Seasonal Watering Plan 2022-23

Section 3

VICTORIAN ENVIRONMENTAL WATER HOLDER

VICTORIA State Government

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: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning • Southern Rural Water	**IAP2 level: Collaborate** • Barwon Water • City of Greater Geelong • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water • Victorian Fisheries Authority
	IAP2 level: Consult • Golden Plains Shire Council • Moorabool Shire Council	**IAP2 level: Consult** • Colac Otway Shire Council	
Landholders/farmers	**IAP2 level: Involve** • Landholders on the Moorabool Stakeholder Advisory Committee	**IAP2 level: Involve** • Landholders on the Upper Barwon Surface Water Advisory Group	**IAP2 level: Involve** • Landholders on the Lower Barwon Community Advisory Committee
Local businesses	**IAP2 level: Involve** • Adelaide Brighton Cement		**IAP2 level: Involve** • Commercial eel fishers
Recreational users			**IAP2 level: Involve** • Association of Geelong and District Angling Clubs Inc. and VRFish • Field and Game Australia (Geelong Branch) • Geelong Gun and Rod Association Inc.
Traditional Owners	**IAP2 level: Collaborate** • Wadawurrung Traditional Owners Aboriginal Corporation	**IAP2 level: Consult** • Wadawurrung Traditional Owners Aboriginal Corporation	**IAP2 level: Collaborate** • Wadawurrung Traditional Owners Aboriginal Corporation
		IAP2 level: Inform • Eastern Maar Aboriginal Corporation	

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

	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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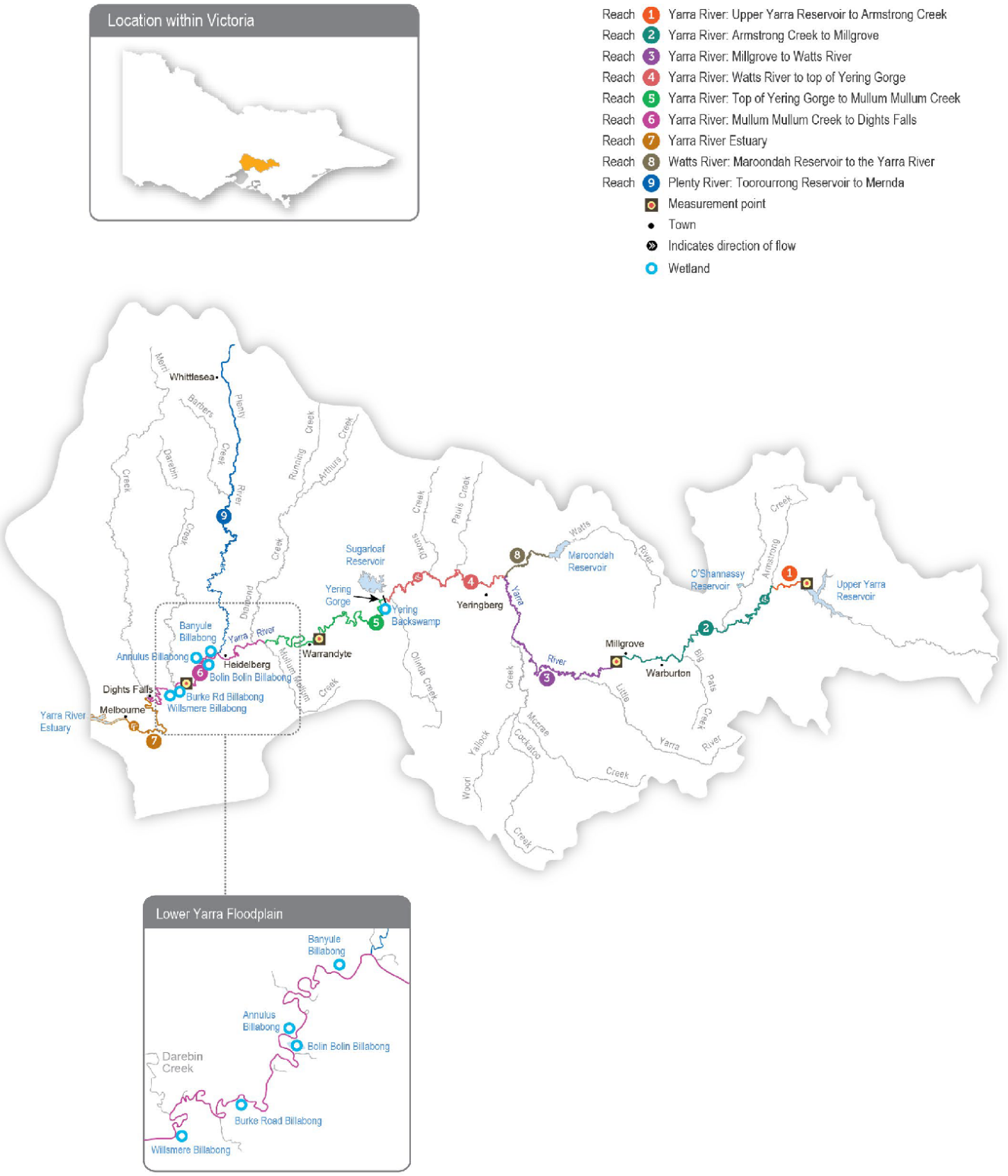
Figure 3.2.1 The Yarra system



