering actions will continue to support cultural objectives and protect cultural heritage.

Applying the framework during seasonal watering proposal engagement with the Barapa Barapa Wamba Wemba Water for Country project members will ensure that planned environmental flows incorporate Barapa Barapa Traditional Owners' cultural aspirations and that water managers are culturally informed when delivering water for the environment.

All potential environmental watering actions in Table 5.2.7 provide the opportunity to support Barapa Barapa cultural values and objectives, but achieving them will depend on climatic conditions.

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Table 5.2.6 Barapa Barapa cultural objectives for environmental flows in Gunbower Forest 2022-23 (from the Barapa Barapa Cultural Watering Objectives Framework)

Cultural objective	Hydrological aim	Indicator	Measure	Watering action
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	• Floodplain watering and wetland top-ups
	• 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 5.2.7, North Central CMA considered how environmental flows could support values and uses, including:

- water-based recreation (such as boating, canoeing, duck hunting, fishing, 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

During 2021-22, rainfall and temperatures at Gunbower Forest and surrounding areas were close to the long-term average. Rainfall in north-east Victoria and south-east New South Wales was well above the long-term average, and it delivered high inflows to the Murray system and its storages. The wet conditions triggered managed releases from Hume Reservoir and frequent high flows in tributaries such as the Kiewa, Ovens and Goulburn rivers, which ensured unregulated flows in the Murray River for much of winter, spring and summer. Without river regulation, Gunbower Forest would have experienced significant flooding during 2021-22. The controlled releases from storages limited flow in the Murray River at Torrumbarry Weir to a peak of 24,400 ML per day in October, which is just below the threshold of an overbank flow into Gunbower Forest.

In 2021-22, allocations against high-reliability water shares reached 52 percent in August and 100 percent in October. Low-reliability water shares began receiving allocations in December and reached their full allocations in February. This is the first

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time Murray seasonal determinations reached maximum availability since the introduction of the current entitlement products in 2007. Spills from Hume Dam resulted in the deduction of most spillable carryover from 2020-21. Section 5.2 has more information about the resource position of water for the environment in the Victorian Murray system during 2021-22.

Deliveries of water for the environment for Gunbower Creek and Forest were managed in line with an average climate scenario throughout 2021-22. All planned watering actions for 2021-22 were achieved with a combination of water for the environment, natural flow and consumptive releases. While there was no overbank flooding in Gunbower Forest in 2021-22, some high-flow water from the Murray River did enter the forest via the lower-lying floodrunners, including at Shillinglaws and Barham Cut regulators, for two weeks during October. These inflows supplemented targeted deliveries of water for the environment to selected wetlands and surrounding low-lying floodplains and improved breeding and feeding habitat for waterbirds. Several species of waterbirds (including little pied cormorants, Australasian darters and threatened musk ducks) were reported breeding at Long Lagoon, Black Swamp and Reedy Lagoon in late spring and summer. Water for the environment was also used to top up lower landscape wetlands over summer to enhance outcomes for wetland vegetation that were triggered by winter and spring watering.

The first managed floodplain watering event in Gunbower Forest since 2018 is due to commence in June 2022. This event will be delivered via the Hipwell channel and aims to improve the condition of river red gums and their flood-dependent understorey, which require inundation events about seven out of every 10 years for optimal condition and to build their resilience to future dry periods.

The section of Gunbower Creek downstream of Gunbower Weir had no flow between mid-May and early August 2021 — the irrigation shut-down period — to allow construction of the Koondrook and Cohuna fishways. The flow was reduced gradually to less than 20 cm drawdown per day to allow fish to migrate to deep pools, which remained over winter. Monitoring conducted during the shut-down period confirmed that populations of small-bodied fish persisted in refuge pools, and fish-trapping at the new fishways in December 2021 demonstrated that native fish are using the structures to move between the Murray River and Gunbower Creek. Additional works may occur between May and August 2022. These works may require a full drawdown of Gunbower Creek upstream of Gunbower Weir for up to two weeks, which may temporarily affect local fish populations, but the long-term benefit of the fishways is expected to significantly improve native fish outcomes for the region. The drawdown will again be gradual and closely monitored.

Scope of environmental watering

Table 5.2.7 describes the potential environmental watering actions in 2022-23, 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 5.2.7 Potential environmental watering actions, expected watering effects and associated environmental objectives for Gunbower Creek and Forest

Potential environmental watering action	Expected watering effect(s)	Environmental objective(s)
Gunbower Forest		
Gunbower Forest floodplain, floodrunners and wetlands inundation (with variable flow rates during winter/spring 2022)	• Continue floodplain watering commenced in June 2022 to inundate river red gums and the flood-dependent and flood-tolerant understorey species for the optimum duration to help recover condition • Maintain the depth and extent of water in wetlands to support the growth and successful recruitment of wetland vegetation following positive outcomes in 2021-22 • Provide a variety of water depths throughout the forest to provide feeding, foraging and refuge habitat for frogs, turtles and waterbirds, including colonial nesting species and access to breeding habitat for small-bodied native fish	
Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates to maintain an appropriate wetted extent during winter/spring 2022)	• Extend the duration and, where possible, the extent of natural floodplain and wetland inundation over the optimal growing season for aquatic vegetation • Maintain the depth and quality of water to provide habitat for small-bodied native fish, including Murray-Darling rainbowfish • Provide a variety of water depths throughout the forest to provide feeding, foraging and refuge habitat for frogs, turtles and waterbirds, including colonial nesting species	

Potential environmental watering action	Expected watering effect(s)	Environmental objective(s)
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)	• Connect Gunbower Creek and the 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 opportunities for native fish	
Black Swamp, Reedy Lagoon, Little Gunbower Creek Complex, Little Reedy Wetland Complex (top-up, variable flow rates during spring/ summer as required in response to bird breeding or significant vegetation responses)	• Maintain adequate water levels in breeding and feeding habitats to allow breeding waterbirds to successfully fledge their chicks • Maintain adequate water levels in wetlands to extend the growth phase of wetland vegetation triggered by inundation earlier in the season	
Gunbower Forest floodplain, floodrunners and wetlands inundation (with variable flow rates during autumn/winter 2023)	• Provide a second consecutive year of floodplain watering in 2023 to inundate river red gums and the flood-dependent and flood-tolerant understorey species for the optimum duration to help recover condition • Maintain the depth and extent of water in wetlands to support the growth and successful recruitment of wetland vegetation • Provide a variety of water depths throughout the forest to provide feeding, foraging and refuge habitat for frogs, turtles and waterbirds, including colonial nesting species and access to breeding habitat for small-bodied native fish	
Gunbower Creek (targeting Koondrook Weir)		
Year-round opportunistic fresh(es) (500 ML/day for one to four weeks, as required)	• Deliver in response to high flow in the Murray River (if conditions allow) to: • promote the exchange of carbon between Gunbower Creek and the Murray River • provide a natural migratory cue for native fish to either: - trigger the migration and spawning of native fish in the Murray River (during spring), or - attract native fish (such as golden perch and silver perch) to migrate into or to the upstream reaches of Gunbower Creek (during autumn), maximising the effect of the fishways at Koondrook and Cohuna weirs	
Autumn/winter low flow (50-200 ML/day during July to August 2022 and March to June 2023)	• At 50 ML/day: • maintain a minimum level of connectivity between Gunbower Creek and lagoons during the off-irrigation period and/or when Hipwell channel is operational • prevent sections drawing down to isolated pools At 200 ML/day: • maintain connectivity through the length of Gunbower Creek and between lagoons and fishways during the off-irrigation period to provide greater access to food resources over the cooler months, if natural inflows to Gunbower Forest are achieved	

Potential environmental watering action	Expected watering effect(s)	Environmental objective(s)
Trigger-based spring/ summer low flow (50-300 ML/day as required during September to February)	• Dilute carbon-rich water exiting Gunbower Forest at Three Corner Hole to improve water quality (oxygen concentrations) in lower Gunbower Creek if required	
Gunbower Creek (targeting Cohuna Weir)		
Spring/summer/autumn low flow (300-400 ML/ day during September to March)	• Maintain habitat and food resources for native fish and support breeding and larval survival (such as Murray cod) by minimising large variations in the water level during the irrigation season and achieving about 1.5 m depth in deeper pools and 30 cm depth in the shallow connecting littoral zone to maintain habitat. A greater area of habitat will be inundated at the upper magnitude	
Summer/autumn/winter fresh(es) flow (500 ML/ day for one to four weeks during July to August 2022 or January to June 2023, as required)	• Increase flowing habitat in Gunbower Creek to provide providing preferred hydraulic conditions for native fish	

Scenario planning

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

Gunbower Forest

The highest-priority potential watering action under all climate scenarios is to inundate the Gunbower Forest floodplain, floodrunners and wetlands via the Hipwell channel in winter/spring 2022 and winter/spring 2023. This is needed to prevent a fourth consecutive year without inundation, which would likely stress and see a drop in the condition of flood-dependent river red gums and their understorey vegetation. These vegetation communities rely on frequent inundation, and ecologists advise that flooding in consecutive years will consolidate improvements in vegetation condition and recruitment and therefore provide greater benefits than a single flood. The watering events aim to inundate about 4,500 ha (about 23 percent of the forest), which is the maximum inundation extent that can be achieved with deliveries of water for the environment. Deliveries may be modified to extend the duration or extent of any natural floods during the planned watering periods. If a second floodplain inundation event cannot be delivered in 2023, water for the environment will be used to top up selected wetlands in lower Gunbower Forest, likely in autumn, to maintain habitat for water-dependent plants and animals over autumn and winter.

There may be additional deliveries of water for the environment in Gunbower Forest in 2022-23 if particular environmental triggers are met. Water levels in selected wetlands in lower Gunbower Forest will be topped up as needed if flooding triggers a significant waterbird breeding event or notable vegetation response. If there are simultaneous high flows in the Murray River and Gunbower Creek, water for the environment may be used to deliver a spring fresh through Yarran Creek to transfer carbon and nutrients between Gunbower Creek, Gunbower Forest and the Murray River and encourage native fish to move into Gunbower Creek. Supporting fish movement through this region is important to optimise recolonisation after disturbances associated with recent fishway construction activities.

Gunbower Creek

Maintaining adequate low flow in Gunbower Creek during the irrigation shut-down period is a high priority in all years to maintain native fish communities. Channel works and reduced capacity due to the operation of the Hipwell channel are likely to limit the low-flow magnitude that can be delivered to the lower reaches of Gunbower Creek during winter 2022. The aim during this period will be to deliver sufficient water to maintain connections between deeper pools. Fish populations and water quality will be monitored during the planned works to determine whether these flows are adequate. If the monitoring identifies a significant risk to the fish populations or if the Hipwell channel is not operated at maximum capacity, flows of up to 200 ML per day will be passed downstream of Cohuna Weir.

Providing a stable flow of at least 300 ML per day over Cohuna Weir is a high priority during spring and summer under all scenarios to support Murray cod to breed and maintain habitat for small-bodied native fish. This flow may be met through a combination of consumptive releases and water for the environment. Maintaining a stable flow is less critical after the Murray cod breeding season, but a flow of about 300 ML per day will still be important between January and March to inundate the littoral zone, which provides food and cover for larval and juvenile fish.

There may be several trigger-based or opportunistic deliveries of water for the environment to Gunbower Creek under average and wet climate scenarios. These include dilution flows to mitigate against low oxygen levels (if natural floods wash significant volumes of carbon-rich water from Gunbower Forest into Gunbower Creek), as well as high flows triggered by a high flow event in the Murray River (to encourage fish movement between Gunbower Creek and the Murray River).

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It will be important to reserve water for carryover to enable high-priority actions commenced in late 2022-23 to continue into early 2023-24. About 40,000 ML of carryover is required to continue watering the Gunbower Forest floodplain, floodrunners and wetlands through to spring 2023. About 16,000 ML may be required to maintain a low flow in Gunbower Creek in 2023-24, but this could increase to 20,000 ML under a drought scenario if there is lower demand by irrigators.

Table 5.2.8 Potential environmental watering for Gunbower Creek and Forest 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 conditions</td><td>• No natural inflow into Gunbower Forest</td><td>• No natural inflow into Gunbower Forest</td><td>• Minor natural inflow into Gunbower Forest may occur in winter/spring</td><td>• Overbank flow is likely in winter/spring</td></tr>
<tr><td colspan="5">Gunbower Forest</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td colspan="3">• Gunbower Forest floodplain, floodrunners and wetlands inundation in winter/spring 2022
• Spring fresh in Yarran Creek
• Black Swamp, Reedy Lagoon, Little Gunbower Creek Complex, Little Reedy Wetland Complex top-up in spring/summer, if required
• Gunbower Forest floodplain, floodrunners and wetlands inundation in autumn/winter 2023</td><td>• Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands in winter/spring 2022
• Spring fresh in Yarran Creek
• Black Swamp, Reedy Lagoon, Little Gunbower Creek Complex, Little Reedy Wetland Complex top-up, if required
• Gunbower Forest floodplain, floodrunners and wetlands inundation in autumn/winter 2023</td></tr>
<tr><td>Potential environmental watering – tier 2 (additional priorities)</td><td colspan="4">• N/A</td></tr>
<tr><td colspan="5">Gunbower Creek (targeting Koondrook Weir)</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td colspan="2">• Autumn/winter low flow</td><td colspan="2">• Autumn/winter low flow
• Trigger-based spring/summer low flow, if required</td></tr>
<tr><td>Potential environmental watering – tier 2 (additional priorities)</td><td colspan="3">• N/A</td><td>• Year-round opportunistic flow</td></tr>
<tr><td colspan="5">Gunbower Creek (targeting Cohuna Weir)</td></tr>
<tr><td>Potential environmental watering – tier 1 (high priorities)[1]</td><td colspan="4">• Spring/summer/autumn low flow</td></tr>
<tr><td>Potential environmental watering – tier 2 (additional priorities)</td><td colspan="3">• N/A</td><td>• Summer/autumn/winter fresh(es)</td></tr>
</table>

Planning scenario	Drought	Dry	Average	Wet
Possible volume of water for the environment required to achieve objectives	• Up to 115,000 ML (tier 1)			• Up to 115,000 ML (tier 1) • 4,000 ML (tier 2)
Priority carryover requirements for 2023-24	• 60,000 ML	• 56,000 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.

5.2.4 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, Kunat Kunat (Round Lake), Lake Cullen, Lake Elizabeth, Lake Murphy, McDonalds Swamp, Muringa wetlands, Richardson's Lagoon, 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, Kunat Kunat, Lake Cullen, Lake Elizabeth, Lake Murphy, McDonalds Swamp, Muringa wetlands, Richardson's Lagoon, Third Reedy Lake and the Wirra-Lo wetland complex. Temporary pumps are currently used to deliver water for the environment from the Murray River to some semi-permanent wetlands in the Guttrum and Benwell forests when required. More permanent water delivery infrastructure for Guttrum and Benwell forests is proposed as part of the Victorian Murray Floodplain Restoration Project.

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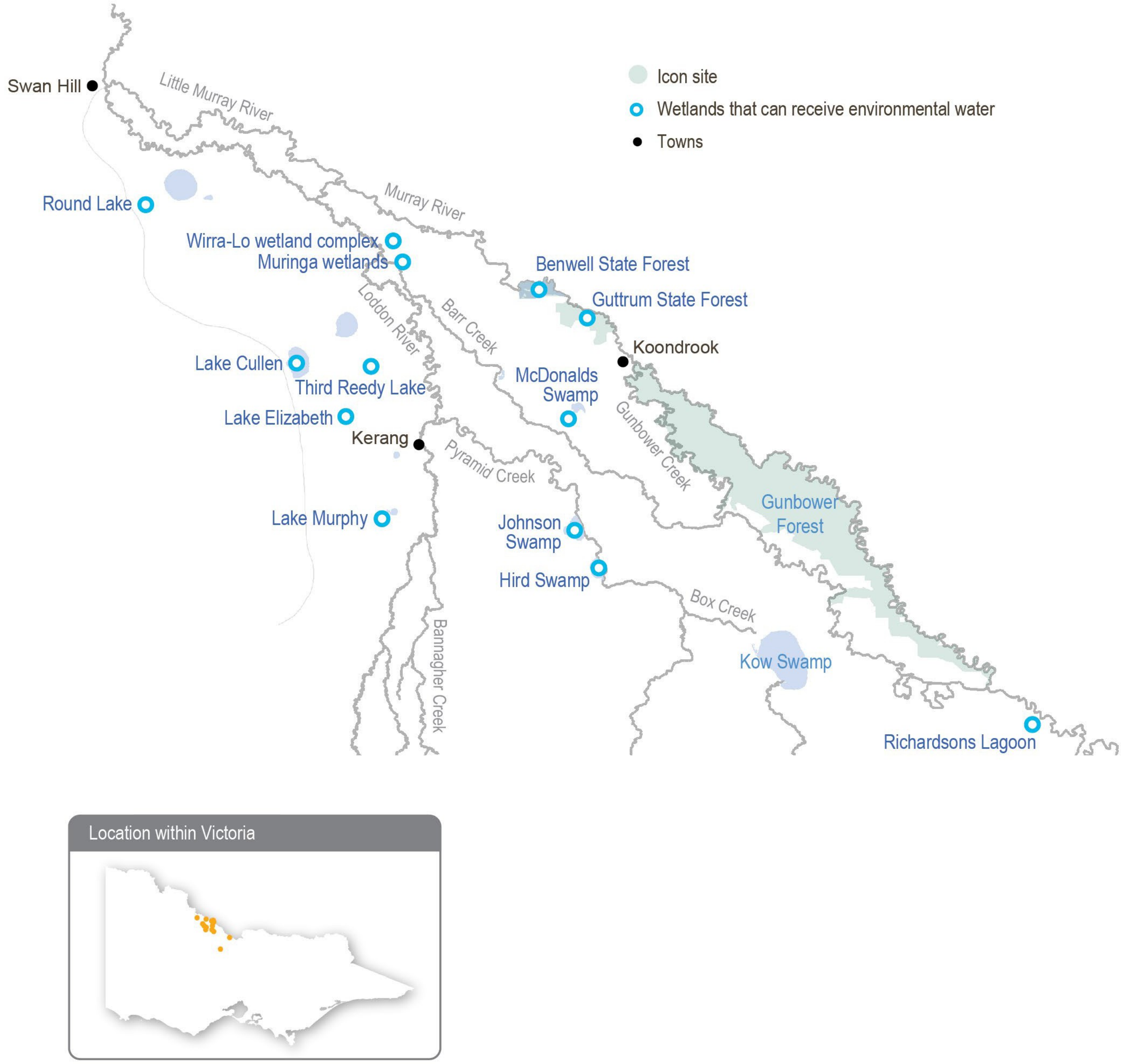
Figure 5.2.3 The central Murray wetlands



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.

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Environmental watering objectives in the central Murray wetlands

Icon	Environmental objectives in the central Murray wetlands
	Maintain 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 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 then maintain the health of streamside trees (such as river red gum and black box) Restore and then maintain mudflat vegetation communities (such as tall marsh, herblands, rushes and sedges) Restore and then 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)
	Increase the diversity and biomass of waterbugs

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 - the Barapa Barapa, Wamba Wemba and Yorta Yorta peoples. Their traditional knowledge is a living culture 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 and Wamba Wemba Traditional Owners have contributed to planning for water for the environment for wetlands important to them in the central Murray region in 2022-23. Focus areas include the following.

- Barapa Barapa and Wamba Wemba Traditional Owners have highlighted maintaining or improving the health of wetland vegetation as a key priority across the wetlands. Traditional Owners have raised concerns about encroachment of lignum and tall marsh at Johnson and McDonald Swamps negatively impacting wetland water flow and habitat for waterbirds. Concerns have also been raised about duck hunting at Lake Murphy and rabbits harming culturally sensitive locations.
- For 2022-23, Barapa Barapa and Wamba Wemba Traditional Owners are supportive of watering wetlands on their Country whilst allowing Lake Murphy and Hird Swamp to go through a drying phase. Barapa Barapa and Wamba Wemba Traditional Owners are interested in undertaking an Aboriginal Waterways Assessment (AWA) at several of the wetlands in the future – during wet and dry phases.
- Watering activities in Guttrum Forest will again be a particular focus for Barapa Barapa and Wamba Wemba Traditional Owners in 2022-23, as described below.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within 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.

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

Barapa Barapa and Wamba Wemba input to watering actions for Guttrum Forest in 2022-23

The proposed delivery of water for the environment to Guttrum Forest during 2022-23 has been planned in conjunction with the Barapa Barapa and Wamba Wemba peoples, for whom the wetlands and surrounding forest are places of high cultural significance. The Traditional Owners have been an important part of Guttrum Forest planning and management from the outset and were directly involved in the delivery of environmental flows to Reed Bed Swamp in 2019-20 and 2021-22.

Barapa Barapa and Wamba Wemba collaborate with waterway managers to ensure that during watering events their cultural heritage is protected and that the hydrological needs of important cultural values (such as food and medicinal plant species, scar trees and ring trees) are supported through the timing and duration of planned watering actions to the forest.

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 2022-23.

Table 5.2.7 Barapa Barapa and Wamba Wemba cultural values and uses at Guttrum Forest

Value/use	Considerations
Food, fibre and medicinal plants	• A winter fill followed by top-ups as required will ensure that the duration of wetting will be long enough to support aquatic vegetation during its optimal growth period. Allowing the wetland to dry before summer will also promote cultural plants on the mudflats in these areas.
Cultural heritage	• Watering of Reed Bed Swamp supports fringing large old trees, including a couple of ring trees and scar trees. The condition of these trees was seen to improve following previous watering: for example, there was new growth.
Spiritual wellbeing	• The improvement in the condition of the wetland and the presence of water and moisture contribute 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 have been present during the set-up of infrastructure and have been able to advise about avoiding impacts on 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 has occurred as part of previous watering of Reed Bed Swamp.
Cultural landscape	• Maintaining the open-water habitat and mudflats underneath will be difficult 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 water for the environment was first delivered in Guttrum Forest, a smoking ceremony and celebration were 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. • Another priority in 2022-23 is to provide more opportunities for women to return to Country and undertake cultural practices such as weaving, emu egg carving and discussion of the wetlands' health as it relates to women's business.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.10, North Central CMA considered how environmental flows could support values and uses, including:

- waterway recreation (such as canoeing, fishing, kayaking, swimming and water sports)
- waterway 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 [hosted annually by North Central CMA] and supporting Aboriginal cultural heritage and history-based tours)
- socio-economic benefits (such as ecosystem services like groundwater recharge, flood mitigation, nutrient treatment, carbon storage and stock and domestic uses).

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Recent conditions

Rainfall across the central Murray wetlands (as recorded at Kerang) was close to the long-term average in 2021-22, but it varied considerably between months. December 2021 and February 2022 recorded the lowest rainfall, whereas January and April exceeded the long-term average significantly. Temperatures remained close to the long-term average and did not vary greatly. Deliveries of water for the environment at central Murray wetlands are made from Murray environmental entitlements.

In 2021-22, allocations against high-reliability water shares reached 52 percent in August and 100 percent in October. Low-reliability water shares began receiving allocations in December and reached their full allocations in February. This is the first time Murray seasonal determinations reached maximum availability since the introduction of the current entitlement products in 2007. Spills from Hume Dam resulted in the deduction of most spillable carryover from 2020-21. Section 5.2 has more information about the resource position of water for the environment in the Victorian Murray system during 2021-22.

Deliveries of water for the environment for the Central Murray wetlands were managed in line with an average climate scenario during 2021-22, and nearly all planned deliveries were achieved.

Richardson's Lagoon and Reed Bed Swamp in Guttrum Forest were filled in late winter/early spring and they received additional top-up deliveries in spring/early summer. Water levels at Richardson's Lagoon inundated both river red gum and black box trees on higher ground and provided a mosaic of habitats. Vulnerable musk duck and turtles were observed breeding at Richardson's Lagoon, although some of the turtle nests were raided by foxes. Reed Bed Swamp held water until February before drawing down, and swathes of the threatened river swamp wallaby grass, wavy marshwort and water nymph responded well.

Kunat Kunat and Lake Elizabeth were filled in spring 2021 and topped up in autumn 2022 to maintain water levels, salinity and habitat conditions for Murray hardyhead. The two Muringa wetlands and six wetlands within the Wirra-lo wetland complex were also watered in spring and topped up over summer and autumn to support growling grass frogs, waterbirds and wetland vegetation communities. Lake Murphy was filled in spring to support vegetation communities, including recently planted river red gums. It was allowed to partially draw down over summer to provide foraging habitat for migratory waterbirds and then topped up again in autumn to optimise the survival of recently planted trees and fringing wetland plants.

Both McDonalds Swamp and Johnson Swamp received a partial fill over late autumn/winter to drown terrestrial weeds and promote aquatic vegetation and habitat for waterbirds, frogs and turtles.

Third Reedy Lake, Hird Swamp and Lake Cullen were all allowed to draw down during 2021-22 to support important dry-cycle wetland processes (such as nutrient cycling and the growth of lake-bed herbland plants). Periodic drying in Hird Swamp is particularly important to help control the encroachment of tall marsh and ensure adequate open-water habitat when it is next filled. Unauthorised tampering of a regulator delivered water to Lake Cullen on several occasions during 2021-22, but the volumes delivered were not significant and did not adversely affect the growing herbland vegetation.

The only planned watering actions not delivered during 2021-22 were a partial fill at Guttrum Forest in autumn/winter 2022 and spring fills at Lignum Swamp North and Red Gum Swamp in the Wirra-lo wetland complex. Guttrum Forest had two planned watering actions for 2021-22, and temporary pumping at the site at the time required significant planning and administrative approvals. The winter/spring fill went ahead as planned, but the need for the autumn partial fill often depends on the level of the drawdown, which is not known until near the end of summer. There was insufficient time for North Central CMA to complete the required approvals for the action to proceed. Recent changes to approval requirements may overcome this issue for future watering events, and delivery will further be streamlined once permanent water delivery infrastructure is constructed at the site, as proposed under the Victorian Floodplain Murray Restoration Project. Watering of Lignum Swamp North and Red Gum Swamp could not proceed due to administrative approvals that were needed for development works to mitigate current delivery constraints.

