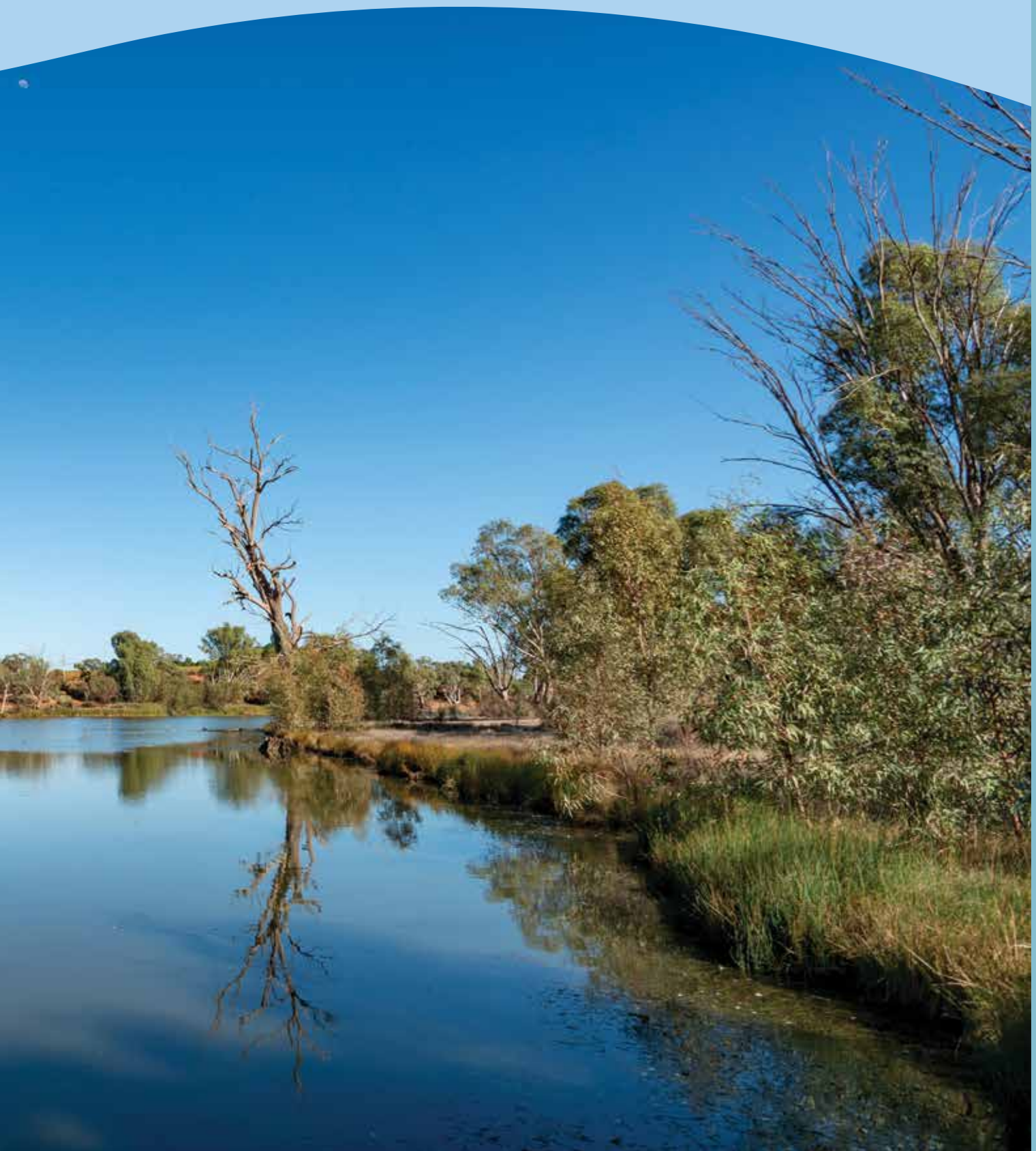
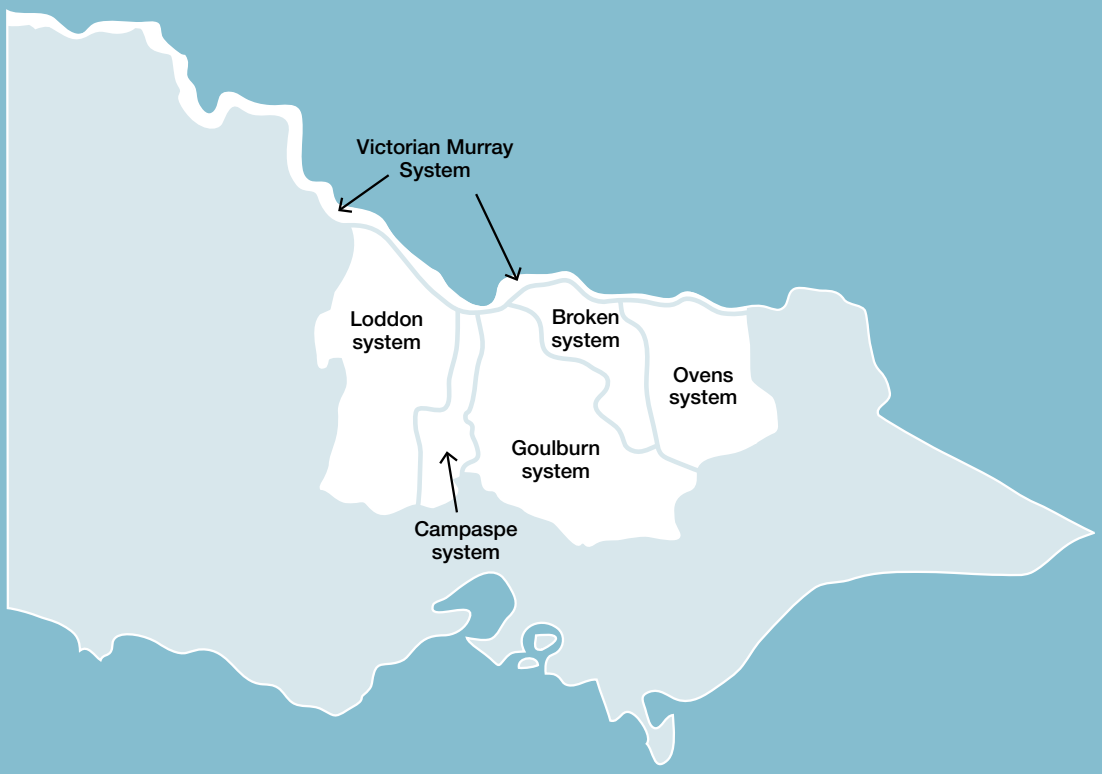
Cowanna Billabong, by Mallee CMA

Section 5

Northern region





5.1 Northern region overview

The northern region has six river systems, four major floodplain sites and many wetlands that can receive water for the environment. The Broken, Campaspe, Goulburn, Loddon and Ovens river systems are tributaries of the Murray River. The four major floodplain sites along the Murray River corridor are Barmah Forest, Gunbower Forest, Hattah Lakes and Lindsay, Mulcra and Wallpolla islands. The other wetlands are distributed across the Broken, Goulburn, Loddon and Murray floodplains. The rivers and wetlands in the northern region are managed by the North East, Goulburn Broken, North Central and Mallee CMAs.

Many of the water systems in the northern region are connected through infrastructure (such as Goulburn Weir and the Waranga Western Channel), which allows water to be physically delivered from the Goulburn River to the Loddon and Campaspe systems. Water trading also enables transfers of allocation between systems. Within the limitations of each mechanism, water for the environment can be moved between systems for delivery to environmental sites across northern Victoria, although most water for the environment is used to provide benefits in the systems in which the water is held.

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

Traditional Owners in the northern region

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

The Traditional Owner groups in and around northern Victoria include Barapa Barapa, Dhudhuroa, Latji Latji, Ngintait, Nyeri Nyeri, Taungurung, Tati Tati, Wadi Wadi, Wamba Wemba, Waywurru, Weki Weki, Yorta Yorta and Yaithmathang. The Dja Dja Wurrung Clans Aboriginal Corporation, First People of the Millewa-Mallee Aboriginal Corporation (representing Latji Latji, Nyeri Nyeri, Ngintait and Wergaia), Taungurung Land and Waters Council Aboriginal Corporation and Yorta Yorta Nation Aboriginal Corporation are Registered Aboriginal Parties under the *Aboriginal Heritage Act 2006*.

There are several formal agreements in place with Traditional Owners in the northern region.

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

In 2004, the Victorian Government entered into a cooperative management agreement with the Yorta Yorta to improve collaboration in the management of their Country including Barmah State Forest and reserves along the Goulburn River.

In 2010 the Yorta Yorta Nation Aboriginal Corporation and the State of Victoria entered into a Traditional Owner Land Management Agreement under the *Conservation, Forests and Lands Act 1987* over Barmah National Park. This established the Yorta Yorta Traditional Owner Land Management Board to jointly manage Barmah National Park.

In 2018, the Victorian Government, the Taungurung Clans Aboriginal Corporation and the Taungurung Traditional Owner group signed agreements under the *Traditional Owner Settlement Act 2010* and related legislation.

Engagement

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

The International Association for Public Participation's Public Participation Spectrum (IAP2 Spectrum) has been used to categorise the levels of participation of stakeholders involved in the environmental watering planning process. Table 5.1.1 shows the IAP2 Spectrum categories and participation goals.

Table 5.1.1 International Association for Public Participation's Public Participation Spectrum categories and participation goals[1]

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

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

Table 5.1.2 shows the partners, stakeholder organisations and individuals with which Goulburn Broken, North Central, North East and Mallee CMAs engaged when preparing seasonal watering proposals. This includes engagement conducted as part of developing the seasonal watering proposals as well as engagement during the preparation of key foundational documents that directly informed the proposals. VEWH staff were also consulted for operational information as part of the development of all annual seasonal watering proposals by CMAs.

The table also shows the level of engagement between Goulburn Broken, North Central, North East and Mallee CMAs and stakeholders of the environmental watering program in the northern region based on the CMAs' interpretation of the IAP2 Spectrum. The NSW Department of Planning, Industry and Environment also undertakes engagement in the development of the seasonal watering proposal for Barmah-Millewa in NSW, which is not included in Table 5.1.2.

The level of engagement differs between organisations and between systems, depending on the availability, capacity or interest of stakeholders to participate, roles and responsibilities of organisations in managing a site or system, and potential interaction of proposed watering with other activities on the waterway. For example, Moira Shire Council is one of two land managers for Kinnairds Wetland in the Goulburn and Broken wetlands systems, so Goulburn Broken CMA engages with them at a higher level than it does for other local councils in areas that receive environmental flows but do not have direct responsibilities.

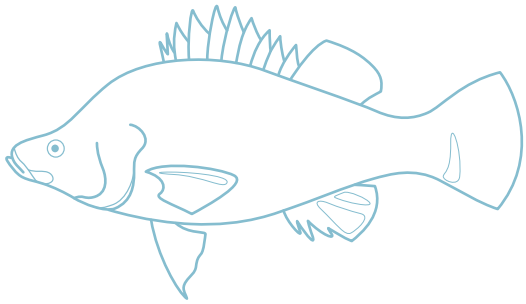


Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken CMA in developing seasonal watering proposals for the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek and lower Broken Creek systems and other key foundation documents that have directly informed the proposals

	Barmah Forest	Goulburn River	Goulburn wetlands and Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
Community groups and environment groups	**IAP2 level: Inform** • Goulburn Murray Landcare Network • Turtles Australia	**IAP2 level: Consult** • Goulburn Valley Environment Group	**IAP2 level: Consult** • BirdLife Australia – Murray Goulburn • Goulburn Murray Landcare Network • Kinnairds Wetland Advisory Committee • Turtles Australia	**IAP2 level: Consult** • Goulburn Valley Environment Group	**IAP2 level: Consult** • Goulburn Valley Environment Group
					IAP2 level: Inform • Broken Boosey Conservation Management Network • Broken Creek Field Naturalists Club • Goulburn Murray Landcare Network
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Parks Victoria • Murray-Darling Basin Authority (the Living Murray program)	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Murray-Darling Basin Authority (the Living Murray program) • Parks Victoria	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning (Land Manger, Environmental Water) • Goulburn-Murray Water (River Operations Planning, Diversions) • Greater Shepparton City Council • Moira Shire Council • Parks Victoria	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Parks Victoria	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water • Parks Victoria

Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken CMA in developing seasonal watering proposals for the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek and lower Broken Creek systems and other key foundation documents that have directly informed the proposals *(continued)*

	Barmah Forest	Goulburn River	Goulburn wetlands and Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
					IAP2 level: Inform • Moira Shire Council
Landholders/ farmers		**IAP2 level: Consult** • Individual landholders who are on the Goulburn Environmental Water Advisory Group	**IAP2 level: Consult** • Landholders	**IAP2 level: Consult** • Individual landholders who are on the Broken Environmental Water Advisory Group	**IAP2 level: Consult** • Individual landholders who are on the Broken Environmental Water Advisory Group
Local businesses	**IAP2 level: Consult** • Trellys Fishing and Hunting	**IAP2 level: Consult** • Local tourism operator • Trellys Fishing and Hunting	**IAP2 level: Consult** • Trellys Fishing and Hunting		
Recreational users	**IAP2 level: Consult** • Field and Game		**IAP2 level: Consult** • Field and Game		**IAP2 level: Consult** • EWAG members
					IAP2 level: Inform • Nathalia and Numurkah angling clubs
Technical experts		**IAP2 level: Consult** • Scientific leads from the CEWO Monitoring, Evaluation and Research Program – Goulburn River	**IAP2 level: Collaborate** • Goulburn Broken Wetlands Technical Reference Group (Waters Edge Consulting, Rakali Consulting, staff of Arthur Rylah Institute, from the Department of Environment, Land, Water and Planning)		

Table 5.1.2 Partners and stakeholders engaged by Goulburn Broken CMA in developing seasonal watering proposals for the Barmah Forest, Goulburn River, Goulburn wetlands and Broken wetlands, Broken River and upper Broken Creek and lower Broken Creek systems and other key foundation documents that have directly informed the proposals *(continued)*

	Barmah Forest	Goulburn River	Goulburn wetlands and Broken wetlands	Broken River and upper Broken Creek	Lower Broken Creek
Traditional Owners	**IAP2 level: Collaborate** • Yorta Yorta Nations Aboriginal Corporation	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land and Waters Council	**IAP2 level: Consult** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council
	IAP2 level: Consult • Taungurung Land & Waters Council				

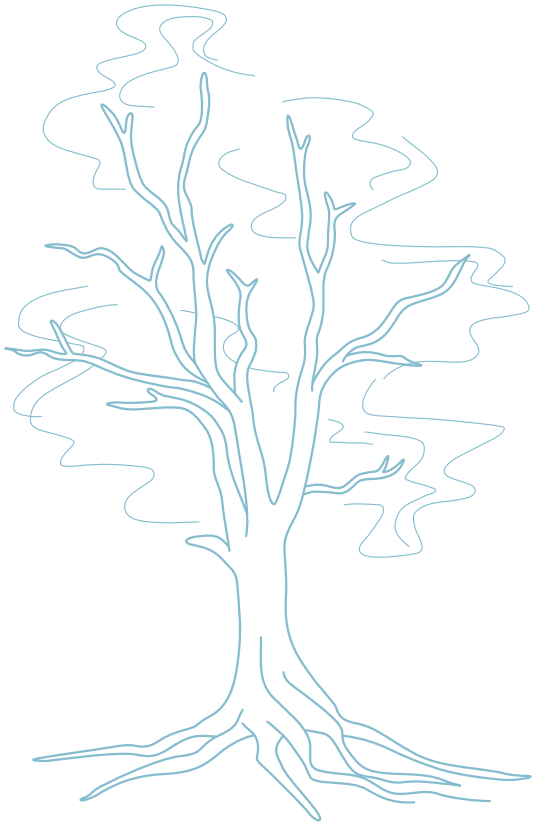


Table 5.1.3 Partners and stakeholders engaged by Mallee CMA in developing seasonal watering proposals for the Hattah Lakes, Lower Murray wetlands, Lindsay, Mulcra and Wallpolla islands systems and other key foundation documents that have directly informed the proposals

	Hattah Lakes	Lower Murray wetlands	Lindsay, Mulcra and Wallpolla islands
Community groups and environment groups	**IAP2 level: Inform** • Local Landcare groups • Mid-Murray Field Naturalists	**IAP2 level: Inform** • Cabarita Inc. • Community members on the Mallee CMA Land and Water Advisory Committee • Local Landcare groups • Mid-Murray Field Naturalists	**IAP2 level: Inform** • OzFish Unlimited • Community members on the Mallee CMA Land and Water Advisory Committee • Local Landcare groups
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Murray-Darling Basin Authority (the Living Murray program) • Parks Victoria	**IAP2 level: Collaborate** • Goulburn-Murray Water • Parks Victoria	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Murray-Darling Basin Authority (the Living Murray program) • NSW Department of Planning Industry and Environment • Parks Victoria • SA Water
	IAP2 level: Consult • Goulburn-Murray Water		
	IAP2 level: Inform • Department of Environment Land, Water and Planning (Fire Forest and Regions) • Department of Environment Land, Water and Planning (Water and Catchments) • Mildura Rural City Council	**IAP2 level: Inform** • Department of Environment Land, Water and Planning (Fire Forest and Regions) • Department of Environment Land, Water and Planning (Water and Catchments) • Lower Murray Water • Loddon Mallee Waste and Resource Recovery Group • Mildura Rural City Council • Swan Hill Rural City Council	**IAP2 level: Inform** • Department of Environment Land, Water and Planning (Fire Forest and Regions) • Department of Environment Land, Water and Planning (Water and Catchments) • Lower Murray Water • Mildura Rural City Council • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Inform** • Landholders and farmers who live around the Hattah Lakes	**IAP2 level: Collaborate** • Trust for Nature • Local landowner	**IAP2 level: Consult** • Neighbouring landholder
			IAP2 level: Inform • Lindsay Point irrigators
Local businesses	**IAP2 level: Inform** • Hattah Store owners	**IAP2 level: Inform** • Sunraysia Apiarist Association • Mallee Tours • Murray Offroad Adventures • Visit Mildura • Wildside Outdoors	**IAP2 level: Inform** • Mallee Tours • Murray Offroad Adventures • Wild Side Outdoors • Sunraysia Apiarist Association
	IAP2 level: Inform • Mallee Tours • Murray Offroad Adventures • Mildura Information Centre • Visit Mildura • Wild Side Outdoors • Sunrasia Apiarist Association		

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

	Hattah Lakes	Lower Murray wetlands	Lindsay, Mulcra and Wallpolla islands
Recreational users	**IAP2 level: Inform** • Birdlife Mildura • Sunraysia Bushwalkers • Four-wheel drive club	**IAP2 level: Inform** • Birdlife Mildura • Four-wheel drive club • Mildura Information Centre • Sunraysia Bushwalkers	**IAP2 level: Inform** • Birdlife Mildura • Sunraysia Bushwalkers • Sunraysia 4WD Club **IAP2 level: Inform** • Mildura Information Centre • Visit Mildura
Technical experts	**IAP2 level: Collaborate** • Mallee CMA Land and Water Advisory Committee	**IAP2 level: Collaborate** • Mallee CMA Land and Water Advisory Committee • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Collaborate** • Mallee CMA Land and Water Advisory Committee
Traditional Owners	**IAP2 level:** • CollaborateTraditional Owners of Hattah Lake (Aboriginal Victorians from Wadi Wadi, Tati Tati, Latje Latje and Munutunga)	**IAP2 level: Collaborate** • Robinvale Elders and communties • First People of the Millewa-Mallee Aboriginal Corporation	**IAP2 level: Collaborate** • Traditional owners of Lindsay-Mulcra-Wallpolla • First People of the Millewa-Mallee Aboriginal Corporation

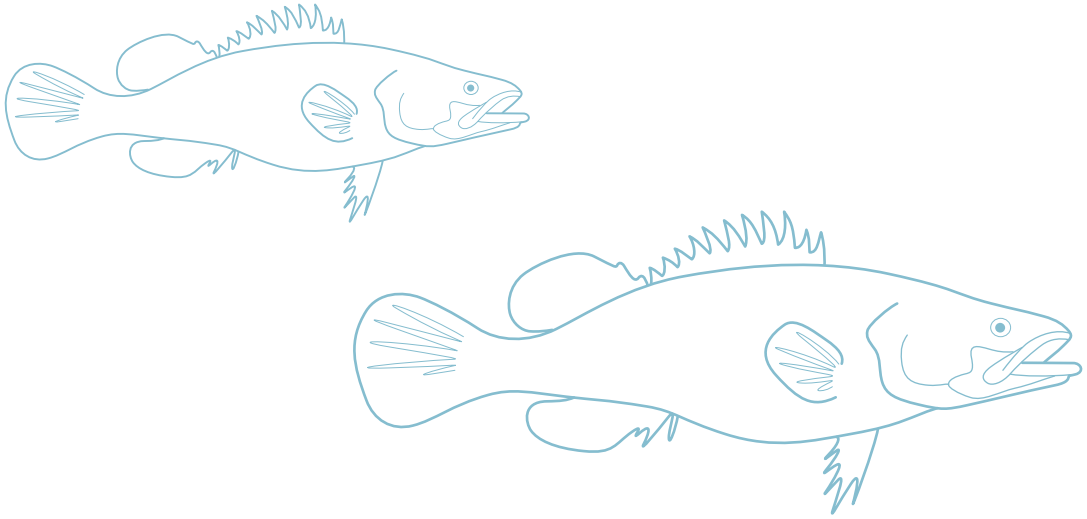


Table 5.1.4 Partners and stakeholders engaged by North Central CMA in developing seasonal watering proposals for the Gunbower Creek and Forest, Central Murray wetlands and Boort wetlands, Campaspe River, Coliban River, Loddon River, Birchs Creek and Guttrum Forest systems and other key foundation documents that have directly informed the proposals

	Gunbower Creek and Forest	Central Murray wetlands and Boort wetlands	Campaspe River	Coliban River	Loddon River	Birchs Creek	Guttrum Forest
Community groups and environment groups	**IAP2 level: Consult** • Gunbower Island Community Reference Group	**IAP2 level: Inform** • Birdlife Australia • BirdLife Australia	**IAP2 level: Inform** • Echuca Moama Landcare Group • Strathallan Family Landcare Group				
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Murray-Darling Basin Authority (the Living Murray program and River Operations) • Forestry Corporation of NSW • Parks Victoria • Vic Forests	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Parks Victoria	**IAP2 level: Collaborate:** • Commonwealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Coliban Water • Commonwealth Environmental Water Office	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water	**IAP2 level: Collaborate** • Goulburn-Murray Water	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Goulburn-Murray Water • Murray-Darling Basin Authority • Forestry Corporation of NSW • Parks Victoria • Vic Forests

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

	Gunbower Creek and Forest	Central Murray wetlands and Boort wetlands	Campaspe River	Coliban River	Loddon River	Birchs Creek	Guttrum Forest
Government agencies *(continued)*	**IAP2 level: Inform** • Gannawarra Shire Council • Campaspe Shire Council	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager) • Gannawarra Shire Council • Campaspe Shire Council • Swan Hill Rural City Council • Loddon Shire Council	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager) • Game Management Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager) • Game Management Authority	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager)	**IAP2 level: Inform** • Department of Environment, Land, Water and Planning (land manager)	
Landholders/ farmers	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Inform** • Individual landholders and community members	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Inform** • Individual Landholders and community members	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Consult** • Individual landholders	**IAP2 level: Inform** • Individual landholders
Local businesses	**IAP2 level: Inform** • Forestry					**IAP2 level: Inform** • Central Highlands Water	**IAP2 level: Inform** • Forestry
Recreational users	**IAP2 level: Inform** • Field and Game Australia • Gateway to Gannawarra Visitor centre	**IAP2 level: Inform** • Field and Game Australia • Gateway to Gannawarra Visitor centre	**IAP2 level: Inform** • VRFish • Local Canoe Clubs	**IAP2 level: Inform** • VRFish	**IAP2 level: Consult** • VRFish • Field and Game Australia		
Technical experts	**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists	**IAP2 level: Consult** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Contracted ecologists	**IAP2 level: Collaborate** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)				**IAP2 level: Collaborate** • Vegetation, fish and bird ecologists

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

	Gunbower Creek and Forest	Central Murray wetlands and Boort wetlands	Campaspe River	Coliban River	Loddon River	Birchs Creek	Guttrum Forest
Traditional Owners	**IAP2 level: Collaborate** • Yorta Yorta Nation Aboriginal Corporation • Barapa Barapa Traditional Owners	**IAP2 level: Collaborate** • Dja Dja Wurrung Clans Aboriginal Corporation • Yorta Yorta Nation Aboriginal Corporation • Barapa Barapa Traditional Owners • Wemba Wemba Traditional Owners	**IAP2 level: Collaborate** • Dja Dja Wurrung Clans Aboriginal Corporation • Taungurung Land & Waters Council • Yorta Yorta Nation Aboriginal Corporation	**IAP2 level: Consult** • Dja Dja Wurrung Clans Aboriginal Corporation	**IAP2 level: Collaborate** • Dja Dja Wurrung Clans Aboriginal Corporation • Barapa Barapa Traditional Owners • Wemba Wemba Traditional Owners		**IAP2 level: Collaborate** • Barapa Barapa Traditional Owners • Wamba Wemba Traditional Owners

Table 5.1.5 Partners and stakeholders engaged by North East CMA in developing the seasonal watering proposal for the Ovens system and other key foundation documents that have directly informed the proposal

	Ovens system
Community groups and environment groups	**IAP2 level: Collaborate** • Wangaratta Landcare and Sustainability Incorporated
Government agencies	**IAP2 level: Collaborate** • Commonwealth Environmental Water Office • Goulburn-Murray Water
	IAP2 level: Involve • City of Wangaratta • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Collaborate** • Catholic Education Department – Sandhurst Diocese
Technical experts	**IAP2 level: Involve** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Involve** • Yorta Yorta Nation Aboriginal Corporation • Taungurung Land & Waters Council

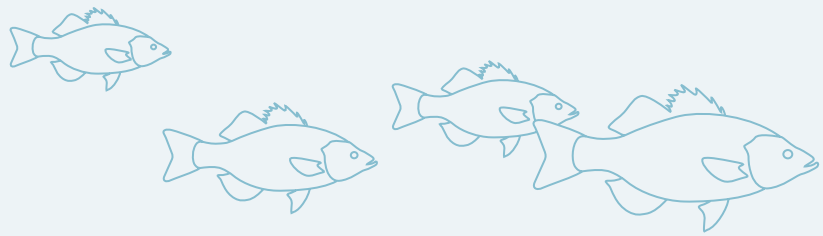
Community benefits from environmental watering

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

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

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

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



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

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

- supporting the Barapa Barapa Wamba Wemba Water for Country project, where Barapa Barapa people, Wamba Wemba people and North Central CMA work together to involve Traditional Owners in the planning, monitoring and reporting of watering in Guttrum Forest, Gunbower Forest and Gunbower Creek
- supporting restoration of significant floodplain sites with the First People of the Millewa-Mallee and other Traditional Owner groups across the lower Murray region
- supporting Taungurung Traditional Owners to achieve ecological goals as part of healing Country, including potentially using Taungurung water entitlements to deliver environmental flows in the King River
- ongoing work by Yorta Yorta Traditional Owners and Goulburn Broken CMA to incorporate Yorta Yorta values into environmental water planning in Barmah Forest and other sites across Yorta Yorta Country.

