Section 3

Central Region

3.1 Central Region overview

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

The landscape

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

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

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

Environmental values

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

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

Community considerations

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

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

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

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

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

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

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

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

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

Integrated catchment management

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

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

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

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

Seasonal outlook 2017–18

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

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

Yarra River and Princes Bridge, by Zarleen Blakeley

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

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

Environmental values

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

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

Social, cultural and economic values

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

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

Environmental watering objectives in the Yarra system

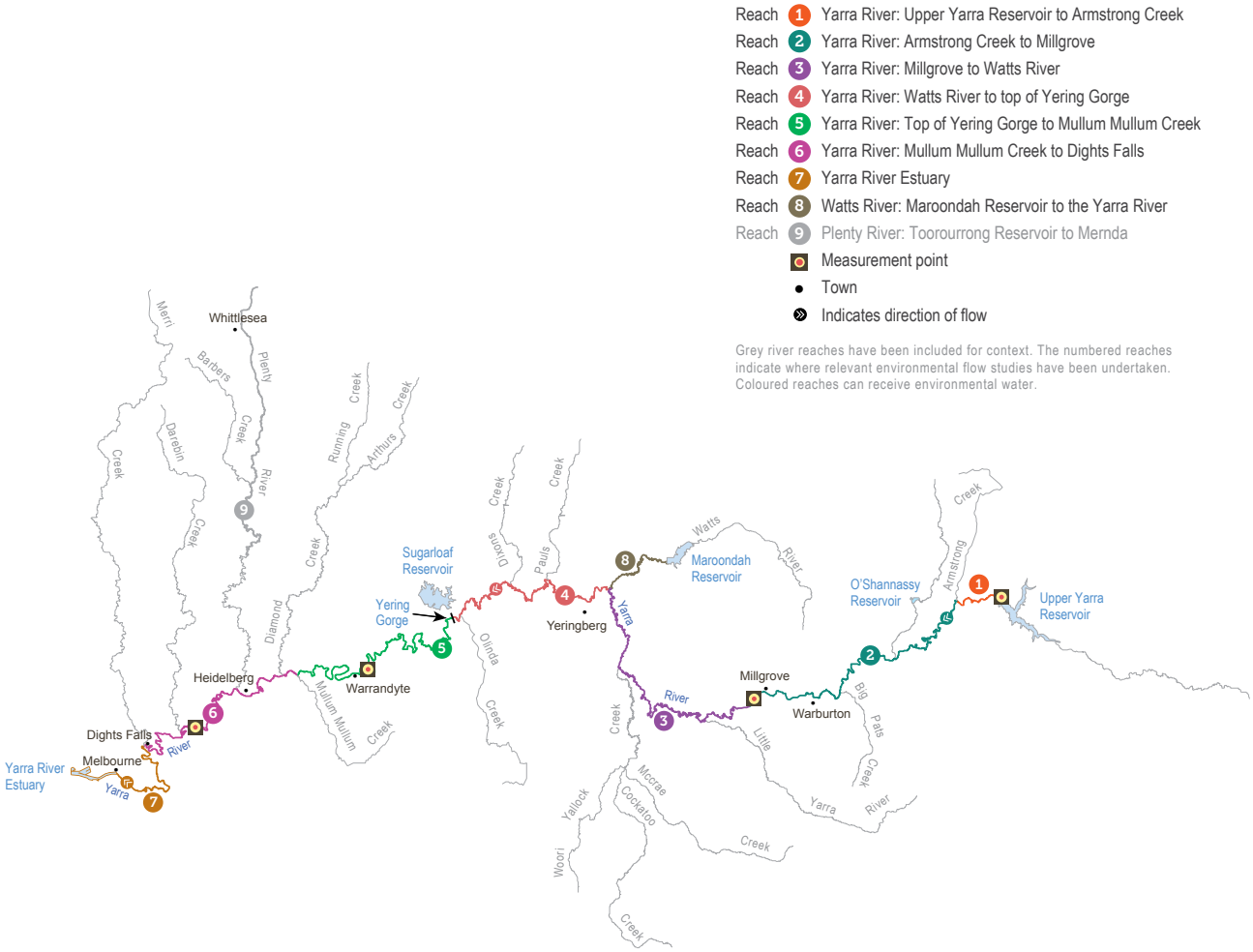
	Increase, strengthen and maintain plant life on the riverbank and in the channel, as well as on the upper Yarra floodplain and in the river's billabongs
	Protect and increase populations of native fish including threatened species (such as the Australian grayling and Macquarie perch)
	Maintain the form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