Scope of environmental watering

Table 5.2.10 describes the potential environmental watering actionsflows in 2022-23, 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.

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Table 5.2.10 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 (fill in winter/spring and further top-ups as required in spring/summer)	• 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 2023)	• Inundate existing adult river red gums to support their growth, and drown river red gum saplings in the open-water habitat • Increase the water depth and extent to trigger wetland plants to germinate in late winter and when follow-up watering is provided in early spring 2023 • Provide feeding and refuge habitat for waterbirds and frogs	
Johnson Swamp (fill in winter/spring and top up as required)	• 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	
Johnson Swamp (throughflow in spring/ summer)	• Provide connectivity between Johnson Swamp and Pyramid Creek to boost productivity, support macroinvertebrates and support nutrient cycling inputs for the creek and food resources for fish • Flush carbon and biofilms within the wetland to promote new growth and increase waterbug activity for native fish	
Kunat Kunat (fill in spring, top up as required)	• Maintain salinity within 15,000-80,000 EC and the water depth to support suitable habitat and breeding conditions for Murray hardyhead and growing conditions for submerged aquatic plants that provide habitat for Murray hardyhead • Maintain the water depth to provide permanent feeding, foraging and refuge habitat for waterbirds	
Lake Cullen (partial fill in winter/spring, top up as required)	• Provide feeding, breeding and refuge habitat for waterbirds • Inundate the wetland to provide feeding and breeding for waterbirds and suitable conditions for macroinvertebrates and submerged plants as food resources for waterbirds	
Lake Elizabeth (fill in spring, top up as required)	• Maintain salinity within 15,000-80,000 EC and the water depth to support suitable habitat and breeding conditions for Murray hardyhead and growing conditions for submerged aquatic plants that provide habitat for Murray hardyhead • Maintain the water depth to provide permanent feeding, foraging and refuge habitat for waterbirds	
McDonalds Swamp (fill in winter/spring, top up as required)	• Drown terrestrial weeds to limit their growth and reduce their extent • Promote the germination and establishment of aquatic vegetation • Inundate the wetland body and fringe to provide habitat for waterbirds, frogs and turtles and provide conditions suitable for macroinvertebrates that are food for waterbirds, frogs and turtles • Support the growth of planted river red gums and other aquatic and herbland vegetation • Wet the fringing river red gums to support their growth	

Potential environmental watering action	Expected watering effects	Environmental objectives
Muringa wetlands (fill in winter/spring, top up as required)	• Support the growth of aquatic and semi-aquatic plants • Increase the area of habitat and grow zooplankton and waterbug communities to provide food resources for frogs and waterbirds	
Richardson's Lagoon (fill in late winter/spring)	• Maintain the water level to support the condition of aquatic macrophytes and aquatic reeds and rushes (i.e. tall marsh) around the deep lagoon channels and wetland fringes • Increase the extent of floodplain inundation to support the growth of floodplain red gums and promote the germination and establishment of flood-dependant understory vegetation • Support the growth of traditional plant species at a significant cultural site enabling the continuation of cultural practices (e.g. harvesting, medicine and weaving) • Provide a diversity of water depths to provide feeding, foraging and refuge habitat for water-dependent animals, including waterbirds, turtles and frogs	
Wirra-Lo wetland complex: Bunyip Swamp East and Bunyip Swamp West (fill in winter/spring, top up 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 winter/spring, top up as required)	• Inundate river red gum woodland trees to promote their growth and improve their condition • Promote the germination and establishment of aquatic vegetation • Inundate habitat to provide feeding and breeding opportunities for frogs and waterbirds	
Wirra-Lo wetland complex: Duck Creek North (fill in winter/spring, top up 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 winter/spring, top up as required)	• Inundate black box and lignum 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 winter/spring, top up 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: Lignum Swamp South (fill in winter/spring, top up as required)	• Inundate recently established reed beds to stimulate their growth to create feeding and nesting habitat for Australasian bittern • 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Wirra-Lo wetland complex: Red Gum Swamp (fill in winter/ spring, top up 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 5.2.11 outlines potential environmental watering and expected water use under a range of planning scenarios.

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, North Central CMA has prioritised potential watering actions for 14 wetlands across the central Murray for watering under all climatic scenarios. These include Guttrum Forest, Johnson Swamp, Kunat Kunat, Lake Cullen, Lake Elizabeth, Muringa wetlands and Wirra-lo wetlands complex: Bunyip Swamp East and West, Cattleyard Creek, Duck Creek North, Emu Creek, Lignum Swamp North and South and Red Gum Swamp. Under dry to wet climatic scenarios, McDonalds Swamp and Richardson’s Lagoon also become a high priority.

Watering actions proposed for Kunat Kunat and Lake Elizabeth are needed to maintain permanent habitat for endangered species like the Murray hardyhead. Sites within the Wirra-lo wetland complex also require water under all scenarios to support endangered species (such as Australasian bittern and growling grass frog) and to maintain red gum and black box communities. Muringa wetlands have recently been added to the environmental watering program, and they were actively watered for the first time in 2021-22. Follow-up watering is considered a high priority in 2022-23 to help planted vegetation communities become established and consolidate the benefits of last year’s watering.

Johnson Swamp, Lake Cullen, McDonalds Swamp and Richardson’s Lagoon are all ephemeral wetlands that are due to commence or complete their planned wet phase in 2022-23. Johnson Swamp completely dried in December 2020 and received a partial fill in autumn 2022 to prime it for the planned fill in winter/spring 2022. Inundating previously dried parts of the wetland is expected to trigger a significant productivity boost, so some water will be passed through the wetland and outfall to Pyramid Creek to supply zooplankton, macroinvertebrates and nutrients to stimulate foodwebs in the creek. Lake Cullen has been dry since 2020-21, and it needs water in 2022-23 to trigger the growth of aquatic plants and provide feeding and breeding opportunities for frogs, birds and turtles while other wetlands in the region enter their dry phase.

McDonalds Swamp and Richardson’s Lagoon received water for the environment in 2021-22, and they need follow-up watering in 2022-23 to achieve the optimal watering regime for their vegetation communities and consolidate the environmental benefits of last year’s watering. Filling these wetlands in winter and spring will enhance the growth and recruitment of wetland plants and fringing trees and provide feeding and breeding opportunities for waterbirds, frogs and turtles. Watering McDonalds Swamp and Richardson’s Lagoon is a lower priority under a drought scenario because watering in 2021-22 partially met many of the vegetation objectives for each site and because waterbirds, frogs and turtles will be unlikely to breed.

In Guttrum Forest, a fill in winter/spring, with top-ups over spring/summer, is planned to maintain the water level and build on environmental outcomes achieved in 2021-22, including supporting recent revegetation works and regeneration at Reed Bed Swamp. A fill may be delivered in autumn/winter 2023 at Guttrum Forest if relevant approvals can be obtained in time. The decision to deliver water in autumn/winter will depend on Traditional Owner and ecological assessments in early 2023 and the level of the drawdown over summer, as well as forecast water availability and carryover for 2023-24. Under a wet climate scenario, overbank flows are likely to fill the wetland naturally in autumn/winter 2023.

Lake Murphy, Third Reedy Lake and Hird Swamp will not receive water for the environment in 2022-23 to support essential dry-phase ecosystem processes in line with recommendations in their management plans.

Priority carryover for 2023-24 of 4,600 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 5.2.11 Potential environmental watering for the central Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected conditions	• Catchment run-off and natural flow into the wetlands are highly unlikely	• Catchment run-off and natural flow into the wetlands are unlikely	• Low-to-moderate catchment run-off and natural flow into the wetlands are possible, particularly in winter/spring	• Catchment run-off and natural flow into the wetlands is likely, with potential flooding in some wetlands, particularly in winter/spring

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 1 (high priorities)	• Guttrum Forest (winter/spring) • Guttrum Forest (autumn/winter 2023)[1] • Kunat Kunat (Round Lake) • Lake Elizabeth • Wirra-lo Wetland complex (Bunyip Swamp East, Bunyip Swamp West, Cattleyard Creek, Duck Creek North, Emu Creek, Lignum Swamp North and South, Red Gum Swamp) • Muringa Wetlands • Lake Cullen • Johnson Swamp	• Guttrum Forest (winter/spring) • Guttrum Forest (autumn/winter 2023)[1] • Kunat Kunat (Round Lake) • Lake Elizabeth • Wirra-lo Wetland complex (Bunyip Swamp East, Bunyip Swamp West, Cattleyard Creek, Duck Creek North, Emu Creek, Lignum Swamp North and South, Red Gum Swamp) • Muringa Wetlands • Lake Cullen • Johnson Swamp • Johnson Swamp throughflow • McDonalds Swamp • Richardson's Lagoon	• Guttrum Forest (winter/spring) • Guttrum Forest (autumn/winter 2023)[1] • Kunat Kunat (Round Lake) • Lake Elizabeth • Wirra-lo Wetland complex (Bunyip Swamp East, Bunyip Swamp West, Cattleyard Creek, Duck Creek North, Emu Creek, Lignum Swamp North and South, Red Gum Swamp) • Muringa Wetlands • Lake Cullen • Johnson Swamp • Johnson Swamp throughflow • McDonalds Swamp • Richardson's Lagoon	• Guttrum Forest (winter/spring) • Guttrum Forest (autumn/winter 2023)[1] • Kunat Kunat (Round Lake) • Lake Elizabeth • Wirra-lo Wetland complex (Bunyip Swamp East, Bunyip Swamp West, Cattleyard Creek, Duck Creek North, Emu Creek, Lignum Swamp North and South, Red Gum Swamp) • Muringa Wetlands • Lake Cullen • Johnson Swamp • Johnson Swamp throughflow • McDonalds Swamp • Richardson's Lagoon
Potential environmental watering – tier 2 (additional priorities)	• McDonalds Swamp • Richardson's Lagoon	• N/A		
Possible volume of water for the environment required to achieve objectives	• 15,160 ML (tier 1) • 2,450 ML (tier 2)	• 16,750 ML (tier 1)	• 16,650 (tier 1)	• 16,250 (tier 1)
Priority carryover requirements for 2023-24	• 4,600 ML			

1 Where it can be delivered within licence approval requirements.

5.2.5 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 contain 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 the 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

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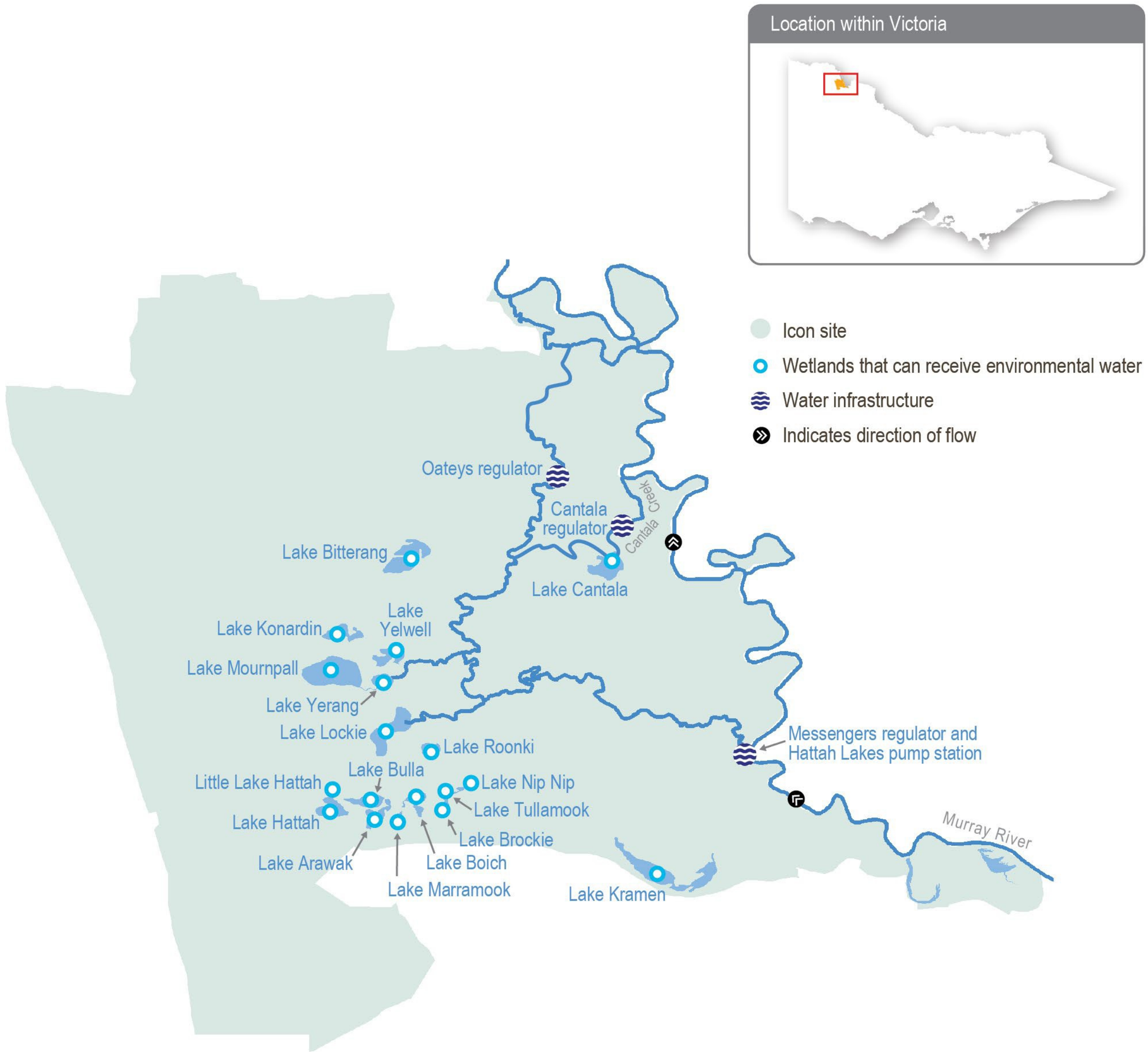
levees to restore a beneficial pattern of flooding to the lakes system. Lake Kramen is in the south-east area of Hattah-Kulkyne National Park and is disconnected from the main Hattah Lakes complex. The Hattah Lakes pump station can deliver up to 145 ML per day to Lake Kramen. The new infrastructure being built under the Victorian Murray Floodplain Restoration Project (VMFRP) will allow water to reach additional wetlands and floodplain areas in the northern Hattah Lakes.

Figure 5.2.4 Hattah Lakes



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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 the Hattah Lakes critically important for water-dependent flora, waterbirds and terrestrial animals during dry periods.

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

Icon	Environmental objectives in the Hattah Lakes[1]
	Maintain populations of small-bodied and large-bodied native fish at the Hattah Lakes
	By 2030, improve the function of water-dependent ecosystems by improving productivity linkages between the river and floodplain/wetland habitats
	Improve the species richness and abundance of native water-dependent floodplain and wetland aquatic vegetation by 2030 Maintain the extent and improve the condition of river red gum, black box and lignum, compared to 2006 baseline levels by 2030
	Maintain and/or increase the regional waterbird population by providing conditions for breeding and fledging at least three times every 10 years Maintain and/or increase the regional waterbird population by providing refuge during droughts
	Maintain a variety of freshwater ecosystem types within the Hattah Lakes Icon Site, including semi-permanent lakes, persistent temporary wetlands, floodplain woodlands, shrublands and episodic wetlands

1 All objectives are derived from the Mallee CMA's 2021 *Hattah Lakes Environmental Watering Management Plan*, and they generally include targets for improving environmental values to be achieved by 2030. Objectives for maintaining the condition of environmental values are not time-bound and should be achieved each year continuously until 2030 and beyond.

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. Groups which have an interest in Hattah Lakes include Latji Latji Mumthelang, Tati Tati, Culpra-Millee, Nyeri Nyeri and Munatunga Elders.

More than 1,000 Aboriginal 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 among the region's Traditional Owners. Local Aboriginal communities maintain strong connections to the land and its resources, such as native species used for food and medicine.

Although COVID-19 restrictions limited opportunities for large on-Country meetings, several face-to-face meetings were held in early 2022 to discuss plans for water for the environment in the Hattah Lakes area. Mallee CMA met with Latji Latji Mumthelang and representatives from Munatunga and Culpra Millee. Traditional Owner groups invited to discussions included Tati Tati and Nyeri Nyeri.

Tati Tati wish to express their lack of representation in no way is a reflection their lack of interest or cultural responsibility in caring for wetlands on Tati Tati Country. It does, however, reflect Tati Tati's deliberate shift to only engaging organisations that demonstrate a commitment to upholding cultural safety. Tati Tati will continue to look to the future to partner with organisations transitioning to First Nations empowerment – not engagement.

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Discussions covered the planning of water for the environment and interests and aspirations for the Hattah Lakes region. Themes raised during discussions included:

- areas where environmental flows are planned to take place in 2022-23 and the quantity of water that will be delivered
- areas that Aboriginal Elders and other participants believe require water (such as Chalka Creek, as it is very dry in this area, and Lake Kramen, although historically this lake has dried out temporarily)
- projects underway that include constructing a levee to allow water to be delivered into the floodplain north of the current area of delivery as part of the VMFRP.

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 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 run by Parks Victoria, including bushwalking, birdwatching and bug hunting; local school education programs; Melbourne-based schools' educational excursions; and tours involving kayaking, bike riding and camping)
- socio-economic benefits (such as commercial beekeepers who rest bees away from horticultural orchards in native flowering trees around the lake, multiple ecotourism operators who benefit directly when the lakes contain water, social wellbeing from connecting with nature, and social gatherings).

Recent conditions

Between July 2021 and March 2022, the temperature and rainfall in the vicinity of the Hattah Lakes were above average.

In 2021-22, allocations against high-reliability water shares reached 52 percent in August and 100 percent in October. Low-reliability water shares began receiving allocations in December and reached their full allocations in February. This is the first time Murray seasonal determinations reached maximum availability since the introduction of the current entitlement products in 2007. Spills from Hume Dam resulted in the deduction of most spillable carryover from 2020-21. Section 5.2 has more information about the resource position of water for the environment in the Victorian Murray system during 2021-22.

While the Hattah Lakes can receive minor inflows after heavy local rainfall, the hydrology is mainly affected by large flows in the Murray River that spill into the lakes and by deliveries of water for the environment.

The southern Hattah Lakes were partially filled with water for the environment in May and June 2021 after a two-year drying period. Unregulated flows in the Murray River in October and November 2021 exceeded the minimum commence-to-flow level into the Hattah Lakes, but they were lower than the water levels in the lakes at the time. The regulators in Chalka Creek were kept closed to prevent existing water from flowing out of the lakes, and the Hattah pumps were used to deliver some of the Murray River flows into the lakes.

Deliveries of water for the environment for the Hattah Lakes were managed in line with an average climate scenario during 2021-22, and all the planned actions were fully achieved. The lakes are only managed in line with a wet climate scenario in years when the Murray River floods and causes widespread inundation of the Hattah Lakes system.

More than 46,000 ML of water for the environment was delivered to the southern Hattah Lakes during October and November 2021, inundating 17 lakes and low-lying parts of the surrounding floodplain. Water levels drew down over summer and autumn through a combination of active releases, seepage and evaporation. About 15,000 ML of water for the environment drained from the Hattah Lakes back into the Murray River from December 2021 to March 2022, carrying carbon, nutrients and organisms that can support riverine food webs. Water that returned to the Murray River was subsequently used for environmental flows at downstream sites in South Australia.

Lake Kramen is a periodically inundated (episodic) wetland, separate from the main Hattah Lakes, that requires filling on average once every eight years. It last filled in 2019 and dried during 2021-22. No active watering is planned at Lake Kramen for at least four years to allow lake-bed herbaceous plants to grow and complete their life cycles.

The influence of La Niña (although weakening) remained steady over south-eastern Australia during autumn 2022 and continues to influence the climate outlook. This climate feature, combined with the prospect of high water availability in 2022-23, may trigger additional deliveries of water for the environment in 2022-23 to build on environmental outcomes achieved in 2021-22.

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Scope of environmental watering

Table 5.2.12 describes the potential environmental watering actions in 2022-23, 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 Hattah Lakes

<table>
<tr><th>Potential environmental watering action[1]</th><th>Expected watering effects</th><th>Environmental objectives</th></tr>
<tr><td>Southern Hattah Lakes (top up and fill selected wetlands between 42.5 m and 43.5 m AHD and lower floodplain during winter/spring 2022)</td><td rowspan="2">• Stimulate the growth and improve the condition of river red gums fringing wetlands and (when filled to 43.5 m AHD) on the lower floodplain
• Provide conditions for lake-bed herbaceous plants to grow during the drawdown phase following watering
• Provide breeding and feeding habitat for waterbirds
• Stimulate new growth of aquatic vegetation
• Inundate dry wetlands to release carbon and nutrients to increase food web productivity
• Increase productivity in the Murray River downstream of the Hattah Lakes through the provision of return flows (when filled to 43.5 m AHD)
• Provide connections between the floodplain and the Murray River to allow the exchange of nutrients, carbon, fish and plant propagules
• Provide spawning and recruitment habitat for small-bodied native fish and nursery habitat for large-bodied native fish (such as golden perch)
• Inundate a variety of wetland types at different elevations across the Hattah Lakes to increase habitat diversity</td><td rowspan="2"></td></tr>
<tr><td>Southern Hattah Lakes (top up and fill selected wetlands and lower floodplain to 43.5 m AHD at any time following a natural flood)</td></tr>
</table>

1 In consultation with the VEWH, Mallee CMA and Parks Victoria, the Hattah Lakes pump station may be operated at any time of year by Goulburn-Murray Water for testing, pump maintenance and repairs.

Scenario planning

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

In 2022-23, deliveries of water for the environment are planned for the Hattah Lakes under all climate scenarios except for drought.

Under a wet climate scenario, natural floods are expected to inundate large parts of the Hattah Lakes. If only minor or moderate flooding occurs, water for the environment may be pumped into the lakes to achieve the target water level of 43.5 m AHD to inundate floodplain habitats.

In the absence of a natural flood in winter or early spring, the Hattah pumps will be used to refill the lakes and low-lying areas of the floodplain that were watered in autumn and spring of 2021. The proposed delivery of 35,000 ML of water for the environment under an average scenario (providing inundation to 43.5 m AHD) will provide consecutive years of high-level inundation of the Hattah Lakes to consolidate and build on environmental outcomes from watering in 2021-22.

The level of watering will likely vary between a dry and average climate scenario to mimic natural variations in water levels associated with each scenario. Up to 15,000 ML of water for the environment will be delivered under a dry climate scenario to top up the semi-permanent wetlands within the southern Hattah Lakes system to 42.5 m AHD. Up to 35,000 ML will potentially be delivered under an average climate scenario to inundate semi-permanent wetlands in low-lying areas as well as some temporary wetlands at slightly higher elevations.

No active watering is proposed under a drought scenario. The water delivered to the Hattah Lakes in spring 2021 will likely persist in some wetlands throughout 2022-23 without additional water, and it will provide refuge habitat for waterbirds and fish that moved into the Hattah Lakes during the deliveries in 2021. 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.

It is envisaged that during 2023-24, Hattah Lakes will enter a drawdown phase, and there is currently no requirement for high-priority carryover under any climate scenario.

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Table 5.2.13 Potential environmental watering for the Hattah Lakes under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Low flow year-round in the Murray River and no natural inflow to the Hattah Lakes; substantial wetland drying will occur	• Rare high-flow events in the Murray River and no natural inflow to the Hattah Lakes	• Short periods of high flow in the Murray River with minor spills from storages, most likely in late winter/ spring, providing minor natural inflow to the Hattah Lakes	• Lengthy periods of high flow in the Murray River with major spills from storages resulting in widespread wetting of the Hattah Lakes and floodplain
Potential environmental watering – tier 1 (high priorities)	• N/A	• Southern Hattah Lakes spring top up and fill to 42.5 m AHD targeting semi-permanent[1] wetlands	• Southern Hattah Lakes spring top up and fill to 43.5 m AHD targeting semi-permanent[1] wetlands, temporary[2] wetlands and low-level floodplain inundation	• Southern Hattah Lakes top up and fill to 43.5 m AHD at any time targeting semi-permanent[1] wetlands, temporary[2] wetlands and low-level floodplain inundation
Possible volume of water for the environment required to achieve objectives	• N/A	• 15,000 ML	• 35,000 ML	• 0-35,000 ML
Priority carryover requirements for 2023-24	• No priority carryover requirements for 2023-24			

1 Lakes Bulla, Hattah, Little Hattah, Lockie, Mournpall and Yerang.
2 Lakes Arawak, Boich, Bitterang, Brockie, Cantala, Konardin, Nip Nip, Roonki, Tullamook, Woterap and Yelwell.

5.2.6 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 the use of irrigation supply infrastructure. Most wetlands that receive environmental flows can be managed independently of each other.