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

Traditional Owners' cultural values and uses are also increasingly considered as part of Murray-Darling Basin Plan annual environmental water planning and management. The Murray Lower Darling Rivers Indigenous Nations have been working on the First Nations Environmental Water Guidance Project to support Nations to identify objectives, priorities and issues related to environmental watering and support increased participation in environmental water planning and management. The project was undertaken with support from Murray Darling Basin Authority and the Commonwealth Environmental Water Office.

A statement prepared by the Murray Lower Darling Rivers Indigenous Nations summarising the participating Nations' priorities for environmental watering in the southern Murray Darling Basin in 2020–21 is provided on page 190. This work has informed development of annual environmental water priorities at the Basin-scale and will support decision making as the year progresses.

The VEWH and its program partners will look for opportunities to continue strengthening the partnerships with and participation of Traditional Owners in environmental water planning and management in Victoria in ways that can support their objectives, cultural values and connection to Country. Through its role in the Southern Connected Basin Environmental Watering Committee, the VEWH will also support the environmental watering priorities and aspirations of Nations in the broader southern Murray-Darling Basin.

Southern Basin First Nations Environmental Watering Priorities Statement 2020-21

Representatives of sixteen First Nations across the Southern Murray Darling Basin have made information about their priorities for the use of environmental water in 2020–21 available, as part of the First Nations Environmental Water Guidance project.

First Nations share common concern for all major rivers across the region. Notably, multiple Nations submitted priorities relating to the Murrumbidgee, Baaka (Darling River), Lachlan, Campaspe, Murray and Edwards-Wakool systems. First Nations understand that declining river health and low-flows in one part of the Basin can affect communities and cultural outcomes across the region.

Nations want to see improvements in water quality and the volume and timing of flows in all major rivers, and particularly in degraded river systems. Improved seasonality of flows, informed by First Nations' science and traditional knowledge, is a key to sustaining the cultural health of major waterways. Addressing barriers and constraints, such as barriers to fish movement, is essential to sustain the interconnectivity, which underpins our stories and cultural values. Improving the health of tributary waterways and ensuring adequate flows, is also a key to revitalising major rivers. Nations recognise that Basin Plan targets for environmental water recovery are inadequate to support revival of the ecological and cultural health of our waterways. More must be done to restore the balance.

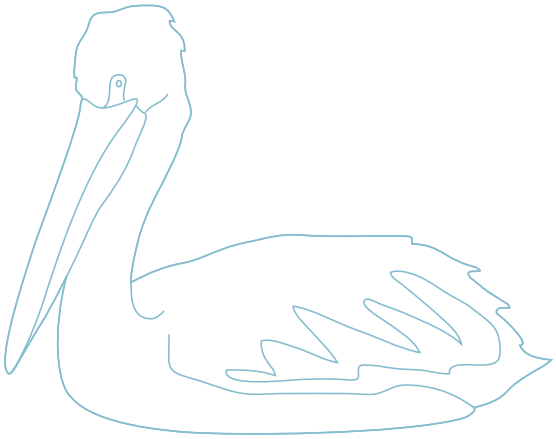
Participating Nations' contributions stressed the significance of wetlands, billabongs and floodplains. Nations want to see life return to these culturally significant places through watering activities that create connectivity between rivers and floodplains and restore the hydrological cycles of degraded wetlands, thereby supporting cultural values and resources.

Participating Nations identified key plant and animal species that are most in need of watering in the 2020–21 watering year. These species are all of totemic significance to diverse clans and Nations. Key culturally significant fish such as Murray cod, golden perch (yellowbelly) and catfish were identified as priorities by most Nations. More than half of all contributing Nations highlighted black swans, pelicans and duck species as culturally significant waterbirds that would benefit from environmental watering. Improved health and abundance of old man weed and other medicinal plants were noted as priorities for vegetation, alongside improved outcomes for river red gums, black box, cumbungi and lignum.

Critically, Nations stressed the importance of considering outcomes beyond fish, waterbirds and vegetation. Nations also want to see improved outcomes for aquatic fauna such as turtles, yabbies, mussels, frogs, platypus and rakali (water rat). The contributions also stressed the importance of environmental watering in sustaining healthy populations of important terrestrial fauna such as kangaroo and emu.

Participating Nations have identified a range of key threats to the cultural health of waterways as well as preferences for improved participation in environmental water planning for 2020–21. Water holders should consider these preferences alongside the detailed, locally specific watering objectives produced by Nations. It is essential that water Holders continue, and strengthen, direct engagement with First Nations to empower our participation in environmental water planning and delivery.

Murray Lower Darling Rivers Indigenous Nations
First Nations Environmental Water Guidance Project



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

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

- supporting populations of native fish species for recreational fishing including 120,000 juvenile golden perch and silver perch that were released into Walpolla Horseshoe Lagoon by the Victorian Fisheries Authority in March 2020. Watering planned for the lagoon will support the rapid growth and survival of juvenile fish
- providing habitat for native fish including Murray cod, golden perch and freshwater catfish in the waterways around Lindsay Island. The island is popular with recreational anglers, with local anglers nominating Mullaroo Creek as the number-one location for fishing in their area
- enhancing opportunities for recreational anglers along the Loddon, Campaspe and Goulburn rivers by using environmental flows to trigger the migration of recreational fishing species into these waterways
- providing nesting material for vulnerable brolga in Gaynor Swamp by increasing the growth of aquatic plants. The presence of brolga attracts birdwatchers from around the region, the state and Australia
- notifying canoers and kayakers of upcoming environmental flows on the Campaspe River, enabling them to schedule trips to popular sites (such as Rocky Crossing).

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

Integrated catchment management

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

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

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

- the release of a strategic action plan for the protection of floodplain marshes in Barmah Forest, which identifies management actions addressing key threats to the delicate floodplain vegetation including removal of feral horses and other invasive animals and control of invasive plants. Parks Victoria and the Yorta Yorta Nations jointly manage Barmah National Park
- construction of fishways enabling fish passage through the Koondrook and Cohuna weirs in Gunbower Creek is planned for winter 2021. The fishways will provide migration opportunities for fish species (such as the iconic Murray cod)
- private land managers undertake vegetation management and carp removal actions at Mullinmur wetland on the Ovens River at Wangaratta. The rehabilitation works have enabled stocking of native catfish brood stock into the wetland, which will support future re-stocking efforts in the region
- manual removal of river red gum seedlings that are encroaching into open wetlands in Guttrum Forest to maintain areas of open-water habitat, which supports aquatic and mudflat plants and in turn provides habitat for a range of waterbird species.

For more information about integrated catchment management programs in the northern region, refer to the Goulburn Broken, Mallee, North Central and North East CMAs' regional catchment strategies and regional waterway strategies.

Risk management

During the development of the seasonal watering proposals for the northern region systems, environmental watering program partners held a workshop to assess risks associated with potential environmental watering actions for 2020–21 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

What is the Basin Plan 2012?

Northern Victoria is a part of the Murray-Darling Basin and deliveries of water for the environment in the northern region are subject to the requirements of the Basin Plan 2012, also known as the Murray-Darling Basin Plan or just the Basin Plan. The Murray-Darling Basin Authority (MDBA) developed the Basin Plan under the *Commonwealth Water Act 2007* and it became law in November 2012. The Basin Plan sets legal limits on the amount of water that can be taken from the Murray-Darling Basin's surface and groundwater resources. Chapter 8 of the Basin Plan sets out a high-level environmental watering plan, which defines environmental objectives to protect, restore and build the resilience of water-dependent ecosystems and their associated functions. The VEWH's environmental planning and delivery is consistent with the requirements of the Basin Plan. The potential environmental watering outlined in sections 4 and 5 of this seasonal watering plan fulfil Victoria's obligations to identify annual environmental watering priorities for Victoria's water resource areas under section 8.26 of the Basin Plan 2012.

What is River Murray Increased Flows (RMIF)?

River Murray Increased Flows (RMIF) is water for the environment that has been recovered as part of the Snowy Water Initiative, established in 2002 to address environmental impacts associated with the operation of the Snowy Mountains Scheme. RMIF is stored in Snowy Hydro Limited's storages and released to maintain and improve environmental values in the Murray River. RMIF becomes available when:

- Snowy Hydro Limited release more than their nominated annual release volume, as part of their power generation operations and/or
- environmental water managers request additional RMIF be made available when volumes in Murray River storages exceed specified limits.

The call for and use of RMIF are coordinated by the Southern Connected Basin Environmental Watering Committee, and they must be authorised by the VEWH and NSW Department of Primary Industry and Environment.

Northern Victoria and the southern Murray-Darling Basin

Rivers, creeks and floodplains in northern Victoria form part of the southern-connected Murray-Darling Basin. Water flows directly from the Victorian rivers and floodplains into the Murray River, which means that environmental flows delivered in northern Victorian systems can achieve ecological objectives at multiple sites throughout the Murray-Darling Basin. For example, water for the environment delivered in the Goulburn River flows into the Murray River and can be managed to ensure it flows all the way to the Lower Lakes and Coorong in South Australia (SA), providing environmental outcomes at Gunbower Forest, Hattah Lakes, Lindsay Island and the Chowilla floodplain along the way.

The *Basin Plan 2012 and the Basin-wide environmental watering strategy* (second edition, 2019) guide the long-term planning of water for the environment in the Murray-Darling Basin. Under the Basin Plan, environmental objectives are met by achieving outcomes for connectivity, native vegetation, waterbirds and native fish.

Objectives and outcomes under the Basin Plan reflect local site- and state-based objectives, though site-based objectives are often broader in scope and cover additional values (such as frogs, turtle, waterbugs and physical processes like sediment movement). Watering actions that support Basin Plan outcomes have significant benefits for many other species that rely on the surrounding landscape (such as squirrel gliders living along the lower Campaspe River or flocks of regent parrots moving into the Hattah Lakes floodplain after watering).

The VEWH coordinates its activities with other environmental water holders in northern Victoria, NSW and SA to achieve environmental outcomes at the southern-connected Murray-Darling Basin scale. Collaborative planning focuses on how upstream and downstream objectives align and how the broader operation of the Murray River system can help support environmental outcomes.

Environmental water holders are also increasingly considering the objectives and cultural values of First Nations in the Murray-Darling Basin in alignment with environmental water objectives, outcomes and priorities (for further information see 'How are Traditional Owners' values and uses considered?' on pages 189 and 190). It is recognised that the health of the Murray-Darling Basin benefits from meaningful partnerships with Traditional Owners and their involvement in water planning, coordination and delivery from the local to the basin scale is a priority for environmental water holders.

Annual planning is documented in basin annual environmental watering priorities (by the MDBA under the Basin Plan), in annual portfolio management plans (by the Commonwealth Environmental Water Office), and in the VEWH's annual seasonal watering plan (this document). In Victoria, all water for the environment must be delivered in line with the VEWH's seasonal watering plan, meaning coordination during annual planning is fundamental to successful basin-scale outcomes.

Environmental water holders in the Murray-Darling Basin are placing an increased emphasis on coordinating water deliveries to achieve landscape-scale environmental outcomes. Examples include:

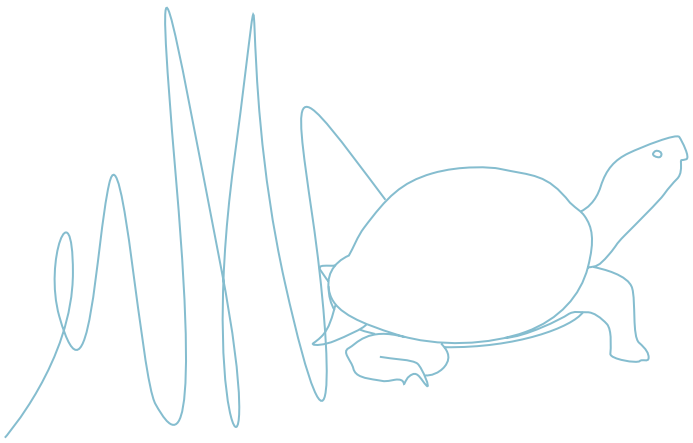
- delivering a winter fresh in the Goulburn River, which subsequently passed through to the Lower Lakes in SA and through the barrages to the Coorong to trigger upstream migration of fish (such as lamprey)
- efficient water use meant that all of the 12,700 ML delivered to Lake Kramen in the Hattah Lakes complex in 2019–20 were return flows from environmental watering actions in the Goulburn River. The same parcel of environmental water helped to meet environmental watering actions in the Goulburn River, Murray River and Lake Kramen. Moreover, the co-ordinated watering actions meant that carbon, nutrients, native plant seeds and native fish eggs and larvae were directly transported from upstream to downstream sites and from the river channel to the floodplain.

The VEWH holds Victorian environmental entitlements for water recovered under interstate projects and agreements — Living Murray and RMIF entitlements — and these require coordinated decision-making about where they are used. The primary objective of Living Murray entitlements is to support Murray icon sites, which include the Barmah Forest, Gunbower Forest, Hattah Lakes and the Lindsay–Mulcra–Wallpolla islands in Victoria. RMIF also support environmental objectives along the Murray system in Victoria, NSW and SA. Recommendations for the coordinated use of Living Murray allocation and RMIF are made by the Southern Connected Basin Environmental Watering Committee.

The VEWH partners with the Commonwealth Environmental Water Office to optimise the benefits of water for the environment held by the Commonwealth Environmental Water Holder (CEWH) and delivered in Victoria. Delivery of the Living Murray's and Commonwealth's environmental Water Holdings, to meet Victorian environmental watering objectives, is included in relevant system sections in the following pages of this document.

Water for the environment delivered through northern Victorian waterways can often be reused to achieve further environmental benefits downstream. If return flows are not reused at Victorian environmental sites, VEWH, Living Murray and CEWH return flows continue to flow across the border to SA where they will be used to provide environmental benefits along the Murray River and in the Coorong, Lower Lakes and Murray Mouth area.

The VEWH may order, or authorise waterway managers to order, Living Murray and Commonwealth environmental water for environmental outcomes at downstream (non-Victorian) sites. The VEWH may also order water for delivery in the Murray system to non-Victorian sites under river operating rules that help improve environmental outcomes while maintaining the reliability of entitlements for all water users. In previous years, this has included deliveries to the Murray from the lower Darling, orders for delivery from Lake Victoria and orders for delivery to the Murray River.



Seasonal outlook 2020–21

Rainfall across the northern region in 2019–20 was below the long-term average for the third consecutive year, and total annual rainfall in parts of the Mallee was among the lowest on record. Despite the overall dry conditions, there were some wetter months. Rain in July and August 2019 produced small natural flow events in the Ovens River, which flowed into the Murray above Barmah Forest, and in the Loddon River. Rainfall in April and May 2020 caused minor flooding in the Ovens, Kiewa and Broken catchments. Spring and early summer were dry and water for the environment was used to deliver the required water regime in the region's regulated rivers during these months, particularly spring freshes in the Campaspe, Goulburn, Loddon and Murray rivers.

Operational demands in the lower Murray through summer resulted in inter-valley transfers (IVTs) being delivered from the Goulburn River, Campaspe River and lower Broken Creek. High IVTs during summer continued to compromise some of the environmental outcomes, particularly in the lower Goulburn River, as they reduce bank vegetation and increase the risk of erosion and bank failure. An interim operating limit on IVTs of up to 50 GL per month was applied by the Minister for Water to minimise the environmental risk to the lower Goulburn River in 2019–20. The intention of the limit was to reduce the effect on bank vegetation and minimise erosion, while still meeting downstream demands. Initial monitoring data indicated that vegetation was again impacted, with the effect on erosion still being assessed. Small, disconnected waterways (such as upper Broken Creek) had little to no flow over summer, except for environmental flows which were used to avoid loss of critical habitat.

The climate outlook from June to August 2020 indicates average to above-average temperatures and higher-than-median rainfall is likely for northern Victoria. The wetting-up of catchments and inflows into major storages during this time will be important to support early season allocations and water availability in 2020–21. Wetter conditions and higher streamflows may result in unregulated flows throughout winter. Longer-term outlooks have a lower level of confidence, but as at May 2020 climate models were predicting a negative Indian ocean dipole event in winter/spring 2020, which increases the likelihood of above-average rainfall during this time.

The allocation outlook for 2020–21 provided by the Northern Victorian Resource Manager (NVRM) on 15 May 2020 indicated low opening allocations are likely across all systems. Carryover of water into 2020–21 will be important to meet early season environmental demands, and possibly most 2020–21 demand if winter/spring is dry to extremely dry. Smaller systems (such as the Campaspe and Broken) are forecast to receive small (if any) increases in allocation during 2020–21 under the extreme dry[1] and dry scenarios, whereas the Goulburn, Loddon and Murray systems are more likely to get closer to a moderate allocation of around 50 percent high-reliability water shares in all but an extreme dry scenario. Under average to wet scenarios, allocations may increase more quickly in the smaller systems in response to increased inflows — a boom-or-bust type of response — when compared to the Goulburn/Loddon and Murray systems, which tend to have more gradual increases as they are larger systems. It may be difficult to commit significant volumes of environmental water to enhance unregulated events in the Goulburn and Murray rivers if these events occur before environmental allocations increase. The NVRM has not provided an outlook for low-reliability entitlements, but for planning purposes the VEWH has assumed allocation against low-reliability entitlements during 2020–21, unless significant rain provides inflows that are more than expected under an average scenario or in line with a wet scenario.

Under a dry scenario, environmental flows are expected to focus on protecting and maintaining habitat for native plants and animals to avoid decline or loss. Examples include watering wetlands (such as Horseshoe Lagoon on the Goulburn River) to maintain vegetation and provide refuge for waterbirds and to maintain low flow in the Campaspe River and other rivers to protect water-dependent species including native fish and platypus. If conditions and allocations improve, water for the environment may be used to deliver larger events to improve the health of environmental values that have experienced hot, dry conditions over the last two years. Under average to wet scenarios, larger floodplain watering events at icon sites along the Murray are planned, as is the watering of additional wetlands across the region. These larger-scale watering events will increase the quality and quantity of wetland habitat for waterbirds, frogs and turtles, support waterbird breeding events and transfer carbon from the floodplain to the rivers to increase the productivity of food webs and provide food for fish and other aquatic animals. Increased flows in creeks and rivers will aim to increase the abundance of waterbugs, enhance the breeding and recruitment of native fish and improve fringing bank vegetation.

[1] Goulburn-Murray Water's resource outlooks refer to the driest outlook as 'extreme dry'. In the seasonal watering plan, the driest planning scenario is usually called 'drought'.

5.2 Victorian Murray system

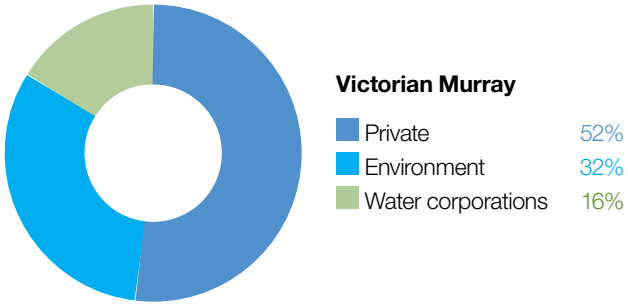
Waterway managers – Goulburn Broken, Mallee and North Central catchment management authorities

Storage managers – Goulburn-Murray Water, Lower Murray Water, Murray-Darling Basin Authority (River Murray Operations), SA Water, WaterNSW.

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

Did you know...?

Early results indicate huge numbers of native fish have been saved, thanks to Australia's first irrigation diversion channel screens at Cohuna. No Murray cod larvae were detected drifting into the irrigation channel during the peak larval drift period, which means potentially thousands of Murray cod could remain in the creek system where they can better survive and thrive! Before the screens were installed, up to 160 cod larvae were lost to the channel a day.



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

Top: Gunbower Creek, by North Central CMA
Above: Intermediate egret on Barmah Lake, by Keith Ward

The Victorian Murray system contains many significant floodplains and wetland systems covering the Goulburn Broken, North Central and Mallee CMA areas. The Barmah Forest, Kerang wetlands and Hattah Lakes are internationally recognised Ramsar-listed sites due to the significance of their wetland types and the abundance and range of waterbird species that use them. Many other wetlands in the system are either nationally or regionally significant.

Water for the environment can be supplied to the Victorian Murray system from a range of sources. These include entitlements held by the VEWH, which includes those held on behalf of the Living Murray program and the Commonwealth Environmental Water Holder; reuse of return flows; and in some instances, use of operational water en route. The source of the water used for individual watering actions and the ability to deliver all watering actions will depend on water availability, water commitments by other environmental water holders and operational requirements. As a result, the following Victorian Murray system sections do not specify the expected availability of water for the environment.

5.2.1 Barmah Forest

System overview

The Barmah-Millewa Forest covers 66,000 ha and spans the New South Wales (NSW)–Victoria border between Tocumwal, Deniliquin and Echuca (Figure 5.2.1). It is listed under the (Ramsar) Convention on Wetlands of International Importance (the Ramsar Convention), the Australian Directory of Important Wetlands and is one of six Living Murray icon sites. The forest's Victorian components are the Barmah National Park and part of the River Murray Reserve, covering 28,500 ha of forest and wetlands that support a vast range of significant plant and animal species.

The wetlands throughout the forest continue to provide a constant source of nutritional foods and significant fibres for the Yorta Yorta People. It is also evident that the resources in the landscape were utilized to manufacture canoes, shields and carrying devices.