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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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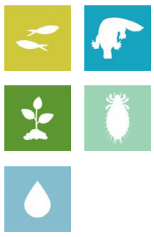
Birdlife Australia conducted bird surveys at four Yarra billabongs in 2021-22. The surveys aimed to compare bird responses at watered and dry billabongs, but Yering Backswamp, Spadonis Billabong, and some parts of *Birrarung* Billabong naturally filled and prevented a direct comparison. The surveys still 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.

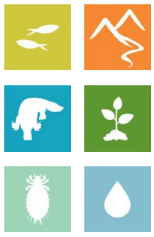
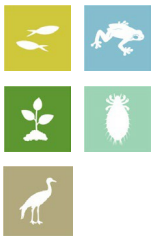
Melbourne Water has installed real-time water-quality monitoring instruments in Birrarung (Yarra River) at Millgrove and upgraded the water-quality monitoring buoy in the lower reaches of the river. These complement the other four water-quality monitoring stations along Birrarung (Yarra River) and will 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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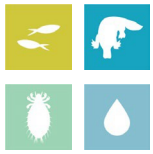
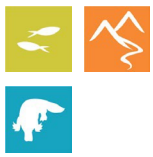
2 In agreement with Melbourne Water and other entitlement holders in the Tarago system, VEWH is allowed to store its share of inflows to Tarago Reservoir in unused airspace when the VEWH's capacity share of 3,000 ML is full.

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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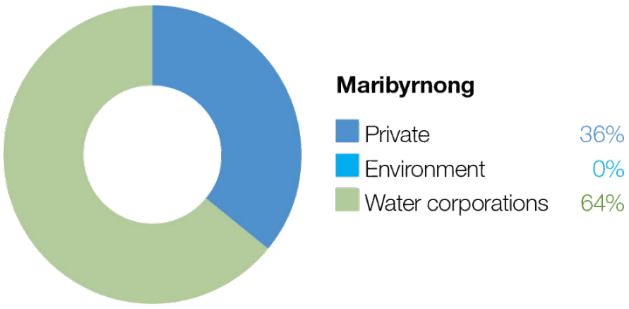
3.4 Maribyrnong system