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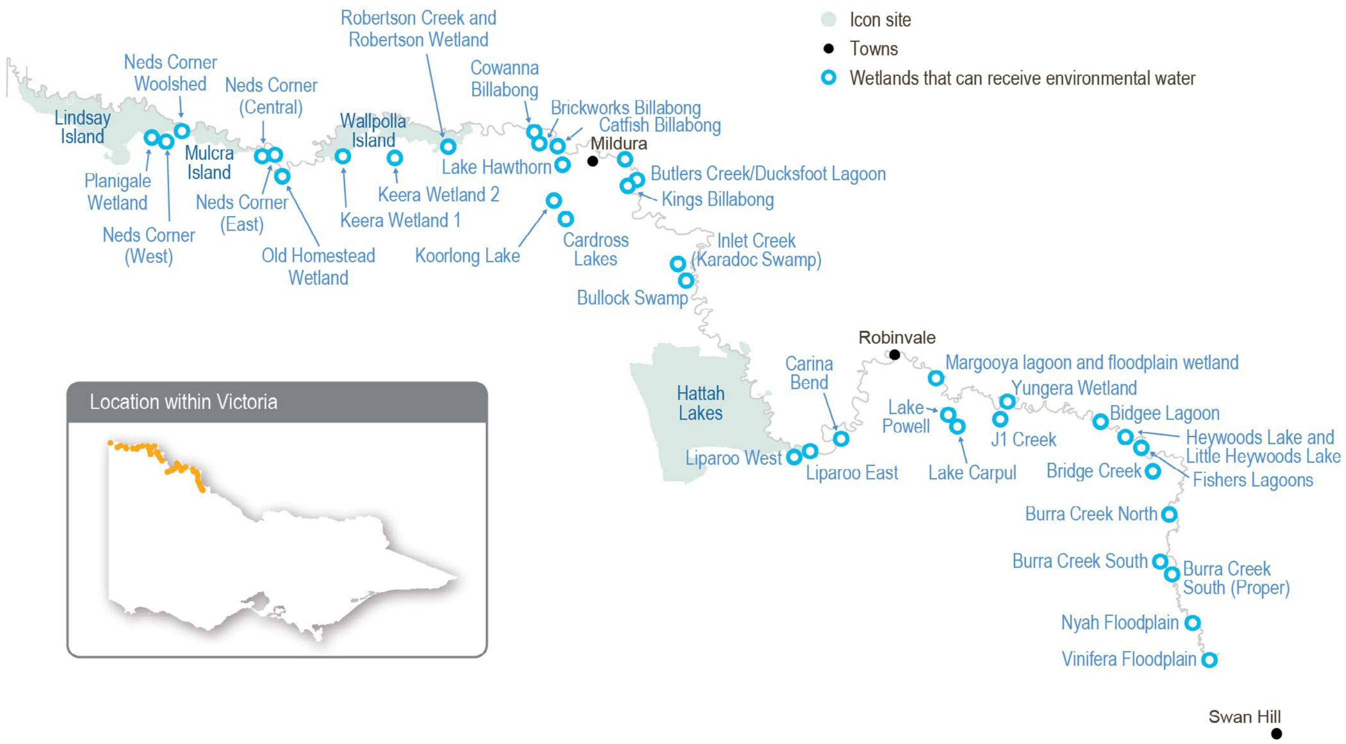
Figure 5.2.5 The lower Murray wetlands



Environmental values

Environmental watering objectives in the lower Murray wetlands

Icon	Environmental 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 communities
	Provide feeding and breeding habitat for a range of waterbird species, including threatened and migratory species and colonial nesting species (such as egrets)

Traditional Owner cultural values and uses

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

On proposed 2022-23 watering of the lower Murray wetlands, Mallee CMA engaged with the First People of the Millewa-Mallee Aboriginal Corporation (FPMMAC) comprised of Latji Latji and Ngintait Traditional Owners (Traditional Owners from Hattah to the South Australian border). Mallee CMA also engaged with Latji Latji Mumthelang and representatives from Culpra Millee and Munatunga.

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Traditional Owner groups invited to discussions included Tati Tati, Wamba Wemba, Wadi Wadi, Weki Weki and Nyeri Nyeri.

Tati Tati wish to express their lack of representation in no way is a reflection their lack of interest or cultural responsibility in caring for wetlands on Tati Tati Country. It does, however, reflect Tati Tati's deliberate shift to only engaging organisations that demonstrate a commitment to upholding cultural safety. Tati Tati will continue to look to the future to partner with organisations transitioning to First Nations empowerment – not engagement.

Discussions covered a range of options for how environmental flows could be delivered in 2022-2023 and what the traditional ecological needs are in the current climate. Discussions also covered how the planning process works, as some community members had not participated in previous years. The values, knowledge and concerns identified in these discussions have supported the Mallee CMA's planning for wetland watering across the lower Murray region.

Elders from the Nyah Floodplain region (Culpra Millee) said that watering creeks across the floodplain is good for their communities, enabling many generations to get out on Country while water is in the creeks. They said they would like to be involved in planning for water for the environment from the start and all the way through: from before water is pumped to when water flows in the creeks. Opportunities to foster intergenerational education and the passing down of cultural knowledge are also very important.

Increasing the involvement of Traditional Owners in the planning and management of water for the environment and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* 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 5.2.14 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 their contribution and indicating progress towards deeper involvement.

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 drying vegetation dies and wind erodes the landscape. The First People of the Millewa-Mallee Aboriginal Corporation is undertaking a program of restoration and protection work at the site. An environmental flow was delivered to the creek in spring 2020-21 and again in 2021-22 to complement the restoration and protection objectives. This has helped improve the condition of trees and shrubs and helped return and protect cultural values which are important for community learning, teaching and overall wellbeing. An environmental flow is planned for Robertson Creek in 2022-23 in all scenarios except drought. This will build on outcomes from previous watering by further improving the condition of the vegetation and increasing protection against wind. It will also support the revegetation of native trees, shrubs and grasses.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.14, 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 sightseeing; 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

Rainfall across the lower Murray floodplain in 2021-22 was close to or slightly above the long-term average. Rainfall in the upper Murray and Murrumbidgee catchments was significantly greater than average, and it delivered sustained periods of unregulated flow in the Murray River. Increased flow in the Murray River during spring and early summer naturally inundated some of the low-lying wetlands on the lower Murray floodplain.

In 2021-22, allocations against high-reliability water shares reached 52 percent in August and 100 percent in October. Low-reliability water shares began receiving allocations in December and reached their full allocations in February. This is the first time Murray seasonal determinations reached maximum availability since the introduction of the current entitlement products in 2007. Spills from Hume Dam resulted in the deduction of most spillable carryover from 2020-21. Section 5.2 has more information about the resource position of water for the environment in the Victorian Murray system during 2021-22.

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Deliveries of water for the environment for the Lower Murray wetlands were managed in line with a dry climate scenario at the start of 2021-22 but shifted to an average scenario in spring in response to increasing flows in the Murray River.

Most of the potential watering actions planned in 2021-22 were fully achieved. Environmental flow objectives at Nyah Floodplain, Vinifera Floodplain, Bidgee Lagoons and Fishers Lagoon were met by natural inflows from the Murray River. Run-off from local rainfall helped meet environmental watering objectives for Murray hardyhead at Lake Koorlong and Lake Hawthorn, which reduced the total volume of water for the environment that was pumped to those sites. Water for the environment was delivered as planned to Robertson's Creek, Brickworks Billabong, Burra Creek South and Burra Creek South Proper. Since 2018-19, Lake Carpul and Lake Powell have remained dry to support dry-phase ecosystem processes.

The only planned environmental watering action for the lower Murray wetlands that was not achieved in 2021-22 was an autumn fill at Burra Creek North. Watering at the site currently relies on temporary pumping, but the proposed pumping site was inaccessible in autumn due to private works. New water delivery infrastructure is due to be built at Burra Creek North during 2022-23 as part of the Victorian Murray Floodplain Restoration Project (VMFRP), and the site will be prioritised for watering in 2023-24.

Scope of environmental watering

Table 5.2.14 describes the potential environmental watering actions in 2022-23, 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 5.2.14 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
Brickworks Billabong (top up in spring, top-ups as required over summer/autumn)	• Maintain water levels (the target water level is between 30.8 m AHD and 31.6 m AHD) 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	
Catfish Billabong (top up winter/spring)	• Fill to 33.5 m AHD to inundate fringing woodland vegetation to improve condition and recruitment • Allow water level to draw down over summer and autumn to: - promote the growth of a range of aquatic macrophytes that favour different water depth and inundation patterns - provide suitable foraging conditions for wading shorebirds • Maintain water levels above 30.8 m AHD to maintain permanent habitat for large-bodied and small-bodied native fish	
Heywood's Lake (fill in autumn)	• Fill to 56.8 m AHD to inundate fringing black box to stimulate growth and flowering to improve condition and recruitment • Provide a range of temporary open-water and shallow-water habitats to trigger the growth of various aquatic macrophytes and provide feeding and breeding opportunities for a variety of waterbirds	
Koorlong Lake (fill in spring, top-ups as required)	• Increase and maintain the water level (the target water level is between 36.7 m AHD and 38.0 m AHD) 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
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 (the target water level is 52.23 m AHD) to improve their condition • Mobilise carbon and nutrients within the wetland to support wetland processes	
Lake Hawthorn (fill in spring, top-ups as required)	• Achieve a target water level between 33 m AHD and 33.3 m AHD to: - increase and maintain a water level to encourage the germination and growth of ruppia to provide nursery habitat for Murray hardyhead and visitation by shorebirds - maintain the water level 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 (the target water level is 51.05 m AHD) to improve their condition • Mobilise carbon and nutrients within the wetland to support wetland processes	
Little Heywood's Lake (fill in autumn)	• Fill to 56.8 m AHD to inundate the fringing black box community to stimulate its growth and flowering to improve condition and recruitment • Provide a range of temporary open-water, shallow-water and emergent-vegetation habitats to provide feeding and breeding opportunities for a variety of waterbirds	
Nyah Floodplain (fill in autumn)	• Inundate the base and littoral zone of Parnee Malloo Creek (the target water level is 63.2 m AHD) 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 (top up in spring)	• Wet fringing river red gum, black box, lignum and vegetation communities (the target water level is 30.4 m AHD) 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)	• Wet fringing river red gum, black box, lignum and vegetation communities (the target water level is 28.4-28.8 m AHD) 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	

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Scenario planning

Table 5.2.15 outlines potential environmental watering and expected water use under a range of planning scenarios.

Brickworks Billabong, Catfish Billabong, Koorlong Lake and Lake Hawthorn are priorities for watering in 2022-23 under all climate scenarios. Brickworks Billabong, Koorlong Lake and Lake Hawthorn support endangered populations of Murray hardyhead and require top-ups each year to ensure salinity levels are maintained within an acceptable range to support submerged vegetation that provides habitat for this species. Catfish Billabong is a new site that supports populations of native fish and wading shorebirds. A new regulator is being built at Catfish Billabong, and watering is prioritised at this site under all scenarios to test the capacity of the new infrastructure to achieve the recommended watering regime.

Nyah Floodplain, Robertson Creek and Robertson Wetland are priority watering sites under dry, average and wet climate scenarios. Nyah Floodplain dried between 2018-19 and 2020-21 and was inundated by unregulated flows in the Murray River during 2021-22. Vegetation at Nyah Floodplain will benefit from a second inundation in two years, which will improve the condition of the site ahead of proposed construction works as part of the VMFRP that will prevent deliveries of water for the environment in 2023-24. Deliveries of water for the environment at Robertson Creek in 2020-21 and 2021-22 have improved the condition of fringing vegetation, including black box and red gum and the waterbird population. Watering the site in 2022-23 aims to consolidate these environmental outcomes and build resilience for future dry conditions. Robertson Wetland was partially inundated by unregulated flows in the Murray River during 2021-22, but most of the wetland has not been inundated since the 2016 floods. Watering at Robertson Wetland in 2022-23 will aim to improve the condition of fringing river red gum that require inundation between four and six years out of ten for optimal condition. Nyah Floodplain and Robertson Wetland may be watered naturally under a wet scenario if the Murray River floods.

Given natural inundation and deliveries of water for the environment achieved watering requirements for most sites on the lower floodplain in 2021-22, the plan under average and wet scenarios is to water sites higher on the floodplain that have exceeded their recommended drying phase. Targeted sites include Lake Carpul and Lake Powell (dry since 2017) and Heywood's Lake and Little Heywood's Lake (dry since 2015). It will be important to deliver water to these sites in 2022-23 where possible because VMFRP construction works will likely prevent them from being actively watered in 2023-24.

Bidgee Lagoons, Fishers Lagoon, Bullock Swamp, Burra Creek South, Burra Creek South Proper and Vinifera Floodplain will be allowed to draw down during 2022-23 (unless they are naturally flooded) to support dry-phase ecosystem processes in accordance with recommendations in their management plans. At Burra Creek South and Burra Creek South Proper, this dry-phase period aligns with planned construction works through VMFRP, which will be completed in 2024-25.

Table 5.2.15 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 cause 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

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 1 (high priorities)[1]	• Brickworks Billabong • Catfish Billabong • Koorlong Lake • Lake Hawthorn	• Brickworks Billabong • Catfish Billabong • Koorlong Lake • Lake Hawthorn • Nyah Floodplain • Robertson Creek • Robertson Wetland	• Brickworks Billabong • Catfish Billabong • Heywood's Lake • Koorlong Lake • Lake Carpul • Lake Hawthorn • Lake Powell • Little Heywood's Lake • Nyah Floodplain • Robertson Creek • Robertson Wetland	• Brickworks Billabong • Catfish Billabong • Heywood's Lake • Koorlong Lake • Lake Carpul • Lake Hawthorn • Lake Powell • Little Heywood's Lake • Nyah Floodplain • Robertson Creek • Robertson Wetland
Possible volume of water for the environment required to achieve objectives[1]	• 2,800 ML (tier 1)	• 6,000 ML (tier 1)	• 13,300 ML (tier 1)	• 10,800 ML (tier 1)
Priority carryover requirements for 2023-24	• N/A			

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.

5.2.7 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 and regulated channels.

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 can significantly impact 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 and 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 help establish fringing vegetation in shallow margins of the river channel and promote the 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, the upper Lindsay River starts flowing (Lock 7) and flow to Potterwalkagee Creek increases (Lock 8). When weir pools are lowered, flow to both the Lindsay River and Potterwalkagee Creek ceases. Mullaroo Creek on Lindsay Island 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 more than 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.

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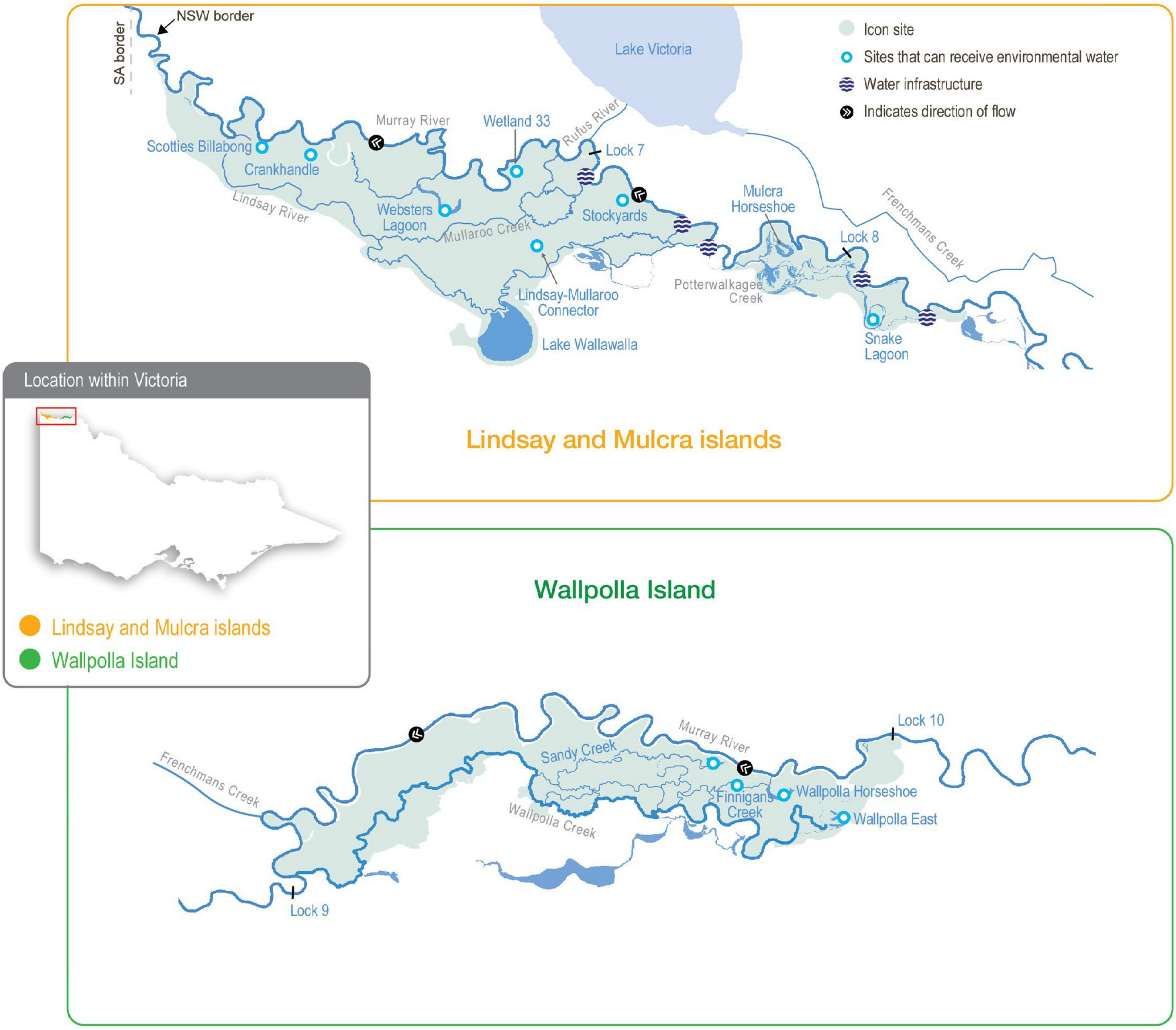
Fluctuation of weir pool levels is a major consideration for jurisdictions managing flow in the Murray River and the anabranch waterways of Lindsay, Mulcra and Wallpolla islands. Environmental objectives and associated water regimes for the Murray River sometimes conflict with those for the Lindsay, 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 that contain various streams, billabongs, large wetlands and swamps. When flooded, waterways and wetlands within these systems provide habitat for native fish, frogs, turtles, waterbirds and water-dependent 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.

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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 in Lindsay, Mulcra and Wallpolla islands

Icon	Environmental objectives in Lindsay, Mulcra and Wallpolla islands[1]
	By 2030, increase the abundance of small-bodied native fish and the spread of age classes for long-lived native fish, compared to 2006 baseline levels
 	Maintain (continuously) or improve (by 2030) populations of flow-dependent fauna
	By 2030, improve the function of water-dependent ecosystems by improving productivity linkages between river and floodplain habitats
	Maintain (continuously) or improve (by 2030) populations of flow-dependent threatened flora Maintain the extent and improve the condition of river red gum, black box and lignum compared to 2006 baseline levels by 2030 By 2030, improve the species richness and abundance of native wetland and floodplain aquatic vegetation functional groups
	Maintain communities and species diversity of colonial nesting waterbirds, waterfowl, waders and animals that feed on fish By 2030, increase populations of colonial nesting waterbirds at Lake Wallawalla and non-colonial waterbirds at Mulcra Horseshoe and Wallpolla Horseshoe

1 All objectives are derived from the Mallee CMA's 2021 *Lindsay Mulcra and Wallpolla Islands Environmental Watering Management Plan* and generally include targets for improving environmental values to be achieved by 2030. Objectives for maintaining the condition of environmental values are not time-bound and should be achieved each year continuously until 2030 and beyond.

Traditional Owner cultural values and uses

The First People of the Millewa-Mallee Aboriginal Corporation (representing Latji Latji and Ngintait Traditional Owners) has identified ways in which water for the environment can support cultural values and uses at the Lindsay-Mulcra-Wallpolla islands icon site. These are explained in Table 5.2.16.

Mallee CMA usually meets on Country with the First People of the Millewa-Mallee Aboriginal Corporation to discuss watering requirements for their Country. COVID-19 restricted opportunities to meet on Country during 2021-22, so Mallee CMA used small-group discussions in early 2022 as well as previous recommendations from Traditional Owners to inform proposed deliveries of water for the environment in 2022-23.

Ngintait Traditional Owners support proposed watering at Mulcra Island and Potterwalkagee Creek in 2022-23.

Table 5.2.16 Traditional Owner values and uses at the Lindsay-Mulcra-Wallpolla islands icon site

Waterway	Traditional Owner group	Values/uses/objectives/opportunities
Lindsay Island	Ngintait	• Black swans — a totemic species —nest 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 riverbanks, creating more nesting opportunities and a greater black swan population.
Lindsay Island	Ngintait	• Three-pronged grass is used for weaving. Traditional Owners are looking at places to plant seeds to grow this species, so Elders can sit with the community and teach weaving using the grass.
Lindsay-Mulcra-Wallpolla islands	Ngintait/Latji Latji	• Old man weed, which grows in mud as water recedes, is used for bush medicine. Both Traditional Owner groups from the Lindsay, Mulcra and Wallpolla region would like to see more of this. • Ngintait/Latji Latji want totemic species, including black swans, frogs, turtles, catfish, possums and ducks, protected, and their numbers increased.
Lindsay-Mulcra-Wallpolla islands	Latji Latji	• Latji Latji would like more opportunities to get back onto Country and further discussions about managing Country.

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Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.18, Mallee CMA has also considered how environmental flows could support other values and uses, including:

- 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 and longstanding repeat visitation, ecotourism and educational programs for school, TAFE and university students)
- socio-economic benefits (such as for commercial beekeepers who rest bees around the floodplain away from crops and pesticides ready for the next season, local businesses providing accommodation and hospitality to tourists, researchers and local water delivery contractors).

Recent conditions

Rainfall across Lindsay, Mulcra and Wallpolla islands during 2021-22 was close to the long-term average, and maximum temperatures were slightly above average.

In 2021-22, allocations against high-reliability water shares reached 52 percent in August and 100 percent in October. Low-reliability water shares began receiving allocations in December and reached their full allocations in February. This is the first time Murray seasonal determinations reached maximum availability since the introduction of the current entitlement products in 2007. Spills from Hume Dam resulted in the deduction of most spillable carryover from 2020-21. Section 5.2 has more information about the resource position of water for the environment in the Victorian Murray system during 2021-22.

Increased flow in the Murray River (driven by rainfall and storage spills in the upper Murray and Murrumbidgee catchments) from October to December 2021 filled some low-lying floodplain wetlands and increased flows through anabranch waterways on Lindsay, Mulcra and Wallpolla islands.

Deliveries of water for the environment for the Lindsay, Mulcra and Wallpolla islands were managed in line with an average climate scenario during 2021-22. All the watering actions planned for the year were fully achieved through a combination of natural and environmental flows.

On Lindsay Island, natural flows in spring filled Scotties Billabong, Stockyards and Wetland 33. Lake Wallawalla and Crankhandle did not fill naturally, and water for the environment was delivered to these sites via pumps. The Lindsay-Mullaroo Connector was partially filled by natural flows in spring and topped up via pumping in autumn. Flows through the Lindsay River and Mullaroo Creek increased through spring in response to increased flow in the Murray River.

Weir pool eight in the Murray River was raised during spring 2021 to increase flow in Potterwalkagee Creek and spread water onto the Mulcra Island floodplain for the first time since 2017. Increased flow in the Murray River during spring 2021 increase the weir pool height and pushed water further onto the Mulcra floodplain. Annual condition monitoring indicates that the floodplain inundation in 2021 arrested the decline in the health of river red gum, black box and lignum communities and water-dependent understorey vegetation that has been observed in recent dry years. Ecologists recommend inundating Mulcra Island floodplain again in spring 2022, if possible, to consolidate the environmental benefits of the 2021 watering event.

Increased flow in the Murray River provided unimpeded flow through Wallpolla Horseshoe, Finnigans Creek and Wallpolla Creek on Wallpolla Island during spring, which allowed the dispersal of native fish that were stocked in Wallpolla Horseshoe in 2019.

Scope of environmental watering

Table 5.2.17 describes the potential environmental watering actions in 2022-23, 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.

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Table 5.2.17 Potential environmental watering actions, expected watering effects and associated environmental objectives for Lindsay, Mulcra and Wallpolla islands

Potential environmental watering action	Expected watering effects	Environmental objective(s)
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 habitat to cue the movement and spawning and improve recruitment opportunities for native fish • Increase 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 northern regulator (45 ML/day for three months during August to December)	• Provide temporary flowing water to connect pools and support the dispersal and recruitment of small- and large-bodied native fish and the spawning of small-bodied native fish • Stimulate the release of carbon and nutrients from the sediment to increase the productivity of the floodplain food web • Maintain bank soil moisture to support the growth of streamside vegetation	
Winter/spring/summer low flow via the southern regulator (5 ML/day for three months during August to December)		
Lindsay Island wetlands		
Scotties Billabong (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	
Mulcra Island – Potterwalkagee Creek		
Spring low flow via the Stony Crossing regulator (35-115 ML/day for three months during September to November)	• Provide temporary flowing water to connect pools and support the dispersal and recruitment of small- and large-bodied native fish, and the spawning of small-bodied native fish • Stimulate the release of carbon and nutrients from the sediment to increase the productivity of the floodplain food web • Maintain soil moisture to maintain the condition of streamside vegetation	
Spring low flow via the upper Potterwalkagee Creek regulator (15 ML/ day for three months during September to November)		
Winter/spring overbank flow via the Stony Crossing regulator (470 ML/day for four months during August to November)	• Connect Potterwalkagee Creek to its 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 four months during August to November)		

Mulcra Island wetlands		
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 • 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	

Potential environmental watering action	Expected watering effects	Environmental objective(s)
Mulcra Island floodplain (floodplain inundation in spring)	• Provide shallow- and open-water habitat to create foraging and breeding opportunities for waterbirds • 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	
Snake Lagoon extension (fill in spring)	• Provide shallow- and open-water habitat to create foraging and breeding opportunities for frogs and waterbirds • Increase soil moisture to maintain and improve the condition of streamside and floodplain vegetation, specifically river red gum, black box and lignum • Provide moisture for lake-bed herbaceous plants to grow during the drying phase of the wetland	
Wallpolla island		
Wallpolla Creek East (low flow in spring)	• Increase soil moisture to maintain and improve the condition of riparian vegetation, specifically black box • Provide a connection between Wallpolla Creek East and other tributaries of the Wallpolla Island floodplain to allow the exchange of carbon, nutrients and propagules through the system	
Wallpolla Horseshoe Lagoon (fill in spring)	• 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 riparian vegetation, specifically river red gum • Provide shallow- and open-water habitat to create foraging and refuge opportunities for frogs and waterbirds • Stimulate the growth of emergent, aquatic and streamside vegetation	

Scenario planning

Table 5.2.18 outlines 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 2022-23 are:

- deliveries of water for the environment to 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.