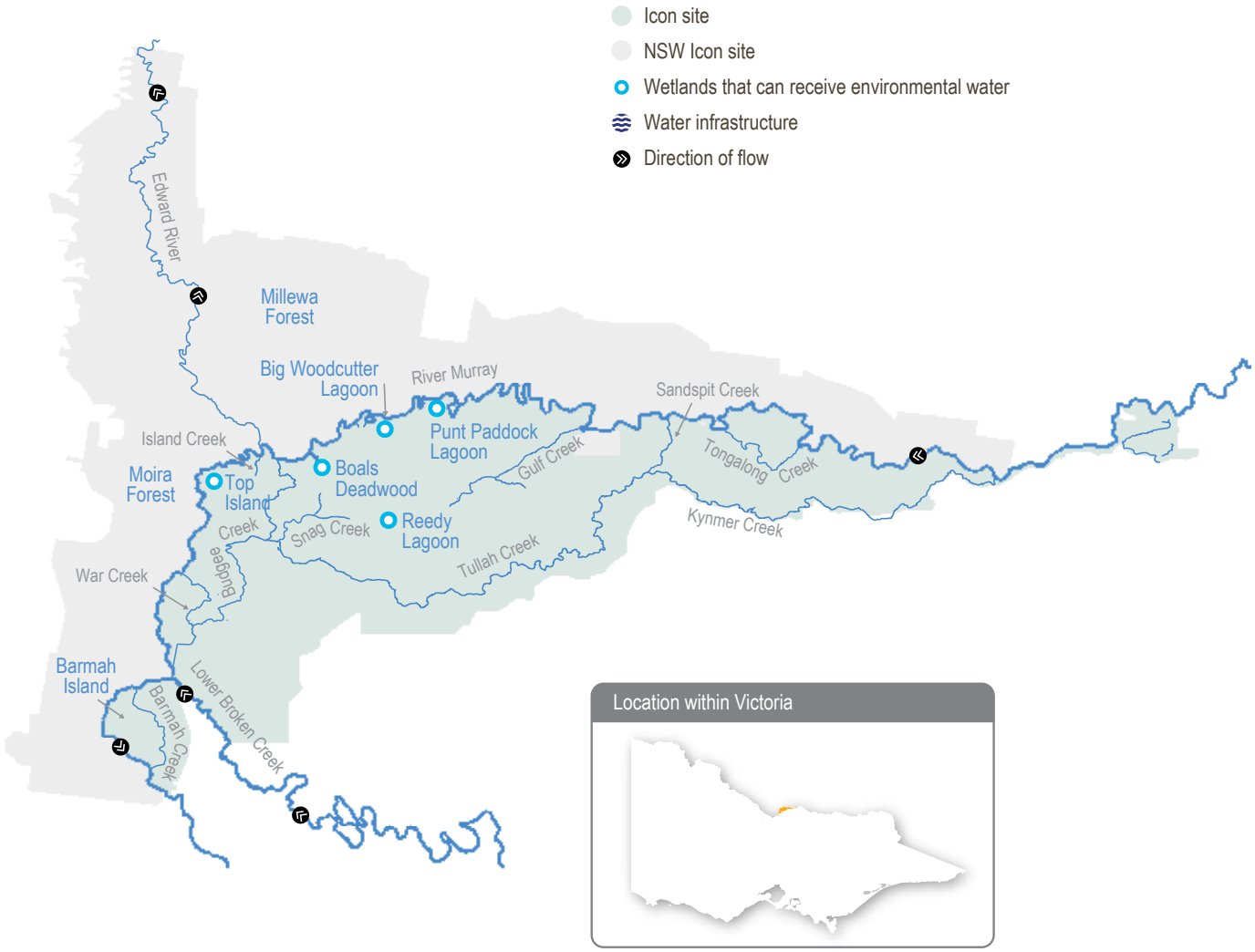
Flooding in the Barmah-Millewa Forest depends on flows in the Murray River. A natural narrowing of the river (known as the Barmah choke) restricts flow and causes overbank flooding when flows below Yarrawonga Weir exceed the channel's capacity. This restriction influences both the operation of Yarrawonga Weir and the upper limit of environmental flows that can be delivered to the forests.

Prior to river regulation for water supply, flooding would have regularly occurred with high flows from rainfall in winter and spring – helping to shape a rich and productive forest environment. Today, flooding in the forest is also influenced by system operation for water supply for users downstream in the Murray River, which can cause damage to the forest and banks of the river depending on the timing and volume of the flows.

The delivery of irrigation water during summer/autumn is managed to minimise unseasonal flooding of the forest. Regulators along the banks of the Murray River that control flow between the river and the forest remain closed during summer and autumn to restrict flow through low-lying flood runners. The delivery of water to Barmah Forest is also limited by a flow constraint below Yarrawonga Weir to minimise impacts to adjacent farming operations in NSW. The current constraint limits releases to a maximum of 18,000 ML per day between July and September (with potentially-affected landholder support) and to 15,000 ML per day for the rest of the year. To overcome this constraint, most environmental flows are shared between Barmah and Millewa forests to deliver water to low-lying wetlands in each forest at least every second year. It is currently not possible to achieve the desired flood depth and duration for floodplain marsh vegetation in both forests at the same time without larger natural flooding.

Water management at Barmah–Millewa Forest seeks to build on natural flow and the delivery of consumptive and operational water en route to optimise environmental outcomes when possible. As Barmah-Millewa Forest is located towards the upper reaches of the regulated portion of the Murray River, water for the environment that passes through the forest can often be used at sites further downstream as part of multi-site watering events.

Figure 5.2.1 Barmah Forest



Environmental values

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

Environmental watering objectives in the Barmah Forest

	Enable carbon and nutrient cycling between the floodplain and river through connectivity
	Maintain or increase habitat for native fish and increase their population
	Maintain or increase habitat available for frogs
	Maintain or increase habitat available for turtles including the broad-shelled turtle
	Enhance the health of river red gum communities and aquatic vegetation in the wetlands and watercourses and on the floodplain Promote the growth of floodplain marsh vegetation communities, with a particular focus on increasing the extent of Moira grass
	Provide feeding and nesting habitat for the successful recruitment of colonial nesting waterbirds
	Provide early-season flushing of the lower floodplain to reduce the risk of low-oxygen events in summer

Traditional Owner cultural values and uses

"We are the First People of this place. We were here even before the Murray River flowed through Barmah." — Uncle Des Morgan, Yorta Yorta Elder (Joint Management Plan for Barmah National Park, 2020).

Yorta Yorta are joint managers of Barmah National Park under a Traditional Owner Land Management Agreement with the State of Victoria. Goulburn Broken CMA worked with Yorta Yorta Nation Aboriginal Corporation during the environmental water planning process to source their feedback about planned watering actions. Yorta Yorta Traditional Owners have been involved in the development of longer-term management plans that have informed these watering actions.

Examples of Yorta Yorta cultural values and uses in Barmah Forest that are supported through environmental flow delivery include:

- maintaining drought refuges, which protects turtles that are an important totemic species for the Yorta Yorta community
- watering to support floodplain marsh vegetation, which includes important food and medicinal plants such as sneezeweed and basket sedge

Yorta Yorta Nation Aboriginal Corporation contribute to Barmah Forest environmental watering planning, monitoring and management through employment as part of the Living Murray Program Indigenous Partnerships Program. This contribution is acknowledged in Table 5.2.1 with an icon.

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

Social, recreational and economic values and uses

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

- water-based recreation (such as fishing)
- riverside recreation and amenity (such as camping and birdwatching)
- community events and tourism (such as providing access for boat tours)
- socio-economic benefits (such as apiarists and irrigation diverters).

Recent conditions

The 2019–20 year was characterised by extremely dry conditions throughout spring, although two small natural flow events originating from the Ovens and Kiewa rivers caused low-level flooding in the forest in mid- and late winter. Carryover in the Murray system from 2018–19 was essential to enable watering early in the year; Victorian Murray allocations increased slowly as a result of the dry conditions during 2019–20.

Forest regulators were opened in July 2019 to allow a natural connection between the Murray River and the waterways in Barmah Forest. Flow increased above the channel's capacity in August 2019 as a result of rainfall in upstream catchments. That event was followed by the delivery of the 'southern spring flow' — a planned environmental flow event for the Murray River between Lake Hume and the sea — which wetted low-lying parts of the Barmah Forest floodplain through September and October 2019. Environmental flows reduced in late October, and forest regulators were closed at the end of October 2019. Most floodplain habitats within the forest dried during summer and autumn. The main exception was a small section of the forest that re-flooded in January 2020 as a result of vandalism to a forest regulator.

Watering actions for Barmah Forest were mostly delivered as planned in 2019–20. Maintaining winter/spring connection between the river and the forest enabled carbon and nutrient exchange and improved food resources and habitat for fish, frogs, turtles and waterbirds. The low-level flooding supported wetland plant growth, but it ended too soon to stimulate some species to flower, due to insufficient water availability. A potential watering action that aimed to support colonial nesting waterbird breeding was not delivered, because significant natural breeding was not observed. Drying throughout the forest in summer/autumn is important to maintain plant diversity and wetland productivity.

A prolonged, low-level, spring watering event in 2020–21 is desirable to allow more floodplain vegetation to flower, set seed and recruit. Waterbird breeding in Barmah Forest was at the lowest level in a decade in 2019–20 as a result of dry conditions. Providing flows to support a successful waterbird breeding event will be a priority in 2020–21. If conditions remain very dry, water for the environment will be mainly used to maintain critical drought refuges (such as waterholes in creek beds).

Scope of environmental watering

Table 5.2.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

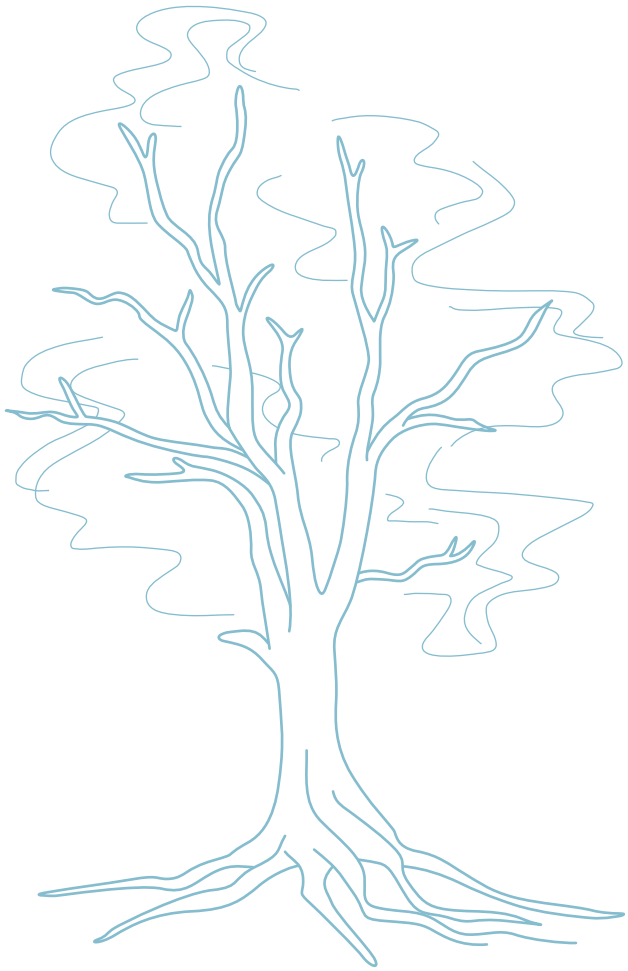


Table 5.2.1 Potential environmental watering actions and objectives for the Barmah Forest

Potential environmental watering action	Functional watering objectives	Environmental objectives
Winter/spring low flow to various waterways in Barmah Forest (variable flow rates and duration during July to December)	• Provide flow in forest waterways to maintain habitat for native fish and turtles • Facilitate the movement of native fish between floodplain waterways and the river • Remove accumulated organic matter from waterways to cycle carbon to the river system and minimise the risk of hypoxic blackwater	
Spring/summer freshes in the Murray River channel (one to three freshes that increase flow by at least 500 ML/day and maintain it for eight days during October to December)	• Trigger spawning of native fish species, primarily golden and silver perch	
Spring/summer/autumn freshes to Gulf and Boals creeks (100 ML/day for three to five days as required during November to April)	• Maintain critical drought-refuge areas in Barmah Forest to provide habitat for native fish and turtles • Flush drought-refuge pools to maintain water quality	
Spring/summer/autumn low flow to floodplain waterways including Sandspit, Gulf, Big Woodcutter, Boals, Island and Punt Paddock Lagoon (200 ML/day for 30 to 60 days during November to April)	• Provide flows to replenish refuge areas and maintain water quality • Provide flows to replenish permanent waterways, to maintain fish and turtle populations • Maintain connectivity to the river • Remove accumulated organic matter, cycle carbon to the river system and minimise the risk of hypoxic blackwater	
Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands (200–400 ML/day for four and a half months during September to February)	• Provide a cue to initiate and/or maintain waterbird breeding • Maintain wetting duration and depth for growth of wetland vegetation	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Spring wetting of floodplain marshes (variable flow rates of 9,500–18,000 ML/day below Yarrawonga Weir for three months during September to December)	• Wet open plains for sufficient duration to allow the growth of floodplain marsh vegetation • Provide water to forest wetlands and low-lying floodplain areas to create foraging opportunities for waterbirds and increase available habitat for turtles, frogs and small-bodied native fish	
Autumn/winter low flow in the Murray River (1,800–4,000 ML/day downstream of Yarrawonga during May to June)	• Increase water depth in the Murray River channel to provide habitat for large-bodied native fish in the Murray River and unregulated anabranches in Barmah–Millewa Forest	

Scenario planning

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

The ecological objectives at Barmah-Millewa Forest require sustained flows in the Murray River that peak in spring. Flow control structures are used to direct water from the Murray River channel into the forest and facilitate the later return of most of that water back to the river for use further downstream.

Demands for water for the environment in Barmah Forest vary significantly in response to natural conditions. Variable winter/spring low flow and spring/summer freshes are required under all scenarios. The variable winter/spring low flow is required to maintain habitat and movement opportunities for aquatic animals (such as native fish) and is achieved by keeping the regulating structures open and allowing water to move in and out of the forest in response to normal flow changes in the Murray River. The spring/summer freshes are achieved by providing changes in the flow rate in the Murray River below Yarrawonga Weir.

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

Under the average or wet scenarios, the focus shifts to building resilience in the system by increasing the ecological response to natural flood events. Specific actions under the average or wet scenarios may include extending the duration of natural flooding to increase the germination of wetland plants (such as Moira grass) in floodplain marshes or extending watering in river red gum forests to maintain the health of the trees. These actions require large volumes of water to be directed into the forest, with environmental water provided as a directed release from Hume Reservoir and managed via forest regulators. Most of the water used for these actions is eventually returned to the Murray River through the natural shedding action of the floodplain. Targeted wetland watering may occur under various scenarios to support the breeding of colonial nesting waterbirds and other flood-dependent birds via the diversion of water through specific regulators.

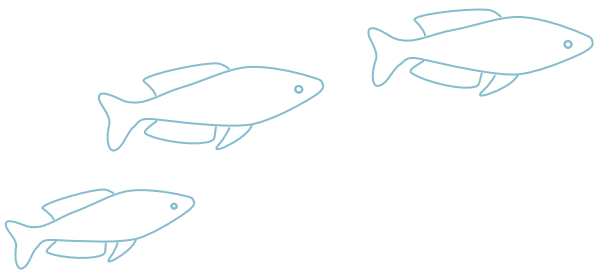
Spring wetting of floodplain marshes is not considered a high priority in 2020–21 under the dry and drought scenarios, but it would provide environmental benefit and may be delivered under certain circumstances. For example, if above-channel-capacity operational transfers from Hume Reservoir are delivered through Barmah Forest, then the watering action could be achieved by delivering a relatively small volume of environmental flow on top of or following the operational delivery. A multi-site environmental watering objective supporting whole-of-River-Murray and/or downstream environmental objectives during winter and spring may also deliver flows through Barmah Forest, and these could be supplemented to optimise environmental outcomes in Barmah Forest. The volume of water for the environment required to achieve the floodplain marsh flow objectives under the dry or drought scenarios depends on demands for operational water or environmental multi-site events, and it is therefore not estimated in Table 5.2.2 below.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flow periods unlikely • Flows in the Murray River will remain within channel all year	• Some small unregulated flow in late winter/spring • Low chance of overbank flows in late winter/spring	• Likely chance of small-to-medium unregulated flow in winter/spring • Likely chance of overbank flows in winter/spring	• High probability of moderate-to-large unregulated flow in winter/spring • Expected large overbank flows
Potential environmental watering – tier 1 (high priorities)[1]	• Winter/spring low flow • Spring/summer freshes • Spring/summer/ autumn freshes to Gulf and Boals creeks	• Winter/spring low flow • Spring/summer freshes • Spring/summer/ autumn low flow • Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands	• Winter/spring low flow • Spring/summer freshes • Spring/summer/ autumn low flow • Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands • Spring wetting of floodplain marshes • Autumn/winter low flow	• Winter/spring low flow • Spring/summer freshes • Fill or top up Boals Deadwood, Harbours Lake, Reedy Lagoon and Top Island wetlands • Spring wetting of floodplain marshes • Autumn/winter low flow
Potential environmental watering – tier 2 (additional priorities)	• Spring wetting of floodplain marshes	• Spring wetting of floodplain marshes		
Possible volume of environmental water required to achieve objectives[2]	• 8,500 ML (tier 1)	• 51,500 ML (tier 1)	• 566,000 ML (tier 1)	• 570,000 ML (tier 1)

[1] Tier 1 potential environmental watering at Barmah Forest is not classified as tier 1a or 1b because the water available for use is shared across various systems, and it is not possible to reliably determine the supply specifically available for Barmah Forest.

[2] The possible volumes of water for the environment required in Barmah Forest are estimates and highly variable, depending on factors such as seasonal conditions and the contributions of operational and/or unregulated flows. Much of the environmental water delivered to Barmah Forest is returned to the River Murray — around 80 percent in the dry to wet scenarios — and can be re-used at downstream environmental watering sites.



5.2.2 Gunbower Creek and Forest

System overview

Gunbower Forest is a large, flood-dependent forest situated on the Murray River floodplain in northern Victoria between Torrumbarry and Koondrook (Figure 5.2.2).

Covering 19,450 ha, it is bounded by the Murray River to the north and Gunbower Creek to the south. It is an internationally significant site under the Ramsar Convention and forms part of the Living Murray Gunbower-Koondrook-Perricoota forests icon site. River regulation and water extraction from the Murray River and Gunbower Creek has reduced the frequency, duration and magnitude of flood events in Gunbower Forest. This has affected the extent and condition of floodplain habitats and the health of plant and animal communities (such as river red gum and black box communities, native fish, birds, platypus, frogs and turtles) that depend on those habitats.

Gunbower Creek is natural creek that has been modified to supply irrigation water from the Murray River to the Torrumbarry Irrigation Area. There are twelve lagoons, largely located in the upper reaches of the creek system, that are permanently or seasonally connected to Gunbower Creek. Water for the environment is used in Gunbower Creek to improve habitat for native fish, especially Murray cod.

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

Environmental values

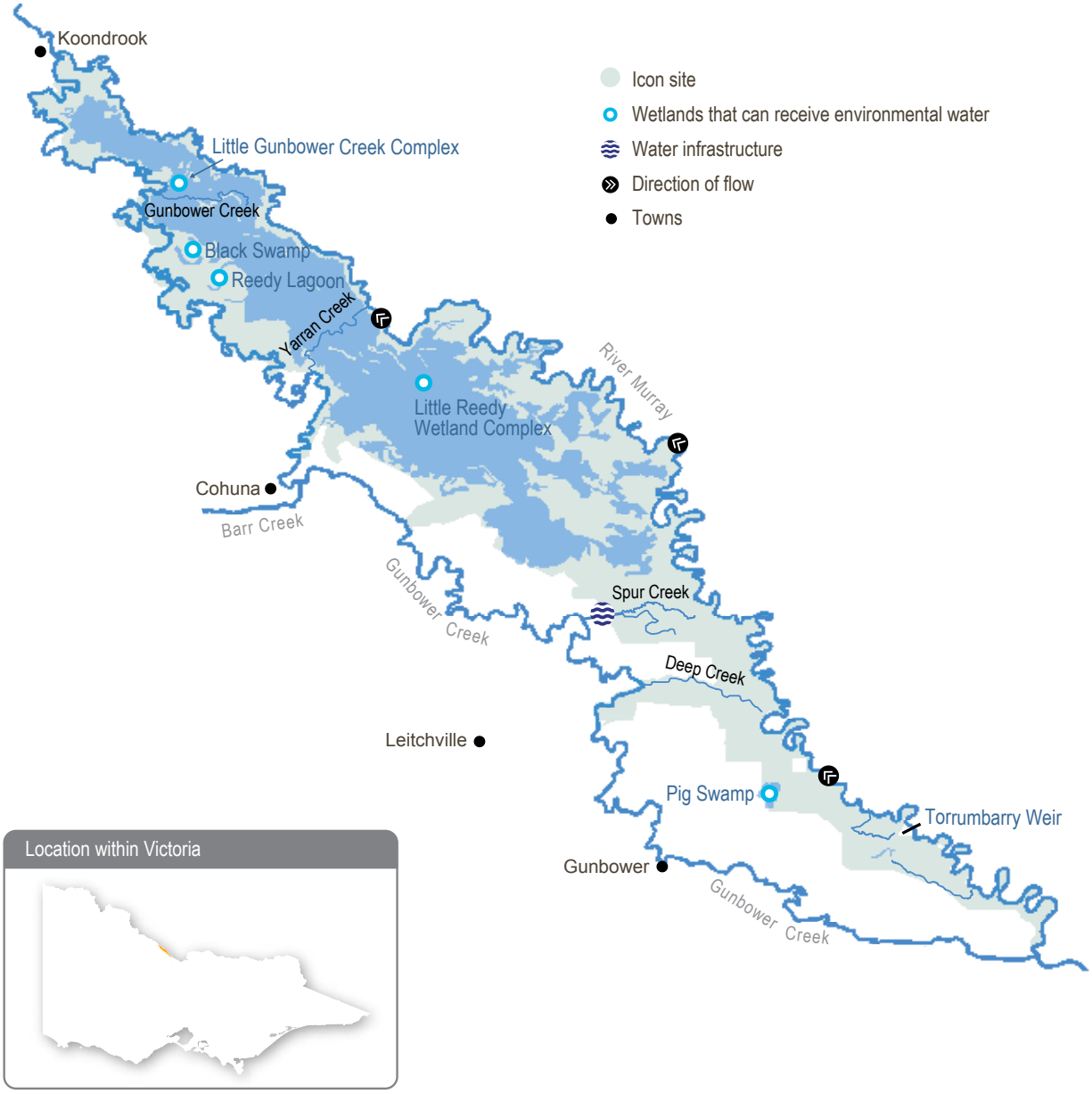
Gunbower Forest contains many important environmental values. It includes rare and diverse wetland habitats and large areas of remnant vegetation communities (such as river red gum forest and woodlands). It is also home to vulnerable and endangered plants and animals including river swamp wallaby-grass, wavy marshwort, Murray-Darling rainbowfish, eastern great and intermediate egrets. It also supports internationally recognised migratory waterbird species.

Gunbower Creek provides important habitat for native fish (such as Murray cod, golden perch and freshwater catfish). It is a valuable refuge for native fish, and it provides a source of fish to recolonise surrounding waterways.

Environmental watering objectives in Gunbower Creek and Forest

Provide feeding, breeding and refuge habitat for small-bodied native fish (such as Murray-Darling rainbow fish) in forest wetlands Maintain and improve populations of large-bodied native fish (such as Murray cod) in Gunbower Creek
Provide suitable feeding, breeding and refuge habitat for frogs
Provide suitable feeding, breeding and refuge habitat for turtles
Support carbon and nutrient cycles in the forest and wetlands and periodically deliver carbon and nutrients from the forest to adjacent waterways to support food webs
Maintain and improve the health and increase the abundance of native vegetation in permanent and semi-permanent wetlands Improve the health of river red gums, black box and grey box communities
Provide feeding, breeding and refuge habitat for waterbirds including colonial nesting species (such as egrets, cormorants and herons)
Maintain and improve water quality in Gunbower Creek

Figure 5.2.2 Gunbower Creek and Forest



Traditional Owner cultural values and uses

At Gunbower Island there are two Traditional Owner groups which recognise the forest as their traditional Country. The mid and lower area of Gunbower Forest is recognised as the traditional Country of the Barapa Barapa people, and the upper Gunbower Forest is recognised as the traditional Country of the Yorta Yorta people. North Central CMA seeks engagement and input from both groups when undertaking annual environmental water planning and throughout the year as part of the Living Murray Indigenous Partnerships Program.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.2.5 with an icon.

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

Barapa Barapa custodians have clearly expressed their aspirations for an active role in the management of land and water, to fulfil custodianship obligations and contribute to improvements in the health of Country.

Barapa Barapa Traditional Owners have been working in partnership with the North Central CMA to deliver the Water for Country project in Gunbower Forest since 2015. The Water for Country project builds on the work of the previous Barapa Barapa Cultural Heritage Mapping of Lower Gunbower Forest project, delivered in 2013–14 to map a catalogue of cultural heritage assets in the forest. The Water for Country project aims to investigate how Traditional Owners' cultural and spiritual values may be better represented in water management. In 2018, the Water for Country group has evolved to also include Wamba Wamba Traditional Owners and continues to have a focus on Gunbower Forest.

Barapa Barapa Traditional Owners identified a range of opportunities for 2020–21 watering to support cultural values (Table 5.2.3).

Table 5.2.3 Barapa Barapa cultural values and uses at Gunbower Forest

Values/uses	Considerations
Cultural values, cultural practices	Water in wetlands and on the floodplain from environmental watering and natural flooding supports culturally important plants throughout Gunbower Forest and allows the continuation of cultural practices including harvesting of food, medicine and weaving plants.
Cultural values	Providing drought refuge and maintaining areas with healthy habitat is a high priority for Barapa Barapa Traditional Owners. In a dry forest, they feel it was important to ensure that water is delivered to healthy areas, such as Reedy Lagoon, which elicit a good vegetation response and can support wetland and forest fauna.
Cultural values, cultural practices	Barapa Barapa Traditional Owners recognise the value of resources that occur on the drawdown after inundation of the forest floodplain, providing food for animals, and cultural plants such as old man weed. Providing this resource is considered particularly important in a dry forest.
Cultural values, cultural practices	Having a diversity of habitat and vegetation responses is a priority for Barapa Barapa Traditional Owners, particularly in a dry year. They highlighted the importance of having a diversity of drought refuge, with a range of water depths, which creates a more diverse vegetation response and results in a range of resources becoming available over a longer timeframe.
Cultural values	Barapa Barapa Traditional Owners value having water in natural creeks and billabongs off main wetlands, which were likely to have traditionally been canoe mooring sites. Evidence of this in the forest can be seen near Long Lagoon by numerous earth mounds and a large canoe tree on the edge of a large floodrunner.
Cultural practices	Barapa Barapa Traditional Owners have aspirations to reintroduce traditional fish traps into natural creeks within Gunbower Forest. The flood-runners around the Little Gunbower Creek Complex have been identified as potential trial sites.
Cultural heritage	Barapa Barapa Traditional Owners have noted that areas of black box and river red gum both have cultural heritage values, however the changed watering regime since regulation and changing climate is causing the encroachment of black box into areas previously dominated by river red gum. Barapa Barapa Traditional Owners expressed the desire to preserve the tree community that was historically present.