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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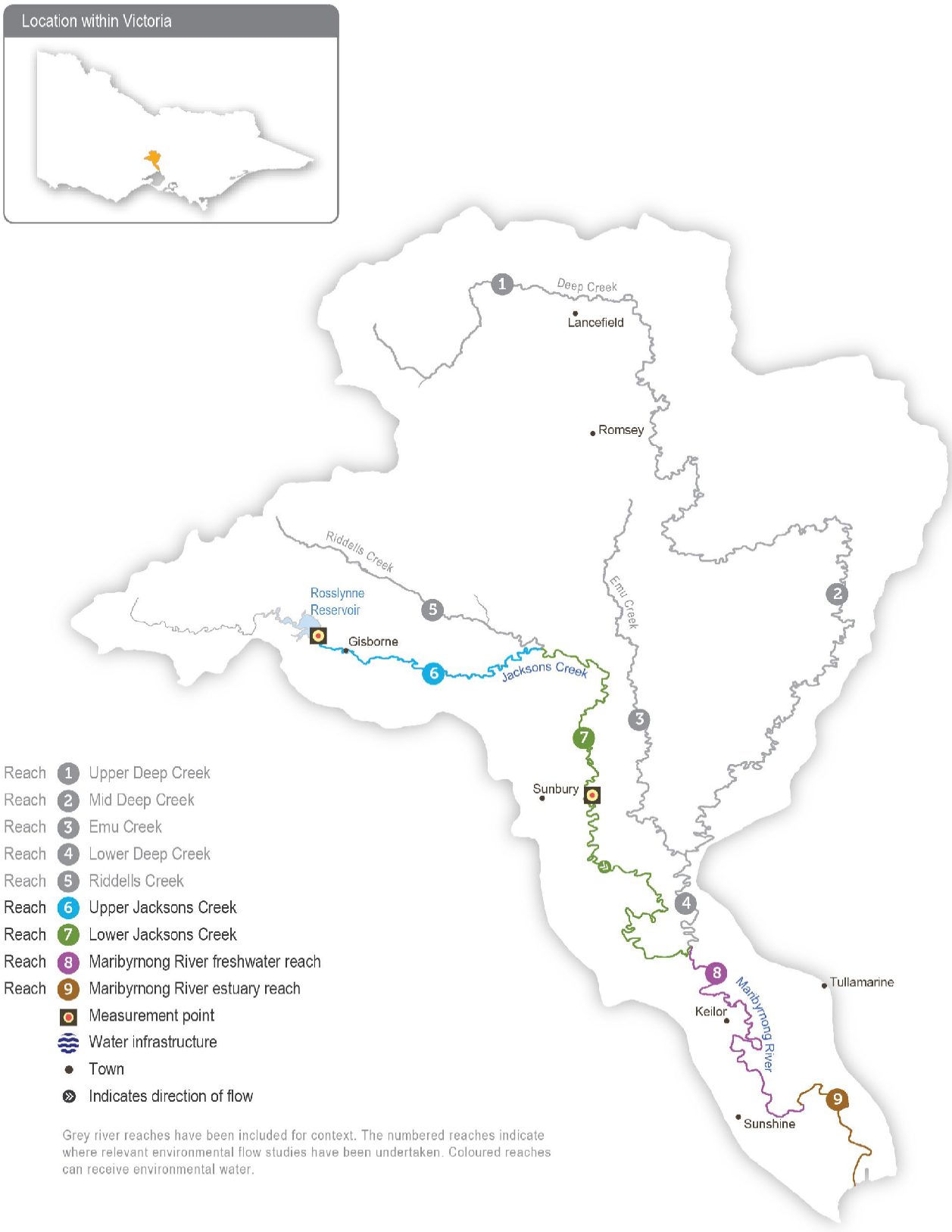
Figure 3.4.1 The Maribyrnong system