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Anabranch and floodplain watering

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 Potterwalkagee Creek (via the Stony Crossing regulator). 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. Potterwalkagee Creek requires a low flow in most years to provide habitat for small-bodied native fish and larger flows for five in every 10 years to allow those fish to disperse between the creek and the Murray River, as well as to water higher terraces within the creek channel.

Under drought and dry scenarios, the operation of Murray River weir pools will only allow a low flow to be delivered to Potterwalkagee Creek. Floodplain inundation at Mulcra Island is a high priority under an average and wet scenario to consolidate benefits achieved from the watering in 2021. To achieve floodplain inundation in an average scenario, weir pool eight will be raised to increase flow in Potterwalkagee Creek (via the upper Potterwalkagee and Stony Crossing regulators), and flow will be temporarily held behind the lower Potterwalkagee Creek regulator to provide overbank flows and connection to the floodplain. Natural flooding under a wet climate scenario is likely to inundate large parts of the Mulcra Island floodplain.

Environmental flows are not proposed for Lindsay River under a drought climate scenario because weir pool seven will be operated at a level that is insufficient to provide flow to Lindsay River. Low flow is needed under dry to wet climate scenarios to connect pools and help disperse fish, plant propagules, carbon and nutrients between the Murray and Lindsay rivers. Under a dry or average scenario, the low flow will be delivered via regulators when weir pool 7 is raised. Flow through Lindsay River will likely be met naturally under a wet climate scenario.

Deliveries via temporary pumps

Five wetlands across Lindsay, Mulcra and Wallpolla islands are identified for deliveries using temporary pumps during 2022-23.

Watering the Snake Lagoon extension on Mulcra Island is a high priority under all scenarios because it has been dry since 2016, and a wet phase is required to replenish water-dependent vegetation and reduce the dominance of terrestrial plant species bordering the wetland. Mulcra Horseshoe still holds water from 2021-22, and it will likely provide refuge for aquatic fauna for two to three years without further top-ups if conditions turn dry. There is no plan to deliver extra water to Mulcra Horseshoe in 2022-23 under a drought scenario, but topping up the wetland is a high priority under all other scenarios to increase plant growth and provide foraging habitat for waterbirds that are likely to be abundant throughout the region. Water will need to be pumped into Mulcra Horseshoe in a dry scenario, but the wetland will likely fill as part of a managed floodplain watering event (via weir pool raising and increased flow in Potterwalkagee Creek) under an average scenario and through natural flooding under a wet scenario.

Scotties Billabong on Lindsay Island was partially filled in spring 2020 and naturally filled in spring 2021. Watering Scotties Billabong again in spring 2022 is a high priority under dry, average and wet climate scenarios because the impending construction activities associated with the VMFRP will limit watering opportunities during late 2023. Watering Scotties Billabong is a low priority under a drought scenario in 2022-23 because there are sufficient refuge sites elsewhere in the nearby landscape, and the minor inundation that occurred in 2021 improved the condition of the wetland vegetation enough to allow them to tolerate the next dry period.

At Wallpolla Island, watering is required at Wallpolla Horseshoe in all scenarios to maintain vegetation quality and stop the encroachment of terrestrial plants into the wetland: it will likely fill naturally under a wet scenario. Wallpolla Creek East is prioritised for water deliveries in a dry or average scenario to provide connectivity and the exchange of carbon, nutrients and propagules between creeks on Wallpolla Island. In a wet scenario, there may be enough natural connectivity through the system to achieve connection objectives, but some delivery of water for the environment may be necessary if the outcomes are only partially achieved. Watering Wallpolla Creek East is a low priority under a drought scenario in 2022-23 to conserve water and because there are sufficient refuge sites elsewhere in the nearby landscape.

Crankhandle, Finnigans Creek, Lake Wallawalla, Lindsay-Mullaroo Connector, Sandy Creek and Stockyards were filled during 2021-22 by natural flows or deliveries of water for the environment. Water will not be delivered to these sites during 2022-23 to allow them to continue to draw down and support dry phase outcomes (such as providing foraging habitat for wading waterbirds and allowing the growth of lake-bed herbland communities). Offsetting wetting and drying phases in different wetlands across Lindsay, Mulcra and Wallpolla islands in non-flood years provides a variety of habitat types and resources for waterbirds, terrestrial birds and other animals.

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Table 5.2.18 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 spring and drawn down below full supply level during summer, autumn and winter • Substantial wetland drying will occur	• Rare high-flow events in the Murray River and no natural floodplain wetting • Weir pools will be raised in spring and drawn down below full supply level in summer, autumn and winter • Substantial wetland drying will occur	• Short periods of high flow, most likely in spring/ summer, providing minor wetting of the floodplain • Weir pool levels will be maintained at full supply level or raised in winter/ spring and summer and drawn down in summer, autumn and winter	• 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 high-low flow (Mullaroo Creek)	• Year-round low flow (Mullaroo Creek) • Spring high-low flow (Mullaroo Creek) • Winter/spring/ summer low flow (Lindsay River via the north and south regulator) • Scotties Billabong (fill in spring)	• Year-round low flow (Mullaroo Creek) • Spring high-low flow (Mullaroo Creek) • Winter/spring/ summer low flow (Lindsay River via the north and south regulator) • Scotties Billabong (fill in spring)	• Year-round low flow (Mullaroo Creek) • Spring high-low flow (Mullaroo Creek) • Winter/spring/ summer low flow (Lindsay River via the north and south regulator) • Scotties Billabong (fill in spring)

Planning scenario	Drought	Dry	Average	Wet
Possible volume of water for the environment required to achieve objectives[2]	• 0-100 ML (tier 1)	• 200-400 ML (tier 1)	• 100-400 ML (tier 1)	• 0 ML (tier 1)
Mulcra Island				

Potential environmental watering – tier 1 (high priorities)[1]	• Snake Lagoon extension (fill in spring) • Spring low flow (Potterwalkagee Creek via Stony Crossing regulator)	• Snake Lagoon extension (fill in spring) • Spring low flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek regulators) • Mulcra Horseshoe (fill in spring)	• Snake Lagoon extension (fill in spring) • Spring low flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek regulators) • Overbank flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek regulators) • Mulcra Horseshoe (fill in spring) • Mulcra floodplain inundation (floodplain inundation in spring)	• Snake Lagoon extension (fill in spring) • Spring low flow (Potterwalkagee Creek via Stony Crossing and upper Potterwalkagee Creek regulators) • 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]	• 110 ML (tier 1)	• 1,110 ML (tier 1)	• 3,610 ML (tier 1)	• 110 ML (tier 1)
Wallpolla Island				
Potential environmental watering – tier 1 (high priorities)[1]	• Wallpolla Horseshoe (fill in spring)	• Wallpolla Horseshoe (fill in spring) • Wallpolla Creek East (fill in spring)	• Wallpolla Horseshoe (fill in spring) • Wallpolla Creek East (fill in spring)	• Wallpolla Horseshoe (fill in spring) • Wallpolla Creek East (fill in spring)
Possible volume of water for the environment required to achieve objectives	• 400 ML (tier 1)	• 1,900 ML (tier 1)	• 1,900 ML (tier 1)	• 0-1,500 ML (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.

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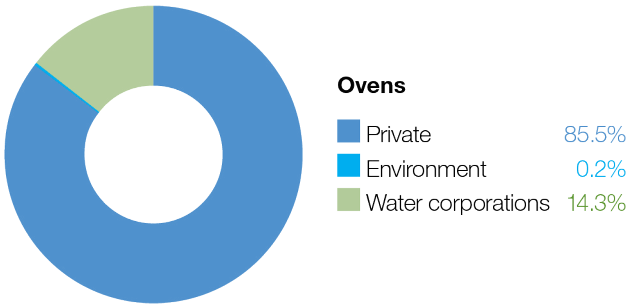
5.3 Ovens system

Waterway manager – North East Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holder – Commonwealth Environmental Water Holder

Proportions of water entitlements in the Ovens basin held by private users, water corporations and environmental water holders on 30 June 2020



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 top up Mullinmur Wetland in Wangaratta.

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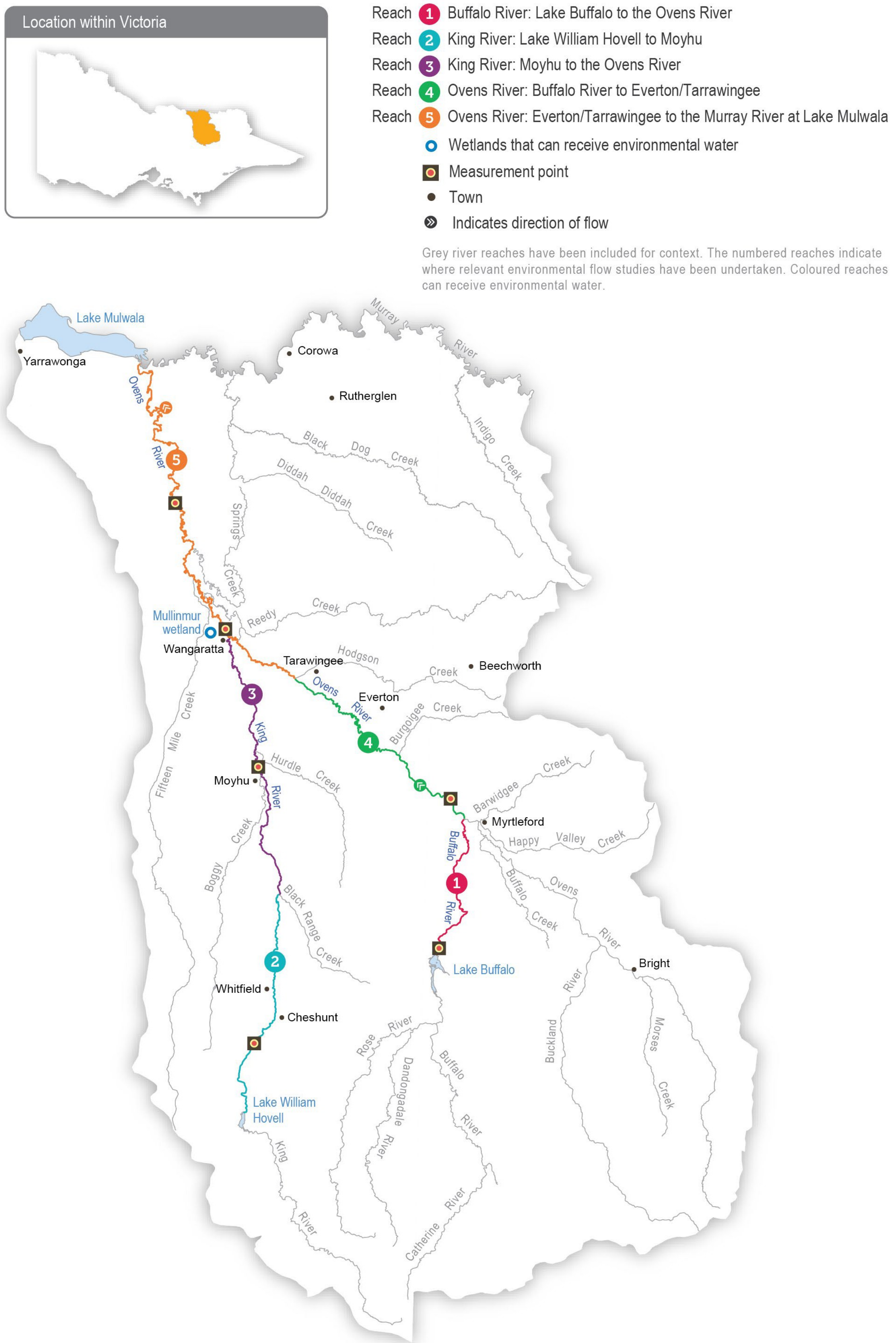
Figure 5.3.1 The Ovens system



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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 the re-introduction of native fish.

Environmental watering objectives in the Ovens system

Icon	Environmental objectives in the Ovens system
	Maintain the size and distribution of native fish populations
	Maintain the form of the riverbank and channel and ensure river bed surfaces are in suitable condition to support all stream life
	Maintain the condition and extent of wetland vegetation communities
	Maintain an adequate abundance and diversity of waterbugs to support river food webs and associated ecosystem processes
	Maintain water quality for all river life

Traditional Owner cultural values and uses

North East CMA consulted the Taungurung Land and Waters Council and the Yorta Yorta Nation Aboriginal Corporation in planning for potential 2022-23 environmental flows in the Ovens system.

The Taungurung Land and Waters Council water knowledge group Baan Ganalina (Guardians of Water) supports increasing Taungurung influence in water management, building internal capacity and advancing Taungurung water rights.

The Taungurung Country Plan's water chapter *Baan Dhumba-Dji-Ngan Mundak Gunga* (We must speak to protect water) lists several water objectives. These include increasing and strengthening Taungurung voices, increasing water literacy and capacity, and returning water to disconnected wetlands. The future delivery of water for the environment by the Taungurung Land and Waters Council on Taungurung Country would contribute to achieving some of these objectives.

The Taungurung Land and Waters Council has a 39 ML entitlement in Lake William Hovell and has transferred unused portions of its annual allocation to the VEWH each year (2019-22) to support environmental flows in the King River to help meet the council's watering objectives and Taungurung cultural responsibilities to heal and care for Country.

The Yorta Yorta Nation Aboriginal Corporation has developed the *Yorta Yorta Whole-Of-Country Plan 2021-2030*, which outlines aspirations and directions for Yorta Yorta Country. The plan identifies the lower Ovens River as a very high priority for management actions. The plan will support more culturally informed planning for water in the lower Ovens River in the future.

North East CMA has started conversations with the Bangerang Aboriginal Corporation, which has expressed aspirations for Mullinmur Wetland. Bangerang Aboriginal Corporation is exploring a cultural burning trial at the site as well as mapping scar trees and traditional stories in partnership with the Rural City of Wangaratta.

Increasing the involvement of Traditional Owners in the planning and management of environmental flows and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* and in some cases, agreements under the *Traditional Owner Settlement Act 2010*.

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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 their contribution and indicating progress towards deeper involvement.

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 and caring for Country. The Taungurung Land and Waters Council's allocation has been released from Lake William Hovell four times as an environmental flow in partnership with the North East CMA, Goulburn-Murray Water and the VEWH to provide additional water to the King River and assist in healing Country.

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/physical health and wellbeing)
- community events and tourism (such as providing a setting for community gatherings, outdoor school learning, sporting events and citizen science projects)
- socio-economic benefits (such as businesses used by anglers and stock and domestic uses which rely on water quality supported by water for the environment deliveries when natural flows are at their lowest from November to March).

A private landholder's water allocation of 56 ML from the King River system was transferred to the VEWH as a donation. This release was combined with an entitlement to water for the environment and the Taungurung Land and Waters Council contribution to provide an increase in flow in February 2022.

Environmental flows are planned for Mullinmur Wetland over summer to support aquatic vegetation and support a native catfish nursery at the site. The water is expected to support other benefits for the local community at this site, which is managed by the Catholic Education Department supported by Wangaratta Landcare and Sustainability Incorporated. A new education hub provides a space for environmental education for students from Galen Catholic College, young people attending the Borinya Wangaratta Community Partnership and other members of the local community, including a team of Waterwatch citizen scientists. These volunteers have been involved in monitoring changes in conditions for plant and fish species after deliveries of water for the environment.

Recent conditions

The Ovens catchment experienced above-average rainfall and average temperatures throughout 2021-22 as a La Niña event continued to influence climate conditions across eastern Australia. Inflows to Lake William Hovell were passed through the storage during winter and spring and were 144 percent of the long-term average for 2021-22. Inflows to Lake Buffalo were also passed through the storage during winter and spring and were 179 percent of the annual average for 2021-22. Periods of high rainfall in both catchments during spring and summer caused storage spills and provided natural freshes to the Buffalo and King rivers. Both storages opened the season at 100 percent allocations against environmental water shares. 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, with the flow at Wangaratta peaking above 16,000 ML per day (which is above the minor flood level) on three occasions during winter and spring.

Deliveries of water for the environment for the Ovens system were managed in line with an average scenario in 2021-22, and all planned watering actions were met through natural flows or water for the environment. Mullinmur Wetland was naturally connected to the Ovens River on multiple occasions throughout winter and spring 2021, and a planned top-up using water for the environment was not required. Held water for the environment was combined with allocations transferred from the Taungurung Land and Water Council and water donated by a private landholder to boost the low flow in the King River during February. A planned autumn fresh in reach 1 of the Buffalo River could not be delivered due to maintenance work, but the impact was likely minimal due to the significant flow variability in the natural flow during the year.

Fish surveys conducted by the Arthur Rylah Institute over the past two years have recorded Macquarie perch, trout cod and southern pygmy perch in the middle reaches of the King River and movement of golden perch into Mullinmur Wetland when it is connected to the Ovens River. Native freshwater catfish that were introduced to Mullinmur Wetland in 2019 have not been detected in follow-up surveys: they have presumably moved into the Ovens River during periods of natural connection.

Scope of environmental watering

Table 5.3.1 describes the potential environmental watering actions in 2022-23, 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.

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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 native fish	
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 potential environmental watering and expected water use under a range of planning scenarios.

The weather and inflows into storages have a large effect on how water for the environment is likely to be used in the Ovens system. Under dry and average conditions, the highest priority will be to use available water for the environment to introduce some variability to the summer/autumn low flow to limit the duration of extremely low-flow or cease-to-flow events that can stress native fish and waterbugs. Under average and wet conditions, the objective will be to provide a greater flow, support fish movement and breeding and 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. 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 2022-23 will be to provide top-ups throughout the warmer months to offset seepage and evaporation, maintain wetland vegetation and maintain habitat for native fish. 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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Possible winter/ early-spring natural fresh • Very low flow through summer and autumn • No bulk water release	• Possible winter/ early-spring natural fresh • Very low flow through summer and autumn • Bulk water release is unlikely	• High winter/spring natural freshes • Moderate flow in summer and autumn with occasional natural freshes • Bulk water release is likely	• High natural freshes and low flow throughout most of the year • Bulk water release is likely • All flow objectives are achieved naturally
Expected availability of water for the environment	• 123 ML			

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• 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

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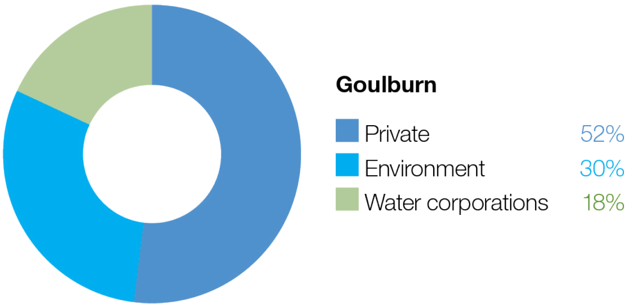
5.4 Goulburn system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder (including the Living Murray Program) and Commonwealth Environmental Water Holder

Proportions of water entitlements in the Goulburn basin held by private users, water corporations and environmental water holders on 30 June 2020



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 the 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 it 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, Yea and Broken rivers 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 inter-valley transfers (IVTs) occur during the irrigation season between spring and autumn and may meet environmental flow objectives without the need to release water for the environment. In recent years, IVTs 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. A new interim Goulburn to Murray trade rule and operating plan was introduced in 2021-22. It is intended to prevent further damage to the lower Goulburn River from prolonged high flow over summer and autumn.

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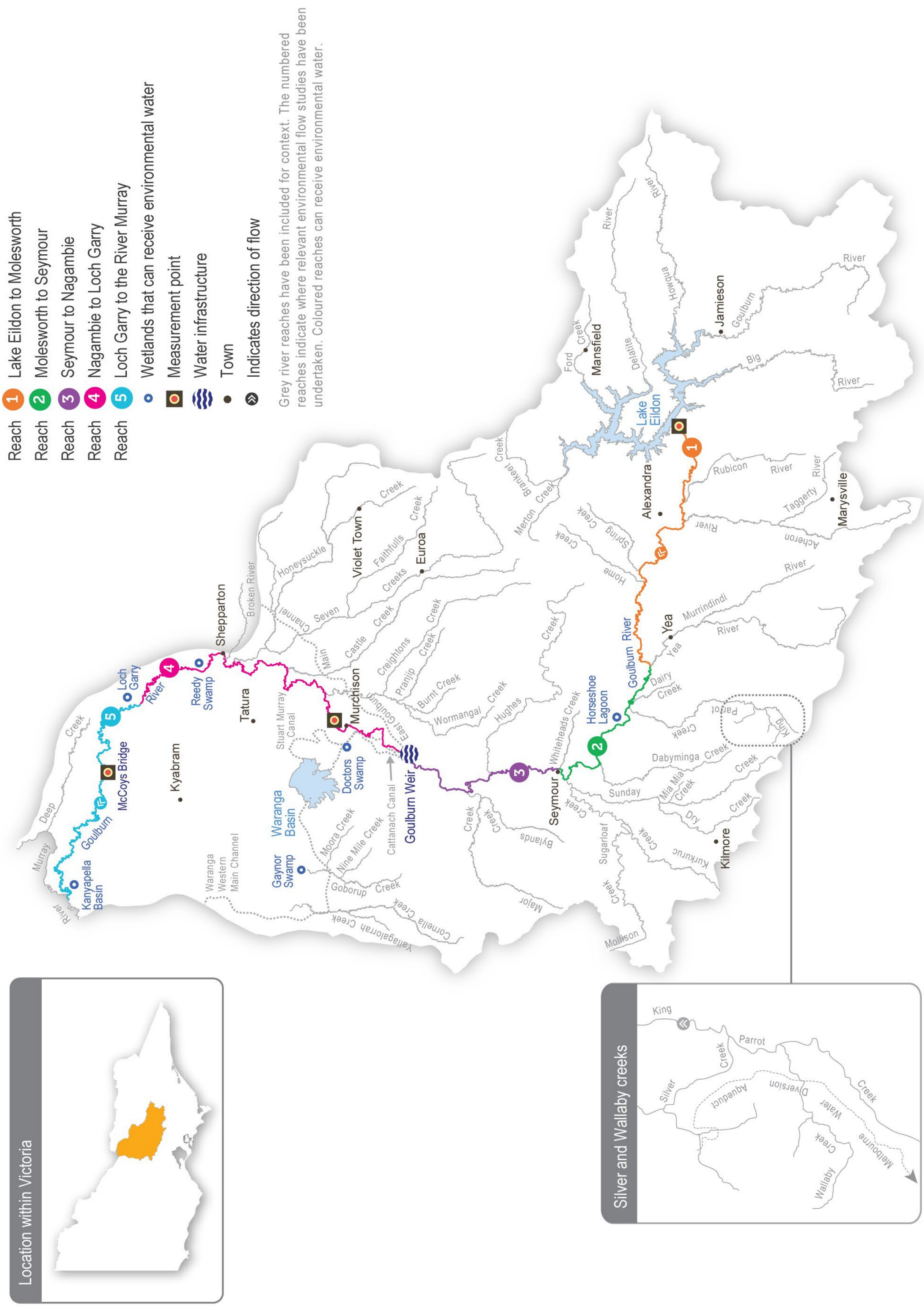
Figure 5.4.1 The Goulburn system



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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

Icon	Environmental 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
	Provide sufficient rates of carbon and nutrient production and processing to support native fish and waterbug communities
	Maintain populations of turtles
	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 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 seasonal water planning for the Goulburn River. The environmental and ecological objectives of the proposals were supported, and they align with the broad values of these Traditional Owner groups.

Increasing the involvement of Traditional Owners in the planning and management of environmental flows and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* 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 their contribution and indicating progress towards deeper involvement.

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

The Taungurung Land and Waters Council indicated there is alignment between planned environmental flows in the mid-Goulburn River (Waring) and Taungurung objectives and responsibilities to heal and care for Country. Reach 1 baseflows, and the winter and spring freshes will help protect the landscape and health of the river. These flows will help support cultural values, protecting intangible cultural heritage, valued species, traditional food and medicine plants. The flows will also support ongoing efforts by Taungurung and partner organisations to care for the river and its floodplain, including investigations into rehabilitating degraded significant sites.

The 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 People. A Yorta Yorta representative contributed to the 2020 Kaiela (Lower Goulburn River) Environmental Flows Study, 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 plant and animal species. 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.

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 (for landholders and visitors)
- community events and tourism (such as paddling and boating businesses)
- socio-economic benefits (such as improving water quality for 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 and inflows to Goulburn storages during 2021-22 were close to the long-term average. Natural flows contributed to winter and spring freshes, including a bankfull event of 19,500 ML per day at Shepparton in September. Allocations to high-reliability water shares reached 100 percent by October 2021, meaning sufficient water was available throughout the year to meet high-priority environmental flow requirements in the Goulburn River and support demands in the Broken, Campaspe and Loddon systems via trade.