The Barapa Barapa Water for Country project has led to the creation of the Barapa Barapa Cultural Watering Objectives Framework, which is a guiding document to ensure cultural priorities and outcomes are considered and incorporated in environmental water planning and management. The framework considers cultural objectives matched with hydrological considerations, indicators and measures for monitoring success (Table 5.2.4). These objectives are considered in conjunction with the environmental and functional watering objectives for the potential watering actions in Table 5.2.5.

Planning for environmental watering in 2020–21 included discussion of vegetation monitoring results, forest condition and potential watering requirements with a field ecologist and a field visit to review the previous year's cultural objectives and outcomes and discuss potential new objectives.

Applying the framework during seasonal watering proposal engagement with Barapa Barapa Traditional Owners will ensure that environmental watering activities incorporate Barapa Barapa Traditional Owners' cultural aspirations and that water managers are culturally informed when delivering environmental water.

All potential watering actions in Table 5.2.5 provide the opportunity to support Barapa Barapa cultural values and objectives, but achievement will be guided by climatic conditions.

Table 5.2.4 Barapa Barapa cultural objectives for environmental watering in Gunbower Forest 2020–21 (from the Barapa Barapa Cultural Watering Objectives Framework)

Cultural objective	Hydrological aim	Indicator	Measure
Promote and maintain healthy and abundant native fish communities in Gunbower Creek and Gunbower Forest	Presence of water in wetlands before spring to support fish spawning events	Presence of native fish spawning Native fish populations show a range of ages	Fish surveys, larval sampling
	Presence of water in deep wetlands, so that fish can survive for longer	Presence of native fish following watering event	Fish surveys
Promote the natural flow of water	Water flows via natural flow paths to culturally important sites	Presence of water at culturally significant sites (e.g. fish ponds)	Photo points, site surveys
	Presence of healthy looking and smelling forest	Presence of healthy canopies and good ground cover on the forest floodplain	Plant surveys
Promote and maintain healthy cultural plants and resources	Presence of water in small wetlands and depressions to provide resources across the forest, particularly in dry years	Presence of food and fibre resources distributed across the forest	Cultural harvests, plant surveys, seed collection
	Presence of water in wetlands which are healthy	A diverse range of plants, animals and insects living in harmony	Results of monitoring activities (e.g. macroinvertebrate surveys, flora and fauna surveys)
Promote healthy waterbird populations	Presence of water in wetlands that support waterbird breeding	Presence of waterbird breeding	Waterbird surveys, spring–summer surveys for eggs

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.5, North Central CMA considered how environmental flows could support values and uses including:

- riverside recreation and amenity (such as birdwatching, duck hunting and photography)
- community events and tourism (such as park visitation)
- socio-economic benefits (such as timber harvesting and education).

Recent conditions

Gunbower Forest and surrounding areas have had below-average rainfall and above-average temperatures for the last three years.

In 2019–20, no natural inflows entered the Gunbower Forest from the Murray River, but a managed spring high-flow event in the Murray River provided an opportunity to deliver water through Yarran Creek to facilitate fish movement between Gunbower Creek and the Murray River. Water for the environment was used in winter 2019 to fill or top-up wetlands in Reedy Lagoon and the Little Gunbower wetland complex within Gunbower Forest. In the absence of a natural flood, selected wetlands within these complexes are planned to be allowed to draw down in 2020 to reduce carp numbers, before potential top-ups in autumn 2021.

Water for the environment was also delivered to Gunbower Creek in 2019–20 to maintain habitat for native fish during winter (when irrigation flows cease) and to improve the quality of nursery habitats for native fish (especially Murray cod) during spring and summer. Annual fish surveys in Gunbower Creek have detected successful breeding and survival of Murray cod each year that water for the environment has been delivered, and the surveys are showing improved abundance and age structure within the resident Murray cod population over time.

Golden perch do not appear to breed successfully in Gunbower Creek, and there are major barriers that limit exchanges with populations in the Murray River and other connected systems. Planned works to build a fishway at Koondrook Weir in winter 2021 aim to improve connectivity between the Murray River and Gunbower Creek. This will allow large-scale fish movement to support natural recruitment within Gunbower Creek and to allow Murray cod and other species that currently breed in Gunbower Creek to disperse and contribute to broader regional populations.

Scope of environmental watering

Table 5.2.5 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

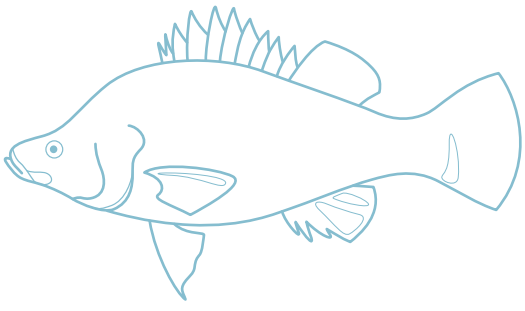


Table 5.2.5 Potential environmental watering actions and objectives for Gunbower Creek and Forest

Potential environmental watering action	Functional watering objectives	Environmental objectives
Gunbower Forest		
Reedy Lagoon (fill and provide top-ups in winter/spring 2020)	• Maintain water depth and extent to support the growth and recruitment of wetland plants • Maintain water depth to provide feeding and refuge habitat for waterbirds, turtles and frogs • Maintain depth and water quality to provide habitat for small-bodied native fish including Murray-Darling rainbowfish	
Black Swamp (partial fill and provide top-ups in winter/spring 2020)	• Increase and maintain water depth and extent to support the growth and recruitment of wetland plants • Provide feeding and refuge habitat for waterbirds, turtles and frogs • Maintain depth and water quality to provide habitat for small-bodied native fish	
Trigger-based top-up permanent and semi-permanent wetlands (variable flow rates during spring/summer as required in response to bird breeding event)	• Maintain a waterbird breeding event • Maintain the wetland vegetation to provide habitat for colonial nesting and flow-dependent waterbirds	
Reedy Lagoon (top-up in autumn/winter 2021)	• Maintain water depth to support wetland plants to grow • Maintain feeding and refuge habitat for waterbirds, small-bodied native fish, turtles and frogs	
Black Swamp (top-up in autumn/winter 2021)	• Maintain water depth to support wetland plants to grow • Maintain feeding and refuge habitat for waterbirds, small-bodied native fish, turtles and frogs	
Winter/spring fresh in Yarran Creek (variable flow rates and duration based on water levels in Gunbower Forest and flows in the Murray River and Gunbower Creek)	• Provide connectivity between Gunbower Creek and Murray River through the Yarran Creek and Shillinglaws regulators, to increase flowing habitat for the lateral movement of native fish, turtles, carbon and nutrients • Provide migration and spawning opportunities for native fish	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Little Gunbower wetland complex (fill in autumn/ winter 2021)	• Increase water depth and extent to trigger wetland plants to germinate in late winter and early spring • Provide feeding and refuge habitat for waterbirds, turtles and frogs • Provide habitat for small-bodied native fish	
Little Reedy wetland complex (including Green Swamp, Corduroy Swamp and Little Reedy Lagoon) (fill in autumn/winter 2021)	• Increase water depth and extent to trigger wetland plants to germinate in late winter and early spring • Provide feeding and refuge habitat for waterbirds, turtles and frogs • Provide habitat for small-bodied native fish	
Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates to maintain an appropriate wetted extent during winter/spring)	• Wet river red gum, black box and grey box communities • Provide access to breeding habitat and food resources for native fish (such as Murray cod) • Provide refuge habitat for frogs, turtles and waterbirds including colonial nesting species	
Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates during autumn/winter 2021)	• Wet river red gum, black box and grey box communities • Provide access to breeding habitat and food resources for native fish (such as Murray cod) • Provide refuge habitat for frogs, turtles and waterbirds including colonial nesting species	
Gunbower Creek		
Autumn/winter low flow (above 200 ML/day during May to August)	• Maintain habitat and food resources for native fish (such as Murray cod) during the non-irrigation season	
Spring/summer/autumn low flow (targeting a gradual increase, stable flow period and decrease in flows ranging between 300-500 ML/day during August to May)[1]	• Maintain breeding habitat and food resources for native fish (such as Murray cod) • Provide cues for the migration and spawning of native fish • Dilute low-oxygen water exiting Gunbower Forest below Koondrook Weir if required	
Autumn/winter fresh (500 ML/day for one to four weeks during May to August)	• Deliver in response to high flow in Murray River and low oxygen water draining off Gunbower Forest during the non-irrigation season to protect water quality and allow fish to move between Murray River and Gunbower Creek	

[1] Flows may be delivered at the upper end of the range — 500 ML per day — at any time between August 2020 and May 2021 in response to unregulated flow in the Murray River or to mitigate the potential impacts of low-oxygen water exiting the Gunbower Forest below Koondrook weir.

Scenario planning

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

The highest-priority potential watering actions under all conditions in 2020–21 are to fill and provide top-ups to Reedy Lagoon and Black Swamp in winter/spring 2020. These are permanent wetlands, and water is needed to support the growth and recruitment of wetland plants as well as provide feeding and breeding habitat for small-bodied native fish, frogs, turtles and waterbirds. If a waterbird breeding event commences in any wetland, top-ups may be needed to maintain water depth and habitats through spring and summer until juvenile waterbirds have fledged. Additional top-ups may be delivered to Reedy Lagoon and Black Swamp in autumn/winter 2021 if dry conditions are expected in 2021–22, to provide refuge over winter for water-dependent animals including waterbirds. Providing the prescribed low flow to Gunbower Creek in all seasons is also a high priority under all scenarios, to maintain and improve populations of native fish.

Under the dry, average and wet scenarios, the environmental watering priorities will be to maintain and improve the condition of semi-permanent and permanent wetlands across the forest and support local populations of waterbirds, frogs, small-bodied fish and turtles. Delivering top-ups and fills to selected wetlands within the Little Gunbower and Little Reedy wetland complexes in autumn/winter 2021 will provide habitat for waterbirds and other water-dependent animals during the cooler months and prime the wetlands for a spring productivity boost. If flow in the Murray River exceeds 15,000 ML per day for more than two weeks in winter/spring, a fresh may be delivered in Yarran Creek to allow carbon, fish, turtles and seed propagules to move between Gunbower Creek, Gunbower Forest and the Murray River. Delivering water for the environment to the Gunbower Forest floodplain in autumn/winter 2021 is a high priority under the dry, average and wet scenarios, to maintain and improve the health of river red gums and provide waterbird and native fish habitat.

Under average and wet conditions, natural flow from the Murray River may wet parts of the Gunbower Forest floodplain in winter/spring 2020. Water for the environment may be used to extend natural flooding events in selected river red gum areas, to maintain and improve tree health.

If significant volumes of water for the environment are delivered to Gunbower Forest via the Hipwell Road Regulator, it may not be possible to deliver the full range of flows to increase the large-bodied fish population in Gunbower Creek. If so, flow in Gunbower Creek will be managed to maintain habitat for the existing native fish population. Low flow may be increased to the upper end of the recommended range — 500 ML per day — to dilute low-oxygen floodwater that drains from the floodplain below Koondrook Weir following a natural or delivered floodplain watering event.

Water for the environment may also be used to temporarily increase flow in Gunbower Creek to the upper end of the recommended flow range — 500 ML per day— in response to higher flows in the Murray River that occur at important times for fish breeding or movement. These high Murray River flows are expected to mainly occur under a wet scenario.

There is a possibility that Goulburn-Murray Water will require Gunbower Creek to be shut down during winter/spring 2021 to allow for the construction of fishways at Koondrook Weir and Cohuna Weir outside the irrigation season. If these works proceed as planned, water will be delivered at a low rate to maintain some pool habitats for resident fish populations, but higher flows to the creek and deliveries to Gunbower Forest via the Hipwell Road Regulator will not be possible. Any potential watering actions that are cancelled as a result of those works will likely become a very high priority to deliver in 2021–22.

A minimum volume of 21,000 ML is planned to be carried over into 2021–22. The carryover volume will provide certainty of supply for low flow in Gunbower Creek during the non-irrigation season to maintain flowing habitat and support top-ups of permanent wetlands in lower Gunbower Forest. Extra water may need to be carried over to support any Gunbower Forest floodplain watering actions that commence in autumn or June 2021.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural inflows into Gunbower Forest	• No natural inflows into Gunbower Forest	• Minor natural inflows into Gunbower Forest may occur in winter/spring	• Overbank flows are likely in winter/spring
Potential environmental watering – tier 1 (high priorities)[1]				
Gunbower Forest	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter)	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter) • Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex • Gunbower Forest floodplain, floodrunners and wetlands	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter) • Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex • Extend natural flooding by wetting Gunbower Forest floodplain, floodrunners and wetlands • Gunbower Forest floodplain, floodrunners and wetlands	• Reedy Lagoon (winter/spring) • Black Swamp (winter/spring) • Trigger-based top-up permanent and semi-permanent wetlands • Reedy Lagoon (autumn/winter) • Black Swamp (autumn/winter) • Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex • Extend natural flooding by wetting Gunbower Forest floodplain, floodrunners and wetlands
Gunbower Creek	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/ autumn low flow	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/ autumn low flow	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/ autumn low flow	• Gunbower Creek winter low flow • Gunbower Creek spring/summer/ autumn low flow
Potential environment watering – tier 2 (additional priorities)				
Gunbower Forest	• Yarran Creek • Little Gunbower wetland complex • Little Reedy wetland complex	• n/a	• n/a	• Gunbower Forest floodplain, floodrunners and wetlands
Gunbower Creek	• n/a	• n/a	• n/a	• Gunbower Creek autumn/winter fresh
Possible volume of environmental water required to achieve objectives[2,3]	• 21,500 ML (tier 1) • 7,500 ML (tier 2)	• 50,000 ML (tier 1)	• 51,500 ML (tier 1)	• 36,500 ML (tier 1) • 31,000 ML (tier 2)
Priority carryover requirements	• 21,000 ML to 56,000 ML[4]			

[1] Tier 1 potential environmental watering at Gunbower Creek and Gunbower Forest is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for Gunbower Creek and Gunbower Forest.

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

[3] These estimates take account of the use of operational water en route to achieve watering action targets (except for discrete wetland watering actions), with water for the environment being required to underwrite the associated losses in Gunbower Creek and Gunbower Forest.

[4] Carryover volumes take into account that wetting of Gunbower Forest floodplain, floodrunners and wetlands has started in autumn/winter 2021 and will require sufficient volumes of carryover to complete the watering action in winter/spring 2021. If no floodplain watering action commences in autumn/winter 2021, this volume is subject to change.

5.2.3 Central Murray wetlands

System overview

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

The Central Murray wetlands are almost wholly contained within the Torrumbarry Irrigation Area and are all wetlands of regional or international significance. The area has experienced dramatic changes since European settlement with the construction of levees, roads and channels. Most of the wetlands are now cut off from natural flow paths and are rarely filled by natural floods. They rely on water for the environment to maintain their ecological character and health.

Ten of the central Murray wetlands can receive water for the environment from permanent infrastructure: Lake Cullen, Hird Swamp, Johnson Swamp, Round Lake, McDonalds Swamp, Lake Elizabeth, Lake Murphy, Richardson's Lagoon, Third Reedy Lake and the Wirra-Lo wetland complex. Temporary pumps may be used to deliver water for the environment from the Murray River to some semi-permanent wetlands in the Guttrum and Benwell forests.

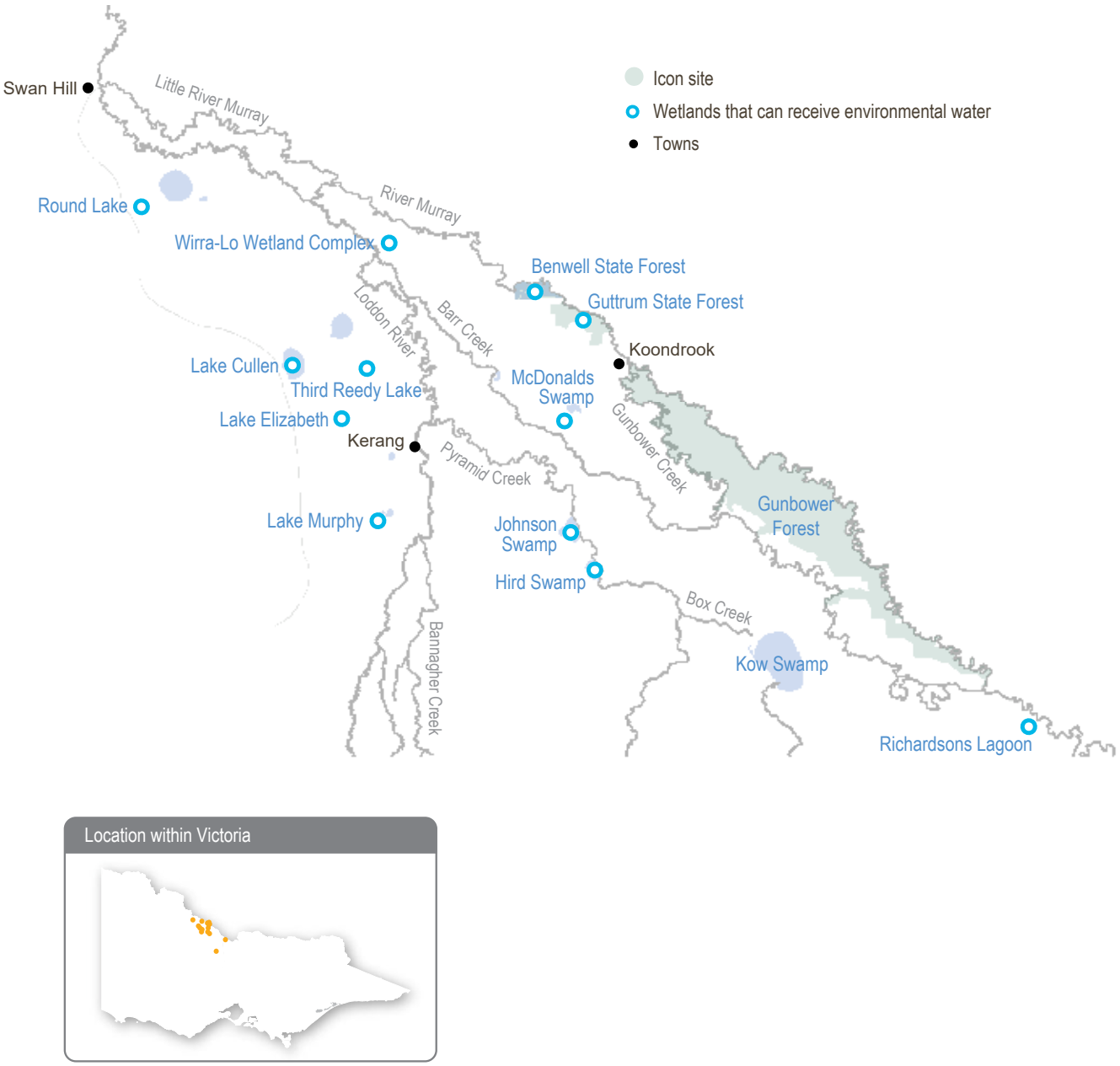
Environmental values

The wetlands in the Central Murray system support numerous listed threatened species ranging from vulnerable to critically endangered including the Australasian bittern, Murray hardyhead, Australian painted snipe, growling grass frog and the southern purple spotted gudgeon, which was presumed extinct in Victoria until it was found at Third Reedy Lake in spring 2019. When the wetlands receive environmental water, they can attract prolific birdlife and provide feeding and breeding habitat for many threatened and endangered bird species (including the eastern great egret and white-bellied sea eagle) listed under legislation and international agreements. Lake Cullen, Hird Swamp and Johnson Swamp are internationally recognised under the Ramsar Convention, while the other wetlands in the Central Murray system have bioregional significance.

Environmental watering objectives in the central Murray wetlands

- Maintain and improve populations of listed threatened species including critically endangered Murray hardyhead and southern purple spotted gudgeon
- Maintain or increase populations of common small-bodied native fish (such as carp gudgeon and flatheaded gudgeon)
- Maintain and improve populations of endangered growling grass frog
- Maintain populations of common native frogs (such as barking marsh frog, Peron's tree frog and spotted grass frog)
- Maintain populations of native turtle species (such as Murray River turtle and the common long necked turtle)
- Restore and maintain the health of streamside trees (such as river red gum and black box)
- Restore and maintain mudflat vegetation communities (such as tall marsh, herblands, rushes and sedges)
- Restore and maintain native aquatic vegetation species (such as tassel, milfoil and pondweed)
- Reduce the extent and density of invasive plant species
- Support a mosaic of wetland plant communities across the region
- Provide resting, feeding and breeding habitat for a variety of waterbird feeding guilds including threatened species (such as Australasian bittern, little bittern and brolga)
- Provide carbon and nutrients to Pyramid Creek to boost the riverine food web

Figure 5.2.3 The Central Murray wetlands system



Traditional Owner cultural values and uses

The wetlands and surrounding land in the central Murray region are rich in cultural heritage, with sites and artefacts of cultural practices present throughout the landscape. The rivers and floodplains are valued as food and fibre sources and contain many sites of significance such as camp sites and meeting places. Environmental watering supports values such as native fish, waterbirds and turtles, and promotes the growth of culturally important plants that provide food, medicine and weaving materials. The presence of water itself can be a cultural value, as well as the quality of the water, as healthy water promotes a healthy Country.

Barapa Barapa, Wamba Wemba and Yorta Yorta Traditional Owners have contributed to environmental water planning for wetlands important to them in the central Murray region in 2020-21. Focus areas include:

- Barapa Barapa and Wamba Wemba Traditional Owners have highlighted maintaining or improving the health of wetland vegetation as a key priority across the wetlands. Watering activities in Guttrum Forest will again be a particular focus for Barapa Barapa and Wamba Wemba Traditional Owners in 2020–21 (as described below)
- North Central CMA and Barapa Barapa Traditional Owners have collaborated to deliver the DELWP-funded Decision-Support Tool project, which is guiding vegetation works at McDonalds Swamp, and Lake Leaghur and Lake Yando (sites within the Boort wetlands, see section 5.7.2). This has allowed them to align watering actions in these wetlands with the watering requirements of the revegetation and enabled monitoring to be completed by Barapa Barapa
- North Central CMA and Yorta Yorta Nation Aboriginal Corporation have considered watering priorities for 2020–21, with a particular focus on Richardsons Lagoon. The Yorta Yorta Traditional Owners are supportive of the current drying phase in the lagoon, and its objectives of aerating sediment, reducing carp and providing a boost to productivity when water returns.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.2.8 with an icon.

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

Barapa Barapa and Wamba Wemba input to watering actions for Guttrum Forest in 2020–21

The proposed delivery of water for the environment to Guttrum Forest during 2020–21 has been planned in conjunction with the Barapa Barapa and Wamba Wemba peoples, for whom the wetlands and surrounding forest are places of high cultural significance. The Traditional Owners have been an important part of Guttrum Forest planning and management from the outset and were directly involved in the delivery of environmental flows to Reed Bed Swamp in 2019–20.

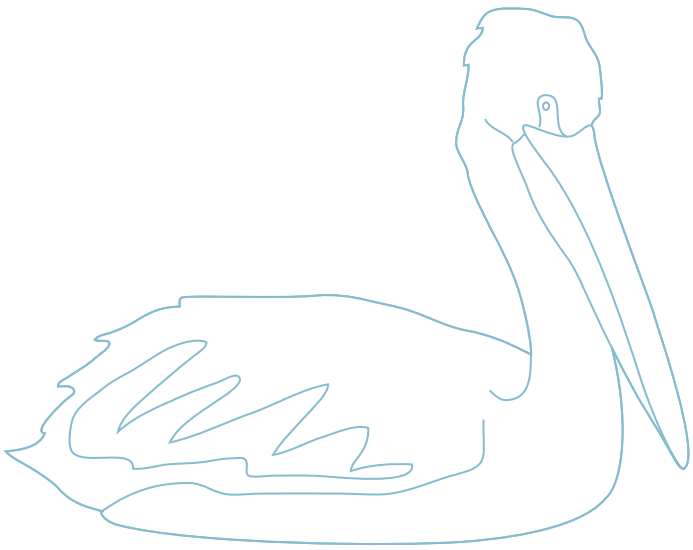
Barapa Barapa and Wamba Wemba collaborate with waterway managers to ensure that during watering events their cultural heritage is protected and that the hydrological needs of important cultural values (such as food and medicinal plant species, scar trees and ring trees) are supported through the timing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

The Traditional Owners advised that filling Guttrum Forest in winter 2020 and a top-up in spring would be appropriate timing to support large old trees and bird breeding. Additional watering in autumn/winter 2021 was recommended to prime the wetland for fills in the 2021–22 water year, to increase the duration of wetting.

Table 5.2.7 outlines the values and uses considered in the planning and management of watering at Guttrum Forest in 2020–21.