System overview

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

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

Figure 3.2.1 The Yarra system



Recent conditions

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

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

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

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

Scope of environmental watering

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

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

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

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

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

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

Scenario planning

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

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

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

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

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

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

Risk management

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

Engagement

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

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

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

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

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

3.3 Tarago system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

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

Environmental values

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

Social, cultural and economic values

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

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

Environmental watering objectives in the Tarago system

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

System overview

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

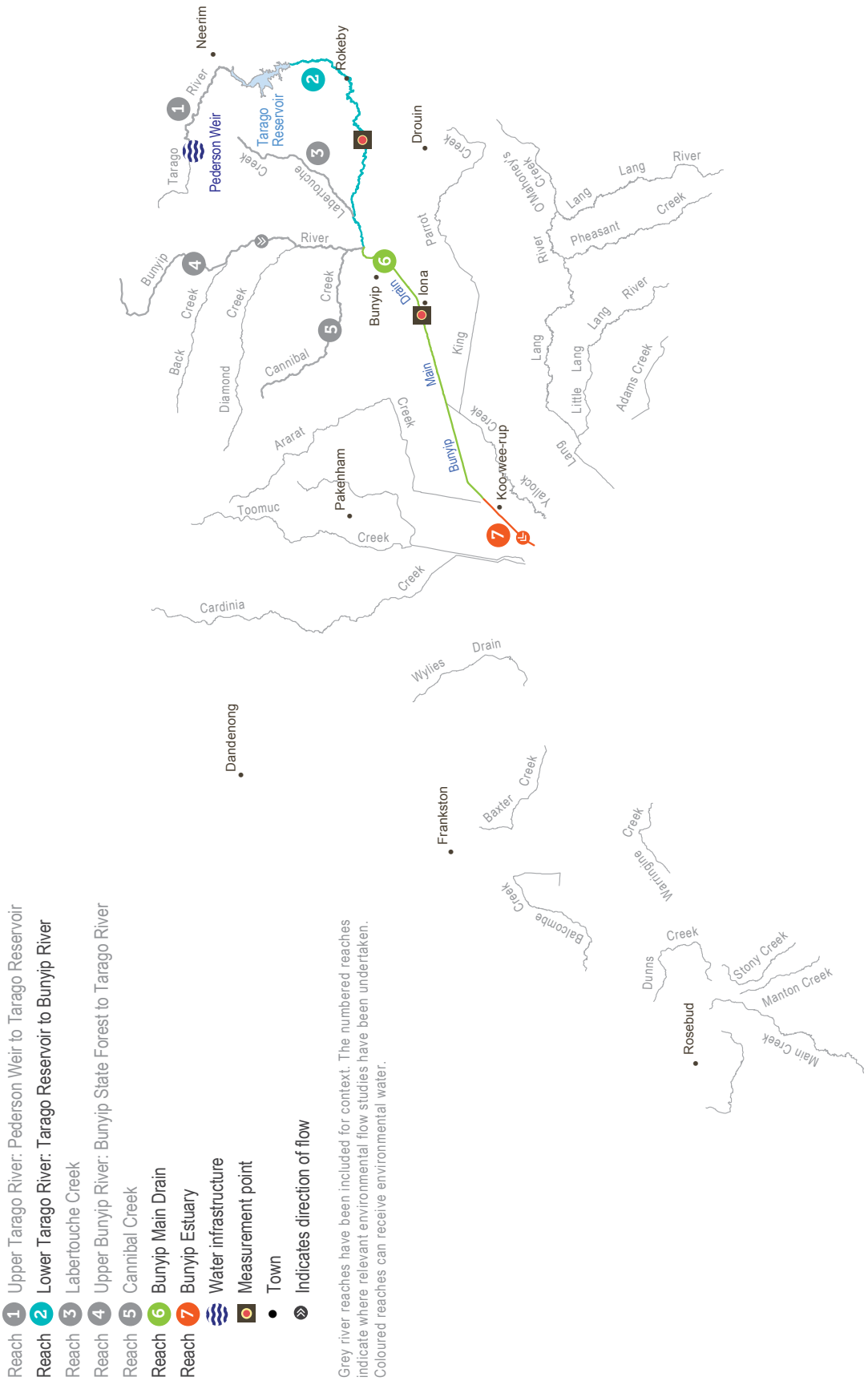
Recent conditions

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

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

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