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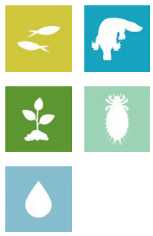
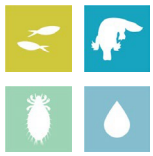
platypus populations. However, they will help to maintain habitat for existing populations and reduce the risk of poor water-quality incidents and are therefore still necessary. Melbourne Water will continue to work with the reservoir operator and relevant government agencies to improve water delivery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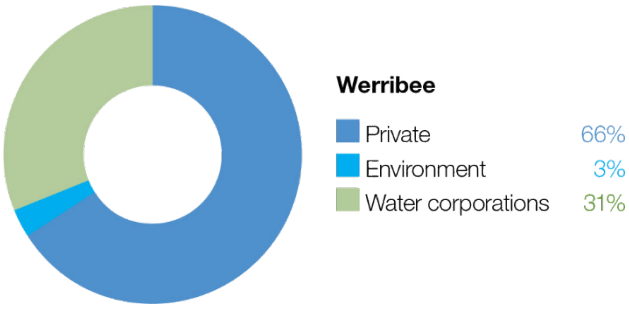
3.5 Werribee system

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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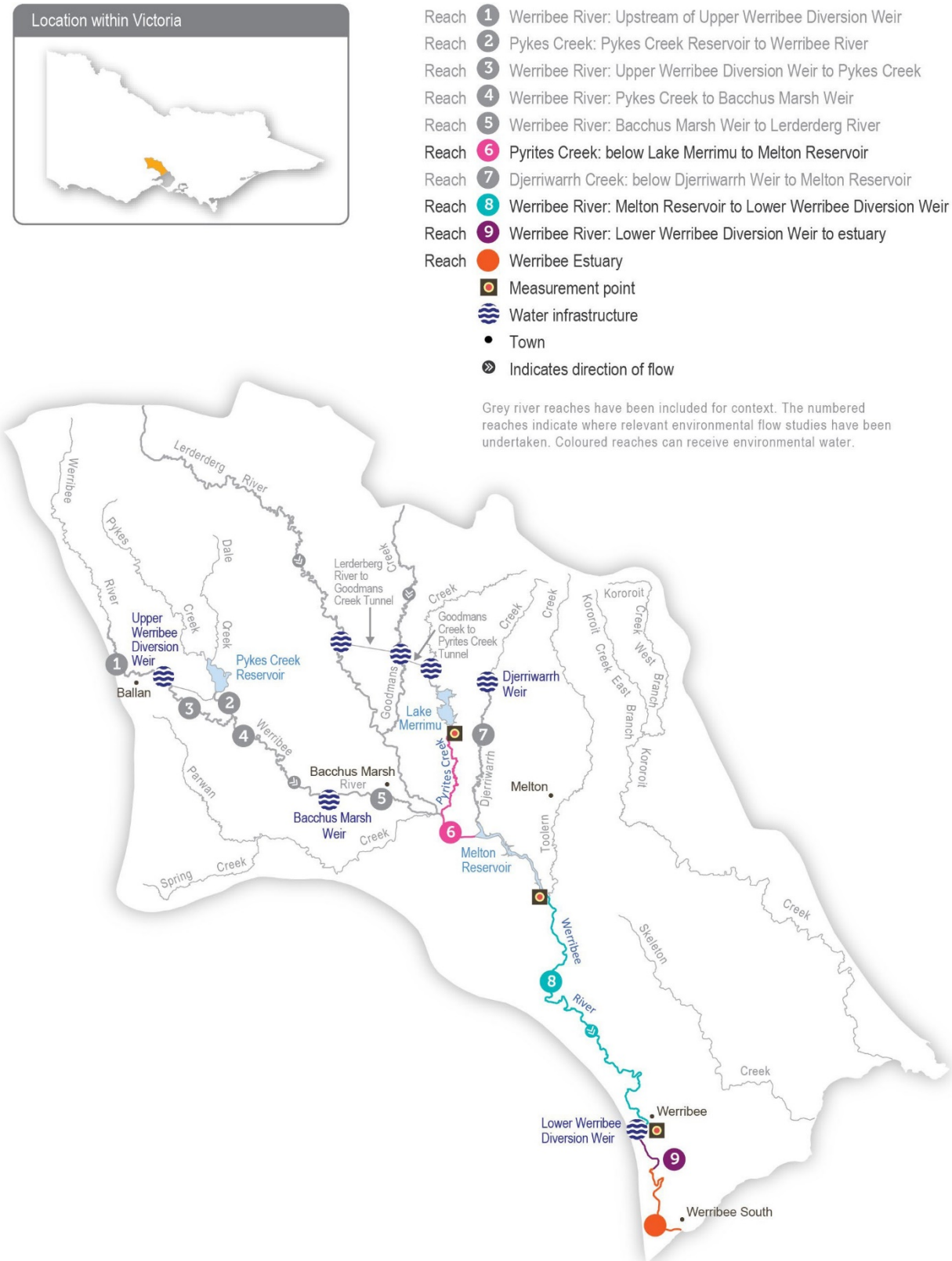
Figure 3.5.1 The Werribee system