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

Value/use	Considerations
Food, fibre and medicinal plants	A winter fill followed by a spring top-up will ensure that the duration of wetting will be long enough to support aquatic vegetation during its optimal growth period. Allowing the wetland to dry before summer will also promote cultural plants on the mudflats in these areas.
Cultural heritage	Watering of Reed Bed Swamp supports fringing large old trees including a couple of ring trees and scar trees. The condition of these trees was seen to improve following the 2019 watering: for example, there was new growth.
Spiritual wellbeing	The improvement in condition of the wetland and the presence of water and moisture contributed to a sense of spiritual wellbeing.
Sharing cultural knowledge	The Traditional Owners provide support and advice about what ecological values to target: that is, they provide information about what the wetland used to look like and what values it previously supported. Traditional Owners were also present during the set-up of infrastructure and were able to provide advice about avoiding impacts to their cultural heritage.
Employment opportunities	Traditional Owners want to become more involved in the management of their Country through increased employment opportunities (such as ecological and cultural monitoring). This occurred as part of the 2019 watering of Reed Bed Swamp.
Cultural landscape	Maintaining the open-water habitat and mudflats underneath that will disappear if the river red gum saplings that germinated in the 2016 floods are not removed. This is important for maintaining the cultural landscape and access to food and medicinal resources.



Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.8, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as kayaking, canoeing, fishing, swimming and water sports)
- riverside recreation and amenity (such as walking, running, cycling, camping, birdwatching and duck hunting)
- community events and tourism (such as visitation during the hunting and fishing seasons, Breakfast with the Birds events (North Central CMA), supporting Aboriginal cultural heritage and history-based tours)
- socio-economic benefits (such as ecosystem services like groundwater recharge, flood mitigation, nutrient treatment and carbon storage).

Recent conditions

The central Murray area had below-average rainfall and above-average temperatures throughout most of 2019–20. Rainfall in spring 2019 was well below the long-term average and as a result, storage inflows for the year were also much lower than average. Water for the environment was delivered to seven central Murray wetlands in 2019–20 in line with planning under a dry scenario.

Round Lake and Lake Elizabeth received environmental water during 2019–20 to maintain salinity within the target range for endangered Murray hardyhead. Lake Cullen, which has held water since the natural floods in 2016, was topped up in spring 2019 to support the growth and recruitment of submerged and emergent aquatic plants and provide feeding and roosting habitat for waterbirds.

Wirra-Lo wetland complex received environmental water during the spring and summer 2019–20 that primarily targeted growling grass frogs and wetland vegetation communities. Wetting and drying regimes are being staggered across the eight wetlands within the Wirra-lo wetland complex based on their ecological condition and site-specific watering needs, including to support revegetation projects and the feeding and breeding habitat of various species (such as the growling grass frog and Australasian bittern).

Water for the environment was delivered to Reed Bed Swamp and Little Reed Bed Swamp in Guttrum Forest for the first time in spring 2019. The watering action aimed to reduce the recent encroachment of river red gum saplings across the bed of the wetland and provide feeding and breeding habitat for waterbirds and frogs. Many of the large old fringing river red gums showed improved tree canopy with new growth after the watering event.

Johnson Swamp was filled in spring 2019 to provide food and breeding habitat for waterbirds, especially Australasian bittern. Subsequent monitoring detected Australasian bittern breeding calls as well as large numbers of small-bodied native fish, waterbugs, frogs and eastern long-neck turtles. A spring fresh in Pyramid Creek was partly diverted through Johnson Swamp to help export nutrients, carbon and waterbugs from the wetland into the creek to increase the productivity of riverine food webs.

After completing its drying cycle, McDonalds Swamp received a partial fill in autumn 2020. The watering aimed to promote the growth of planted and naturally recruited river red gums, support early plant germination and promote winter feeding conditions for waterbirds and frogs, and prime the wetland for a spring fill.

Water for the environment was delivered to Third Reedy Lake for the first time in 2019–20. Goulburn-Murray Water used to manage Third Reedy Lake as a water storage, but it is no longer needed for that purpose and the long-term plan for the site is to restore a more natural wetting and drying regime to support a range of environmental values. Ecological surveys conducted as part of the de-commissioning work recorded several southern purple spotted gudgeon at the site. The species was thought to be extinct in Victoria, and water for the environment is currently being used to maintain the population at Third Reedy Lake while long-term management plans for the site and the species are being developed.

Scope of environmental watering

Table 5.2.8 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.2.8 Potential environmental watering actions and objectives for the central Murray wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Round Lake (top-up as required)	• Maintain salinity within 25,000–60,000 EC (may go up to 80,000 EC) to support suitable habitat and breeding conditions for Murray hardyhead and growing conditions of submerged aquatic plants	
Lake Elizabeth (top-up as required)	• Maintain salinity within 25,000–60,000 EC (may go up to 80,000 EC) to support suitable habitat and breeding conditions for Murray hardyhead, and growing conditions of submerged aquatic plants • Provide permanent water as habitat for waterbirds	
Wirra-Lo wetland complex – Brolga Swamp (fill in spring and top up as required)	• Promote growth and maintenance of submerged and emergent aquatic vegetation • Provide feeding and breeding habitats for growling grass frog and other frog species • Provide open water and foraging habitats for shallow wading waterbirds and mudflat specialists to feed and breed • Provide refuge and recruitment sites for freshwater turtles	
Wirra-Lo wetland complex – Red Gum Swamp (fill in spring and top up as required)	• Promote the growth and maintenance of existing red gum trees • Provide feeding and breeding habitats for growling grass frog and other frog species • Provide recruitment sites for freshwater turtles • Provide resting, feeding and breeding habitat to support waterbirds	
Wirra-Lo wetland complex – Bunyip Swamp East and Bunyip Swamp West (top up in spring, and further top-up as required)	• Support the growth of recently established reed beds to create nesting habitat for Australasian bittern	
Third Reedy Lake – (top up as required)	• Maintain water level above 74.0m AHD (Australian Height Datum) to support critical habitat and breeding for the southern purple spotted gudgeon	
McDonalds Swamp (fill in late winter/spring, and top up as required)	• Promote the growth of planted and naturally recruited river red gums, native semi-aquatic and aquatic plants, which provide high-quality habitat for waterbirds to feed and breed • Maintain feeding conditions for waterbirds if significant waterbird breeding occurs	
Hird Swamp (west) (fill in spring and top up as required)	• Promote the growth and establishment of wetland plant communities to provide high quality habitat for waterbirds, reptiles and frogs to feed and breed • Maintain food for nesting waterbirds if significant breeding occurs	
Hird Swamp (west) (through-flow to Pyramid Creek in spring/summer)	• Deliver carbon-rich water to Pyramid Creek to increase the productivity of riverine food webs	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Guttrum Forest (partial fill in winter 2020, with top-ups in spring/summer if required to support waterbird breeding)	• Wet existing adult river red gums to support growth and drown river red gum saplings to maintain open-water habitat • Promote the growth and re-establishment of aquatic and tall marsh vegetation • Maintain depth of wetland to support frogs and waterbird feeding and breeding	
Richardsons Lagoon (fill in winter/spring, top up as required)	• Promote the growth of aquatic macrophytes, reeds and rushes, which in turn would support aquatic biota • Wet the higher floodplain environment to maintain eucalypt floodplain woodland and create habitats for waterbirds, reptiles and frogs and associated wetland animals to feed and breed • Increase food resources (e.g. waterbugs and zooplankton) for waterbirds and other wetland animals	
Guttrum Forest (partial fill in autumn/winter 2021)	• Increase water depth and extent to trigger wetland plants to germinate in late winter and early spring • Provide feeding and refuge habitat for waterbirds and frogs	

Scenario planning

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

There are seven high-priority (tier 1) wetlands that are planned to receive environmental water releases under all scenarios during 2020–21. Watering at four of these wetlands aims to maintain critical habitat for rare or threatened species: Round Lake (Murray hardyhead), Lake Elizabeth (Murray hardyhead), Third Reedy Lake (southern purple spotted gudgeon) and Wirra-Lo wetland complex (growling grass frog). Watering at McDonalds Swamp, Hird Swamp and Guttrum Forest is needed to support North Central CMA's strategy of providing a mosaic of wetland habitat types and ecosystem services across the central Murray region over multiple years. The planned watering actions at these seven sites are expected to use between 17,700 ML and 18,300 ML, depending on weather conditions. Watering at Richardson's Lagoon is also a high priority under the average and wet scenarios, as water availability will allow the optimum watering regime to be met.

The environmental values at Richardsons Lagoon will benefit from watering in winter/spring 2020, but it is considered a lower priority as its minimum watering regime will allow for the site to remain dry between events for up to two years. A flow through Hird Swamp from Pyramid Creek has been identified as a tier 2 watering action under all scenarios, but it may be elevated to a high-priority action if a spring high flow occurs in Pyramid Creek when Hird Swamp is already full. This is very similar to the flow delivered through Johnson Swamp in 2019–20, and it would enhance the environmental benefit of the planned winter/spring fill at Hird Swamp by transporting carbon and waterbugs from the wetland to Pyramid Creek, where it can increase food for native fish. Potential watering actions for Pyramid Creek in 2020–21 are described in section 5.7.1. Partially filling Guttrum Forest in autumn/winter 2021 has also been identified as a tier 2 watering action under all scenarios. This watering action aims to prime the wetland ahead of a larger fill in winter/spring 2021, and it will only be delivered if the winter/spring event is likely to proceed and there is sufficient water available at the time.

There are no plans to deliver water for the environment to Johnson Swamp, Lake Cullen and Lake Murphy in 2020–21. If there are no natural floods, these wetlands will be allowed to draw down to oxygenate the soil, control invasive aquatic weeds and support the growth of lake-bed herbland vegetation communities that rely on periodic drying phases to develop and reproduce.

Priority carryover requirements have primarily been calculated based on the estimated volume required to support Murray hardhead sites, Guttrum Forest, Wirra-Lo wetland complex and the southern purple-spotted gudgeon in 2021–22.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment runoff and natural flow into the wetland are unlikely	• Some catchment run-off and natural flow into the wetlands are possible, particularly in winter/spring	• Low to moderate catchment run-off and natural flow into the wetlands are likely, particularly in winter/spring	• Catchment run-off and natural flow into the wetlands is likely with potential widespread flooding in some wetlands, particularly winter/spring
Potential environmental watering – tier 1 (high priorities)[1,2]	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020)	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020)	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020) • Richardsons Lagoon	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex (Brolga Swamp, Red Gum Swamp, Bunyip Swamp East, Bunyip Swamp West) • Third Reedy Lake • McDonalds Swamp • Hird Swamp (west) • Guttrum Forest (winter/spring 2020) • Richardsons Lagoon
Potential environmental watering – tier 2 (additional priorities)[2]	• Richardsons Lagoon • Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)	• Richardsons Lagoon • Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)	• Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)	• Hird Swamp 'through flow' • Guttrum Forest (autumn/winter 2021)
Possible volume of environmental water required to achieve objectives[3]	• 17,700 ML (tier 1) • 3,700 ML (tier 2)	• 18,500 ML (tier 1) • 3,700 ML (tier 2)	• 21,700 ML (tier 1) • 500 ML (tier 2)	• 21,500 ML (tier 1) • 500 ML (tier 2)
Priority carryover requirements	• Up to 14,000 ML			

[1] Tier 1 potential environmental watering for the central Murray wetlands is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the central Murray wetlands.

[2] Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios.

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

5.2.4 Hattah Lakes

System overview

The Hattah-Kulkyne National Park is situated in north-west Victoria adjacent to the Murray River (Figure 5.2.4). The national park contains a complex of more than 20 semi-permanent freshwater lakes known collectively as the Hattah Lakes.

The ecology of the Hattah Lakes and surrounding floodplain is strongly influenced by flooding regimes of the Murray River. The system fills when there is high flow in the Murray River, and some lakes hold water for several years after floods recede. Regulation of the Murray River has significantly reduced the frequency and duration of small- to medium-sized natural floods in the Hattah Lakes system. Over time, this has degraded vegetation communities and reduced the diversity and abundance of animals that use the vegetation and wetlands for habitat and food.

The Hattah Lakes complex can be broadly divided into the southern Hattah Lakes, which contains permanent to semi-permanent wetlands, and the higher-elevation northern Hattah Lakes, which are mostly ephemeral wetlands.

The Messenger, Oateys and Cantala regulators allow water to flow between the Murray River and Hattah Lakes. When flows in the Murray River are about 26,000 ML per day, water begins to flow through Messengers regulator into Chalka Creek and through to the Hattah Lakes complex. A permanent pump station has also been constructed that can deliver up to 1,000 ML per day to Hattah Lakes through Chalka Creek. The regulators and pump station are used in combination with several small constructed levees to restore a beneficial pattern of flooding to the lakes.

Lake Kramen in the south east of Hattah-Kulkyne National Park is disconnected from the main Hattah Lakes complex. The Hattah Lakes pump station can deliver up to 145 ML per day to Lake Kramen to restore flooding regimes.

Environmental values

Hattah Lakes is home to a diverse range of flood-dependent vegetation that changes with the topography of the landscape. Vegetation types range from wetland communities in lower-lying areas that require almost annual flooding to lignum and black box communities situated higher on the floodplain that only need flooding once every four to five years (on average).

A combination of natural flooding and the delivery of environmental flows since 2010 has improved tree canopy health and recruitment of black box and river red gum communities throughout the Hattah Lakes. Woodland birds, including the endangered regent parrot, have benefited from the improved tree health.

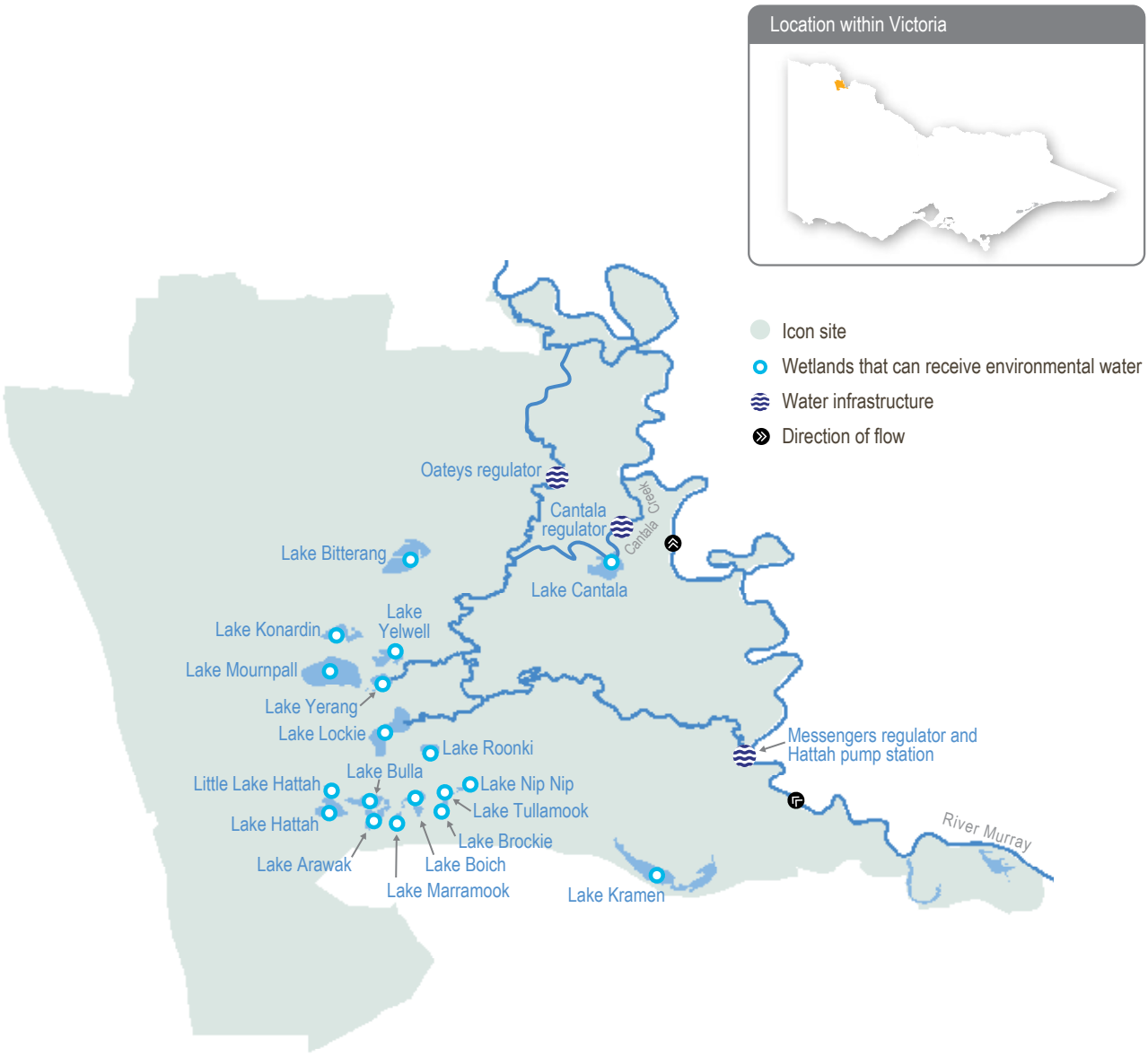
Hattah Lakes provides important waterbird breeding sites in an arid landscape. A total of 34 species of waterbirds are known to breed at the lakes when conditions are suitable. Another six species of waterbirds breed in the surrounding floodplain. Wetland drought-refuge sites are limited in the region,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

The Hattah Lakes support native fish species such golden perch and endangered freshwater catfish, which can move between the lakes and the Murray River when flows are suitable. Fish can also persist in permanent wetlands in the Hattah Lakes during dry years.

Environmental watering objectives in the Hattah Lakes

- Increase the native fish populations
- Restore and maintain a mosaic of healthy wetland and floodplain plant communities
- Provide feeding and nesting habitat for the successful recruitment of waterbirds and woodland birds

Figure 5.2.4 The Hattah Lakes system



Traditional Owner cultural values and uses

The Hattah Lakes system is part of a highly sensitive region for Aboriginal cultural heritage values and contains considerable evidence of past Aboriginal occupation. More than 1,000 Indigenous archaeological sites at the Hattah Lakes are registered with Aboriginal Victoria.

The local Aboriginal community maintains strong connections to the land and its resources such as native species used for food and medicine.

Mallee CMA and members of Tati Tati, Latje Latje, Gilby Corporation and Munutunga discussed a range of options for how environmental flows can be delivered at Hattah Lakes in 2020–2021. Elders spoke of the importance of drying cycles for wetlands and the abundance of the culturally significant old man weed that is flourishing on the drying lake beds. They also warned of not leaving the system dry too long and provided advice on the method of mimicking natural inundation when water does return. Their recommendations for watering actions have shaped environmental water planning for 2020–21.

Social, economic and recreational values and uses

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

- water-based recreation (such as canoeing, kayaking and fishing)
- riverside recreation and amenity (such as camping, photography, birdwatching and bushwalking)
- community events and tourism (such as 'Junior Ranger' school holiday programs including bushwalking, birdwatching and bug hunting, school education programs, citizen science projects (microbats), tours involving kayaking, mountain bike riding, camping, fishing and swimming)
- socio-economic benefits (such as beekeeping).

Recent conditions

Weather observations at the nearest weather station to Hattah Lakes in Ouyen indicate there was below-average rainfall and above-average temperatures in the area during 2019–20. The average maximum temperature at Ouyen during 2019–20 was less than the previous year, but long-term data indicates that temperatures have increased over the previous 10 years. Rainfall totals were substantially below average for the year. Overbank flows from the Murray River affect the ecology of the Hattah Lakes floodplain more than local weather conditions, but the trend of increasing temperature and decreasing rainfall is harmful to plant and animal communities between floods.

2019–20 was dry across the entire Murray River valley and the major upstream tributaries that contribute flows to the mid-Murray river system. There were no spills from major upstream storages and the magnitude of operational flows and environmental flows that were released was well below the threshold for inflows to Hattah Lakes.

Decisions about environmental watering interventions at Hattah Lakes during 2019–20 focussed on the need to water Lake Kramen — a disconnected wetland at the fringes of the system — and the need to dry the main southern Hattah Lakes.

At Lake Kramen, observations of tree health indicated that environmental watering was necessary during spring 2019 to avoid a permanent decline of vegetation condition, therefore environmental water was released as planned to Lake Kramen during August to October 2019.

Water for the environment delivered the last flood in the southern Hattah Lakes wetland complex in 2017. The wetlands have been allowed to draw down since then, and the last wetlands to hold water dried in February 2020. The moisture remaining in the lake-bed soils and local rainfall is supporting the growth and recruitment of specialised lake-bed native vegetation.

If there is no natural wetting before autumn 2021, the lake-bed vegetation in the southern Hattah Lakes will have likely completed its life cycle and will die off, due to reduced soil moisture. Water for the environment may be used in autumn/winter 2021 to refill these wetlands and restart the important wetting and drying cycle. Lake Kramen is expected to gradually draw down over several years. The planned timing of future environmental watering at Lake Kramen will be determined by the condition of the fringing vegetation.

Scope of environmental watering

Table 5.2.10 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.2.10 Potential environmental watering actions and objectives for the Hattah Lakes

Potential environmental watering action[1]	Functional watering objectives	Environmental objectives
Southern Hattah Lakes (fill of selected wetlands during autumn/winter 2021)	• Stimulate the growth and improve the condition of river red gums • Provide refuge and feeding habitat for waterbirds • Stimulate the growth of aquatic vegetation in wetlands that are currently dry	
Hattah Lakes (floodplain inundation up to 45.0 m AHD at any time if there is a natural flood)	• Wet river red gums and black box on the floodplain to stimulate growth and improve the condition of mature trees • Provide suitable soil conditions for the germination of black box trees on the floodplain and support the growth of trees that germinated in the flows provided in 2017 • Provide suitable conditions to support waterbird and woodland bird breeding and feeding • Provide connections to allow native fish to move between Hattah Lakes and the Murray River • Provide spawning and recruitment habitat for small-bodied native fish and nursery habitat for large-bodied native fish (such as golden perch)	

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

Scenario planning

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

Environmental watering is planned under all scenarios during 2020–21. The magnitude, extent and duration of environmental watering will increase through the spectrum of dry, average and wet scenarios.

In the absence of a natural flood, the highest-priority potential watering action will be to fill up selected wetlands in the southern Hattah Lakes in autumn/winter 2021. Under drought and dry scenarios, water for the environment should target the lowest-lying wetlands: Lakes Bulla, Hattah, Little Hattah, Lockie, Yewell and Yerang. Watering these wetlands would create a mosaic of wetland habitats within the southern Hattah Lakes that are at different stages of their wetting and drying cycle and provide significant refuge for waterbirds and terrestrial fauna in a generally dry landscape.

Under an average scenario, potentially significant local rainfall and higher flows in the Murray River may provide an environmental cue to wet more wetlands. This would provide benefits for a larger area of native vegetation, increase the total amount of available habitat for waterbirds and provide the first opportunity in several years to grow waterbird populations.

If the potential watering actions planned for autumn/winter under the dry and average scenarios begin and cannot be completed by 30 June 2021, it will be necessary to continue watering into the 2021–22 water year.

In a wet scenario, natural flow is expected to wet Hattah Lakes, and environmental water may be used to extend the duration and extent of wetting to ensure parts of the floodplain that rely on natural floods are watered. Little or no environmental watering may be needed to supplement a large flood, but if there is only moderate natural flooding, the Hattah pumps may be used to enhance environmental outcomes.

The tier 2 watering actions that are identified would target extra wetlands and the floodplain to broaden the area watered and increase the overall environmental benefits. The tier 2 watering actions could be delivered if circumstances allow, but they can likely be deferred without significant environmental harm.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Low flow year-round in the Murray River and no natural inflows to Hattah Lakes; substantial wetland drying will occur	• Rare high-flow events in the Murray River and no natural inflows to Hattah Lakes; substantial wetland drying will occur	• Short periods of high flow, most likely in late winter/spring, providing minor natural inflows to Hattah Lakes	• Lengthy periods of high flow with major spills from storages resulting in widespread wetting of Hattah Lakes and floodplain
Potential environmental watering – tier 1 (high priorities)[1]	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bulla, Hattah, Little Hattah, Lockie, Yewell and Yerang	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bulla, Hattah, Little Hattah, Lockie, Yewell and Yerang	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bulla, Hattah, Little Hattah, Lockie, Yewell, Yerang, Arawak, Boich, Brockie, Konardin, Marramook, Mournpall, Nip Nip and Tullamook	• Hattah Lakes (floodplain inundation up to 45.0 m AHD)
Potential environmental watering – tier 2 (additional priorities)		• Autumn/winter fill of southern Hattah Lakes, targeting lakes Arawak, Boich, Brockie, Konardin, Marramook, Mournpall, Nip Nip and Tullamook	• Autumn/winter fill of southern Hattah Lakes, targeting lakes Bitterang and Cantala	
Possible volume of environmental water required to achieve objectives[2]	• Up to 12,000 ML (tier 1)	• 12,000 ML (tier 1) • 18,000 ML (tier 2)	• 30,000 ML (tier 1) • 30,000 ML (tier 2)	• Up to 125,000 ML (tier 1)[3]

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

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

[3] In a wet scenario, it is expected that natural floods will meet most of the required watering actions, with environmental water making up shortfalls as needed.