Figure 3.3.1 The Tarago system



Scope of environmental watering

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

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

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

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

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

Scenario planning

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

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

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

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

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

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

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

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

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

Risk management

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

Engagement

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

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

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

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

3.4 Maribyrnong system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – N/A

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

Environmental values

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

Social, cultural and economic values

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

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

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

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

Environmental watering objectives in the Maribyrnong system

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

System overview

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

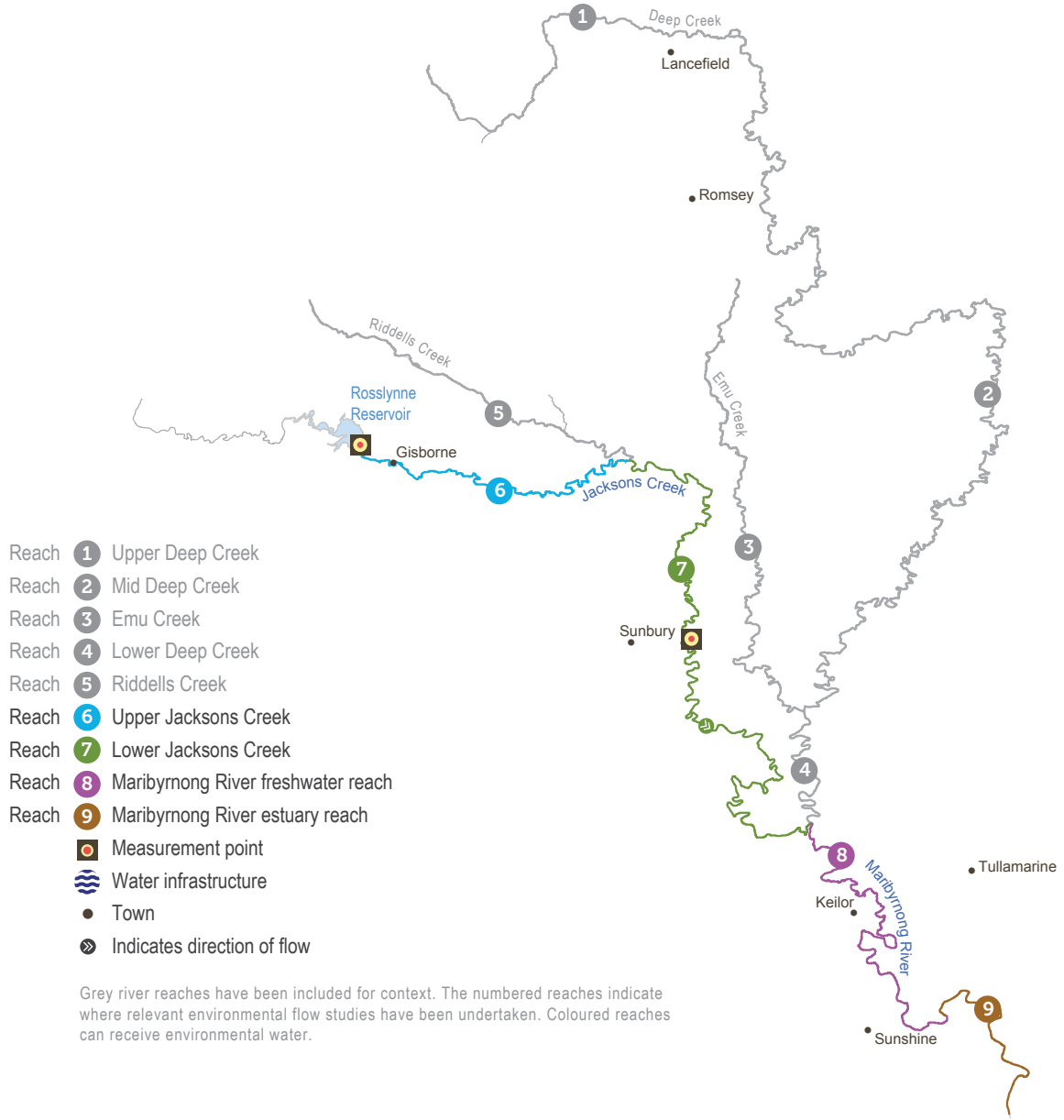
The VEWH does not hold an environmental entitlement in the Maribyrnong system and depends on temporary trade to meet demands. Over the past four years, Melbourne Water and the VEWH have worked with local diversion licence holders to purchase unused water that can then be delivered specifically for environmental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