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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.

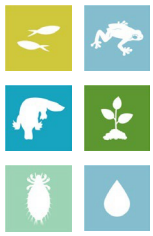
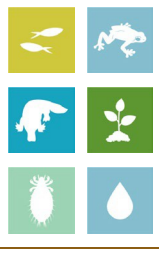
The only planned watering action that was not fully achieved was a summer fresh in the lower Werribee River. Water for the environment was ordered and released from Melton Reservoir to deliver a fresh in late January, but the order was cut short due to operational requirements. Natural freshes before 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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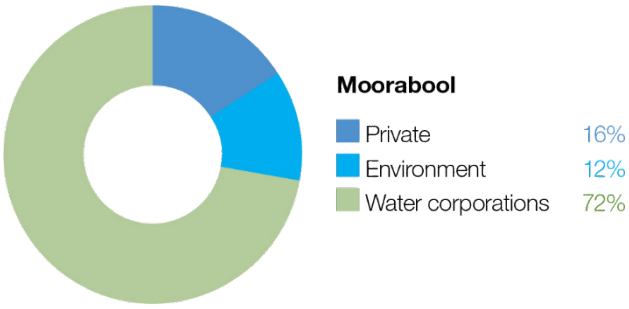
3.6 Moorabool system

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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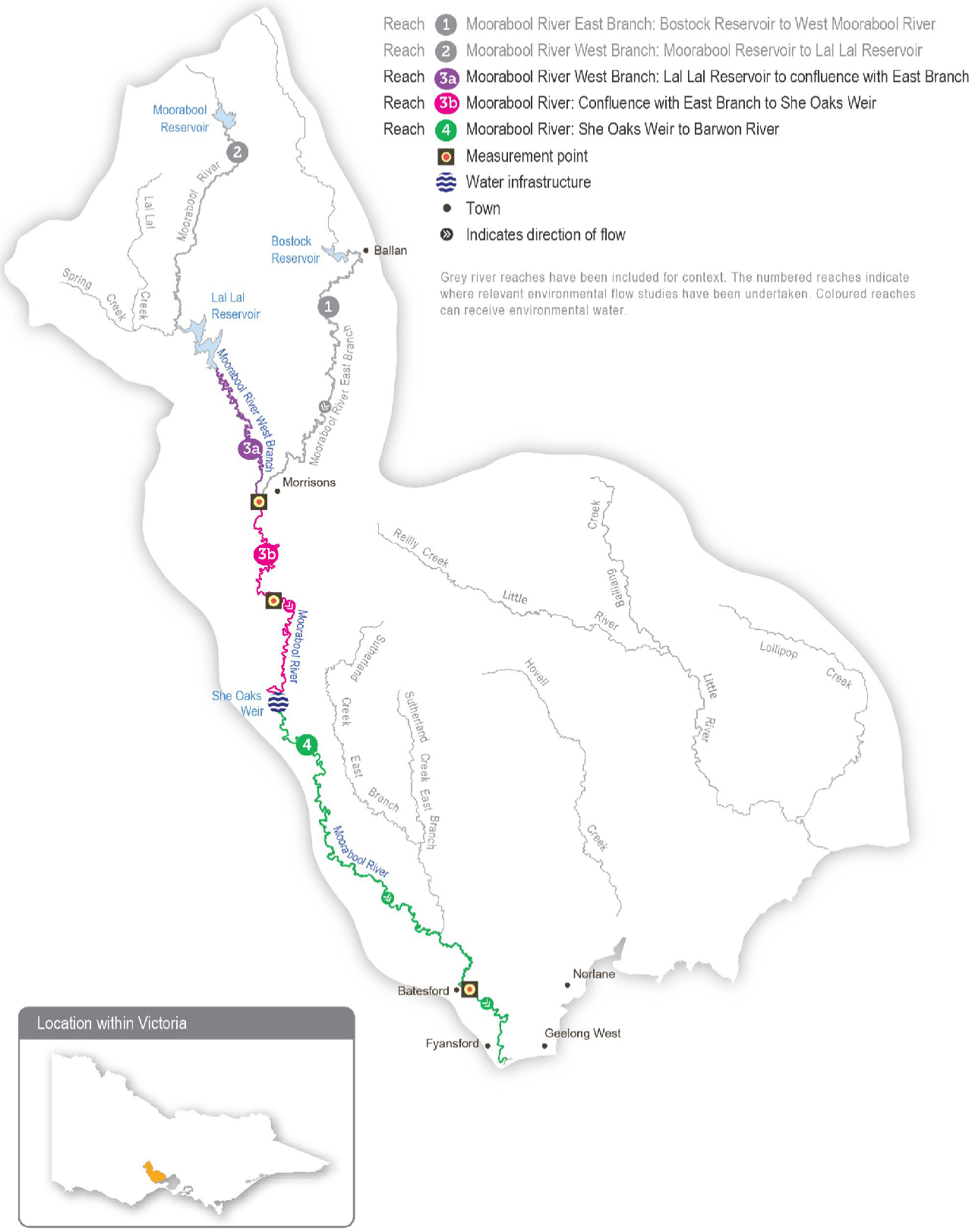
Figure 3.6.1 The Moorabool system