5.2.5 Lower Murray wetlands

System overview

The lower Murray wetlands are dispersed across the Murray River floodplain between Swan Hill and the South Australian border. The system includes a myriad of interconnected creeks, wetlands and floodplains that are ecologically important and reflect the natural character and attributes of the floodplain. While the number of wetlands across the lower Murray region are in their hundreds, about 54 of these have received water for the environment to date.

Regulation and diversion of Murray River flows have substantially reduced the frequency and duration of the high river flows that would naturally water the lower Murray wetlands. This change to the water regime has been exacerbated by climate change and has reduced the variety and condition of environmental values associated with billabongs and other floodplain habitats.

Water for the environment can be delivered to some wetlands in the region through direct pumping from the Murray River and/or use of irrigation supply infrastructure. Most wetlands that receive environmental flows can be managed independently of each other.

Some wetlands within the lower Murray region can receive water through weir pool manipulation and regulator operation, for improved environmental outcomes. However, because they do not receive held environmental water, they are not specified under this plan. Details of the environmental objectives associated with those wetlands can be found in the Mallee CMA's *Seasonal Watering Proposal for the Lower Murray Wetlands 2020–21*.

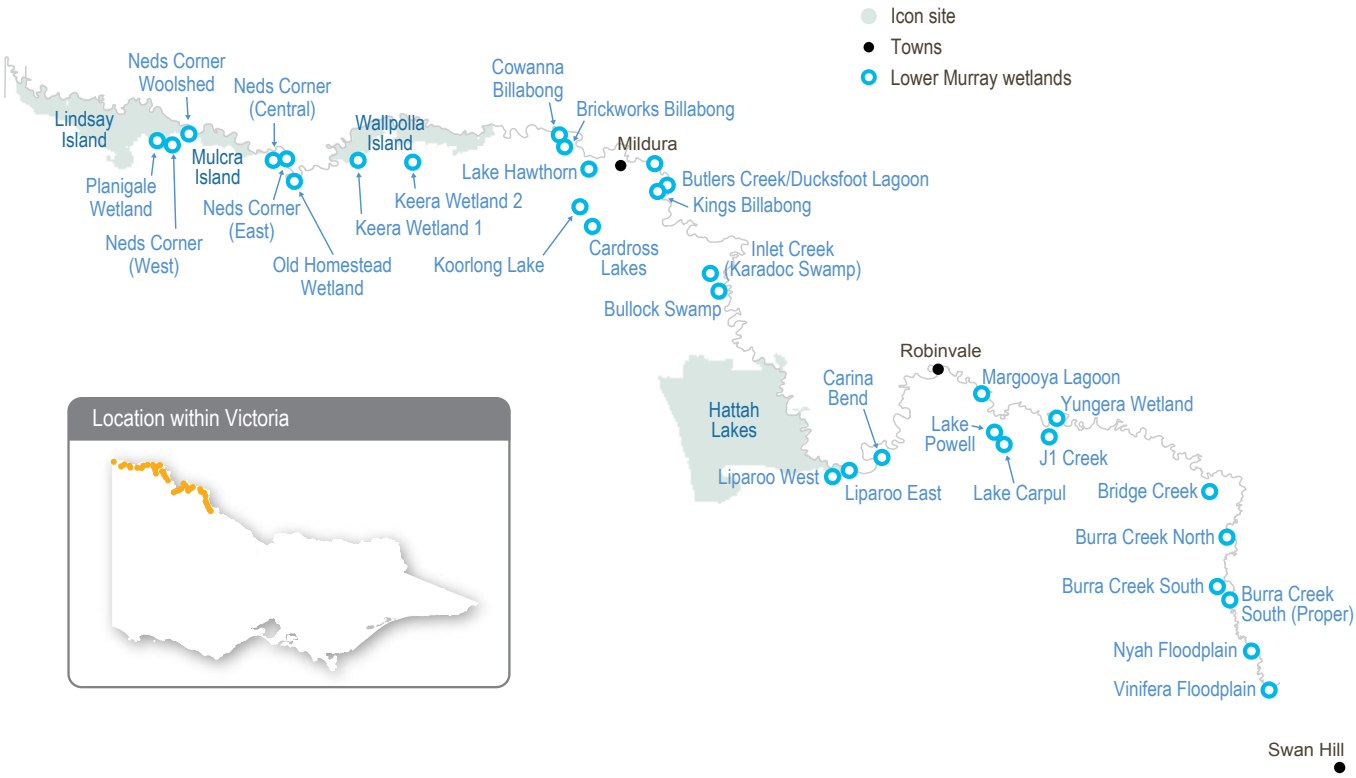
Environmental values

The lower Murray wetlands are comprised of multiple wetlands, creeks and billabongs. Depending on their location in the landscape, interactions with groundwater and their management history, the wetlands may be permanent or temporary, freshwater or saline. Differences in water regime and water quality between the wetlands provide a range of habitats for plants and animals. For example, permanent, saline wetlands (such as Koorlong Lake) provide vital habitat for the endangered Murray hardyhead fish. Ephemeral wetlands support different ecological processes in their wet and dry phases. During the wet phase, they provide short-term boom periods when river red gum trees and wetland plants grow, spread and provide habitat for aquatic animals (such as waterbugs, birds, frogs and in some cases fish). During the dry phase, sediments are exposed to the air (which is important for carbon and nutrient cycles), and terrestrial plants grow and complete life cycles.

Environmental watering objectives in the lower Murray wetlands

- Maintain and/or increase populations of native fish in permanent wetlands
- Maintain and/or grow populations of native frogs including the endangered growling grass frog
- Increase the diversity, extent and abundance of wetland plants
  Improve the condition of river red gums, black box and lignum
- Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial nesting species (such as egrets)

Figure 5.2.5 The lower Murray wetlands



Traditional Owner cultural values and uses

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

Mallee CMA has met with the First People of Millewa-Mallee Aboriginal Corporation (representing Latji Latji, Ngintait, Nyeri Nyeri and Wergaia Traditional Owners), and representatives from Tati Tati, Weki Weki, Wadi Wadi, Gilby Corporation and Munutunga Elders. Discussions covered a range of options for how environmental flows can be delivered in 2020–2021 and what the traditional ecological needs were in the current climate. Elders participated in planning and prioritisation processes on Country important to them and relationships with the Mallee CMA were strengthened. The values, knowledge and concerns raised through these discussions have supported Mallee CMA's planning for wetland watering across the lower Murray region.Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.2.12 with an icon.

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

Robertson Creek is an area of high cultural significance that is being degraded as vegetation dies from lack of water and wind erodes the landscape. The First People of the Millewa Mallee Aboriginal Corporation are undertaking a program of restoration and protection work at the site. To complement the protection and restoration objectives, environmental water is planned to be delivered under all scenarios except drought, to improve the canopy cover of black box trees and to regenerate understory vegetation along Robertson Creek. In turn, the improved vegetation health will provide wind protection to the landscape alongside Robertson Creek.

Margooya Floodplain Wetland is a new site to be incorporated in the lower Murray wetlands environmental watering program in 2020-21. It is a small wetland to the north-east of Margooya Lagoon and the area is known to be of significant Indigenous cultural value. The main lagoon can receive water using existing infrastructure, but the surrounding floodplain is showing signs of drought stress. Mallee CMA has worked closely with the local Aboriginal community to identify potential watering actions to preserve and enhance cultural values at the site, including availability of traditional foods and medicines and preservation of an ecosystem and landscape used for ceremonies and featuring in song lines.

Social, economic and recreational values and uses

In planning the potential watering actions in Table 5.2.12, Mallee CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing, swimming and yabbying)
- riverside recreation and amenity (such as bushwalking, photography, running, yoga, geocaching, camping, birdwatching and four-wheel driving)
- community events and tourism (such as Parks Victoria's 'Junior Ranger' school holiday programs including bushwalking, birdwatching and bug hunting, citizen science projects (frogs and bats), community education and engagement programs, and tourists visiting the wetlands)
- socio-economic benefits (such as local businesses).

Recent conditions

The lower Murray region had below-average rainfall and above-average temperatures throughout 2019–20. Rainfall in some areas was the lowest recorded across two consecutive years. Flow in the Murray River was not sufficient to connect any wetlands on the lower Murray floodplain, and there was very limited run-off from local catchments.

In 2019–20, environmental water was delivered to 10 lower Murray wetlands that were identified as a high priority for environmental watering under a dry scenario. Most deliveries were in spring to maintain native vegetation, provide refuges for fish and waterbirds and maintain key ecosystem functions. Top-ups were provided to Lake Hawthorn, Brickworks Billabong and Koorlong Lake during summer and autumn to protect habitat for endangered Murray hardyhead.

During 2019–20, the Mallee CMA monitored water levels at wetlands that it had identified as important refuge habitats for native fish and frogs. Continued surveillance of refuge habitats will be a high priority in 2020–21.

Scope of environmental watering

Table 5.2.12 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.2.12 Potential environmental watering actions and objectives for the lower Murray wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Brickworks Billabong (fill in spring, with top-ups over summer/autumn as required)	• Fill in spring to 34.0 m AHD (Australian Height Datum) to wet and grow ruppia to provide nursery habitat for Murray hardyhead, and provide high levels of aquatic productivity • Allow natural recession of a maximum 1 m in late summer/autumn (to 33.0 m AHD) to provide shallow-water habitat and expose the mudflats to support foraging and resting of small waders	
Lake Hawthorn (top up in spring/summer/autumn as required)	• Fill the wetland to 33.3 m AHD to encourage the germination and growth of ruppia to provide nursery habitat for Murray hardyhead and visitation by shorebirds • Maintain water levels within a 30 cm range to provide resources for shorebirds and to maintain the Murray hardyhead population	
Koorlong Lake (top up in spring/summer/autumn as required)	• Fill the wetland to 38.0 m AHD in spring to support the growth of ruppia to provide nursery habitat for Murray hardyhead and provide high levels of aquatic productivity • Maintain water levels within a 30 cm range to provide resources for shorebirds and to maintain the Murray hardyhead population	
Margooya Floodplain Wetland (fill in autumn)	• Wet the floodplain to improve the health of the river red gum	
Robertson Creek (fill in spring)	• Fill the creek to wet the vegetation on the creek bed, banks and terraces to maintain the health and persistence of fringing black box and lignum communities	
Neds Corner Woolshed (through-flow in spring)	• Slow through-flow to allow seepage and fill deeper holes, to maintain the health of the fringing red gum vegetation communities and water-dependent species	
Bidgee lagoons (fill in spring)	• Fill the wetlands to maintain the health of river red gum communities, promote emergent vegetation communities and provide habitat for waterbirds	
Robertson Wetland (west) (partial fill in spring)	• Partially fill the wetland to promote the growth of cane grass and lignum and provide habitat for waterbirds	
Fishers lagoons (fill in spring)	• Fill the wetland to maintain the health of fringing river red gum communities	
Burra Creek South proper (fill in spring)	• Fill the creek line to maintain the fringing river red gum communities	
Lake Powell (fill in spring)	• Fill the lake to maintain the river red gum communities • Improve nesting habitat for waterbirds in flooded trees bordering the lake	
Lake Carpul (fill in spring)	• Fill the lakes to maintain the river red gum communities • Improve nesting habitat for waterbirds in flooded trees bordering the lake	

Scenario planning

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

In the event of ongoing dry conditions, a modest watering program is proposed for the 2020–21 year. The highest priority under all scenarios is to ensure water and salinity levels at Brickworks Billabong, Lake Hawthorn and Koorlong Lake are suitable to protect the endangered Murray hardyhead. Lake Hawthorn and Koorlong Lake will likely require managed environmental water deliveries under all scenarios, but natural floods are likely to meet the required watering regime at Brickworks Billabong under a wet scenario. Maintaining varying levels of permanent water at these sites also provides shallow-water habitat for wading, feeding and loafing by small wading bird species and migratory birds.

Under dry and average scenarios, additional priority sites include Robertson Creek, Neds Corner Woolshed Creek, Margooya Floodplain Wetland and the Bidgee lagoons (see the additional information below). The target water levels and volumes delivered to these sites may vary under each scenario depending on the available water, local rainfall and assessed environmental conditions. The rationale for watering these sites in 2020–21 is described below.

Robertson Creek contains black box woodland and shrubby understory communities, which are currently in poor condition and considered to have a low resilience to ongoing drought. Watering at this site aims to improve the condition of these vegetation communities and help protect nearby areas of cultural significance.

Watering at Neds Corner Woolshed Creek in 2019–20 had a very positive effect on native plants and animals at the site. Follow-up watering in 2020–21 will help improve the condition of the low herb communities at the wetland base and the large old river red gums, and it will build their resilience.

Under dry and average scenarios, environmental water may be pumped from the Murray River into the Margooya floodplain wetland in autumn 2021 to improve the health of river red gum that haven't been wetted since the 2016 floods. This watering will support Aboriginal cultural objectives at the site.

The Bidgee lagoons support two water-dependent ecological vegetation classes (floodplain grassy wetland and riverine chenopod woodland) that are classified as endangered in the Murray Fans bioregion. The lagoons have received water four times in the last 10 years, but the duration of these natural events was relatively short and did not deliver the environmental benefit expected of longer-duration events. Vegetation in some parts of the lagoons is in moderate condition, but vegetation in other areas is in poor condition. Targeted environmental watering is planned under dry and average scenarios in 2020–21 to improve the condition of vegetation communities across the whole site.

Under a wet scenario, many wetlands across the lower Murray floodplain are likely to be watered by natural floods and local rainfall. The only high-priority sites that are likely to require environmental water to meet their recommended watering regime under wet conditions are Lake Hawthorn, Koorlong Lake, Robertson Creek and Burra Creek South proper.

Burra Creek South proper has received water only twice in the last 10 years, with environmental water delivered in 2013–14 and 2014–15; and it did not receive any flood water in 2016. The site contains lignum, red gum and black box communities and was last observed in 2018 as being in moderate condition. However, due to persistent dry conditions after 2016, the site is at risk of deterioration. A fill in spring would improve vegetation condition and provide habitat for waterbirds and waterbugs.

If more water is available under average or wet conditions, it may be used to improve the condition of other sites on the lower Murray floodplain considered a lower priority. Under average conditions, extra water may be used at Robertson Wetland and Fishers lagoons. Under wet conditions, extra water may be used at Lake Powell and Lake Carpul. Watering these sites in 2020–21 if the opportunity arises will reduce the need to water them in the next one to two years if dry conditions return.

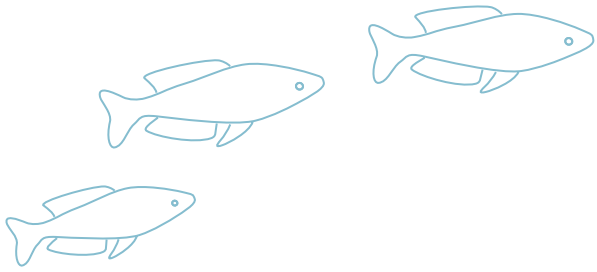
Table 5.2.13 Potential environmental watering for the lower Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural flow in the Murray River year-round and wetlands rely on delivery of water for the environment; very low rainfall year-round and extremely hot and dry conditions in summer/autumn causes substantial wetland drying	• Short periods of high flow in the Murray River are possible, however overbank flows to wetlands are unlikely; low rainfall and very warm summer/autumn	• Sustained periods of high flow in the Murray River in late winter and early spring may wet some low-lying wetlands but most wetlands will rely on delivery of water for the environment • Local rainfall may be high and provide run-off to some wetlands	• Lengthy periods of high flow and floods with major spills from storages, resulting in widespread wetting of the floodplain and most wetlands • Some reliance on water for the environment to achieve target water levels • Local rainfall may be high and will provide run-off to most wetlands
Potential environmental watering – tier 1 (high priorities)[1,2]	• Brickworks Billabong • Lake Hawthorn • Koorlong Lake	• Brickworks Billabong • Lake Hawthorn • Koorlong Lake • Margooya floodplain wetland • Robertson Creek • Neds Corner Woolshed Creek • Bidgee lagoons	• Brickworks Billabong • Lake Hawthorn • Koorlong Lake • Margooya Floodplain Wetland • Robertson Creek • Neds Corner Woolshed Creek • Bidgee lagoons	• Lake Hawthorn • Koorlong Lake • Robertson Creek • Burra Creek South proper
Potential environmental watering – tier 2 (additional priorities)	• n/a	• n/a	• Robertson Wetland (west) • Fishers lagoons	• Lake Powell • Lake Carpul
Possible volume of environmental water required to achieve objectives[3]	• 1,970 ML (tier 1)	• 3,555 ML (tier 1)	• 3,835 ML (tier 1) • 710 ML (tier 2)	• 2,200 ML (tier 1) • 6,200 ML (tier 2)

[1] Tier 1 potential environmental watering at the lower Murray wetlands is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the lower Murray wetlands.

[2] Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios.

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



5.2.6 Lindsay, Mulcra and Wallpolla islands

System overview

Lindsay, Mulcra and Wallpolla islands cover over 26,100 ha of Victorian floodplain in the Murray-Sunset National Park, as Figure 5.2.5 shows. They form part of the Chowilla Floodplain and Lindsay-Wallpolla islands icon site that straddles the Victoria–SA border in the mid-Murray River system.

The Lindsay, Mulcra and Wallpolla islands floodplain is characterised by a network of permanent waterways, small creeks and wetlands. The Lindsay River, Potterwalkagee Creek and Wallpolla Creek form the southern boundaries of the site and create large floodplain islands with the Murray River to the north.

In their natural state, these waterways and wetlands would regularly flow and fill in response to high water levels in the Murray River. Large floods still occur, but major storages in the upper reaches of the Murray River system have reduced the frequency of small- to moderate-sized floods.

Flows in the mid-Murray River system are regulated through a series of weir pools, generally referred to as locks. Water levels in the weir pools are managed primarily to provide safe navigation and adequate water levels for off-stream diversion via pumps. In recent years, the water level of weir pools 7 and 8 has also been managed to achieve ecological benefits in the Murray River channel, for example by lowering pool levels to increase the velocity of flowing water, which can support drift of golden and silver perch larvae when conditions are suitable for breeding.

Weir pool levels have a big effect on flows in Mullaroo Creek, the Lindsay River and Potterwalkagee Creek. When water levels in locks 7 and 8 are raised above the full supply level, flows to Potterwalkagee Creek increase and Lindsay River starts flowing. When weir pools are lowered, flows to both the Lindsay River and Potterwalkagee Creek cease. Mullaroo Creek is less-affected by weir pool levels and flows are controlled through the Mullaroo Creek regulator which connects the creek and the Murray River. Moderate lowering of the lock 7 weir pool level has little effect on Mullaroo Creek but lowering to or beyond 0.5 m below full supply level makes it difficult to deliver the recommended minimum flow of 600 ML per day that is required to maintain fast-flowing habitat for native fish, especially Murray Cod.

Fluctuation of weir pool levels is a major consideration for jurisdictions managing flows in the Murray River and the anabranch waterways of Lindsay, Mulcra and Wallpolla islands. Environmental objectives and associated water regimes for the Murray River sometimes conflict with those for the Lindsay, Mulcra and Wallpolla anabranch systems. Responsible agencies in Victoria and NSW and the Murray-Darling Basin Authority collaboratively plan how to manage weir pools and flows effectively.

Environmental values

The Lindsay, Mulcra and Wallpolla islands represent three separate anabranch systems including streams, billabongs, large wetlands and swamps. When flooded, waterways and wetlands within these systems provide habitat for native fish, frogs, turtles and waterbirds. Terrestrial animals (such as woodland birds) also benefit from improved productivity and food resources when the system floods. Large floodplain wetlands (such as Lake Wallawalla) can retain water for several years after receiving inflows; they provide important refuge for wetland-dependent species and support terrestrial animals (such as small mammals and reptiles).

Mullaroo Creek and the Lindsay River support one of the most-significant populations of Murray cod in the lower Murray River. These waterways provide fast-flowing habitat that Murray cod favour, and contrast with the mostly slow-flowing and still habitats created by the nearby Murray River weir pools. Fish in Mullaroo Creek and Lindsay River breed and produce juveniles that colonise other parts of the Murray system. Waterways and wetlands throughout the icon site support several other fish species including freshwater catfish, golden perch, silver perch, Murray-Darling rainbowfish and unspecked hardyhead.

The reduced frequency and duration of floods in the Murray River has degraded the water-dependent vegetation communities throughout the Lindsay, Mulcra and Wallpolla island system, which has in turn reduced the diversity and abundance of animals that rely on healthy vegetation for habitat.

Environmental watering objectives for Lindsay, Mulcra and Wallpolla islands

	Restore nutrient and carbon cycling between floodplains, floodplain wetlands and waterways to increase ecosystem productivity
	Increase the abundance, diversity and distribution of native fish
	Support frog populations
	Support waterbug populations
	Support turtle populations
	Increase the abundance and diversity of wetland vegetation
	Increase the waterbird population by providing feeding and breeding habitat in floodplain wetlands

Traditional Owner cultural values and uses

Mallee CMA has met on Country with Traditional Owners of Lindsay, Mulcra and Wallpolla islands and the First People of the Millewa-Mallee Aboriginal Corporation (representing Latji Latji, Ngintait, Nyeri Nyeri and Wergaia Traditional Owners) to discuss watering requirements for their Country. After much discussion, Elders' key focus was to support Country to recover from the ravages of drought. Their recommendations for watering actions have shaped the environmental water planning for 2020–21.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.2.14, Mallee CMA has also considered how environmental flows could support other values and uses such as:

- water-based recreation (such as kayaking, fishing and swimming)
- riverside recreation and amenity (such as walking, camping, birdwatching and relaxing with friends and family)
- community events and tourism (such as school education programs, commercial tours and citizen science projects)
- socio-economic benefits (such as apiarists, local businesses such as accommodation and shops).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.2.14 with an icon.

 Watering planned to support angling activities

Native recreational fish species that are stocked into recently wetted wetlands can undergo rapid growth and achieve high survival rates. In March 2019, the Victorian Fisheries Authority conducted a trial in partnership with First People of the Millewa-Mallee Aboriginal Corporation and Mallee CMA that released 120,000 juvenile golden perch and silver perch to Wallpolla Horseshoe Lagoon.

In order to protect the juvenile perch, water will be delivered to the lagoon as a series of top-ups as required in spring and autumn, as part of the regular environmental water deliveries to support the naturally occurring environmental values of the site (such as fish and aquatic vegetation).

The stocked native fish are expected to benefit from environmental watering at Wallpolla Horseshoe Lagoon without compromising the primary watering objectives for the site. Once the fish have grown to a suitable size, they will be released into the Murray River to contribute to the regional populations and provide opportunities for anglers.

Recent conditions

Weather observations at Lake Victoria — the nearest weather station to Lindsay, Mulcra and Wallpolla islands — indicate there was below-average rainfall and above-average temperatures in the region during 2019–20. The average maximum temperature at Lake Victoria during 2019–20 was less than in the previous year, but long-term data indicates that temperatures have increased over the previous 10 years. Monthly rainfall totals were substantially below average for the year.

The 2019–20 year was mostly dry in the entire Murray River valley and major upstream tributaries (such as the Goulburn and Murrumbidgee rivers). There were no spills from major upstream storages, and the magnitudes of operational flows and environmental flows that were released in the Murray system were well below the threshold required to provide flows to wetlands and floodplains at Lindsay, Mulcra and Wallpolla islands. Summer floods in northern New South Wales (NSW) and Queensland provided flow in the Darling River and in April 2020 the Darling River provided substantial flow to the Murray River for the first time in more than two years. This inflow was well below the magnitude needed to wet Lindsay, Mulcra and Wallpolla islands.

All of the high-priority potential watering actions were delivered during 2019–20. These included year-round flows to maintain fish habitat in Mullaroo Creek and spring high flows in Mullaroo Creek, Potterwalkagee Creek and the upper reaches of the Lindsay River to help native fish disperse, spawn and recruit. Water for the environment was also pumped to wetlands and creeks on Wallpolla Island in spring and autumn, to improve vegetation condition and provide habitat for waterbirds and fish.