Deliveries of water for the environment for the Goulburn system were managed in line with an average climate scenario throughout 2021-22. Most planned watering actions were fully or partially met with natural or environmental flows. A late-spring fresh was not delivered to allow newly germinated lower bank vegetation to establish. Natural flows delivered a winter fresh and spring fresh in the lower Goulburn River. Water for the environment was used to slow the recession after these natural events, to help optimise environmental outcomes. Water for the environment was also used to supplement lower-than-normal operational flow in reach 1 between March and November, to maintain habitat for fish and waterbugs and to deliver a spring and autumn fresh in the lower Goulburn River. The autumn fresh aimed to support bank vegetation and was timed to attract juvenile fish that recruited in the Murray River in the previous year. Ecologists used satellite tracking technology to monitor the movement of tagged golden perch and silver perch from the Murray River in response to freshes in the Goulburn River and other Murray tributaries. The results of that monitoring will inform future deliveries of water for the environment.

A new interim trade rule and operating plan for IVTs was introduced in 2021-22, which specifies the maximum monthly volumes of water that can be delivered from the Goulburn system to the Murray system. Wet conditions across the southern connected basin created low demand for IVTs from the Goulburn system, which meant the new trade rules were not tested. The low demand for IVTs also meant flow in spring and summer in the lower Goulburn River was within environmental flow recommendations for the first time since 2015-16. Ecological monitoring conducted during 2021-22 detected an improvement in vegetation condition on the banks of the lower Goulburn River compared to previous years and highlighted the importance of maintaining flows within environmental flow recommendations. Water for the environment will be used to build on bank vegetation recovery and support native fish migration in 2022-23.

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Scope of environmental watering

Table 5.4.1 describes the potential environmental watering actions in 2022-23, 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 5.4.1 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 (400-2,000 ML/day in reach 1)	• Maintain habitat for small-bodied native fish • Maintain adequate foraging habitat for platypus and reduce the risk of predation • Provide habitat and food for turtles • Wet and maintain riffles to provide habitat for biofilms and waterbugs • Additional benefits to reach 1 of the Goulburn River when flows delivered are above 800 ML/day: - scour fine sediment from the gravel bed and riffle substrate - maintain existing beds of in-channel vegetation - provide connection to off-stream wetland habitats, which increase food resources (waterbugs) available for fish and native animals	
Winter/spring fresh (one fresh of more than 5,000 ML/day for two days during July to September in reach 1)	• 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 fine sediment from the gravel bed and riffle substrate • Maintain existing beds of in-channel vegetation	
Winter/spring off-stream habitat flow trial (one fresh of up to 6,000 ML/day for three days during May to June 2023 in reach 1)	• Maintain off-stream habitat for small-bodied native fish and platypus • Scour fine sediment from the gravel bed and riffle substrate • Maintain existing beds of in-channel vegetation • Connect lower Goulburn River wetlands and anabranches to the river channel	
Goulburn River reach 4 and 5		
Year-round low flow (600-800 ML/day in reach 4 and 600-1,000 ML/day in reach 5)	• Provide slow, shallow habitat required for the recruitment of larvae/juvenile fish and habitat for adult small-bodied fish • Provide deep-water habitat for large-bodied fish • Submerge snags 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 to enable vegetation to establish to protect against notching and bank erosion	

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/autumn fresh (one fresh of more than 7,300 ML/day for two days in reaches 4 and 5 during July to August 2022 and May to June 2023)	• 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 up 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 the natural tributary flow in the mid-Goulburn to reaches 4 and 5 when flow in reach 3 is 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	
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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Autumn fresh (one fresh of more than 5,700 ML/ day for two to five 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 • Scour old biofilm from hard substrates to allow new biofilm growth to improve food and habitat for macroinvertebrates	
Slow recession of unregulated flow 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	

Scenario planning

Table 5.4.2 outlines potential environmental watering and expected water use under a range of planning scenarios.

The recently updated environmental flows study for the Goulburn River recommends a range of watering actions that are needed most years to achieve the target environmental outcomes. High water availability in the Goulburn system at the end of 2021-22 and a strong resource outlook for 2022-23 mean all recommended watering actions can potentially be met, even under a return to dry conditions. Therefore, the proposed actions are the same for all planning scenarios in 2022-23.

Providing year-round low flow in all reaches of the Goulburn River is the highest priority under all climate scenarios. Year-round low flow in the mid-Goulburn river (reach 1) maintains habitat for fish, platypus, turtles and waterbugs, and it also ensures in-stream vegetation remains inundated and persists through the non-irrigation season when operational flow ceases. Year-round low flow in the lower Goulburn River (reaches 4 and 5) provides habitat for fish and macroinvertebrates and helps lower bank vegetation to recover following multiple years of high operational flows during warmer months. Water for the environment in the lower Goulburn River continues to focus on vegetation recovery, to improve the condition of the lower banks that showed signs of recovery in 2021-22 following lower-than-normal demand for IVTs. Goulburn-Murray Water generally diverts a proportion of the natural high flow from Goulburn Weir into the Waranga Basin. These operational transfers can cause the flow rate in the lower Goulburn River to drop rapidly after a natural high-flow event. Water for the environment may be used as required to slow the recession of natural spills at Goulburn Weir, reduce the risk of bank slumping, improve water quality 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 all climate scenarios to scour bed sediments, support channel-forming processes and improve habitat. In reach 1, a winter/spring fresh is a high priority under all scenarios to cue platypus to nest higher up the bank.

A winter/spring off-stream habitat flow trial is proposed in 2022-23 to connect low-lying wetlands and anabranches to the main river channel. Operational flows delivered from Lake Eildon mean these habitats are often wet in the summer months when they should be drawing down, and they dry through the winter months when they should be filling. The flow trial will assess ecological responses to a more natural watering regime and inform how infrastructure could be used to implement better water regimes in the future. The flow trial is a partnership project between Goulburn Broken CMA and the Taungurung Land and Waters Council, and it aims to boost environmental and Traditional Owner outcomes.

Timing deliveries of water for the environment alongside natural-flow events will again be a focus for 2022-23. Passing tributary flows from the mid-Goulburn River to the lower Goulburn River to provide variability through winter and spring is a high priority under all 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.

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 a tier 2 priority under all scenarios. Golden and silver perch are long-lived species that do not need to spawn annually to maintain good populations, and events delivered in November 2020 and 2021 achieved good spawning outcomes in the lower Goulburn River. However, if bank vegetation on the lower banks has had sufficient time to establish and is in good condition, or high natural flows have delayed germination, a late-spring fresh could be delivered under below-average to wet scenarios in 2022. There may not be sufficient water to deliver a late-spring fresh under drought and dry scenarios. 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 2023 to maintain the bank vegetation and allow new seeds to germinate and provide a cue for native fish to move into the lower Goulburn River from the Murray River.

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Carrying over water to meet minimum low-flow objectives from July 2023 to September 2024 is an important consideration under drought and dry climate scenarios but is less important under average and wet scenarios due to likely high early-season allocations.

Table 5.4.2 Potential environmental watering for the Goulburn River under a range of planning scenarios

Planning scenario	Drought	Dry	Below average	Average	Wet
Expected river conditions	• 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 freshes and/ or overbank flow events in winter/spring
Expected availability of water for the environment[1]	• 438 GL	• 567 GL	• 567 GL	• 567 GL	• 567 GL
Goulburn River (targeting reach 1)					
Potential environmental watering – tier 1 (high priorities)[2]	**Tier 1a (can be achieved with predicted supply)**				
	• Year-round low flow • Winter/spring fresh • Winter/spring off-stream habitat flow trial	• Year-round low flow • Winter/spring fresh • Winter/spring off-stream habitat flow trial	• Year-round low flow • Winter/spring fresh • Winter/spring off-stream habitat flow trial	• Year-round low flow • Winter/spring fresh • Winter/spring off-stream habitat flow trial	• Year-round low flow • Winter/spring fresh • Winter/spring off-stream habitat flow trial
Goulburn River (targeting reaches 4 and 5)					
Potential environmental watering – tier 1 (high priorities)[3]	**Tier 1a (can be achieved with predicted supply)**				
	• 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 • 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 • Autumn fresh • Recession flow management
Potential environmental watering – tier 2 (additional priorities)[2]	• Late-spring fresh	• Late-spring fresh	• Late-spring fresh	• Late-spring fresh	• Late-spring fresh

Planning scenario	Drought	Dry	Below average	Average	Wet
Possible volume of water for the environment required to achieve objectives	• 390,000 (tier 1a) • 50,000 ML (tier 2)	• 515,000 (tier 1a) • 50,000 ML (tier 2)	• 505,000 (tier 1a) • 50,000 ML (tier 2)	• 515,000 ML (tier 1a) • 50,000 ML (tier 2)	• 420,000 ML (tier 1a) • 50,000 ML (tier 2)
Priority carryover requirements for 2023-24	• 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 A winter/spring off-stream habitat flow trial fresh is not required in 2023 if delivered in May to June 2022.
3 Preceding low-flow periods and bank vegetation condition triggers must be met before delivery of late-spring and autumn freshes are considered.

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 greater salt concentration than other wetlands in the region, and it attracts a different suite of feeding waterbirds as it draws down. One of the most significant species that feeds on exposed mudflats at Gaynor Swamp is the red-necked avocet.

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).

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Environmental watering objectives in the Goulburn wetlands

Icon	Environmental objectives in the Goulburn wetlands
	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 the Yorta Yorta Nation Aboriginal Corporation on planning for water for the environment for the Goulburn wetlands. Both groups indicated they support the watering 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 the planning and management of environmental flows and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* 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 their contribution and indicating progress towards deeper involvement.

	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 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 environmental flow 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 Land and Waters Council also participated in the development of the environmental water management plan for the site in 2019. 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. In 2021, Taungurung Land and Waters Council staff and Baan Ganalina members coordinated the delivery of environmental flows to the site by managing the pumping and delivery. Following the delivery, Parks Victoria and the Taungurung Land and Waters Council have begun reintroducing aquatic plant species that are either missing or in low numbers to boost the diversity and abundance of aquatic plants.

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 by restoring a more natural watering regime to degraded significant sites and rehabilitating 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.

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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. The Taungurung Land and Waters Council is currently monitoring biocultural values and habitat conditions at six of the disconnected wetlands as part of an ongoing Reading Country program. This process and its findings will inform future seasonal watering proposals and planning for water for the environment. Currently, Taungurung is working with partners 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 these 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 and rushes). Watering also supports a wide range of bird and animal species that provide a variety of cultural values. Yorta Yorta are supportive of planned drying at Doctors Swamp in 2022-23.

Kanyapella Basin plays an important role in the Yorta Yorta People'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 the delivery of environmental flows in winter 2020, Yorta Yorta People 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 the Yorta Yorta People, with stone scatters, marked trees and significant sand hills in the higher elevations. Yorta Yorta support planned drying at Loch Garry in 2022-23.

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 experienced rainfall and temperature conditions close to the long-term averages throughout 2021-22, with particularly high rainfall in winter 2021 and summer 2022. Catchment storages also had above-average inflows, and allocations against high-reliability water shares across the Goulburn, Broken and Murray systems reached 100 percent by mid-October 2021.

Deliveries of water for the environment for the Goulburn wetlands were managed in line with an average climate scenario during 2021-22, and five out of the six planned watering actions were achieved through a combination of managed deliveriese and natural inflows.

Horseshoe Lagoon filled naturally in autumn 2021, and water for the environment was used to water deeper sections of the wetland in winter 2021. The watering triggered the growth of new vegetation, and numerous broad-shelled, common long neck and Murray River turtles were observed at the wetland.

Kanyapella Basin and Loch Garry were both filled with water for the environment in spring 2021. Monitoring detected positive responses by aquatic vegetation, native frogs and waterbirds. These wetlands have only been actively watered a few times, and the monitoring results will be used to help refine future environmental watering actions.

Doctors Swamp and Gaynor Swamp were both filled with water for the environment in autumn 2022. At the time of writing, monitoring results were not yet available, and delivery was still in progress at Gaynor Swamp. Delivery at Doctors Swamp had temporarily ceased due to capacity constraints within the Cattanach Canal, which needs to be near-full capacity for delivery to recommence.

The only planned watering action that was not delivered in 2021-22 was an autumn fill of Reedy Swamp. Reedy Swamp is a temporary freshwater wetland that benefits from periodic dry phases. It last filled in April 2020, and it was expected to dry out before the end of 2021. However, frequent rain events during 2021-22 have prevented complete drying, so a decision was made to defer the planned fill until spring 2023 to allow dry-phase plant species to grow and complete their life cycles.

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Scope of environmental watering

Table 5.4.3 describes the potential environmental watering actions in 2022-23, 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
Gaynor Swamp (fill in spring 2022 and top up as required)	• Provide nesting, breeding and feeding habitat for waterbirds, in particular for brolga • 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	
Horseshoe Lagoon (partial fill or top-up as required in winter 2022)	• Inundate the deeper section and wetland margins to maintain wetland vegetation communities by supporting their growth and recruitment • Suppress the growth of weeds • Provide feeding and breeding habitat for turtle populations	
Kanyapella Basin (partial fill in autumn 2023)	• Inundate deeper parts of the wetland to maintain soil moisture and promote vegetation communities to grow and flower • Support the growth of rigid water-milfoil and river swamp wallaby grass populations	

Scenario planning

Table 5.4.4 outlines potential environmental watering and expected water use under a range of planning scenarios.

A partial fill of Gaynor Swamp and Horseshoe Lagoon are high priorities across all climate scenarios in 2022-23. These watering actions are required to support an optimum watering regime and to support and build on ecological outcomes achieved in 2021-22. Gaynor Swamp was filled in autumn 2022 to support the growth of various wetland plants and improve nesting and feeding resources for potential waterbird breeding events later in the year. If breeding is triggered over winter, watering in spring 2022 to maintain water levels and vegetation materials will be of high importance. Horseshoe Lagoon naturally filled in autumn 2021, had a top-up in winter 2021 and dried in March 2022. A partial fill in winter 2022 will promote the growth of threatened plant species in the lower parts of the wetland that will have met their recommended dry period interval. It will also support dry-phase ecosystem processes in more elevated parts of the wetland complex.

A partial fill of Kanyapella Basin is a high priority in autumn 2023 under dry to wet climate scenarios to further establish aquatic vegetation (such as rigid water-milfoil and river swamp wallaby grass) that have benefitted from deliveries of water for the environment in 2020 and 2021. This site would not naturally receive water as often as some of the other Goulburn wetlands, so watering is not a priority under a drought scenario. Water for the environment will likely need to be actively delivered to Kanyapella Basin to achieve the planned watering action under dry and average climate scenarios, but it is likely to be filled to retard downstream floods under a wet scenario.

Doctors Swamp, Loch Garry and Reedy Swamp will not be deliberately watered in 2022-23 to allow them to draw down or remain dry to support dry-phase ecosystem processes. However, if natural inundation triggers a significant waterbird breeding event at either site, water for the environment may be delivered to help the chicks successfully fledge.

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Table 5.4.4 Potential environmental watering for the Goulburn wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment 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 are likely to fill or partially fill the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Gaynor Swamp • Horseshoe Lagoon	• Gaynor Swamp • Horseshoe Lagoon • Kanyapella Basin	• Gaynor Swamp • Horseshoe Lagoon • Kanyapella Basin	• Gaynor Swamp • Horseshoe Lagoon • Kanyapella Basin
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 1,120 ML (tier 1)	• 2,120 ML (tier 1)	• 2,120 ML (tier 1)	• 560 ML (tier 1)

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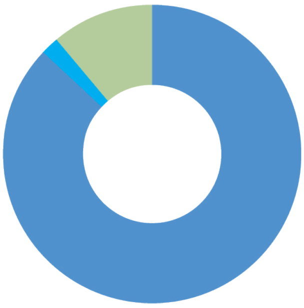
5.5 Broken system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holder – Victorian Environmental Water Holder

Proportions of water entitlements in the Broken basin held by private users, water corporations and environmental water holders on 30 June 2020



Broken

Private	87%
Environment	2%
Water corporations	11%

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 greater 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 small volume of water holdings in the Broken system. Environmental water holders can trade water 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 passing flows and 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 freshes in the Broken River. 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.

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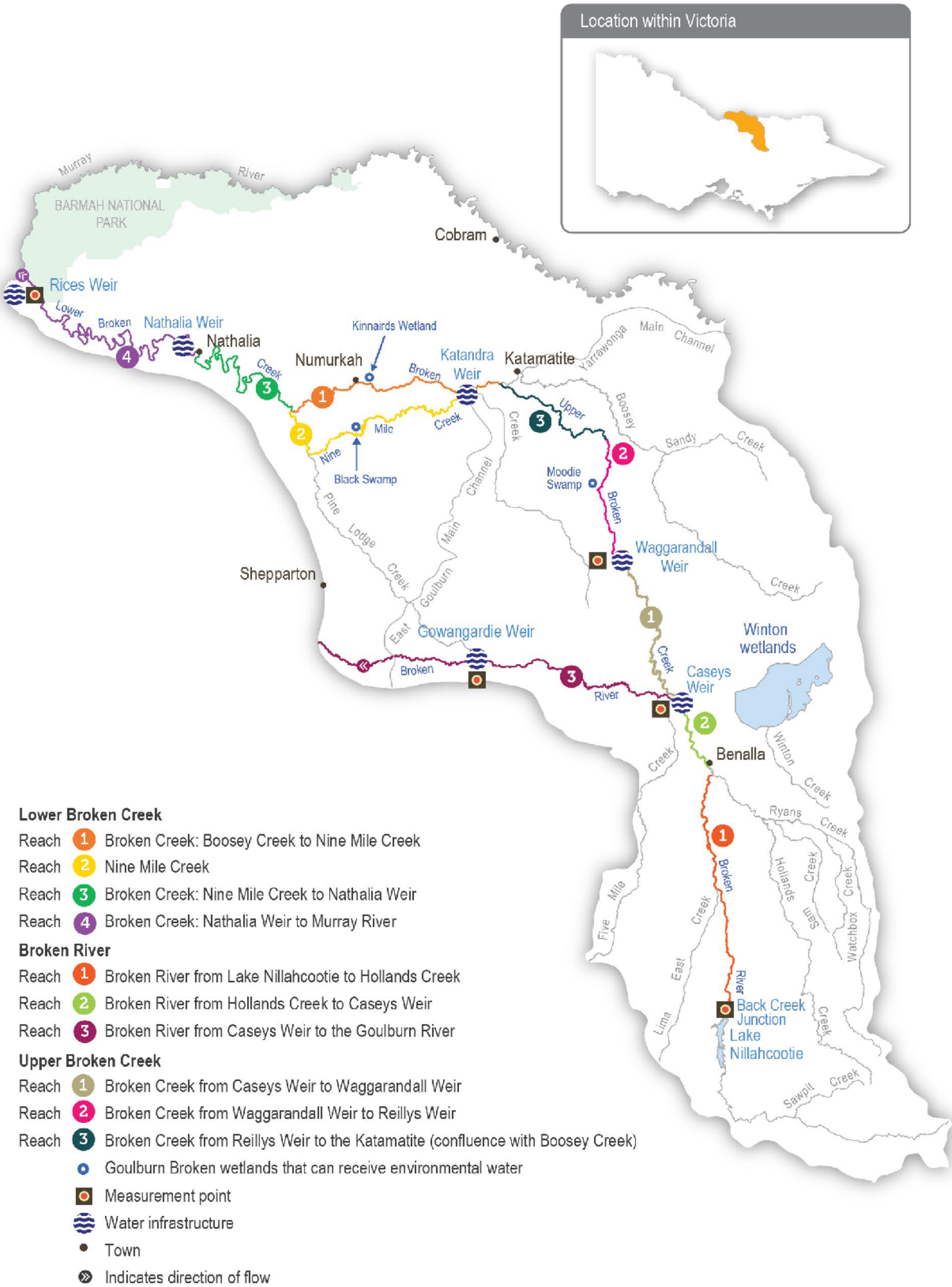
Figure 5.5.1 The Broken system



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.

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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, southern pygmy perch 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 and upper Broken Creek

Icon	Environmental objectives in the Broken River and upper Broken Creek
	Maintain 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 practise 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 the Taungurung Land and Waters Council in identifying more specific cultural objectives for the system in future. The 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 has provided the following statement about the cultural values of the Broken River and upper Broken Creek:

> "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."

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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 and blue spaces are important to the community for wellbeing and mental health due to the otherwise dry environment
- community events and tourism (such as markets around Benalla Lake)
- socio-economic benefits (such as maintaining the volume of water in the lower sections to optimise the efficiency of deliveries of consumptive water, maintain water quality for irrigation, stock and domestic use and support terrestrial birds that help control agricultural pests).

Recent conditions

Rainfall across the Broken River catchment during 2021-22 was slightly above the long-term average, and January rainfall was the highest recorded since 2011. Lake Nillahcootie filled and spilled in August 2021, and the lake remained at full capacity until mid-November. Several natural freshes ranging from 500 ML per day to 3,500 ML per day occurred in the Broken River between July and February, and a bankfull flow of 5,000 ML per day occurred in early September. Upper Broken Creek also had two natural overbank flow events in late January. Allocations against high- and low-reliability water shares in the Broken system reached 100 percent by September and October, respectively. About 2.6 GL of water for the environment from VEWH and CEWH entitlements in the Goulburn was traded into the Broken system to meet demands in upper Broken Creek and Moodie Swamp: subsection 5.5.3 Broken wetlands has more information about this.

Deliveries of water for the environment for the Broken system were managed in line with an average climate scenario during 2021-22. Planned watering actions for Broken River were largely met by natural flow and operational releases, while planned watering actions for upper Broken Creek were only partially met. Water for the environment was used to help meet low flow requirements in upper Broken Creek during summer and autumn and to deliver a fresh to try to minimise the impact of a hypoxic blackwater event that was caused by the January overbank flow. The fresh helped to improve oxygen levels in upper Broken Creek, but not before some fish died (mainly European carp and a small number of Murray cod).

Scope of environmental watering

Table 5.5.1 describes the potential environmental watering actions in 2022-23, 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

Potential environmental watering action	Expected watering effects	Environmental objectives
Upper Broken Creek (reach 1)		
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 at 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Broken River (reach 1, 2 and 3)		
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 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 operational water deliveries and water for the environment. 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 and upper Broken Creek are required across all climatic scenarios, but there is insufficient water for the environment to meet most of them, and no environmental allocations are expected for the Broken system in 2022-23 under a drought scenario. The VEWH may elect to trade water into the system to meet high priority potential watering actions if a trade opportunity is available.

The main objective of environmental flows in the upper Broken Creek is to maintain low flow throughout the year so as to maintain water quality and habitat for native fish, platypus and waterbugs. Maintaining adequate flow and connectivity is particularly important during spring, when native fish, platypus, waterbugs and aquatic vegetation are most active and productive. Water for the environment will likely be prioritised for spring low flow under a dry climate scenario, and greater allocations under average and wet scenarios may be used to supplement low flow at any time of year as needed. Summer/ autumn freshes may be needed to help mitigate hypoxic blackwater events. The natural high flow that causes hypoxic blackwater events is most likely under average or wet climatic conditions. Goulburn Broken CMA will monitor conditions and may limit the use of water for the environment for low flow during low-risk periods to enable them to deliver emergency freshes if needed.

Year-round low flow is needed to support the Broken River environmental objectives, but there is little capacity to influence these with environmental flows, 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, and water for the environment may be used to supplement any of the recommended low flows or summer/autumn freshes if needed.

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Table 5.5.2 Potential environmental watering for the Broken River and upper Broken Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flow in Broken River or upper Broken Creek • Low and cease-to-flow events are probable throughout the year in all reaches	• Low, unregulated flow in Broken River and none in upper Broken Creek • Low and cease-to-flow events are possible throughout the year in all reaches	• High winter/spring flow in Broken River • Some unregulated flow in upper Broken Creek	• High winter/spring flow in Broken River • Unregulated flow in upper Broken Creek with some winter/spring freshes
Expected availability of water for the environment	• 0 ML	• 226 ML	• 647 ML (plus available trade opportunity up to 1,500 ML)	• 647 ML (plus available trade opportunity up to 1,500 ML)
Upper Broken Creek (targeting reach 1)				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• N/A	• Spring low flow	• Winter low flow • Spring low flow • Summer low flow • Autumn low flow • Summer/autumn fresh	• Winter low flow • Spring low flow • Summer low flow • Autumn low flow • Summer/autumn fresh
	Tier 1b (supply deficit)			
	• Winter low flow • Spring low flow • Summer low flow • Autumn low flow • Summer/autumn fresh	• Winter low flow • Summer low flow • Autumn low flow • Summer/autumn fresh	• N/A	
Potential environmental watering – tier 2 (additional priorities)	• N/A			
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 • Summer/autumn fresh	• Winter low flow • Spring low flow • Summer low 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 • Autumn low flow • Summer/autumn fresh	• N/A	

Planning scenario	Drought	Dry	Average	Wet
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) • 11,724 ML (tier 1b)	• 2,147 ML (tier 1a)[1] • 0 ML (tier 1b)	• 490 ML (tier 1a)[1] • 0 ML (tier 1b)
Priority carryover requirements for 2023-24	• N/A			

1 This assumes water available made through trade opportunity.

5.5.2 Lower Broken Creek

System overview

The Lower Broken Creek system is within Yorta Yorta Country, and their cultural connection 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 water level 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. 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 periods 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.

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Environmental watering objectives in lower Broken Creek

Icon	Environmental 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 Increase 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 during the planning of deliveries of water for the environment in lower Broken Creek. The following cultural values were identified for lower Broken Creek in 2021. The YYNAC were again consulted on this for the 2022-23 watering season.

> "The Broken Creek holds 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 creek also has significant stands of old growth river red gum containing important habitat and exhibiting scars made from carving out canoes and coolamons."