Recent conditions

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

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

Figure 3.4.1 The Maribyrnong system



Scope of environmental watering

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

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

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

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

Scenario planning

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

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

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

Jacksons Creek at Sunbury, by Melbourne Water

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

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

Risk management

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

Engagement

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

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

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

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

3.5 Werribee system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

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

Environmental values

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

Social, cultural and economic values

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

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

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

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

Environmental watering objectives in the Werribee system

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

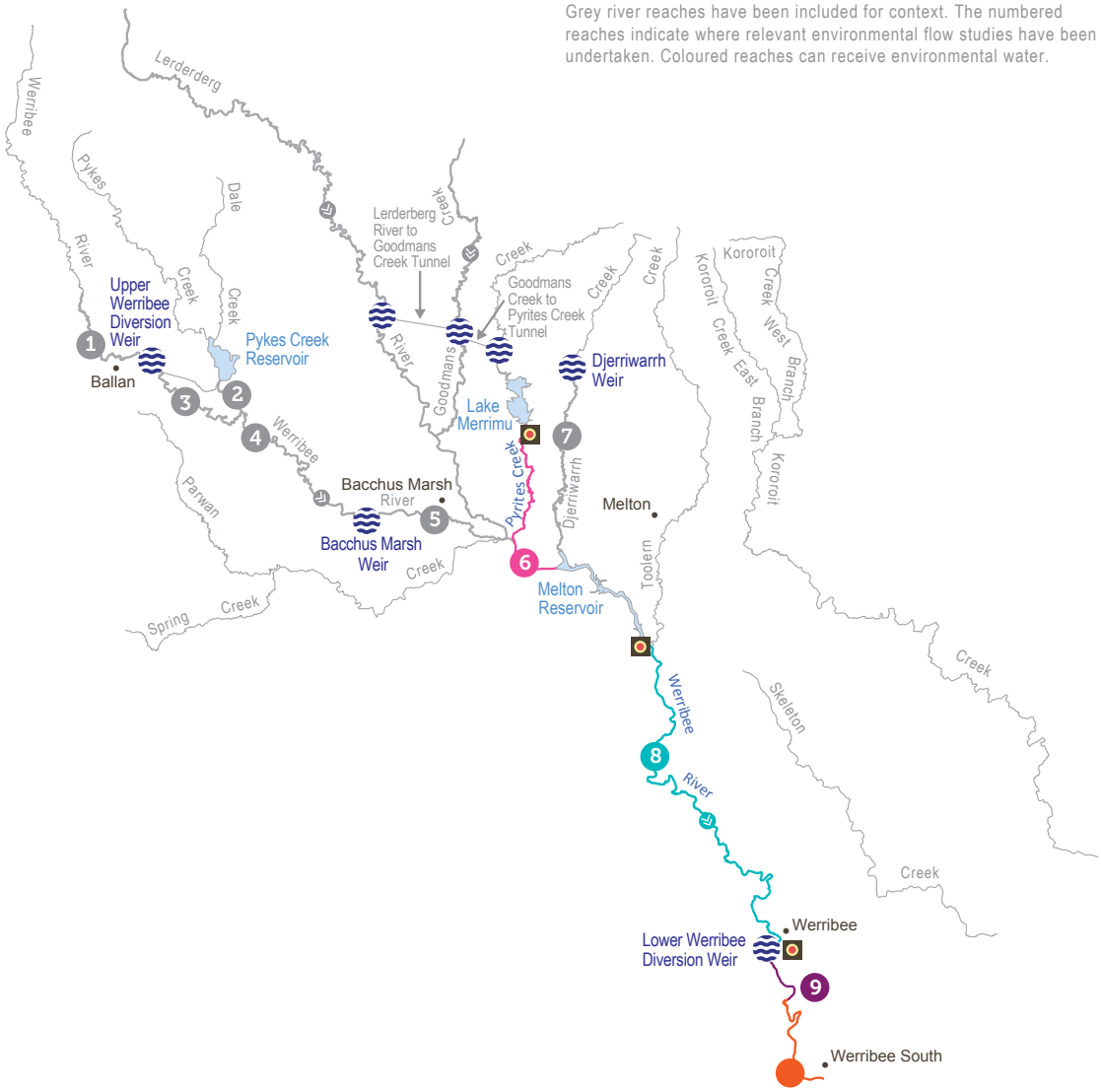
System overview

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

Figure 3.5.1 The Werribee system

Reach 1 Werribee River: Upstream of Upper Werribee Diversion Weir
Reach 2 Pykes Creek: Pykes Creek Reservoir to Werribee River
Reach 3 Werribee River: Upper Werribee Diversion Weir to Pykes Creek
Reach 4 Werribee River: Pykes Creek to Bacchus Marsh Weir
Reach 5 Werribee River: Bacchus Marsh Weir to Lerderderg River
Reach 6 Pyrites Creek: below Lake Merrimu to Melton Reservoir
Reach 7 Djerriwarrh Creek: below Djerriwarrh Weir to Melton Reservoir
Reach 8 Werribee River: Melton Reservoir to Lower Werribee Diversion Weir
Reach 9 Werribee River: Lower Werribee Diversion Weir to estuary
Reach Werribee Estuary
Measurement point
Water infrastructure
Town
Indicates direction of flow