Scope of environmental watering

Table 5.2.14 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

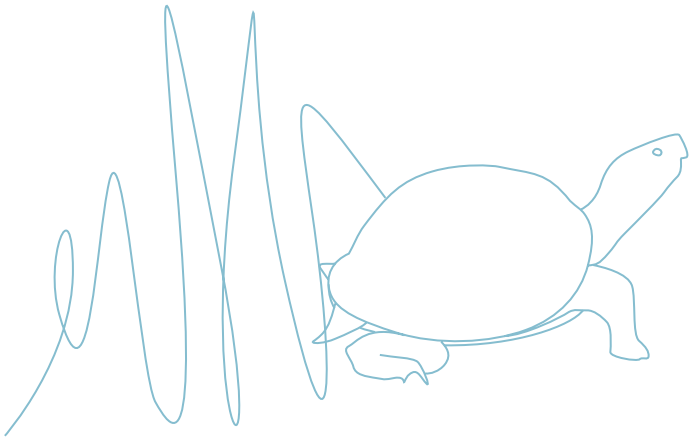


Table 5.2.14 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Lindsay Island – Mullaroo Creek		
Year-round low flow (minimum of 600 ML/day)	• Maintain fast-flowing habitat for native fish (such as Murray cod, silver perch and golden perch) • Maintain habitat for aquatic vegetation and maintain soil moisture to maintain the condition of streamside vegetation	
Spring fresh (one fresh of up to 1,000-1,400 ML/day for three months during September to November)	• Cue fish movement and spawning and improve recruitment opportunities for native fish	
Lindsay Island – Lindsay River		
Spring/summer fresh (one fresh of 65-200 ML/day via the northern regulator and one fresh of 20-200 ML/day via the southern regulator for a maximum of four months during September to December)	• Provide temporary flowing water to reconnect pools and support dispersal, spawning and recruitment opportunities for native fish • Wet the substrate and debris (snags) close to the bank to promote the growth of biofilms, which provide a food source for animals higher in the food chain	
Autumn/winter fresh (one fresh of 130 ML/day via the northern regulator and 90 ML/day via the southern regulator for two months during May to June)	• Wet the substrate and debris (snags) close to the bank to promote the growth of biofilms, which provide a food source for animals higher in the food chain[1]	
Lindsay Island wetlands		
Websters Lagoon (complete fill in spring)	• Provide a connection between Websters Lagoon and the Murray River to allow the exchange of carbon, nutrients and fish between the wetland and the river • Provide conditions for lake bed herbaceous plants and semi-aquatic plants in the littoral zone to grow in the drying phase after watering • Provide variable water levels in the littoral zone to provide feeding habitat for shorebirds • Provide open-water habitat as refuge and feeding and breeding habitat for waterbirds	
Scotties Billabong (complete fill in spring)	• Provide shallow-water habitat to provide foraging and breeding opportunities for frogs • Stimulate the growth of streamside and instream vegetation • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	
Wetland 33 (complete fill in spring)	• Fill to the wetland fringe to increase growth of shrubs and lignum on the wetland fringe • Provide shallow-water habitat and open-water habitat to create foraging opportunities for waterbirds, frogs and turtles • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	
Lindsay-Mullaroo connector (complete fill in spring)	• Provide a temporary connection to the Lindsay River to allow the exchange of nutrient, carbon and plant propagules • Provide conditions for lake bed herbaceous plants and semi-aquatic plants to grow in the littoral zone in the drying phase after watering • Stimulate the growth of severely stressed streamside vegetation	

Table 5.2.14 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Crankhandle (complete fill in spring)	• Provide shallow-water habitat to provide foraging and breeding opportunities for frogs • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering • Fill to the wetland fringe to increase the growth of shrubs and lignum on the wetland fringe	
Lake Wallawalla (partial fill in autumn/winter)	• Provide shallow-water habitat, open-water habitat and shoreline habitat to create foraging opportunities for waterbirds, frogs and turtles • Break the dormancy of yabbies so they emerge from burrows, feed and reproduce • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	
Mulcra Island – Potterwalkagee Creek		
Winter/spring fresh (one fresh of 90-475 ML/day via the Stoney Crossing regulator and 440 ML/day via the upper Potterwalkagee Creek regulator for a maximum of five months during September to November)	• Provide temporary flowing water to reconnect pools and support dispersal, spawning and recruitment opportunities for native fish • Wet the substrate and debris (snags) close to the bank to promote the growth of biofilms, which provide a food source for animals higher in the food chain • Maintain soil moisture to maintain the condition of streamside vegetation	
Mulcra Island – wetlands		
Mulcra Horseshoe (complete fill in spring)	• Provide shallow-water habitat and open-water habitat to create foraging and breeding opportunities for waterbirds, frogs and turtles • Provide a connection to the Murray River to support dispersal, spawning and recruitment opportunities for native fish • Stimulate the growth of emergent, aquatic and streamside vegetation • Provide a connection to the Murray River to allow the exchange of carbon, nutrients between the floodplain and the river	
Mulcra Island floodplain (floodplain inundation in spring)	• Stimulate the growth of emergent, aquatic and streamside vegetation • Provide shallow-water habitat and open-water habitat to create foraging and breeding opportunities for waterbirds, frogs and turtles • Support fish spawning events and provide temporary habitat for juvenile fish	
Snake Lagoon (complete fill on spring)	• Stimulate growth of emergent, aquatic and streamside vegetation • Provide conditions for lake bed herbaceous plants to grow in the drying phase after watering	

Table 5.2.14 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Wallpolla Island		
Wallpolla Horseshoe Lagoon (partial or complete fill in spring/autumn)	• Wet/drown river red gum saplings in the bed of Wallpolla Horseshoe to limit their coverage • Provide suitable breeding conditions for waterbirds • Provide shallow-water habitat and open-water habitat to create foraging and breeding opportunities for waterbirds, frogs and turtles • Provide the conditions for lake bed herbaceous plants and semi-aquatic plants to grow in the littoral zone during the drying phase after watering • Provide nursery habitat for naturally occurring fish populations and juvenile golden perch and silver perch stocked by Victorian Fisheries Authority to increase growth rates before fish are released to the Murray River	
Finnigans Creek (low flow in spring) Sandy Creek (low flow in winter/spring) Wallpolla Creek East (low flow in winter/spring)	• Provide connections between Wallpolla East, Sandy Creek and Finnigans Creek to allow nutrient exchange, increased wetland productivity and the dispersal of plant propagules • Provide variable water levels in the littoral zone to improve wetland productivity and promote the growth of native aquatic and fringing plants • Provide variable water levels in the littoral zone to provide feeding habitat for shorebirds • Provide open-water habitat to create foraging opportunities for waterbirds	

[1] The autumn fresh in the Lindsay River also has an operational objective of providing water that can be efficiently delivered to Lake Wallawalla via pumping.

Scenario planning

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

There are two categories of planned environmental watering opportunities for Lindsay, Mulcra and Wallpolla islands in 2020–21:

- environmental watering of anabranch waterways (Mullaroo Creek, Lindsay River and Potterwalkagee Creek) and floodplain wetlands in coordination with operation of weir pools
- a program of small-scale pumping to deliver water to individual wetlands at Lindsay and Wallpolla islands.

Of the waterways and floodplain wetlands connected to the weir pools, the only sites proposed to receive environmental water under all planning scenarios are Mullaroo Creek and Websters Lagoon. Even under drought conditions, it is essential to provide flows to Mullaroo Creek to maintain flowing water habitat for large-bodied native fish. Websters Lagoon can be efficiently managed via a regulator to provide an annual wet-dry cycle under all scenarios. Under an average scenario, environmental water may be delivered to Lindsay River and Potterwalkagee Creek in spring, when locks 7 and 8 will be at suitable levels. These locks are expected to be lowered during summer/autumn under an average scenario and all year under a drought or dry scenario, which will prevent flow into Lindsay River and Potterwalkagee Creek. No environmental watering is planned for these systems under a wet scenario, because natural flows and floods are likely to meet all ecological watering requirements.

Water for the environment may be pumped to up to nine high-priority wetlands and ephemeral creek lines across Lindsay and Wallpolla Islands in 2020–21. Water will need to be pumped directly into Wallpolla Horseshoe under drought, dry and average scenarios, but it is expected to fill naturally under a wet scenario. Other wetlands on Lindsay and Wallpolla islands are likely to need active watering under dry and average scenarios. Most of these wetlands will likely be watered in spring 2020, but pumping at Lake Wallawalla is planned to commence in autumn 2021 under average and wet scenarios and continue through to late spring 2021. All sites are expected to receive natural inflows under a wet scenario; but if only minor-to-moderate flooding occurs, pumping may still be required to reach target water levels in Lake Wallawalla and Wallpolla Creek East.

Additional environmental watering priorities (tier 2) have been identified for Lindsay and Mulcra islands wetlands and floodplain under dry and average scenarios. The tier 2 priorities identified are critical to achieving environmental objectives at the site in the long term and could be delivered in 2020–21 if circumstances allow, but they could be deferred without significant environmental harm.

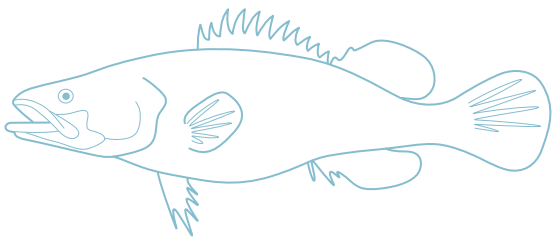


Table 5.2.15 Potential environmental watering for Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet[1]
Expected conditions	• Year-round low flow in the Murray River and no natural floodplain wetting. Weir pools will be drawn down below full supply level year-round. Substantial wetland drying will occur.	• Rare high-flow events in the Murray River and no natural floodplain wetting. Weir pools will be drawn down below full supply level year-round. Substantial wetland drying will occur.	• Short periods of high flow, most likely in late winter/spring, providing minor wetting of the floodplain. Weir pool levels raised in winter/spring and drawn down in summer/autumn.	• Long periods of high flow, with major spills from storages resulting in widespread wetting of the floodplain and wetting of most wetlands. Weirs would be removed to allow the passage of natural flows.
Lindsay Island				
Lindsay Island potential environmental watering – tier 1 (high priorities)[2]	• Year-round low flow (Mullaroo Creek) • One spring fresh (Mullaroo Creek) • Websters Lagoon (complete fill)	• Year-round low flow (Mullaroo Creek) • One spring fresh (Mullaroo Creek) • Websters Lagoon (complete fill) • Scotties Billabong (complete fill) • Wetland 33 (complete fill) • Lindsay-Mullaroo connector (complete fill) • Crankhandle (complete fill)	• Year-round low flow (Mullaroo Creek) • One spring fresh (Mullaroo Creek) • One spring fresh (Lindsay River) • One autumn/winter fresh (Lindsay River) • Websters Lagoon (complete fill) • Scotties Billabong (complete fill) • Wetland 33 (complete fill) • Lindsay-Mullaroo connector (complete fill) • Crankhandle (complete fill) • Lake Wallawalla (partial fill)	• One autumn/winter fresh (Lindsay River) • Lake Wallawalla (partial fill)
Possible volume of water for the environment required to achieve objectives[3]	• < 950 ML	• 950 ML	• Up to 6,250 ML	• Up to 4,000 ML

Table 5.2.15 Potential environmental watering for Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios *(continued)*

Planning scenario	Drought	Dry	Average	Wet[1]
Mulcra Island				
Potterwalkagee Creek potential environmental watering – tier 1 (high priorities)[2]	• N/A		• One spring fresh (Potterwalkagee Creek)	• N/A
Potterwalkagee Creek potential environmental watering – tier 2 (additional priorities)	• N/A		• Mulcra Horseshoe (complete fill) • Mulcra Island floodplain inundation • Snake Lagoon (complete fill)	• N/A
Possible volume of water for the environment required to achieve objectives[4,5]	• 0 ML		• Up to 3,000 ML (tier 1) • Up to 3,000 ML (tier 2)	• 0 ML
Wallpolla Island				
Wallpolla Island wetlands potential environmental watering – tier 1 (high priorities)[2]	• Wallpolla Horseshoe Lagoon (partial fill)	• Wallpolla Horseshoe Lagoon (partial fill) • Finnigans Creek • Sandy Creek • Wallpolla Creek East	• Wallpolla Horseshoe Lagoon (partial fill) • Finnigans Creek • Sandy Creek • Wallpolla Creek East	• Wallpolla Creek East
Potential environmental watering – tier 1 (high priorities)	• 400 ML	• 4,900 ML	• 4,900 ML	• 1,000 ML

[1] Natural wetting of wetlands and the floodplain under a wet scenario achieves the environmental watering requirements of most sites, so few potential watering actions are planned under a wet scenario.

[2] Tier 1 potential environmental watering at Lindsay, Mulcra and Wallpolla islands are not classified as tier 1a or 1b, because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the Lindsay, Mulcra and Wallpolla islands.

[3] These estimates include environmental use for Mullaroo Creek, Lindsay River and the lock 7 weir pool. Environmental water used at these sites may be accounted for in Victoria and New South Wales.

[4] These estimates include environmental use for Potterwalkagee Creek, Mulcra Island and the lock 8 weir pool. Environmental water used at these sites may be accounted for in Victoria and New South Wales.

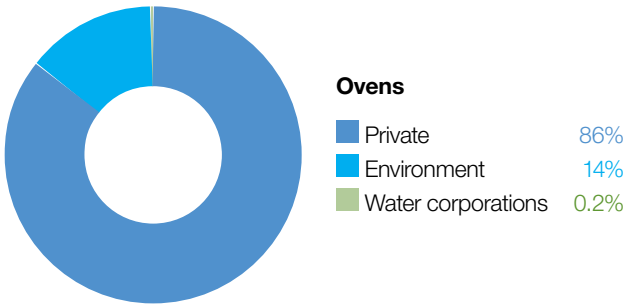
[5] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

5.3 Ovens system

Waterway manager – North East Catchment Management Authority
Storage manager – Goulburn-Murray Water
Environmental water holder – Commonwealth Environmental Water Holder

Did you know...?

In June 2019 and March 2020, 39 ML of water owned by Taungurung Land and Waters Council was delivered as an environmental flow down the King River. The flows have contributed to healing Country by providing a boost to the health and productivity of the waterway.



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

Top: Buffalo River, by Natalie Ord courtesy of North East CMA
Above: Catfish release at Mullinmur Wetland, by Manifeasto Photography

System overview

The Ovens River rises in the steep, forested mountains of the Great Dividing Range near Mount Hotham and flows about 150 km to join the Murray River in the backwaters of Lake Mulwala. The system contains two small water storages: Lake Buffalo on the Buffalo River and Lake William Hovell on the King River. The regulated reaches of the Ovens system include the Buffalo and King rivers below these storages and the Ovens River from its confluence with the Buffalo River to the Murray River.

As its storages are quite small and spill regularly, the Ovens system maintains a large proportion of its natural flow regime, particularly in winter/spring. However, the storages and licensed water extractions throughout the system can restrict flow during low flow periods, and parts of the system can become quite flow stressed during summer and autumn.

The Ovens River flows into Lake Mulwala on the Murray River, the largest weir pool on the Murray regulated system. Ovens River flows contribute to the reliability and variability of flows in the Murray River and support many downstream uses including irrigation, urban supply and watering of iconic floodplain sites (such as Barmah Forest).

Water for the environment is held in Lake Buffalo and in Lake William Hovell and can be released when the storages are not spilling. Five reaches in the Ovens system can benefit from releases of water for the environment. While all are important, there is a relatively small volume (123 ML) of water available, and it is insufficient to meet most of the environmental flow objectives. The available water is used selectively to deliver the greatest possible environmental benefit. Water for the environment is most commonly used in the Ovens system to deliver critical flow events in reaches immediately below the two main storages, or it is used in conjunction with operational water releases to influence flow in the lower Ovens River. It is also used to fill and top up Mullinmur Wetland in Wangaratta.

Environmental values

The diverse aquatic habitat and abundant food resources associated with the Ovens system support a wide range of native fish species including Murray cod, trout cod, golden perch and unspecked hardyhead. The Buffalo River provides valuable habitat for large-bodied fish species during part of their breeding cycle, while trout cod have a large range within the system and are found as far up the King River as Whitfield. A project to recover trout cod populations in the Ovens system has been successful, and efforts to reintroduce Macquarie perch are continuing.

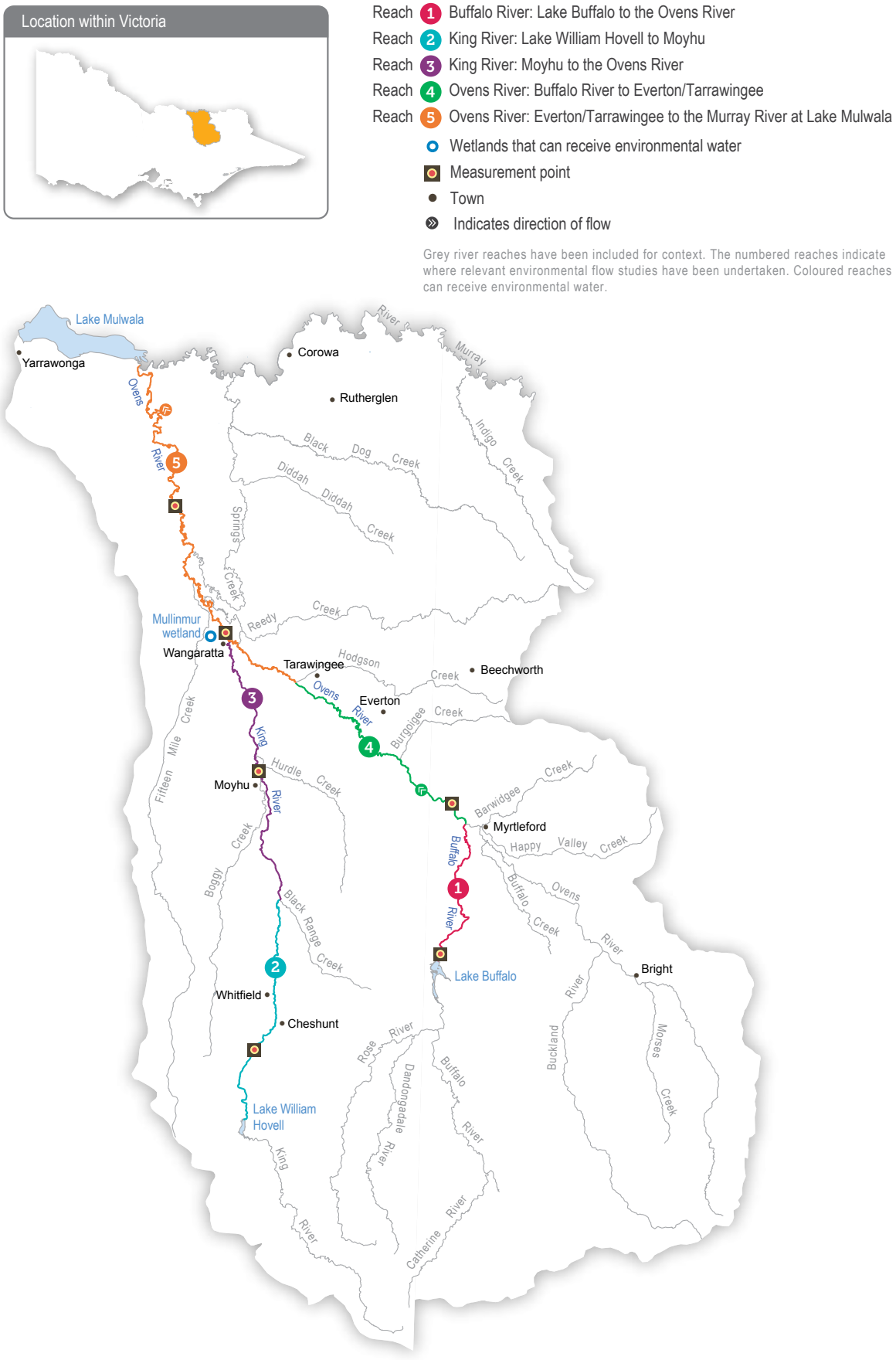
Frogs (such as the giant banjo frog and growling grass frog) are abundant in the lower reaches and associated wetlands of the Ovens River and in the King River above Cheshunt. The lower Ovens wetland complex contains over 1,800 wetlands, is listed as nationally significant and is home to a variety of waterbirds including egrets, herons, cormorants and bitterns. The streamside zones of river channels throughout the Ovens system support some of Victoria's healthiest river red gum forests and woodlands, while the wetlands support a variety of aquatic and semi-aquatic vegetation communities.

Water for the environment was delivered to Mullinmur Wetland at Wangaratta for the first time in 2019–20. This site has been the focus of several environmental improvement projects in recent years. Specific management actions include carp removal, a revegetation program and a project that started in December 2019 to determine whether the wetland can support a sustainable brood stock population of native freshwater catfish. The Arthur Rylah Institute translocated 60 freshwater catfish into Mullinmur Wetland in December 2019, and ongoing monitoring throughout 2020–21 will assess the viability of the population.

Environmental watering objectives in the Ovens System

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

Figure 5.3.1 The Ovens system



Traditional Owner cultural values and uses

North East CMA has consulted with Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation in environmental water planning for the Ovens system. The environmental and ecological objectives of the proposals were supported and align with the broad values of these Traditional Owner groups. Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in 5.3.1 with an icon.

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

Taungurung Land and Waters Council may consider using their water entitlement in the King River system to support environmental objectives as part of their goal of healing Country. Taungurung Land and Waters Council's 39 ML of allocation has been released from Lake William Hovell twice previously as an environmental flow in partnership with North East CMA, Goulburn-Murray Water and the VEWH to provide additional water to the King River and assist in healing Country. The flow provided a small variation within the water level to inundate new habitat for instream biota (fish and macroinvertebrates), allowing them to move more freely and find new sources of food.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.3.1, North East CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as boating and fishing)
- riverside recreation and amenity (such as camping)
- community events and tourism (such as providing a setting for community gatherings and sporting events, and citizen science projects)
- socio-economic benefits (such as businesses used by anglers).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.3.1 with an icon.

Watering planned to support angling activities

Environmental water will be used to top up Mullinmur Wetland over summer, support aquatic vegetation and support native catfish which were translocated to the wetland in 2019 from a drying lake in Barham, New South Wales. This will enable the site to be used as a catfish broodstock location for future reintroductions into the region.

The water will also support other benefits for the local community, as the site is managed by the Catholic Education Department with support from Wangaratta Landcare and Sustainability Incorporated. It is used as a community and environmental educational site for Galen Catholic College students, young people attending the Borinya Wangaratta Community Partnership and other members of the local community, demonstrating the important ecological functions that wetlands provide and how water for the environment is used to support ecological values.

Recent conditions

Hot, dry conditions prevailed throughout much of the Ovens River catchment in 2019–20, resulting in flows into Lake Buffalo and Lake William Hovel being well below the long-term average until rainfall began filling storages in March 2020. Water for the environment held in Lake Buffalo was used in conjunction with an operational bulk water transfer to deliver a small autumn fresh in the Buffalo River in early March. Small increases in river height were also observed in reach 4 of the Ovens River during this fresh. Water for the environment was delivered in conjunction with water held by the Taungurung Land and Waters Council from Lake William Hovell in late March, providing flow variability to reaches 3 and 4 of the King River.

Bushfires burnt large areas of the catchment above Lake Buffalo during summer, and subsequent heavy rainfall washed ash and other sediment into upstream tributaries, causing poor water quality on occasions in the Buffalo and Ovens rivers. Natural events, operational deliveries and the use of water for the environment helped flush deposited ash and sediments and improve water quality.

Water for the environment was delivered to Mullinmur Wetland at Wangaratta for the first time in December 2019, to prepare habitat for translocated freshwater catfish. A second top-up was delivered in February 2020, to maintain water levels to support the growth and recruitment of aquatic vegetation and sustain the translocated fish.

Scope of environmental watering

Table 5.3.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.3.1 Potential environmental watering actions and objectives for the Ovens system

Potential environmental watering action	Functional watering objectives	Environmental objectives
Autumn fresh (one fresh of greater than 430 ML/day for three days in reaches 1 and 4, and greater than 130-260 ML/day in reach 5 during March to April)	• Provide flow cues to stimulate the movement of native fish • Maintain connectivity between pools for fish movement • Mix pools to improve the water quality • Provide small variations in river levels and velocity, to flush sediment from hard substrates and maintain waterbug habitat • Scour biofilm from the river bed	
Summer/autumn low-flow variability (greater than 80 ML/day for one to two days during February to March in reaches 1, 2 and 3) 	• Maintain connectivity between pools for fish movement and water quality • Provide small variations in river levels to move sediment and maintain waterbug habitat	
Mullinmur Wetland (top-up during November to February) 	• Maintain the water level to support the growth and recruitment of aquatic vegetation • Maintain habitat for freshwater catfish	

Scenario planning

Table 5.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

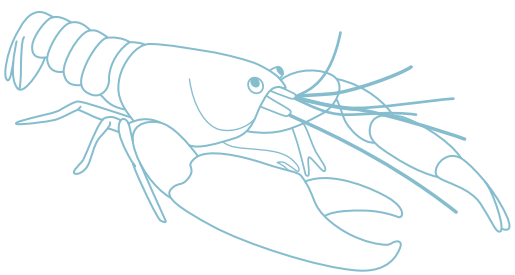
The weather and inflows into storages have a large effect on how water for the environment is likely to be used in the Ovens system. Under dry and average conditions, water for the environment may be used to provide low flow variability and avoid cease-to-flow events in the river reaches immediately below the storages. Under average conditions, water for the environment may also be used in conjunction with operational water bulk transfers from Lake Buffalo to deliver larger freshes and achieve environmental outcomes over a much greater length of river. Planned watering actions under a drought scenario remain the same as those under a dry scenario, however access to entitlements may be restricted if rights to environmental water are qualified.

Watering Mullinmur Wetland is a high priority under dry and average scenarios. No potential watering actions have been identified for the Ovens system under a wet scenario because the environmental flow requirements are likely to be achieved naturally through storage spills and unregulated tributary inflows.

Table 5.3.2 Potential environmental watering for the Ovens system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Possible winter/early spring natural flow • Highly likely low summer/autumn flows • No bulk water release	• Possible winter/early spring natural flow • Highly likely low summer/autumn flows • Bulk water release unlikely	• High winter/spring natural flow • Possible summer/autumn low flow • Bulk water release likely	• High natural flow throughout most of the year • Bulk water release likely • All flow objectives achieved naturally
Expected availability of water for the environment[1]	• 123 ML			
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flow variability • Mullinmur Wetland top-up	• Summer/autumn low flow variability • Mullinmur Wetland top-up	• Autumn fresh • Summer/autumn low flow variability • Mullinmur Wetland top-up	• None required
Possible volume of environmental water required to achieve objectives	• 0–123 ML	• 123 ML	• 123 ML	• 0 ML

[1] Access to entitlements may be restricted if rights to environmental water are qualified under a drought scenario.