The Yorta Yorta Nation Aboriginal Corporation continues to pursue the Yorta Yorta People's inherent rights to water for Country to improve their spiritual, cultural, environmental, social and economic needs, in line with the *Yorta Yorta Whole-Of-Country Plan 2021-2030*.

The environmental objectives in 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 plants and animals. 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.

The Yorta Yorta Nation Aboriginal Corporation has raised concerns about flow regulation in all their waterways, which is affecting 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)
- community events and tourism
- 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 to above-average rainfall and temperatures throughout most of 2021-22 as a La Niña weather event influenced climate conditions across eastern Australia. Winter/spring rainfall in the Broken catchment provided unregulated inflows from upper Broken Creek to the south and Boosey Creek to the east. These were the highest unregulated inflows to lower Broken Creek since 2016. Allocations against high-reliability water entitlements in the Goulburn and Murray storages that supply lower Broken Creek reached 100 percent by October 2021, and low-reliability entitlements in the Murray system reached 100 percent by February 2022.

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Deliveries of water for the environment in lower Broken Creek were managed in line with an average climate scenario in 2021-22. IVTs and Murray Bypass flows (which often meet environmental flow targets) were not delivered via lower Broken Creek throughout spring, summer and autumn due to high, unregulated flow in the Murray River. This meant greater volumes of water for the environment were required to achieve environmental objectives. Planned watering actions were largely achieved between mid-August 2021 and mid-May 2022, but maintenance works on the Yarrawonga Main Channel and the East Goulburn Main Channel during July 2021 meant the winter low-flow target of 40 ML per day was not met. Fishways were also closed during this period to maintain water levels in the weir pools, and other sections of the creek contracted to a series of shallow pools, which provided limited habitat for native fish and platypus. This was the fourth consecutive year that maintenance works during the irrigation shut-down period have limited deliveries of water for the environment in lower Broken Creek.

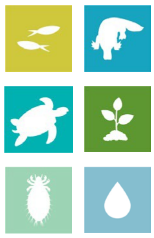
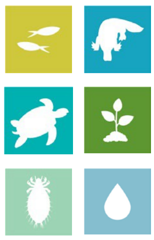
Oxygen levels in lower Broken Creek dropped below the critical level of 4 mg/L during hot weather on four occasions in summer. Environmental flows were increased to 350 ML per day under emergency watering provisions to reduce stress on resident fish populations. Water for the environment was also used to dilute a hypoxic blackwater event that was caused by a heavy rain event in late January.

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 deliveries of water for the environment started in 2010-11. There are also anecdotal reports the native fish population has improved. Some monitoring in lower Broken Creek is planned during 2022 to inform the Goulburn to Murray Trade Rule Review. The monitoring will investigate how different flow patterns affect vegetation and erosion rates on the riverbank, and it will inform future creek operations.

Scope of environmental watering

Table 5.5.3 describes the potential environmental watering actions in 2022-23, 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 conditioning of females in preparation for the breeding season • Provide habitat for turtles, including protection from exposure during their winter dormancy • 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 frost • Reduce the stagnation of weir pools	
Spring/summer/autumn low flow (70-250 ML/day in reaches 1 and 2 and 200-450 ML/day in reaches 3 and 4 during August to May)	• Provide habitat for native fish, platypus, rakali, turtles and waterbugs • Support the movement and recruitment of fish • Maintain oxygen levels in summer • Additional benefits when delivered from December to February (at 250-450 ML/day): - mobilise azolla and increase oxygen levels during high-risk periods	
Winter/spring fresh(es) (one to three freshes of 300-450 ML/day for one to two weeks during July to November)	• 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 • Reduce the stagnation of weir pools	

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 closing fishways to maintain water in weir pools and scheduling works to minimise the duration of impacts on flow.

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Scenario planning

Table 5.5.4 outlines 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 are the same under all 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.

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. Goulburn Broken CMA will monitor water quality throughout the year, and it may increase flow to the upper end of the recommended range in Table 5.5.3 if oxygen levels drop below 4.0 mg/L. The total volume of water for the environment that will be needed to achieve planned watering actions in 2022-23 will vary depending on operational deliveries (including IVTs) and the sizes and durations of any unregulated flow events. A carryover target of 5,000 ML applies under all climate scenarios to ensure minimum low flow and a small fresh can be delivered early in 2023-24.

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	• Some unregulated flow in winter • No unregulated flow throughout the irrigation season (mid-August to May) • No diversion of unregulated Murray River flow is available	• Unregulated flow in winter/spring • Unregulated flow is unlikely from October to May • Diversion of unregulated Murray River flow is available from mid-August to October	• Unregulated flow is likely in winter/ spring • Unregulated flow is possible from November to May • Diversion of unregulated Murray River flow available from 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	• 80,000 ML			
Priority carryover requirements for 2023-24	• 5,000 ML			

1 Tier 1 potential environmental watering for lower Broken Creek is not classified as tier 1a or 1b because the water available for use is shared across various systems, and it is not possible to reliably determine the supply specifically available for lower Broken Creek.

5.5.3 Broken wetlands

System overview

Of some 2,000 natural wetlands in the Goulburn Broken area, only three in the Broken catchment have infrastructure that allows them to receive environmental water: Black Swamp, Kinnairds Wetland and Moodie Swamp.

These wetlands are on Country of the Yorta Yorta People, 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. The VEWH, waterway managers and storage managers adjust the timing and rate of environmental deliveries where possible to optimise environmental outcomes within the current system constraints.

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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

Icon	Environmental 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
	Provide breeding habitat for frogs

Traditional Owner cultural values and uses

Goulburn Broken CMA consults with the Yorta Yorta Nation Aboriginal Corporation when planning 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 the 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 the establishment of 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 the planning and management of water for the environment and ultimately providing opportunities to progress towards self-determination within the environmental watering program is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislative and policy commitments, including the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, the 2016 *Water for Victoria* 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 their contribution and indicating progress towards deeper involvement.

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

Black Swamp and Kinnairds Wetland have significant diversity within the landscape, and multiple varieties of nardoo (a food source), native grasses (such as old man weed and sneezeweed, which have medicinal uses) and sedges and rushes (used for basket weaving) are in the area. Each of the sites, including Moodie Swamp, supports a wide array of bird life and other animals that provide a variety of cultural values. At Black Swamp, there is evidence of cooking mounds around the perimeter, and there are basket weaving sedges at Moodie Swamp.

Traditional Owner icons in the tables below indicate which proposed watering actions support these values.

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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 community gatherings at Kinnairds Wetland and the Walk and Squawk event)
- socio-economic benefits (such as tourism, which is a large contributor to the local economy).

Recent conditions

Rainfall in the Broken catchment during 2021-22 was close to the long-term average, and significant rain events in June 2021, September 2021 and January 2022 contributed some local run-off to the region's wetlands. Allocations against high-reliability water shares in the Goulburn, Murray and Broken systems reached 100 percent by mid-October 2021, which meant there was sufficient supply to meet planned deliveries of water for the environment.

Deliveries of water for the environment for the Broken wetlands were managed in line with an average climate scenario in 2021-22, and all planned watering actions were fully achieved through a combination of water for the environment and natural inflows. All three wetlands are ephemeral systems that rely on wet and dry phases to support ecological processes.

For the second year in a row, Kinnairds Wetland and Black Swamp were filled in spring and allowed to draw down and dry by summer. Moodie Swamp was originally going to be filled in autumn 2022, but natural inflows during winter 2021 attracted brolga to the site, so deliveries of water for the environment were brought forward to spring 2021 to encourage the birds to nest and breed. Specific responses to deliveries of water for the environment in 2021-22 included the vigorous growth of newly planted river red gum saplings at Black Swamp, spotted marsh frogs breeding at Kinnairds Wetland and brolga feeding and courting at Moodie Swamp. Kinnairds Wetland and Black Swamp dried by the end of 2021-22, but Moodie Swamp still held some water.

Scope of environmental watering

Table 5.5.5 describes the potential environmental watering actions in 2022-23, 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 5.5.5 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 autumn 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 • Provide habitat and food resources to support waterbirds and frogs	
Kinnairds Wetland (fill in autumn and top up as required)	• Promote the growth and improve the condition of Red Gum Swamp EVC and Plains Grassy Wetland EVC vegetation, including rigid water-milfoil • Provide habitat and food resources to support waterbirds and frogs	

Scenario planning

Table 5.5.6 outlines 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 autumn 2023 are high priorities across all climate scenarios. The timings of the proposed fills will allow the wetlands to experience a slightly longer dry phase than they have in recent years. This will enhance nutrient cycling processes without exceeding the dry tolerance interval of red gum swamp vegetation communities. These watering actions may be brought forward to spring 2022 if wet conditions naturally inundate the beds of the wetlands and disrupt dry-phase ecological processes.

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Moodie Swamp was still holding water in autumn 2022. Active watering is not planned in 2022-23 to allow it to complete a dry-phase cycle.

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 in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Black Swamp • Kinnairds Wetland	• Black Swamp • Kinnairds Wetland	• Black Swamp • Kinnairds Wetland	• Black Swamp • Kinnairds Wetland
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 680 ML (tier 1)	• 680 ML (tier 1)	• 680 ML (tier 1)	• 340 ML (tier 1)

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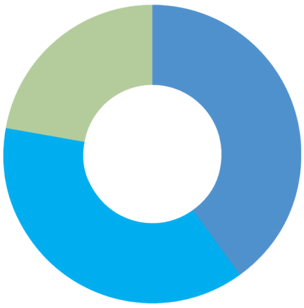
5.6 Campaspe system

Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water

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

Proportions of water entitlements in the Campaspe basin held by private users, water corporations and environmental water holders on 30 June 2020



Campaspe

Private	40%
Environment	38%
Water corporations	22%

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 meet environmental demands in reach 4. Water for the environment is primarily used in the Campaspe River to improve the magnitude and variability of flow during winter and spring, but it is also used to deliver critical flow in summer and autumn that is not met or exceeded by operational deliveries. 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 flow objectives. High IVT flows delivered at a time when the Campaspe River would naturally have 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 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.

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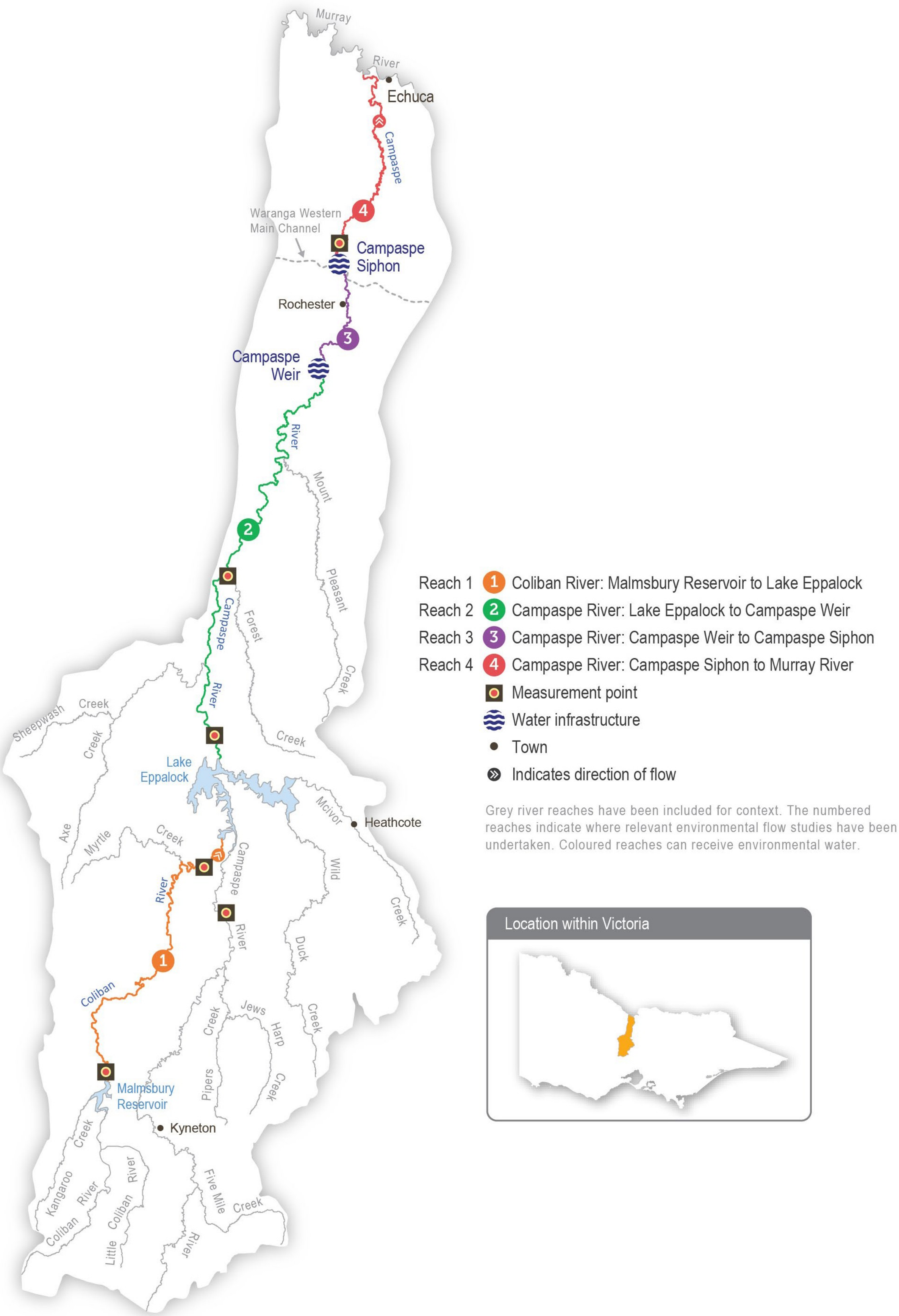
Figure 5.6.1 The Campaspe system



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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

Icon	Environmental objectives in the Campaspe River
	Protect and increase populations of native fish Facilitate recolonisation by native fish species (including trout cod and blackfish) that have been presumed lost
	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
	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 (trading as DJAARA), Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation to discuss how cultural values and uses can be supported by water for the environment and the importance of Traditional Owner involvement in management.

Despite the significant impacts of the Covid-19 pandemic on the ability to conduct face-to-face engagement on 2022-23 watering priorities, all three Corporations reviewed the watering priorities and discussions were had. These included:

1. discussions between the DJAARA Kapa Gatjin (water advisory) Group and North Central CMA about 2022-23 priorities, including opportunities for Djaara (the Dja Dja Wurrung people) to participate in field visits and monitoring. In 2020, Kapa Gatjin expressed their aspirations and environmental objectives for the Campaspe River in a more general sense and highlighted the significance of native fish, turtles, medicine plants and pest control. I Dja Dja Wurrung will continue to build on traditional ecological knowledge to further inform seasonal watering proposals and plans and will play a greater role in the administering of environmental water.
2. discussions between Taungurung Land and Waters Council's Baan Ganalina Advisory Group and North Central CMA about 2022-23 priorities, including opportunities for Dja Dja Wurrung field visits and monitoring. This included discussions at the 2022 North Central CMA River Tour. In late 2019, Baan Ganalina 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.
3. discussions between the Yorta Yorta Nation Aboriginal Corporation Consultation group and Goulburn Broken, North East and North Central CMAs, where CMA activities on Country are discussed. At these meetings in the past, 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.

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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 management 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 like to camp. Aysons Reserve is a popular camping site near Elmore, and it draws hundreds of campers during school holiday periods. Where possible, freshes are delivered outside of peak visitation periods (such as the March and April long weekends) to ensure the flow is not too high for campers and water-related activities.

Recent conditions

Rainfall in the Campaspe system in 2021-22 was close to the long-term average, although spring 2021 was wetter than average. Maximum temperatures across the system were slightly above the long-term average. Allocations against high-reliability water shares rose from 14 percent at the start of July to 100 percent in September, but there were no allocations against low-reliability water shares. Available allocations were not enough to meet demands for environmental flows, so 4 GL of water for the environment from the Goulburn was traded into the Campaspe system to support 2021-22 potential watering actions.

Deliveries of water for the environment for the Campaspe system were managed in line with an average climate scenario throughout 2021-22. Most planned watering actions were achieved through a combination of environmental flows, natural flows and operational deliveries. Extremely low demand for IVTs from the Campaspe River meant more water for the environment was needed to achieve the target low flow and freshes from late spring to autumn, compared to previous seasons. Two of the planned summer/autumn freshes were used to help mitigate low-oxygen conditions that were detected during hot weather in mid-December and late January.

The only planned watering action not delivered in 2021-22 was a second winter/spring fresh. Winter/spring freshes aim to flush organics from the riverbanks and low benches to reduce the risk of blackwater events in summer, support river red gums and prevent terrestrial grasses from colonising the river banks. The Campaspe River has received most of its recommended flow regime over the last two years, and the first fresh delivered in September 2021 met its objectives. The second fresh was not delivered to avoid unnecessarily disturbing Murray cod during their nesting season. North Central CMA is working with fish ecologists to determine the circumstances under which future freshes should be delivered during the Murray cod nesting season.

Regular fish surveys conducted as part of the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) demonstrate that native fish communities in the Campaspe River have steadily improved since 2014. VEFMAP has also reported better streamside and in-stream vegetation in sections of the river where livestock are excluded. Watering actions that aim to expose mudflats during autumn to promote native vegetation recruitment in these areas may be trialled in 2022-23.

Scope of environmental watering

Table 5.6.1 describes the potential environmental watering actions in 2022-23, 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.

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Table 5.6.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Campaspe River

Potential environmental watering action	Expected watering effects	Environmental objectives
Campaspe River (targeting reach 4)		
Winter/spring low flow (50-200 ML/day during June to November)	• Increase longitudinal connectivity to allow native fish to access new habitats • 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[1] • Provide a variety and large abundance of habitats for high macroinvertebrate productivity supporting food webs • Greater-magnitude flows will facilitate: - long-distance movement by male platypus, especially in the August to October breeding season - greater movement of large-bodied native fish	
Winter/spring fresh(es) (one to two[2] freshes 1,000-1,800 ML/day for two to seven 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) • Provide sufficient velocity to scour accumulated sediment from pools and scour biofilms • Maintain connectivity to allow native fish movement and to access new habitats • Encourage female platypus to select nesting burrows higher up the bank to reduce the risk of a high flow later in the year flooding burrows when juveniles are present	
Summer/autumn low flow (40-50 ML/day[3] at the Campaspe Siphon during December to May)	• Maintain slackwater habitats for zooplankton and nursery habitats for native fish • Maintain the water depth and prevent stratification in deep pools in summer to maintain habitat for native fish and platypus • Inundate a variety of habitats to increase the growth of biofilms and support waterbug productivity • Allow platypus to safely move between pools while foraging, and ensure there is adequate food for lactating females • Reducing flow to 20 ML/day in reaches 2 and 3 in autumn will expose mudflats and encourage the recruitment of some fringing vegetation	
Summer/autumn freshes (three freshes of 100-200 ML/day for one to three days during December to May)	• Increase longitudinal connectivity to allow native fish to access new habitats • Wet submerged wood and flush fine silt and old biofilms to promote new biofilm growth and increase waterbug productivity for native fish and platypus • Facilitate the downstream dispersal of juvenile platypus in April/May to colonise other habitat areas	

Potential environmental watering action	Expected watering effects	Environmental objectives
Year-round fresh (trigger-based, 5-200 ML/day as required) *Triggers:* • *the oxygen level is below 5 mg/L* • *the air temperature is above 28°* • *there are high water temperatures and/or low river flow*	• Destratify 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)	

1 A greater-magnitude flow rate will wet a larger perimeter of the riverbank, supporting increased littoral vegetation.
2 A second winter/spring fresh may be delivered under average or wet climate scenarios to further enhance the river conditions if required.
3 Reach 4 flow will target 40-50 ML/day. However, a reduction in flow to 20-30 ML/day at reaches 2 and 3 may be considered in autumn to expose the river's mudflats and promote native vegetation recruitment. To achieve these two flow rate targets, water for the environment from the Goulburn flows will need to be delivered to reach 4 at the Campaspe Siphon.

Scenario planning

Table 5.6.2 outlines potential environmental watering and expected water use under a range of planning scenarios.

Planned watering actions for the Campaspe River focus on meeting low-flow targets throughout the year and delivering a mix of small and medium-sized freshes. Low-flow actions will likely be delivered at the lower end of the target magnitude range under dry and drought scenarios to conserve water, and the number of freshes delivered will also likely vary between scenarios.

Under a drought scenario, there is unlikely to be enough available supply to deliver summer/autumn freshes to boost ecosystem productivity and allow fish and platypus to disperse. There is also likely to be less need for these flows under drier scenarios because platypus and fish may not breed. Available water will instead be used to deliver small to medium-sized freshes when needed, to maintain pool habitat and improve water quality to prevent significant losses of existing plants and animals. North Central CMA will monitor water levels and water quality throughout the year to inform the timing of these trigger-based freshes.

Under average and wet climate scenarios, there will be more available supply. This will allow more freshes to be delivered to help increase the size and condition of platypus, native fish and native plant populations. A second winter/spring fresh will only be delivered if it can be timed to not interfere with potential Murray cod breeding.

Flow may be lowered to about 20 ML per day in reaches 2 and 3 in autumn under all scenarios to encourage recruitment of fringing plants on exposed mudflats. This action is a joint initiative between North Centra CMA and vegetation ecologists working on VEFMAP, and it will be supported by dedicated monitoring if it proceeds. Lowering flow in reach 4 may pose a risk to water quality, so the watering trial will only proceed if sufficient water can be delivered from the Western Waranga Channel to supplement flow downstream of the Campaspe Siphon.

The carryover target for 2023-24 is based on the volume required to deliver priority summer/autumn low flow during 2023-24 if there is a return to dry or drought conditions. No carryover targets are set for the average/wet scenario as early-season allocations are likely to be sufficient to meet summer/autumn low flow environmental flow demands.

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Table 5.6.2 Potential environmental watering for the Campaspe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average/Wet
Expected river conditions	• Little to no natural flow from tributaries and local run-off • Low passing flow • Operational water deliveries	• Some natural flow from tributaries and local run-off • Increased passing flow • Operational water deliveries	• Moderate to high natural flow from tributaries and local run-off • Increased passing flow • No expected spills from storage, except under extremely wet conditions
Expected availability of water for the environment	• 19,500 ML	• 25,200 ML	• 30,400 ML
Campaspe River (targeting reach 4)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow (at lower magnitude) • Winter/spring fresh (one fresh) • Summer/autumn low flow[1] • Year-round fresh (if required)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow[1] • Summer/autumn freshes (three freshes) • Year-round fresh (if required)	• Winter/spring low flow • Winter/spring fresh (one to two freshes[2]) • Summer/autumn low flow[1] • Summer/autumn freshes (three freshes) • Year-round fresh (if required)
	Tier 1b (supply deficit)		
	• Summer/autumn freshes (three freshes)	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 19,000 ML (tier 1a) • 900 ML (tier 1a Goulburn) • 2,100 ML (tier 1b)	• 24,500 ML (tier 1a) • 1,200 ML (tier 1a Goulburn)	• 26,400 ML (tier 1a) • 1,200 ML (tier 1a Goulburn)
Priority carryover requirements for 2023-24	• 7,500 ML[3]	• 6,000 ML[3]	• N/A

1 This potential watering action may have a period of a lower flow rate in reaches 2 and 3 (20 ML/day) while maintaining the 40-50 ML/day flow in reach 4. To achieve this outcome, water for the environment from the Goulburn will need to be delivered to reach 4 at the Campaspe Siphon.

2 A second winter/spring fresh may be delivered under average or wet climate scenarios to further improve streamside vegetation by wetting riverbanks, support fish movement and clear accumulated leaf litter to reduce the risk of blackwater events during summer high flow.

3 These carryover targets may be achieved by trading water from other systems, and they have not been included in the determination of potential watering actions in this climate scenario.

5.6.2 Coliban River

System overview

The Coliban River is the major tributary of the Campaspe River and 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 2022-23.

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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

Icon	Environmental objectives in the Coliban River
	Increase the abundance and diversity of small-bodied native fish Facilitate recolonisation by native fish species (including river blackfish) that have been presumed lost
	Maintain 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
	Maintain water quality to support aquatic life and ecological processes

Traditional Owner cultural values and uses

In planning for environmental flows in the Coliban River, Dja Dja Wurrung Clans Aboriginal Corporation (trading as DJAARA) Kapa Gatjin (water advisory) Group 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 *Dhelkunya Dja (Healing Country) Country Plan 2014-2034* describes their aspirations around the management of rivers and waterways and articulates Djaara's (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 Djaara's aspirations for the Coliban River and play a greater role in the management and administering of environmental water, with an aim of future ownership and management of environmental water.

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 swimming, canoeing, fishing and water sports)
- riverside recreation and amenity (such as socialising, relaxing, birdwatching, bushwalking, camping and cycling)
- socio-economic benefits (such as tourism to Malmsbury, 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

Rainfall in the Coliban River catchment during 2021-22 was close to the long-term average. Accumulated passing flows that made up the holdings of water for the environment were lost when Malmsbury Reservoir spilled in late July 2021. However, unregulated and natural flows following this spill provided the required winter/spring low flow and six freshes between July and January. The largest event peaked at 1,493 ML per day at Lyal in September 2021, and it was the largest flow in the river since the 2016 floods.

Deliveries of water for the environment for the Coliban system were managed in line with an average climate scenario throughout 2021-22. All planned watering actions for the Coliban River were fully or partially achieved with passing flow, natural inflow and/or the managed release of accumulated passing flow. Passing flow provided continuous flow between Malmsbury Reservoir and Lake Eppalock, and 2021-22 was the first year since 2011-12 that the Coliban River had not had a cease-to-flow event. Some accumulated passing flow was used to deliver a fresh in April 2022 to support the dispersal of juvenile platypus.