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



Recent conditions

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

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

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

Scope of environmental watering

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

Werribee River after environmental watering, by Melbourne Water

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

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

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

Scenario planning

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

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

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

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

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

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

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

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

Risk management

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

Engagement

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

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

Werribee River, by Erin Round

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

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

3.6 Moorabool system

Waterway manager – Corangamite Catchment Management Authority

Storage operator – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder

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

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

Environmental values

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

Social, cultural and economic values

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

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

Environmental watering objectives in the Moorabool system

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

System overview

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

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

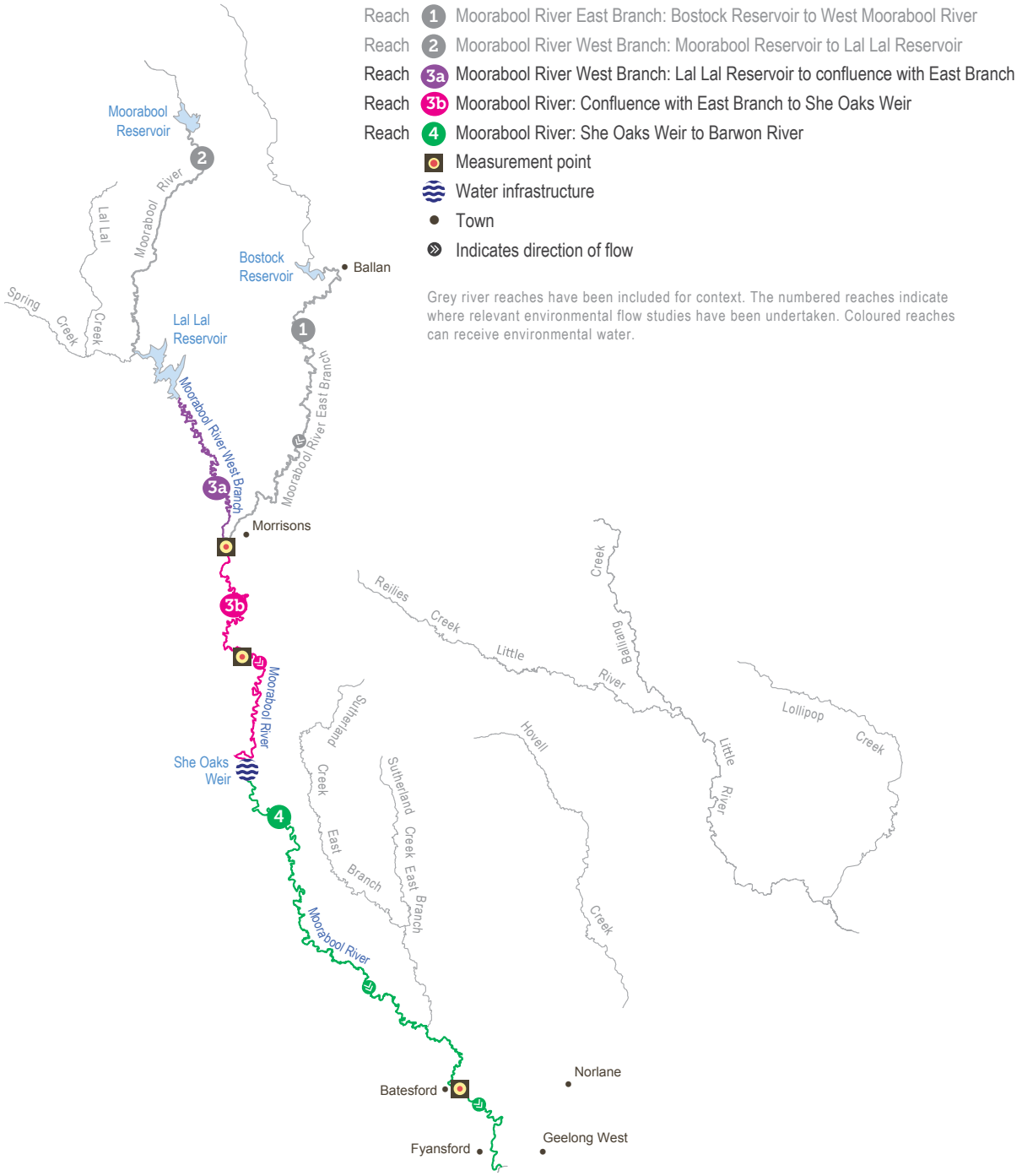
Water allocated to the Moorabool River environmental entitlement is stored in Lal Lal Reservoir and includes passing flows that help maintain flows in the river. Passing flows are a significant component of annual streamflow and are important in maintaining baseflows through winter. The priority reaches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