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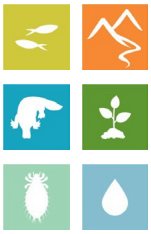
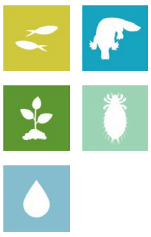
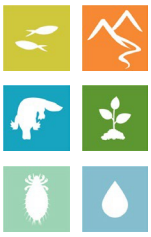
Table 3.6.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Moorabool system

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	

Potential environmental watering action	Expected watering effects	Environmental objectives
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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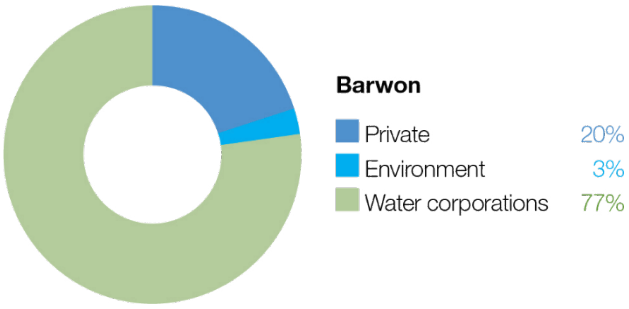
3.7 Barwon system

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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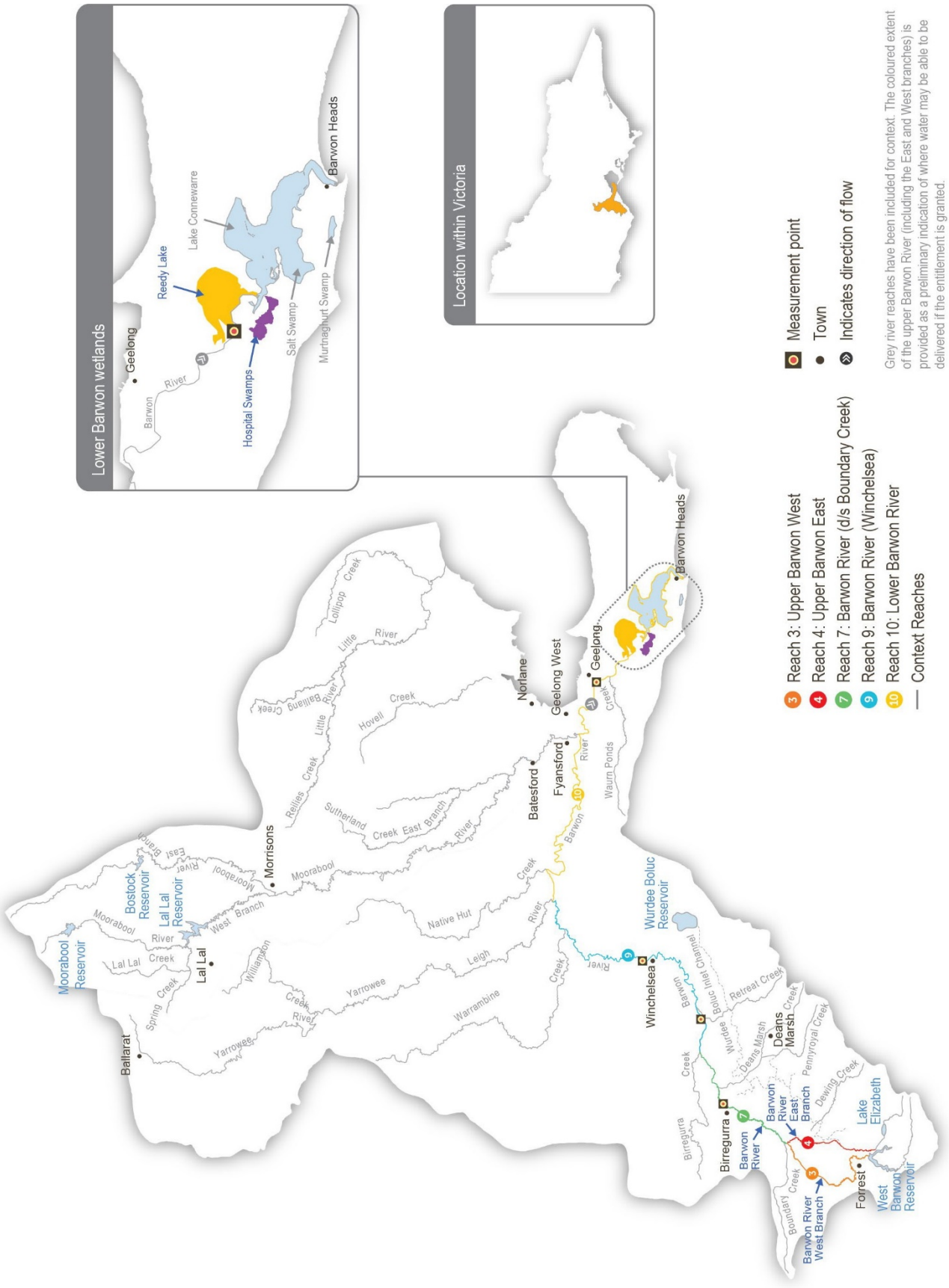
Figure 3.7.1 The Barwon system



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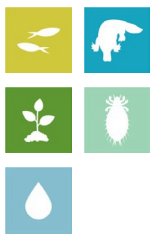
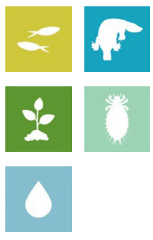
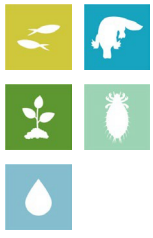
for the environment was used to maintain target summer/autumn low flows in the west branch when needed. Water for the environment was not delivered in the east branch during 2021-22.

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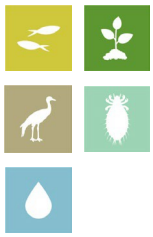
Table 3.7.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the lower Barwon wetlands

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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