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Scope of environmental watering

Table 5.6.3 describes the potential environmental watering actions in 2022-23, 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
Coliban River (targeting reach 1)		
Winter/spring low flow (2-10 ML/day during June to November)	• Maintain a connected river that allows small-bodied native fish and platypus to disperse throughout it • Increase wet areas for native aquatic and streamside plants while limiting terrestrial species encroaching into the river channel • 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 to 160 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 greater flow later in the year flooding the burrow when juveniles are present • Increase 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 (2-10 ML/day during December to May)	• Maintain up to 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 25-160 ML/day for three to five days during December to May)	• Increase the water depth through riffle-run habitats to 8-20 cm for a 25-50 ML/day event to maintain water quality and habitat for waterbugs • Increase the water depth through riffle-run habitats to 45-60 cm for a 160 ML/day event 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 (5-15 ML/day for up to 14 days during December to May, trigger-based) *Triggers:* • *the oxygen level is below 5 mg/L* • *the air 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	

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Scenario planning

Table 5.6.4 outlines potential environmental watering and expected water use under a range of planning scenarios.

The potential environmental flows required for the Coliban River include low flow and freshes under all climate scenarios, but the magnitude of particular flows and the numbers and durations of freshes that can be delivered will vary between scenarios, based on available supply and other flows in the system. Where supply is limited, low flow will be delivered at the lower end of the recommended magnitude to maintain some connecting flow for a longer period. Freshes will be delivered where possible to facilitate the dispersal of platypus and fish and clean biofilms from in-stream surfaces.

The highest-priority watering action in the Coliban River under all climate scenarios is the summer/autumn low flow to maintain sufficient habitat for native fish, platypus and waterbugs. Natural baseflow and tributary inputs help to maintain some flow through the Coliban River during winter and spring each year, but long sections of the river contract to a series of pools or completely dry during late summer and autumn, especially in dry years. Releases of water for the environment in summer and autumn help to maintain water quality (especially when oxygen levels are low) and maintain the depth of pools in the upper reaches to help sustain populations of native fish and platypus. Providing Malmsbury Reservoir does not spill over winter/spring, passing flows that were banked but not used in 2021-22 will be carried over and used to help maintain a continuous low flow under all climate scenarios in 2022-23. If a continuous flow cannot be maintained, shorter, pulsed flows may be delivered to maintain refuge habitats as required. These trigger-based pulses will most likely be needed under a dry scenario but may also be needed under wetter scenarios if there is insufficient supply to deliver continuous low flow in late summer or early autumn. Where possible, summer and autumn freshes will be delivered to facilitate fish and platypus movement and support fringing vegetation. These freshes will aim to be delivered in March or April to support juvenile platypus dispersal and reduce predation.

Accumulated passing flows can be carried over for use in the next year, but it will be forfeited if Malmsbury Reservoir spills. A carryover target of 720 ML has been set for all climate scenarios to ensure enough supply for high-priority summer and autumn low flows in 2023-24. This target will be revised throughout the year based on climatic forecasts, the risk of spill and the extent to which priority actions for 2022-23 have been met. For example, delivering at least one summer/autumn fresh in 2022-23 will be a higher priority than achieving the full 720 ML carryover target.

Table 5.6.4 Potential environmental watering for the Coliban River under a range of planning scenarios

Planning scenario	Drought	Dry	Average/Wet
Expected river conditions	• Little to no natural flow	• Some natural flow	• Extended periods of natural flow, including some high-flow events and reservoir spills
Expected availability of water for the environment[1]	• 1,600 ML	• 2,000 ML	• 2,800 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) • Pulsed summer/autumn low flow (trigger-based)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn fresh (one fresh, lower magnitude) • Pulsed summer/autumn low flow (trigger-based)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn fresh(es) (one to two freshes, lower magnitude) • Pulsed summer/autumn low flow (trigger-based)
	Tier 1b (supply deficit)		
	• Summer/autumn low flow (higher magnitude) • Summer/autumn fresh (one to two freshes)	• Winter/spring fresh (one fresh) • Summer/autumn fresh (one additional fresh, increased magnitude)	• Winter/spring fresh (one fresh) • Summer/autumn fresh (one to two freshes at higher in magnitude)

Planning scenario	Drought	Dry	Average/Wet
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 1,460 ML (tier 1a) • 920 ML (tier 1b)	• 1,870 ML (tier 1a) • 1,900 ML (tier 1b)	• 2,280 ML (tier 1a) • 2,500 ML (tier 1b)
Priority carryover requirements for 2023-24	• 720 ML		

1 As there is no formal environmental entitlement in the Coliban River, these are estimated volumes of passing flows that may be accumulated for a managed environmental flow.

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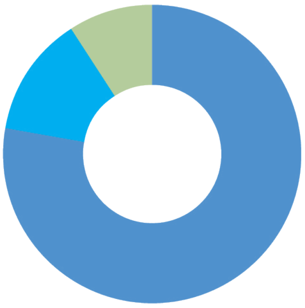
5.7 Loddon system

Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water

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

Proportions of water entitlements in the Loddon basin held by private users, water corporations and environmental water holders on 30 June 2020



The Loddon system includes the Loddon River system (including Tullaroop, Serpentine and Pyramid creeks), the Boort Wetlands and Birchs Creek subsystems.

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.

The two main storages on the Loddon River are Cairn Curran Reservoir and Tullaroop Reservoir. Laanecoorie Reservoir is a smaller storage that is used to regulate water released from the larger upstream storages. Flow in the Loddon River downstream of Laanecoorie Reservoir 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 (Ghow) Swamp, which receives water diverted from the Murray River at Torrumbarry Weir. Water is diverted from the Loddon River to the Loddon Valley Irrigation Area to supply agriculture and to Serpentine Creek to support environmental values and 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 can help achieve 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. These issues can constrain the timing and delivery of water for the environment or lead to greater-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, which make it harder to achieve good outcomes for native fish and possibly platypus.

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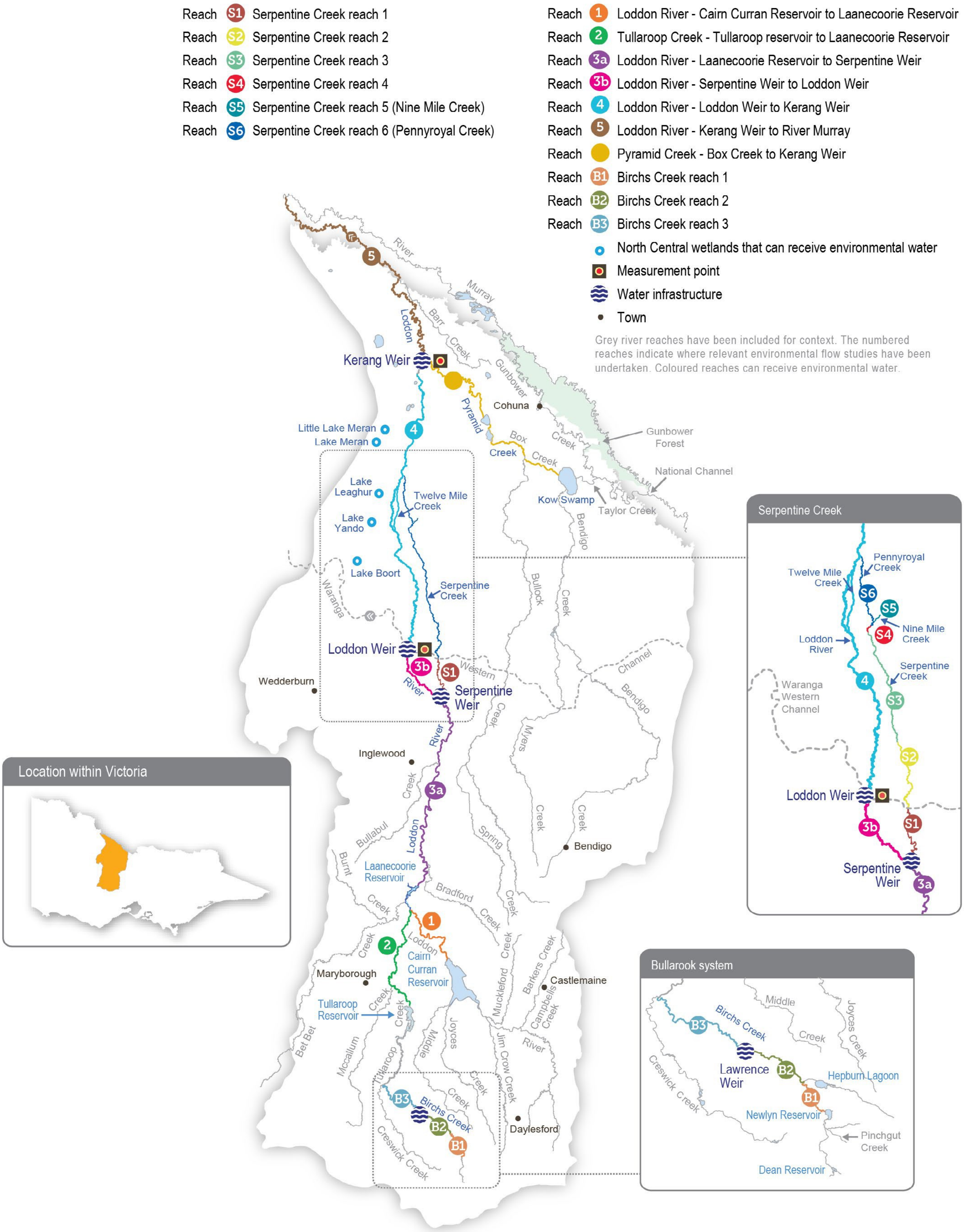
Figure 5.7.1 The Loddon system



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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 and Pyramid flows are stimulating native fish movement through the fishways.

Environmental watering objectives in the Loddon River system

Icon	Environmental 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 the diversity and increase the 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

The Barapa Barapa and Wamba Wemba are the Traditional Owners in the northern part of the Loddon catchment, and the Djaara (Dja Dja Wurrung People) are the Traditional Owners in the southern part of the catchment. Artefacts of cultural practices are present throughout the Loddon and Pyramid system and its floodplain.

In planning for environmental flows in the Loddon River system, Djaara, Barapa Barapa and Wamba Wemba and North Central CMA have considered how environmental flows in the Loddon system can be managed to support their respective values, priorities and uses.

In the southern part of the catchment, Dja Dja Wurrung Clans Aboriginal Corporation (trading as DJAARA) Kapa Gatjin (water advisory) Group and North Central CMA have been working together to identify opportunities and sites where water for the environment can support Djaara aspirations for the Loddon River. A key aspiration is for Djaara to play a greater role in the management and administering of environmental water, with an aim of future ownership and management of environmental water.

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Recently DJAARA conducted a Cultural Values Assessment (CVA) – similar to an Aboriginal Waterways Assessment (AWA) – at two sites along the Loddon River. The assessments included detailed visual inspections, questionnaires and data analysis. On Country DJAARA participated in two-way learning with North Central CMA staff. Discussion points included cultural heritage, effects of river regulation, and alignment of watering and cultural objectives. This is the beginning of a longer journey to collaborate on realising joint aspirations for the Loddon River.

In early 2022, Barapa Barapa and Wamba Wemba Traditional Owners joined North Central CMA staff on Country to reflect upon environmental watering in the Loddon River system in 2021-22 and to discuss aspirations for 2022-23. Barapa Barapa and Wamba Wemba Traditional Owners emphasised the importance of water for the environment in supporting fish populations (such as Murray cod and golden perch) in the Loddon River system, particularly over summer.

Barapa Barapa and Wamba Wemba Traditional Owners discussed a long-term vision to create a golden perch nursery at Kow (Ghow) Swamp and supported the North Central CMA re-snagging of Pyramid Creek. Traditional Owners also expressed the need for improved access to Pyramid Creek, and the fact that private land tenure often creates impediments to floodplain watering and Traditional Owner restoration efforts on Country.

Barapa Barapa Traditional Owners have 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, including 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

Rainfall across the Loddon system during 2021-22 was close to the long-term average, while temperatures were warmer than average. Two unregulated high-flow events occurred in the Loddon River in August and November; the largest event peaked at 961 ML per day at Loddon Weir on 5 November. High-reliability water share allocations in the Loddon system opened at 33 percent at the start of July and reached 100 percent by early October. No low-reliability water share allocation was issued in 2021-22. The VEWH also traded 5 GL into the Loddon system from its Goulburn entitlements to support planned watering actions in 2021-22.

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Deliveries of water for the environment for the Loddon system were managed in line with an average climate scenario during 2021-22. Most planned watering actions for the Loddon River, Serpentine Creek and Pyramid Creek were achieved through the use of environmental flow, passing flow, releases for consumptive use and some unregulated flow.

The winter/spring high flow in reach 4 of the Loddon River and Pyramid Creek was coordinated in October 2021 to deliver a high flow at Kerang Weir that aimed to cue native fish to move into the system from the Murray River. The flow was delivered at a slightly lower magnitude than in previous years — peak flow at Kerang Weir was 638 ML per day on 17 October — to avoid flooding private land. The effectiveness of the lower flow rate is yet to be confirmed by monitoring.

Heavy rainfall in January 2022 delivered a natural fresh in the lower Loddon River that washed a lot of organic matter into the river and caused low oxygen levels during a subsequent hot spell. North Central CMA delivered one of three planned summer/autumn freshes to increase oxygen levels, but it was not effective, and a larger fresh — 200 ML per day — was delivered under the emergency watering provision to prevent fish deaths. Water for the environment was also used to deliver a summer fresh in Serpentine Creek in late January to alleviate water quality issues.

Flow in Pyramid Creek was reduced in May and June 2022 to allow water levels to draw down in Kow (Ghow) Swamp. The low flow remained within the minimum recommended range, and it was not considered harmful to native fish or other environmental values in the creek.

Two planned watering actions were not delivered in 2021-22. The first was a combined autumn high flow in the Loddon River and Pyramid Creek, which aimed to trigger the upstream movement of native fish from the Murray River and facilitate the dispersal of juvenile platypus. This is the second consecutive year that capacity constraints in Pyramid Creek have prevented delivery of an autumn high flow, and delivering it in 2022-23 will be a high priority to help achieve environmental objectives for native fish and platypus. The second planned watering action not achieved in 2021-22 was a winter/spring fresh in Serpentine Creek. It was not delivered to avoid potential flooding of private land at the end of the system. The flood risk applies to any increased flow in Serpentine Creek that cannot be redirected back into the irrigation channel system. The North Central CMA, storage manager and the VEWH have partly resolved the issue to allow summer/autumn freshes to be delivered in Serpentine Creek, and we will continue to explore options that will allow larger environmental flows to be safely delivered in future.

Scope of environmental watering

Table 5.7.1 describes the potential environmental watering actions in 2022-23, 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 5.7.1 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 (25-100 ML/day during June to November)	• At 25-50 ML/day, low flows will provide a minimum level of continuous flow through the reach and maintain water quality[1] • At 100 ML/day: - 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 provide foraging habitat - prevent silt and fine sediment from 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 low flow trial (100-200 ML/day for one to 10 days during June to November, if triggered by an unregulated flow event)	• Increased longitudinal connectivity by drowning out fish barriers to allow fish to access new habitats • Inform future works to modify or remove fish barriers	

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring high flow (one high flow of 400-450 ML/day for six to 10 days during August to November)	• Provide sufficient velocity to scour accumulated sediment from pools and scour biofilms, promoting the growth of new biofilms and increasing waterbug productivity • 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)[2]	• At 25 ML/day, low flows will provide a minimum level of continuous flow through the reach • At 50 ML/day: - 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 low flow trial (50-100 ML/day for one to two months during January to February, if triggered by hot conditions)	• Provide continuous flow through the reach to maintain water quality and potentially mitigate against a hypoxic blackwater event • Prevent emigration of native fish species due to low water quality	
Summer/autumn freshes (three freshes of 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 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	
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	
Year-round fresh (trigger-based, 50-200 ML/day as required) *Triggers:* • *the oxygen level is below 5 mg/L* • *the air temperature is above 28°* • *there are low or cease-to-flow river conditions* • *there are high water temperatures and/or low river flow*	• Destratify 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)	

Potential environmental watering action	Expected watering effects	Environmental objectives
Pyramid Creek and Loddon River (targeting reach 5)		
Year-round low flow (90-300 ML/day at Box Creek regulator)	• At 90 ML/day, low flow will maintain connectivity between pools and provide habitat for aquatic animals At 200 ML/day: • increase longitudinal connectivity to allow native fish and platypus to access new habitats • improve water quality by reducing salinity levels • increase the wetted area to maintain and promote the growth of fringing emergent (non-woody) vegetation along the lower banks of the channel At 300 ML/day: • facilitate greater movement for large-bodied native fish • wet a larger perimeter of the riverbank to enhance the growth of fringing emergent (non-woody) vegetation along the lower banks of the channel • increase hydrodynamic diversity and improve the quality of flowing habitats	
Winter/spring high flow (one high flow of 650 ML/day at Kerang Weir for 10 days)[4]	• 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 650 ML/day at Kerang Weir for six days[3] during March to April)[4]	• 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 • Provide sufficient energy to flush accumulated sediment from pools and substrates	
Serpentine Creek (targeting reach 1)[5]		
Winter/spring low flow (10-30 ML/day[6] during June to November)	• At 10 ML/day, low flow will maintain connectivity between habitats • At 20-30 ML/day: - 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	

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring fresh (one fresh of 40-120 ML/ day[6] for two days during August to November)	• 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 • Wet the banks to promote the recruitment and growth of streamside and emergent vegetation • At 120 ML/day: - maintain the channel form and scour pools - encourage female platypus to select nesting burrows higher up the bank to reduce the risk of greater flow later in the year flooding burrows when juveniles are present - flush accumulated leaf litter from the banks and low benches to reduce the risk of blackwater events during summer	
Summer/autumn low flow (10-20 ML/day[6] 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)	
Summer/autumn freshes (three freshes of 40 ML/ day[6] 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, promoting the growth of new biofilms, increasing waterbug productivity and replenishing the food supply for aquatic animals • Increase connectivity between pools to promote the local movement of fish and prompt the dispersal of juvenile platypus in autumn • Transport organic matter that has accumulated in the channel to provide 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 reoxygenate pools	

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 Under all scenarios, a 100 ML/day summer low flow rate may be trialled in January and February to mitigate hypoxic blackwater and prevent the emigration of native fish species.
3 The peak magnitude of this event is planned to be delivered for six days, but there is an extended, 14-day ramp-down period.
4 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. 650 ML/day is the total combined target at Kerang Weir.
5 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.
6 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.

Scenario planning

Table 5.7.2 outlines potential environmental watering and expected water use under a range of planning scenarios.

Loddon River

In the Loddon River, delivery of three summer/autumn freshes and continuous, year-round low flow are high priorities under all climate scenarios to maintain habitat for native fish, platypus and native vegetation and prevent poor water quality. Flow will likely be delivered at the lower end of the recommended range under drought conditions to conserve supply. Lower magnitude flow will aim to prevent critical harm to aquatic plants and animals rather than improve their condition. Low-oxygen incidents in recent years have highlighted the need for a fresh that can be delivered at any time to respond to poor water quality. This new watering action may be delivered up to a magnitude of 200 ML per day, based on the flow rate needed to improve water quality in 2017 and 2022, and it is considered a high priority under all climate scenarios.

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The prescribed passing flow in the Loddon River between May and October is 77 ML per day. Under the drought climate scenario, the passing flow may be reduced to 25 ML per day (in consultation with Goulburn-Murray Water) to accrue additional water savings that can be used to supplement flow in summer and autumn, when there are higher risks of poor water quality, and to prevent cease-to-flow events in reaches that do not carry consumptive water. The forecast high water availability will potentially allow summer/autumn freshes to be delivered at 100 ML per day under all climate scenarios in 2022-23. Under a dry climate scenario, the winter/spring low flow will likely be delivered at the standard passing flow rate of 77 ML per day, and the summer/autumn low flow will be delivered at 40 ML per day. If additional water becomes available or an average or wet scenario eventuates, water for the environment may be used to increase winter/spring low flow to 100 ML per day and summer/autumn low flow to 50 ML per day to improve the condition of vegetation higher up the bank, improve water quality and increase the abundance and improve the condition of fish and platypus populations.

Fish ecologists have recommended trialling different flow rates to improve fish outcomes in the Loddon River if sufficient water is available. The first trial is to increase summer/autumn low flow to 100 ML per day during January and February if hot conditions are forecast to reduce the risk of fish emigration and mitigate water quality issues. The second trial involves increasing the winter/spring low flow to 200 ML per day after an unregulated event to increase fish passage past low-level barriers. The first trial may occur under any scenario if there is an available supply, but the second trial will only be considered if there are large natural events; it is, therefore, more likely under a wet climate scenario. There will need to be appropriate monitoring as part of either trial.

Pyramid Creek

Pyramid Creek is regionally significant for native fish. Fish populations within Pyramid Creek have increased since the Millennium Drought, and the removal of fish barriers means it is now an important dispersal corridor for fish moving between the Murray River, Kow (Ghow) Swamp and Gunbower Creek. Maintaining adequate low flow to allow fish to remain in Pyramid Creek all year (including during the non-irrigation season) and delivering high flow to cue and facilitate fish movement at key times of the year are high priorities under all climate scenarios.

Modelling conducted by the Arthur Rylah Institute indicates that maintaining a low flow of at least 200 ML per day throughout the year in Pyramid Creek is optimal for resident fish populations. Maintenance and fishway construction works planned for the 2023 irrigation shut-down period may affect water deliveries to Pyramid Creek and make it difficult to maintain a flow of at least 200 ML per day. North Central CMA and the storage manager will aim to maintain flow within a range of 90-300 ML per day in Pyramid Creek during this period if construction works proceed.

The winter/spring high flow in Pyramid Creek has a target flow rate of 650 ML per day at Kerang Weir, which requires coordinated releases in Pyramid Creek and reach 4 of the Loddon River. The ideal duration of this event is 10 days, but it may be reduced to six days under a drought or dry climate scenario to conserve water. The reduced duration should still be sufficient to allow many fish to move through the system. A similar-sized event in autumn is recommended for average and wet climate scenarios, when large numbers of juvenile fish are likely to be trying to migrate from the Murray River into the Loddon system. It may also be delivered under drought and dry climate scenarios, if it can be delivered with the available supply or, more likely, by using operational transfers.

Serpentine Creek

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 water.

Carryover of 4,338 ML is prioritised into 2023-24 under all scenarios. This water will help meet early-season, low-flow and winter/spring fresh 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 are 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 is likely	• Spills from Loddon system storages will provide extended-duration high flow, and overbank flow is most likely in late winter/spring

Planning scenario	Drought	Dry	Average	Wet
Expected availability of water for the environment[1]	• 18,002-23,745 ML[2]	• 21,568 ML	• 21,568 ML	• 21,568 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 25-50 ML/day[3]) • Winter/spring high flow (one high flow, delivered at a lower duration)[4] • Summer/autumn low flow (delivered at 25-40 ML/day)[5] • Summer/autumn freshes (three freshes) • Year-round fresh (trigger-based)	• Winter/spring low flow (delivered at 50-77 ML/day) • Winter/spring high flow (one high flow, delivered at a lower duration) • Summer/autumn low flow (delivered at 40 ML/day) • Summer/autumn freshes (three freshes) • Year-round fresh (trigger-based)	• Winter/spring low flow (delivered at 77-100 ML/day) • Winter/spring high flow (one high flow) • Summer/autumn low flow (delivered at 50 ML/day) • Summer/autumn freshes (three freshes) • Year-round fresh (trigger-based)	• Winter/spring low flow (delivered at 77-100 ML/day) • Winter/spring high flow (one high flow) • Summer/autumn low flow (delivered at 50 ML/day) • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow) • Year-round fresh (trigger-based)
	Tier 1b (supply deficit)			
	• Summer/autumn low flow (delivered at 40-50 ML/day)	• Winter/spring low flow (delivered at 77-100 ML/day) • Summer/autumn low flow (delivered at 40-50 ML/day)	• Autumn high flow (one high flow)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring low flow delivered at 50-100 ML/day magnitude • Summer/autumn low flow trial (50-100 ML/day) • Autumn high flow (one high flow)	• Summer/autumn low flow trial (50-100 ML/day) • Autumn high flow (one high flow)	• Summer/autumn low flow trial (50-100 ML/day)	• Winter/spring low flow trial (100-200 ML/day) • Summer/autumn low flow trial (50-100 ML/day)
Possible volume of water for the environment required to achieve objectives	• 5,000-9,300 ML (tier 1a) • 600 ML (tier 1b) • 12,200 ML (tier 2)	• 9,300 ML (tier 1a) • 4,000 ML (tier 1b) • 8,800 ML (tier 2)	• 8,200 ML (tier 1a) • 3,500 ML (tier 1b) • 4,300 ML (tier 2)	• 8,400 ML (tier 1a) • 3,000 ML (tier 2)
Pyramid Creek and Loddon River (targeting 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)	• Autumn high flow (one high flow)		• N/A	

Planning scenario	Drought	Dry	Average	Wet
Possible volume of water for the environment required to achieve objectives[6]	• 4, 000 ML (tier 1a) • 2,000 ML (tier 2)		• 6,000 ML (tier 1a)	
Serpentine Creek (targeting reach 1)[7]				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Winter/spring low flow (delivered at 10 ML/day) • Winter/spring fresh (one fresh, delivered at 40 ML/day) • Summer/autumn low flow (delivered at 10 ML/day) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (delivered at 10 ML/day) • Winter/spring fresh (one fresh) • Summer/autumn low flow (delivered at 10 ML/day) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (delivered at 10 ML/day) • Winter/spring fresh (one fresh) • Summer/autumn low flow (delivered at 10 ML/day) • Summer/autumn freshes (three freshes)	• Winter/spring low flow (delivered at 10 ML/day) • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)			
	• Winter/spring fresh (tier 1a fresh delivered at 120 ML/day) • Summer/autumn low flow (delivered at 10-20 ML/day) • Winter/spring low flow (delivered at 10-20 ML/day)	• Winter/spring low flow (delivered at 10-20 ML/day) • Summer/autumn low flow (delivered at 10-20 ML/day)	• Winter/spring low flow (delivered at 10-30 ML/day) • Summer/autumn low flow (delivered at 10-20 ML/day)	• Winter/spring low flow (delivered at 10-30 ML/day)
Potential environmental watering – tier 2 (additional priorities)	• N/A	• N/A	• N/A	• N/A
Possible volume of water for the environment required to achieve objectives	• 1,430 ML (tier 1a) • 3,700 ML (tier 1b)	• 1,430 ML (tier 1a) • 2,500 ML (tier 1b)	• 1,300 ML (tier 1a) • 3,200 ML (tier 1b)	• 1,160 ML (tier 1a) • 2,000 ML (tier 1b)
Priority carryover requirements for 2023-24	• 4,400 ML for early-season low flow and winter/spring high flow	• 4,000 ML for early-season low flow and winter/spring high flow		

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 to enable passing-flow savings.
3 When passing flow can be accumulated or water availability allows, the winter/spring low flow magnitude may be increased to 50 ML/day to maintain seasonal variability, support vegetation and aquatic animals and prevent a decline in oxygen levels.
4 In 2022-23, it is expected that passing flow will be accumulated in winter/spring (when the combined volume in Cairn Curran and Tullaroop reservoirs exceeds 60,000 ML), providing sufficient water to deliver the winter/spring high flow. If the combined volume in storage is less than 60,000 ML, the winter/spring high flow will become a Tier 1b watering action.
5 If passing flow has been accumulated in winter/spring (when the combined volume in Cairn Curran and Tullaroop reservoirs exceeds 60,000 ML) or water availability allows, the summer/autumn low-flow magnitude may be increased to 40 ML/day.
6 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. The actual demand for each event is expected to be a much lower volume.
7 Delivery of low flow in Serpentine Creek is constrained below recommended flow rates until an approach to deal with end-of-system flow is agreed on.