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

Recent conditions

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

Figure 3.6.1 The Moorabool system



Scope of environmental watering

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

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

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

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

Scenario planning

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

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

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

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

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

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

Risk management

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

Engagement

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

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

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

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

3.7 Barwon system

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

3.7.1 Upper Barwon River

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

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

3.7.2 Lower Barwon wetlands

Waterway manager – Corangamite Catchment Management Authority

Environmental water holder – Victorian Environmental Water Holder

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

Environmental values

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

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

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

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

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

Social, cultural and economic values

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

Environmental watering objectives in the lower Barwon wetlands

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

System overview

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

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

Recent conditions

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

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

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

Scope of environmental watering in 2017–18

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

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

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

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

Figure 3.7.1 The lower Barwon wetlands

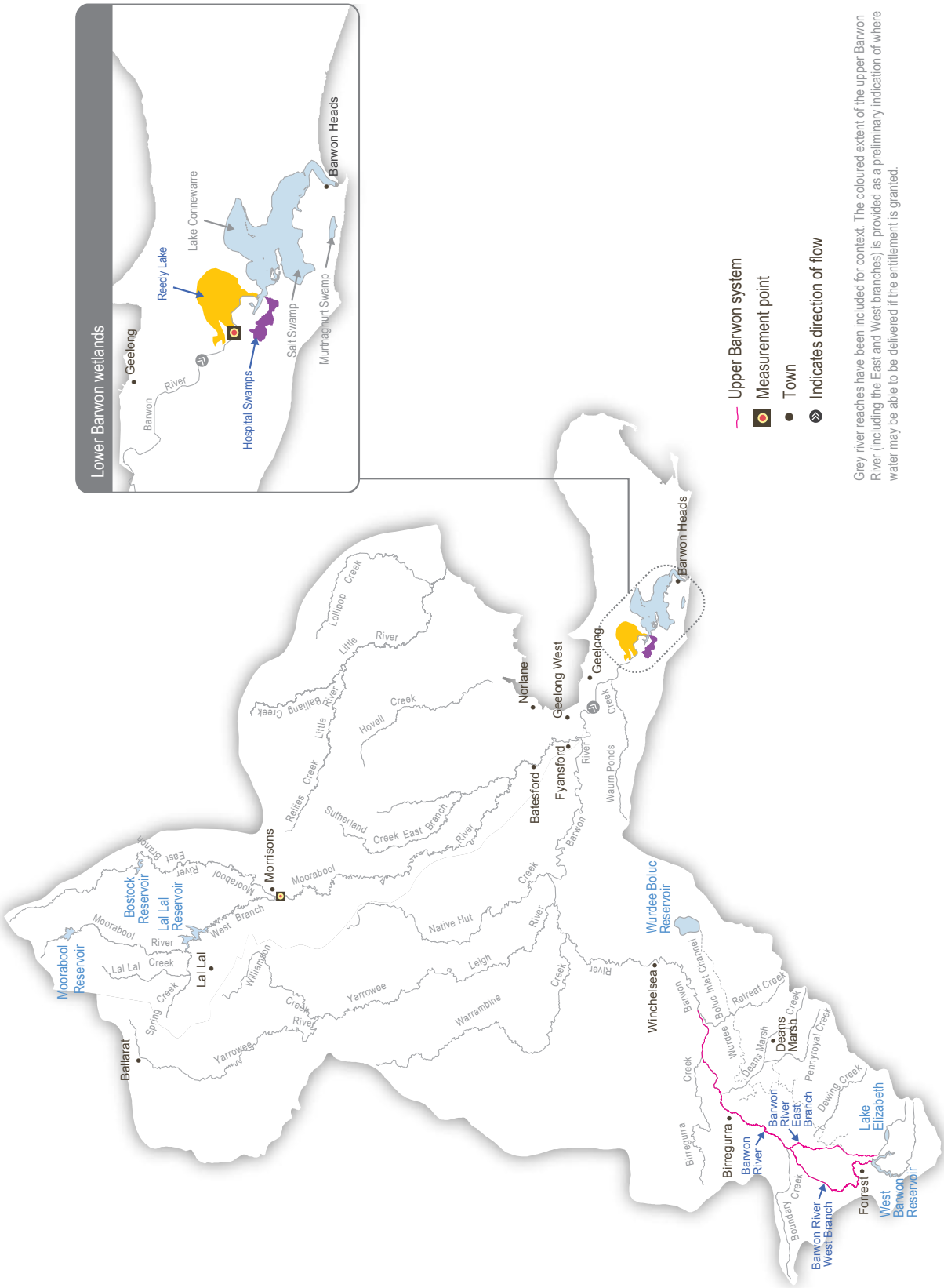


Table 3.7.1 Potential environmental watering actions and objectives for the lower Barwon wetlands

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

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

Scenario planning

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

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

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

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

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

Risk management

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

Engagement

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

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

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

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

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