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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

Icon	Environmental 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 Wamba Wemba Traditional Owners and Dja Dja Wurrung Clans Aboriginal Corporation (trading as DJAARA) to identify opportunities to engage on environmental water planning and delivery, now and in the 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 *Dhelkunya Dja (Healing Country) 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 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*

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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

DJAARA is completing a Water For Country 'Gatjin' Strategy to set the vision, objectives and targets for cultural water on Country. Aboriginal Waterway Assessments (AWAs) planned to be undertaken in 2022-23 will feed into the Strategy. Through the Water For Country 'Gatjin' Strategy DJAARA will integrate data from completed AWAs into water planning processes to better influence how water is managed on Country (such as through the Seasonal Watering Plan process).

The North Central CMA is committed to working with DJAARA including their local family group Yung Balug, to enable the proposed watering at Lake Boort while managing cultural heritage, to the satisfaction of all partners. This includes the inundation of culturally significant plant communities.

In early 2022, Barapa Barapa and Wamba Wemba Traditional Owners went on a field visit to Lake Leaghur, Lake Meran and Little Lake Meran. The group discussed which Boort and central Murray wetlands to water in 2022-23, and supported the proposal to water most of the actively managed wetlands on their Country and to allow Lake Yando to go through a dry phase. The group also indicated a preference to water Little Lake Meran over Lake Leaghur (if water supply is an issue) as the fringing black box trees are looking stressed. The group indicated that they are very interested in undertaking Aboriginal Waterway Assessments (AWAs) at several of the Boort wetlands in the future – in both wet and dry phases.

Social, recreational and economic values and uses

In planning the potential environmental flows 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)
- waterway 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 and water levels and quality for flood mitigation, nutrient treatment and carbon storage).

Recent conditions

Rainfall across the Boort wetlands and the upstream catchment was close to the long-term average during 2021-22, and temperatures were above the long-term average. Allocations in the Loddon and Goulburn systems against high-reliability water shares rose from 33 percent at the start of July to 100 percent in October, but there were no allocations against low-reliability water shares. Loddon allocations were not enough to meet all environmental demands in the Loddon River and Boort wetlands in 2021-22, so the VEWH traded 5 GL of water from its entitlements in the Goulburn to the Loddon system.

Deliveries of water for the environment for the Boort wetlands were managed in line with an average climate scenario throughout 2021-22. Watering actions were planned for Lake Boort, Lake Meran and Lake Leaghur, but water for the environment was only delivered to Lake Meran and Lake Boort.

The winter/spring fill at Lake Meran was a high priority for 2021-22, and additional water to enable the delivery was sought from the Goulburn system. Capacity constraints in the irrigation supply channel limited the rate at which water could be delivered to the lake and prevented the target level from being achieved by the end of spring. Watering ceased during summer to avoid unseasonal inundation, but it resumed in autumn to inundate fringing river red gums and black box. Lake Meran will be allowed to draw down in 2022-23 and 2023-24 to support dry-phase ecosystem processes.

A low-level partial fill at Lake Boort commenced in autumn 2022 to prime the wetland before a higher partial fill is delivered in winter/spring 2022. This was the first time water for the environment has been delivered to Lake Boort, and it is the first inflow to the lake since the 2016 floods. The Lake Boort partial fill was planned in consultation with Dja Dja Wurrung and the local Yung Balug family group, and it aimed to support river red gums that were planted in 2017 and culturally important vegetation (such as spiny flat sedge).

Lake Leaghur received a priming fill in autumn 2021, and it held sufficient water throughout winter and spring to meet the environmental objectives for 2021-22. Delivering additional water in winter/spring would have potentially compromised river red gum saplings and cane grass that were planted at Lake Leaghur in 2019-20, so the planned watering action was cancelled. Trigger-based top-ups were also not required because no significant waterbird breeding was observed.

Lake Yando was filled in 2020-21, and Little Lake Meran last filled in 2019-20. Both wetlands were allowed to draw down in 2021-22 to support dry-phase ecosystem processes.

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Scope of environmental watering

Table 5.7.3 describes the potential environmental watering actions in 2022-23, 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 5.7.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Boort wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Lake Boort (partial fill in winter/spring, top-ups as required)	• Increase the water depth around the wetland fringe (the target water level is 90.2 m AHD) to promote the germination and recruitment of fringing vegetation, including culturally significant species (such as spiny flat sedge) • Support the growth of aquatic and semi-aquatic plants within the wetland • Grow zooplankton and waterbug communities to provide food for waterbirds and frogs	
Lake Leaghur (partial fill in spring/summer or autumn/winter)[1]	• Provide increased habitat area and grow zooplankton and waterbug communities to provide food resources for frogs and waterbirds • A spring/summer partial fill will: - increase the water depth (the target water level is 84.4 m AHD) 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 • An autumn/winter partial fill will: - prime the wetland for spring watering in 2023-24 by breaking the dormancy of aquatic vegetation propagules so they can grow and reproduce	
Lake Yando (top up to support waterbird breeding or vegetation outcomes if triggered by a natural flood or flood mitigation water)	• Wet the wetland fringe (the target water level is 87.6 m AHD) to promote the germination and recruitment of river red gums and black box and maintain the existing mature trees • Support the growth of aquatic and semi-aquatic plants • Provide habitat and food resources for aquatic animals • Grow zooplankton and waterbug communities to provide food for waterbirds and frogs	
Little Lake Meran (fill in winter/spring, top-ups as required)	• Wet the wetland fringe (the target water level is between 78.7 m AHD to 79.7 m AHD) to promote the growth and recruitment of river red gums and black box and maintain existing mature trees • Support the growth of aquatic and semi-aquatic plants • Grow zooplankton and waterbug communities to provide food for waterbirds and frogs	

1 An ecological assessment will occur at Lake Leaghur in spring 2022 to determine the best season to water this wetland based on observed environmental conditions, forecast climatic conditions, water availability and expected operational delivery constraints.

Scenario planning

Table 5.7.4 outlines potential environmental watering and expected water use under a range of planning scenarios.

The highest-priority action in the Boort wetlands in 2022-23 under all climate scenarios will be to continue the partial fill at Lake Boort that commenced in autumn 2022. That watering action aims to trigger the growth of aquatic vegetation, including many species that are culturally important to Traditional Owners. Additional top-ups may be required to ensure fringing river red gums are sufficiently inundated to improve their condition after being dry for more than five years.

Watering Little Lake Meran is a priority under dry to wet scenarios in 2022-23. Little Lake Meran was last watered in 2019-20, and it then underwent a drying phase. Watering Little Lake Meran in winter and spring 2022 will likely trigger the germination of aquatic plants and initiate a productivity boom of zooplankton and macroinvertebrates that will provide food for frogs and waterbirds. Subsequent top-ups may be required throughout the year to water fringing trees that have been dry for three years and support potential waterbird and frog breeding events. Watering Little Lake Meran is not a priority under a drought scenario, as the lake and its associated vegetation community can withstand up to two more years before their maximum recommended dry period is exceeded.

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Lake Leaghur may be partially filled in spring/summer or autumn/winter under average or wet climate scenarios. In the past decade, Lake Leaghur has had its minimum recommended watering regime and is currently in a rehabilitation phase. Delivering water for the environment in 2022-23 will build on environmental outcomes from its partial fill in autumn 2021. An ecological assessment will be conducted in spring 2022 to determine if Lake Leaghur needs to be watered this year and the best time to deliver water. The assessment will consider the wetland's condition, expected climatic conditions over summer/ autumn and potential delivery constraints, including concurrent deliveries to other Boort wetlands and the Loddon River. Filling Lake Leaghur is a low priority under drought and dry scenarios because the watering event in 2021 has maintained the minimum required watering regime.

Lake Yando may flood naturally under a wet climate scenario or receive flood mitigation water. If either of these things occurs, water for the environment may be used to top up the water level and/or extend the inundation period, to support waterbird breeding and allow wetland vegetation to complete their life cycles through spring and summer.

Lake Meran will be allowed to draw down during 2022-23 to support dry-phase ecosystem processes in accordance with the recommended water regime in the *Meran Lakes Complex Environmental Water Management Plan*.

Priority carryover requirements for 2023-24 focus on completing any watering actions that commence in autumn/winter 2023. A carryover target of 500 ML has been set under scenarios where Lake Leaghur is likely to be watered. The final carryover requirements will be revised during the year once the likely status of planned watering actions becomes clear.

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 is possible	• Moderate inflow from local catchment run-off, but little if any inflow from nearby creeks or flood runners	• Extended durations of high flow and overbank flow from creeks and flood runners, which fill most wetlands
Expected availability of water for the environment[1]	• 18,002-23,745 ML	• 21,568 ML	• 21,568 ML	• 21,568 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Lake Boort (partial fill in winter/ spring, top-ups as required)	• Lake Boort (partial fill in winter/ spring, top-ups as required) • Little Lake Meran (fill in winter/ spring, top-ups as required)	• Lake Boort (partial fill in winter/ spring, top-ups as required) • Lake Leaghur (partial fill in spring/ summer or autumn/ winter) • Little Lake Meran (fill in winter/ spring, top-ups as required)	• Lake Boort (partial fill in winter/ spring, top-ups as required) • Lake Leaghur (partial fill in spring/ summer or autumn/ winter) • Little Lake Meran (fill in winter/ spring, top-ups as required)
	Tier 1b (supply deficit)			
	• N/A	• N/A	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A	• Lake Leaghur (partial fill in spring/ summer or autumn/ winter)	• N/A	• Lake Yando (top up if triggered)
Possible volume of water for the environment required to achieve objectives	• 5,000 ML (tier 1a)	• 6,400 ML (tier 1a) • 600 ML (tier 1b)	• 7,000 ML (tier 1a)	• 6,800 ML (tier 1a) • 600 ML (tier 2)
Priority carryover requirements for 2023-24	• N/A	• 500 ML[2]	• 500 ML[2]	• 500 ML[2]

1 Loddon system entitlements are shared between the Loddon River system and the Boort wetlands.
2 Priority carryover of 500 ML is required for delivery to Lake Leaghur if the partial fill is delivered in autumn/winter 2023.

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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 — that 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.

Anecdotal reports suggest the removal of willows along the creek in 2018 has improved in-stream vegetation and habitat for populations of small-bodied fish.

Environmental watering objectives in Birchs Creek

Icon	Environmental objectives in Birchs Creek
	Increase the abundance and diversity of small- and medium-bodied native fish, including river blackfish, mountain galaxias, flat-headed gudgeon and Australian smelt
	Increase the platypus population and improve its resilience to future droughts andfloods Provide surplus juvenile platypus that can disperse to Creswick and Tullaroop creeks
	Maintain the diversity and increase the 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 (trading as DJAARA) and North Central CMA have identified the creek as a potential site for future projects.

The *Dhelkunya Dja (Healing Country) Country Plan 2014-2034* describes their aspirations around the management of rivers and waterways and articulates Djaara's (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 DJAARA continue to work towards increased engagement on planning and delivery of environmental watering activities, including identifying opportunities for Dja Dja Wurrung to play a greater role in the management and administering of environmental water.

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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 [particularly in Newlyn, Smeaton and Clunes] and improved amenity at key community spaces like Anderson's Mill)
- improved water quality (such as for domestic and stock use).

Recent conditions

Rainfall in the Birchs Creek catchment during 2021-22 was above the long-term average. Water for the environment allocated in December 2020 was carried over into 2021-22, but it was lost due to spills from Newlyn Reservoir through winter and spring in 2021. These spills produced three distinct high flows in the winter/spring period, with the largest event peaking at 447 ML per day at Smeaton in early September 2021. Another spill in January provided a large summer fresh that reached 254 ML per day at Smeaton. Seasonal determinations against high-reliability water shares in the Bullarook system opened at 40 percent allocation on 1 July 2021 and reached 100 percent allocation by mid-July. The VEWH was allocated the full 100 ML volume on 1 December 2021.

The Bullarook system was managed in line with an average climate scenario throughout 2021-22. All planned watering actions for the year were met or exceeded through natural flows, including groundwater baseflows, spills from storage and consumptive releases. The allocation from December 2021 will be carried over to support watering actions in 2022-23.

A census of platypus and river blackfish in Birchs Creek was undertaken in 2021-22 using environmental DNA. The methods replicated a survey conducted in 2015-16, and the results indicate that platypus and river blackfish have increased their distribution and are now present at more sites throughout the system. Platypus also appear to have dispersed into Creswick Creek and Tullaroop Creek.

Scope of environmental watering

Table 5.7.5 describes the potential environmental watering actions in 2022-23, 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 2)[1]		
Winter/spring fresh (one to four freshes of 27-30 ML/day for three to five 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 • Improve water quality by freshening refuge pools and provide connectivity between pools for fish and platypus movement	
Summer/autumn fresh(es) (one to four freshes of 10-15 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 • Improve the condition of riffle/run habitats for waterbugs • Top up pools to refresh water quality (particularly oxygen levels) and enhance connectivity between pools for fish and platypus movement	

1 Environmental flows target outcomes in reach 3, but compliance can only be assessed in reach 2.

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Scenario planning

Table 5.7.6 outlines potential environmental watering and expected water use under a range of planning scenarios.

The water for the environment in Birchs Creek is primarily used to deliver winter/spring freshes and summer/autumn freshes, where they are not met by natural flows or consumptive water deliveries. The volume of available water for the environment is not sufficient to deliver any of the other environmental flows that are recommended for the system. The Birchs Creek Environmental Water Advisory Group (which recently combined with the Tullaroop Catchment Restoration Plan Project Reference Group) and ecologists have advised available water for the environment should be used to deliver recommended freshes in full, rather than a small proportion of recommended low flows.

Winter/spring freshes are important for cycling nutrients throughout the system and wetting higher channel features to increase connectivity between habitat types for aquatic animals. Summer/autumn freshes are needed to maintain water quality over the warmer months and ensure pools do not dry out.

Regular winter/spring freshes are important to cycle nutrients throughout the system and wet higher channel features to increase connectivity between habitat types for aquatic animals. Summer/autumn freshes are needed to maintain water quality in the warmer months and ensure pools do not dry out. However, both watering actions are important, and if required and where allocation allows, summer/autumn freshes may be prioritised to avoid critical loss of environmental values when the system is likely to be under the greatest stress. Summer/autumn freshes should be delivered at the upper magnitude where possible, either by augmenting natural or consumptive flows or by using water for the environment to deliver greater-magnitude freshes after one fresh has been met naturally. Under a drought scenario, the environment is unlikely to receive its allocation in December, so carryover from 2021-22 should be used to deliver a winter/spring fresh before the water is forfeited on 30 November. Winter/spring freshes will likely be delivered naturally by reservoir spills under average and wet climate scenarios.

Table 5.7.6 Potential environmental watering for Birchs Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected creek conditions	• Reservoir is unlikely to spill • Extremely low flow in winter/spring • Limited irrigation releases due to low allocations	• Reservoir spill is 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	• Reservoir spills are certain in winter/spring • Natural flow through summer/autumn • Groundwater contributes to baseflow throughout the year
Expected availability of water for the environment	• 100 ML (2021 carryover)	• 100-200 ML (2021 carryover and likely 2022 allocation)	• 100 ML (2022 allocation)[1]	• 100 ML (2022 allocation)[1]
Birchs Creek (targeting reach 2)				
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Winter/spring fresh (one fresh for three days)	• Winter/spring fresh (one fresh for three days) • Summer/autumn fresh(es) (one to three freshes, lower magnitude)	• Winter/spring fresh (one fresh for three days) • Summer/autumn fresh(es) (one to three freshes, lower magnitude)	• Winter/spring freshes • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)			
	• Summer/autumn freshes (three freshes)	• Summer/autumn freshes (deliver tier 1a freshes at upper magnitude)	• Winter/spring fresh(es) (one to four freshes for five days) • Summer/autumn fresh(es) (one to four freshes, deliver tier 1a freshes at upper magnitude)	• Summer/autumn fresh(es) (one to four freshes, deliver tier 1a freshes at upper magnitude)

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 81-90 ML (tier 1a) • 135 ML (tier 1b)	• 171-180 ML (tier 1a) • 45 ML (tier 1b)	• 90 ML (tier 1a) • 690 ML (tier 1b)	• 0 ML (tier 1a) • 180 ML (tier 1b)
Priority carryover requirements for 2023-24	• If the 100 ML allocation is received on 1 December 2022 and water for the environment is not required to achieve summer/autumn freshes, carry over 100 ML allocation into 2023-24 for use by 30 November 2023.			

1 Under an average or wet scenario, it is likely that Newlyn Reservoir will spill before 30 November 2022, losing the 100 ML carryover from December 2021.

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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

CEWO – Commonwealth Environmental Water Office

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

VMFRP – Victorian Murray Floodplain Restoration Project

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. These soils are stable when inundated but can generate sulphuric acid (and severe environmental impacts) when exposed to air.

Adaptive management – An iterative decision-making process based on continuous learning that aims to improve outcomes over time.

Allocation (of water) – The specific volume of water made available against a water entitlement in a given water year.

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).

Bank slumping – When a coherent mass of loosely consolidated materials or rock layers that form part of the river bank moves a short distance down a slope. Bank slumping is usually associated with bank erosion.

Bankfull flow – A flow of sufficient size to reach the top of the riverbank, with little flow spilling onto the floodplain.

Biodiversity – The variety 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.

Blackwater – A natural occurrence caused by the breakdown of organic matter in a waterway leading to discolouration. In some cases, the breakdown of organic matter can deplete oxygen in the waterway, which if severe 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 allocation that entitlement holders are allowed to retain for use in subsequent years, according to specified rules.

Catchment management authority (CMA) – A Victorian statutory authority responsible for the integrated planning and coordination of land, water and biodiversity management in a designated catchment and land protection region. Victoria's CMA's are listed in '6.3 Contact details'.

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 phenomenon caused by cold water being released (usually from large dams) into rivers. Such releases have the potential to disrupt ecological processes (such as fish breeding) that are influenced by temperature.

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 to complete specific parts of their life cycle.

Deficit in supply – The situation when the available volume of environmental water is insufficient to meet identified requirements to deliver water for the environment.

Drawdown – Water released or allowed to evaporate from a dam, reservoir or wetland to lower the water level. Drawdowns in dams and reservoirs are usually done for operational or maintenance purposes and may be done in wetlands to support specific ecological outcomes.

Ecological vegetation class – A standard unit for classifying vegetation types in Victoria, based on floristic, structural and ecological features.

En route (water) – Water that has been released from a storage and is moving downstream to meet an urban, irrigation or operational need.

Environmental flow study – A scientific study of the flow requirements of a particular river and/or wetland system that is used to inform decisions about the management and allocation of water resources.

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Environmental objective – A measurable environmental outcome sought from deliberate management actions (such as the application of water for the environment) in a particular system. An environmental objective may take years or even decades to achieve.

Environmental water entitlement – A legal right to take and use water for the purpose of maintaining an Environmental Water Reserve or improving the environmental values and health of the water ecosystem. 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 the water regime required to support those objectives.

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 action to deliver water for the environment. Each potential action will have one or more expected watering effects.

Fishway – A series of pools built like steps to enable fish to travel past an artificial obstruction (such as a dam or weir).

Fledging – The stage at which a young bird becomes independent and can fly and leave its nest.

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, short-duration increase in flow magnitude within a river. A fresh can occur in any season and usually lasts from several days to a couple of weeks.

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 collection of water storage infrastructure (such as reservoirs, diversion weirs and channels) that support the harvest and distribution of water within one or more catchment regions.

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 flow in a river, generally being its minimum natural level for that season.

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 (also called a waterbug) – An aquatic animal without a backbone that can be seen with the naked eye. Worms, snails, mites, bugs, beetles, dragonfly larvae, shrimps and freshwater crayfish are all macroinvertebrates.

Macrophyte – An aquatic plant that is either emergent (growing out of the water, such as phragmites), submergent (growing under the water, such as ribbon weed) or floating (such as floating pondweed).

Managed release – A deliberate release of stored water for the environment to deliver a potential watering action and associated 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.

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Operational release – A release of water from a water supply storage to support the operation of the water distribution system or to make water available to consumptive water users.

Overbank flow – a flow event that exceeds the capacity of the river channel and inundates adjacent floodplain habitats.

Passing flow – A release of water from a water supply storage to operate a river and distribution system — often to help deliver water for environmental or consumptive uses — and to maintain environmental values and provide 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 action to deliver water for the environment – An environmental flow component that has been identified for a particular system in a particular year.

Program partner – An organisation responsible for delivering a part of the environmental watering program. Program partners include waterway managers, storage managers, land managers and environmental water holders. In some areas, Traditional Owners, scientists and community members may also be program partners.

Pulse – Water released to increase the flow magnitude for a short duration, usually to cue an ecological response (such as to trigger fish movement).

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 section of a river, generally defined in an environmental flow study.

Recruitment – The process by which individuals are added to a population (such as when plants and animals mature from their early life stages to breeding ages).

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 – The portion of an environmental water delivery that flows back into the river channel or out the end of a river system and is available for use further downstream. Return flows may be captured and stored for later reuse, but are more commonly used as it moves downstream.

Riffle – A shallow section of stream where water flows at a higher velocity; turbulence increases, and the surface is disturbed.

Riparian vegetation – plants that grow along the banks of waterways: that is, in the zone between the waterway and adjacent land.

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 actions to deliver water for the environment 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 – An authorisation from the VEWH to allow a CMA or Melbourne Water to apply water from specific environmental entitlements to deliver the watering actions specified in the seasonal watering plan.

Shared benefits – The many cultural, economic, recreational, social and Traditional Owner benefits of delivering water for the environment.

Shared risk – A risk associated with the environmental watering program that is shared by two or more agencies and that requires coordinated management by more than one agency.

Slackwater habitat – Areas of a river or stream with little or no current. These areas may be immediately downstream of an obstruction (such as a rock) or at the margins of the channel, and they are often important areas for waterbugs, fish larvae and small-bodied fish.

Spawning – The process of fish releasing eggs and sperm to reproduce.

Stakeholder – An organisation or individual with an interest in the environmental watering program that is engaged by a program partner 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.

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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.

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 actions to deliver water for the environment that are required this year to achieve intended environmental objectives, given current environmental conditions and the planned strategies to deliver water for the environment 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 – see **Water trading**

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 during periods of unregulated flow in a river system, usually when high rainfall causes river flow to exceed consumptive and system storage demands.

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 actions to deliver water for the environment 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 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 trading – The process of buying, selling or exchanging rights to water. A water trade can be a permanent transfer of ownership of a water entitlement or the trade of an annual water allocation. The Minister for Water sets rules for water trading in Victoria. For the purposes of the seasonal watering plan, the term 'trade' refers to the purchase, sale or transfer of annual water allocation.

Water year – The twelve-month period from 1 July to 30 June that is used for allocating, managing and reporting the use of water entitlements.

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.

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6.3 Contact details

For further information about the *Seasonal Watering Plan 2022-23*, 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
1800 002 262
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
reception@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
Agriculture Victoria Centre, 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 or (02) 6043 7600
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
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
33 Allara Street, Canberra City, ACT 2601
GPO Box 1801, Canberra City, ACT 2061
(02) 6279 0100 or 1800 630 114
www.mdba.gov.au

Commonwealth Environmental Water Office
John Gorton Building, King Edward Terrace, Parkes, ACT 2600
GPO Box 858, Canberra, ACT 2061
(02) 6274 1111
ewater@environment.gov.au
www.awe.gov.au/water/cewo

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