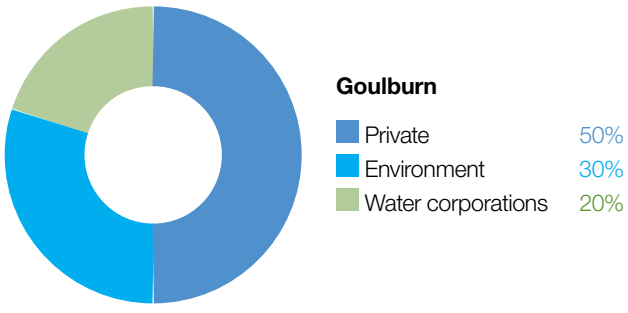


5.4 Goulburn system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

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



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

Did you know...?

Taungurung people know the Goulburn River as *Waring*, and have a special connection to it and its tributaries.

The waters of Waring have a special connection with Taungurung, including its tributaries such as the Broken River, Hughes Creek, Seven Creeks, Yea River, Acheron River, King Parrot Creek, Rubicon River, Jamieson River, and the Howqua and Delatite rivers. Taungurung's involvement is crucial to incorporate their traditional ecological knowledge into water management in the region.

Horseshoe Lagoon is a culturally significant site for Taungurung women. Water for the environment was delivered to the site, outside Seymour, for the first time in July 2019. Celebrating the delivery Taungurung water knowledge group Baan Ganalina (Guardians of Water), Goulburn Broken CMA, local landholders and partners came together to mark the significant occasion. Horseshoe Lagoon is one of the many Goulburn River associated wetlands which are highly significant for Taungurung.

Top: Goulburn River, by Goulburn Broken CMA
Above: Checking in-stream vegetation in the Goulburn River, by Goulburn Broken CMA

The Goulburn system includes the Goulburn River and Goulburn wetlands.

5.4.1 Goulburn River

System overview

The Goulburn is Victoria's largest river basin, covering over 1.6 million ha or 7.1 percent of the state. The Goulburn River flows for 570 km from the Great Dividing Range upstream of Woods Point to the Murray River east of Echuca. It is an iconic heritage river because of its environmental, Aboriginal cultural heritage and recreational values.

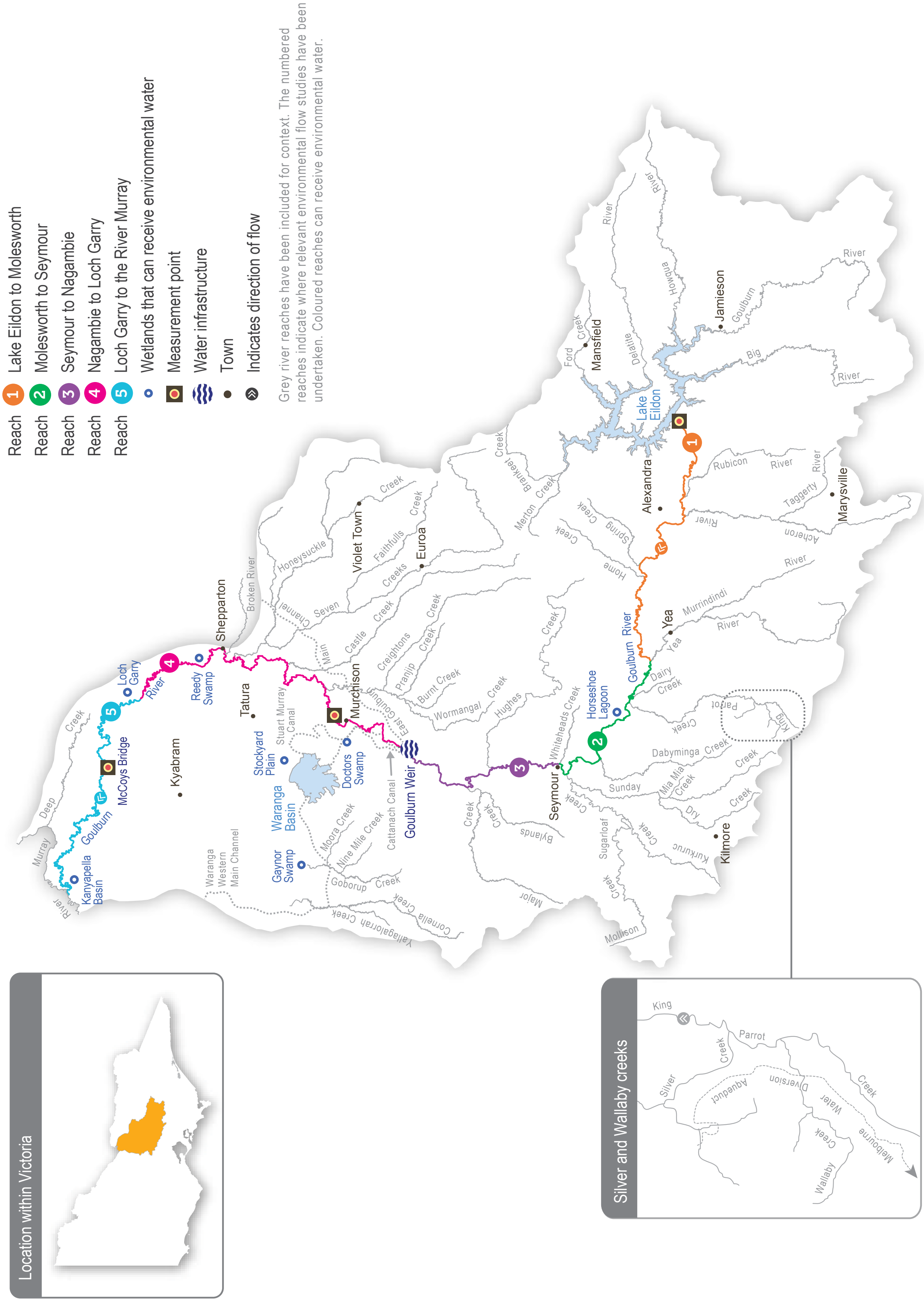
There are several environmental water holders in the Goulburn system. The Commonwealth Environmental Water Holder (CEWH) holds the largest volume and use of Commonwealth environmental water is critical to achieving outcomes in the Goulburn River, as well as priority environmental sites further downstream. Water for the environment held on behalf of the Living Murray program may assist in meeting objectives in the Goulburn system en route to icon sites in the Murray system (see subsection 1.4.2). Water held by the VEWH in the Goulburn system is primarily used to meet environmental objectives in the Goulburn River and the Goulburn wetlands, but can also be used to support ecological objectives at downstream sites along the Murray River and in SA.

The construction and operation of Lake Eildon and Goulburn Weir have significantly altered the natural flow regime of the Goulburn River. Water harvesting during wet periods, and releases to meet irrigation and other consumptive demands during dry periods, means that flow below these structures is typically low in winter/spring and high in summer/autumn. This effectively reverses the natural seasonal flow pattern. Land use changes and the construction of small dams and drainage schemes have further modified the Goulburn River's flow regime. Levees and other structures prevent water inundating the floodplain and filling many of the natural wetlands and billabongs. Several tributaries including the Acheron and Yea rivers and the Broken River below Lake Eildon add some flow variation on top of the Goulburn River's regulated flow regime. Large floods that cause the Goulburn River's storages to fill and spill are also important for the overall flow regime and its associated environmental values.

The priority environmental flow reaches in the Goulburn River are downstream of Goulburn Weir (reaches 4 and 5), which are collectively referred to as the lower Goulburn River. The mid-Goulburn River extends from Lake Eildon to Goulburn Weir (reaches 1 to 3). From early spring to late autumn, large volumes of water are delivered from Lake Eildon to Goulburn Weir to supply the irrigation system. During that period, flow in the mid-Goulburn River is usually well above the recommended environmental flow targets. Deliveries of water for the environment have the most benefit in the mid-Goulburn River (especially in reach 1 immediately downstream of Lake Eildon) outside the irrigation season, when flow is much lower than natural.

Environmental flow targets can sometimes be met by the coordinated delivery of operational water being transferred from Lake Eildon to the Murray River. These transfers are known as inter-valley transfers (IVTs). These transfers occur during the irrigation season between spring and autumn, and they may meet environmental flow objectives without the need to release water for the environment. In recent years, operational transfers in the Goulburn River have significantly exceeded the environmental flow recommendations for summer and early autumn and have damaged bank vegetation and eroded the riverbanks. Interim operating rules have been put in place to help minimise this damage, and a review of the Goulburn to Murray trade rule is currently underway.

Figure 5.4.1 The Goulburn system



Environmental values

The Goulburn River and its tributaries support a range of native fish species including golden perch, silver perch, Murray cod, trout cod, Macquarie perch and freshwater catfish. Aquatic vegetation, scour holes and woody debris within the channel provide high-quality habitat for adult and juvenile fish. River red gums are a dominant feature of the streamside zone along the length of the Goulburn River. These trees shade the river and provide habitat for many species including the squirrel glider. Leaves that fall from the river red gums provide carbon that supports riverine food webs, and dead trees that fall into the river provide a surface for biofilms and macroinvertebrates and habitat for fish. Birds (such as egrets, herons and cormorants) use trees along the river to roost and feed, while frogs benefit from shallowly- wetted vegetation at the edge of the river channel and in adjacent wetlands.

The Goulburn River system is an important conservation area for threatened species. Several wetlands in the Goulburn catchment are formally recognised for their conservation significance. Tributaries of the mid-Goulburn River between Lake Eildon and Goulburn Weir host some of the last remaining Macquarie perch populations in the Murray-Darling Basin, while freshwater catfish can be found in lagoons connected to reach 3 of the Goulburn River. Monitoring over recent years shows that environmental flows in the lower Goulburn River trigger golden perch and silver perch to spawn. However, further monitoring is required to determine how these spawning events contribute to populations locally and in the wider southern basin. Self-sustaining populations of Murray cod have been confirmed, and trout cod have been spawning and extending their range in the lower Goulburn River.

Environmental watering objectives in the Goulburn River

- Protect and boost populations of native fish
- Maintain the form of the riverbank and channel including maintaining a high diversity of river bed surfaces to support all stream life
- Provide sufficient rates of carbon and nutrient production and processing to support native fish and waterbug communities
- Increase aquatic and flood-tolerant plants in the river channel and on the lower banks, to provide shelter and food for animals and to stabilise the riverbank
- Maintain abundant and diverse waterbug communities, to support riverine food webs
- Minimise the risk of hypoxic blackwater

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with the Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the Goulburn River. The environmental and ecological objectives of the proposals were supported and align with the broad values of these Traditional Owner groups.

Yorta Yorta Nation Aboriginal Corporation raised concerns about the cultural damage IVTs are having on the lower Goulburn River and the Barmah Choke in addition to the ecological damage being caused. Environmental flow deliveries and system planning in the Goulburn River aim to mitigate some of these impacts. Taungurung Land and Waters Council also shared these concerns, and strongly supports the implementation of a new operational rule for IVTs and the Victorian Government's review of the trade rule to avoid further damage of the ecological and cultural values of the river.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.4.1, Goulburn Broken CMA considered how environmental flows could support values and uses such as:

- water-based recreation (such as boating and fishing)
- riverside recreation and amenity (such as walking, camping and other outdoor activities)
- socio-economic benefits (such as irrigation diverters and water supply for settlements on the Goulburn River).

The Goulburn River provides numerous recreational and economic benefits. Using water for the environment to provide fish passage and habitat and delivering freshes to encourage fish migration and spawning enhances native fish populations for recreational benefit. Following community feedback, the timing of a targeted environmental flow in November/December is planned to reduce impacts on river access, benefiting anglers and local businesses. This flow will be identified in Table 5.4.1 with an icon.

Watering planned to support angling activities

The delivery of the spring/summer fresh provides a cue for golden perch to spawn, and it is timed to minimise impacts on regional communities and businesses during the annual Murray cod opening weekend — the first weekend in December — while still ensuring the environmental objectives of the fresh can be achieved.

Recent conditions

Conditions in the Goulburn catchment in 2019–20 were very similar to those in 2018–19, with below-average rainfall in winter/spring. Temperatures throughout most of the year were above the long-term average, particularly in summer, leading to high evaporation rates from storages. Heavy rainfall in autumn helped replenish storages and resulted in a series of natural flows being passed at Goulburn Weir. Despite below-average inflows to Goulburn system storages in 2019–20, sufficient water was available for the environment through carryover and new allocation to meet high-priority flow requirements throughout the year.

Little natural flow occurred below Goulburn Weir in winter, and water for the environment was used to deliver a winter fresh in July 2019. This was followed by variable low flow that aimed to pass mid-Goulburn tributary inflows to the lower Goulburn River below Goulburn Weir. Conditions remained dry in spring, with a spring fresh delivered from September to October 2019 to support native fish and to trigger the germination of bank vegetation. IVTs started after the spring fresh, and no environmental water was delivered between mid-November 2019 and mid-March 2020. IVTs were delivered as a series of pulses (to reduce the effect on bank vegetation), but flows were consistently above the recommended environmental limit in summer/autumn. Although high IVT flows likely compromised some of the lower bank vegetation outcomes that were achieved by the spring fresh, wetting of the middle-to-upper bank during the spring fresh facilitated the growth and seed development of existing vegetation, provided carbon and nutrient cycling benefits and maintained habitat for waterbug communities. Higher rainfall in autumn delivered several natural flow events in the lower Goulburn River. Water for the environment was used to slow operational recessions after spills at Goulburn Weir, to minimise the risk of erosion and bank slumping.

Water for the environment delivered in the Goulburn River is reused at downstream sites along the Murray River, after a deduction for losses. In 2019–20, environmental flows that passed through the Goulburn River were subsequently used to support native fish objectives in Gunbower Creek, wet wetlands in the Gunbower and Guttrum forests and the Hattah Lakes system, and support ecological objectives in SA. Water for the environment that is delivered from the Goulburn system makes a significant contribution to environmental objectives further downstream, which helps to achieve environmental outcomes at the Murray-Darling Basin scale.

Scope of environmental watering

Table 5.4.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.4.1 Potential environmental watering actions and objectives for the Goulburn River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Year-round low flow (500-830 ML/day in reach 4 and 540-940 ML/day in reach 5)	• Provide slow, shallow habitat required for the recruitment of larvae/juvenile fish and habitat for adult small-bodied fish • Provide deep-water habitat for large-bodied fish • Submerge snags to provide habitat for fish and waterbugs and a substrate for biofilms to grow • Maintain habitat for aquatic vegetation and water the root zone of low-bank vegetation • Vary flow within a specified range to encourage planktonic production (for food), disrupt biofilms and maintain water quality	
Winter/spring fresh (one to two freshes of more than 6,600 ML for 14 days during July to October in reaches 4 and 5)	• Improve macroinvertebrate habitat by improving water quality and by increasing the wetted perimeter • Provide carbon (e.g. leaf litter) to the channel • Wet bench habitats to encourage plant germination • Remove terrestrial vegetation and trigger the recruitment of native bank vegetation	
Provide slower recession to unregulated flows or releases from Goulburn Weir (3,000 ML/day and below in summer/autumn and from 6,000 ML/day in winter/spring) in reaches 4 and 5	• Minimise the risk of bank erosion associated with rapid drying • Minimise the risk of hypoxic blackwater after natural events	
Spring/autumn/winter low flow (400 ML/day during July to September and April to June in reach 1)	• Wet and maintain riffles to provide habitat for biofilms and waterbugs • Scour fine sediment from the gravel bed and riffle substrate • Maintain the wetted perimeter of the channel and habitat for aquatic vegetation • Maintain existing beds of in-channel vegetation • Maintain habitat for small-bodied native fish	
Winter fresh (up to 15,000 ML/day with more than 14 days above 6,600 ML/day in June/July 2021, reaches 4 and 5)	• Improve macroinvertebrate habitat by improving water quality and by increasing the wetted perimeter • Provide carbon (e.g. leaf litter) to the channel • Wet bench habitats to encourage plant germination • Remove terrestrial vegetation and trigger the recruitment of native bank vegetation	
Flows should not exceed 1,000 ML/day for five to six weeks after a spring fresh (in late spring/summer) in reaches 4 and 5	• Allow newly grown littoral emergent and semi-aquatic plants to become established and persist • Provide habitat for small-bodied fish and macroinvertebrates	
One spring/summer fresh (greater than 6,600 ML for one day between November and December in reaches 4 and 5) 	• Provide a cue for golden and silver perch to spawn	

Table 5.4.1 Potential environmental watering actions and objectives for the Goulburn River *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Autumn fresh (one fresh up to 6,000 ML/day for two days between March and April in reaches 4 and 5)	• Encourage the germination of new seed on the lower banks and benches • Improve water quality by reducing turbidity and mixing stratified water • Flush fine sediment from hard substrates to allow new biofilm growth and to improve food and habitat for macroinvertebrates	
Flows should not exceed 1,000 ML/day (for more than 20 consecutive days, with a minimum of seven days between pulses in summer/autumn in reaches 4 and 5)	• Maintain for more than one season a littoral fringe of emergent or semi-aquatic plants • Provide slow-flowing littoral habitat for small-bodied fish and macroinvertebrates	

Scenario planning

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

In 2020–21, the focus of water for the environment in the lower Goulburn River will be on vegetation recovery to improve the condition of the lower banks that have been damaged by high IVTs in summer/autumn in recent years and to help offset the impact of future IVTs. Under all scenarios, providing year-round low flow is the highest priority under all scenarios. This flow provides habitat for fish and macroinvertebrates and helps the vegetation to recover. Goulburn-Murray Water generally diverts a proportion of natural high flow from Goulburn Weir into the Waranga Basin. These operational transfers cause flow rates in the lower Goulburn River to drop rapidly after a natural high-flow event. Water for the environment is used when required to slow the recession of natural spills at Goulburn Weir, to reduce the risk of bank slumping and provide a more natural flow pattern for native fish. The highest environmental watering priority in reach 1 will be to maintain minimum low flow outside the irrigation season, to maintain habitat for small-bodied native fish, aquatic vegetation and waterbugs.

Delivering a winter/spring fresh followed by five to six weeks of low flow is a high priority in 2020 under dry and average scenarios, to aid vegetation recovery. These flows are expected to occur naturally under a wet scenario and are planned under a drought scenario as an additional priority.

A focus this year will be on timing environmental water deliveries alongside unregulated events and tributary inflows. Ongoing monitoring suggests that unregulated inflows carry more plant seed, nutrients and sediments that are beneficial to the lower Goulburn River.

A winter fresh is included under average and wet scenarios to enhance environmental objectives that cannot normally be achieved under drier scenarios. A spring/summer fresh will also be considered under average and wet scenarios to cue golden perch spawning, but this watering action will not be delivered if it is likely to impact the recovery of bank vegetation. If summer low flow targets are met (that is, if IVTs are not too high), an autumn fresh may be delivered in March or April 2021 to maintain bank vegetation and allow new seeds to germinate.

Carrying over water to meet minimum low flow objectives in July 2021 to September 2022 is an important consideration under drought, dry and average scenarios.

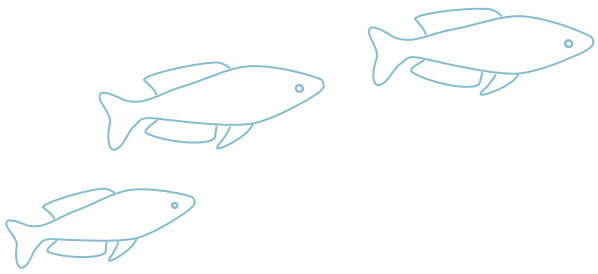


Table 5.4.2 Potential environmental watering for the Goulburn River under a range of planning scenarios

Planning scenario	Drought	Dry	Below average	Average	Wet
Expected river conditions	• No natural flow • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide some low flow for half a month from winter/mid-spring and is likely to provide small, short winter/spring freshes • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide some low flow for a few months from winter/mid-spring and is likely to provide small winter/spring freshes • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide low flow for most of the year and is likely to provide the winter/spring freshes • Blackwater could be an issue in the warmer months	• Natural flow is expected to provide low flow and multiple overbank flow events in winter/spring
	• Normal minimum passing flows at reach 5 of 400 ML/day during July to October and 350 ML/day during November to June				
Expected availability of water for the environment[1]	• 154,000 ML	• 265,000 ML	• 386,000 ML	• 461,000 ML	
Potential environmental watering – tier 1a (high priorities)[2]	• Year-round low flow • Recession flow management • Spring/autumn/winter low flow (reach 1)	• Year- round low flow • Winter/spring fresh (partial) • Recession flow management • Spring/autumn / winter low flow (reach 1)	• Year-round low flow • Winter/spring fresh • Recession flow management • Spring/autumn/winter low flow (reach 1) • Extend natural flow events	• Year-round low flow • Winter/spring fresh • Recession flow management • Spring/autumn/winter low flow (reach 1) • Winter fresh 2021 • Spring/summer fresh • Extend natural flow events	• Year-round low flow • Recession flow management • Spring/autumn/winter low flow (reach 1) • Winter fresh 2021 (partial) • Spring/summer fresh • Extend natural flow events
Potential environmental watering – tier 1b (high priorities with shortfall)	• Winter/spring fresh (partial)	• Winter/spring fresh • Winter fresh 2021 (full) • Spring/summer fresh	• Winter fresh 2021 (full) • Spring/summer fresh	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring fresh	• N/A	• N/A	• Autumn fresh (partial)	• Autumn fresh (partial)
Possible volume of environmental water required to achieve objectives[3]	• 120,000 ML (tier 1) • 107,000 ML (tier 1b) • 28,000 ML (tier 2)	• 234,000 ML (tier 1) • 188,000 ML (tier 1b)	• 366,000 ML (tier 1) • 175,000 ML (tier 1b)	• 388,000 ML (tier 1) • 47,000 ML (tier 2)	• 316,000 ML (tier 1) • 47,000 ML (tier 2)
Priority carryover requirements	• 23,000 ML	• 23,000 ML	• 23,000 ML	• 0 ML	• 0 ML

[1] When trading opportunities are available, additional water for the environment allocations from the Murray River can be transferred in to meet Goulburn demand.

[2] Low-flow periods following a spring fresh or between summer/autumn pulses are considered tier 1a priorities under all planning scenarios.

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

5.4.2 Goulburn wetlands

System overview

Within the Goulburn Broken catchment, there are about 2,000 natural wetlands identified, but only five (Reedy Swamp, Gaynor Swamp, Doctors Swamp, Horseshoe Lagoon and Loch Garry) have received water for the environment through VEWH or CEWH entitlements. Several other small wetlands in the Goulburn catchment have been watered under a separate arrangement through the Murray-Darling Wetlands Working Group.

Gaynor Swamp, Reedy Swamp, Loch Garry, Doctors Swamp and Kanyapella Basin wetlands can receive water for the environment through irrigation supply infrastructure. The volume of water that can be delivered to each wetland depends on the physical capacity of the infrastructure and the seasonal allocation. Water for the environment can be delivered from the Goulburn River to Horseshoe Lagoon via a temporary pump.

Environmental values

Many natural wetlands across the Goulburn catchment including Reedy Swamp, Loch Garry, Gaynor Swamp, Kanyapella Basin and Doctors Swamp are formally recognised for their conservation significance. The Goulburn wetlands support a variety of plant communities ranging from river red gum swamps to cane grass wetlands.

Reedy Swamp contains a mosaic of vegetation types including tall marsh, floodway pond herbland and rushy riverine swamp. It is an important drought refuge, nesting site for colonial waterbirds and stopover feeding site for migratory birds (such as sharp-tailed sandpiper and marsh sandpiper).

Doctors Swamp is considered one of the most intact red gum swamps in Victoria, supporting over 80 wetland plant species.

Gaynor Swamp is a cane grass wetland situated on paleosaline soils: soils formed from historic oceans. The wetland supports thousands of waterbirds including brolga and intermediate egrets when wet. Gaynor Swamp has a higher salt concentration than other wetlands in the region and it attracts a different suite of feeding waterbirds as it draws down. One of the most significant species that feeds on exposed mudflats at Gaynor Swamp is the red-necked avocet.

Loch Garry incorporates an old channel of the Goulburn River that provides deep, open-water habitat. The channel is surrounded by shallow, vegetated wetland depressions, red gum forest and sand ridges. It is an important site for waterbird feeding and roosting, and it is a drought refuge for eastern great egrets, musk ducks, nankeen night herons and royal spoonbills.

Kanyapella Basin is a shallow freshwater marsh that provides habitat for numerous plant and animal species including the threatened intermediate egret. Historically, it has been a popular breeding site for ibis, heron and cormorants.

Horseshoe Lagoon, a former channel of the Goulburn River, comprises vegetation mainly of tall marsh, floodway pond herbland and floodplain streamside woodland.

Environmental watering objectives in the Goulburn wetlands

	Maintain or increase the diversity and abundance of frog species
	Maintain turtle populations
	Increase the diversity and cover of native wetland plant species consistent with ecological vegetation class[1] benchmarks Reduce the cover and diversity of exotic plants Maintain populations of rigid water milfoil, slender water milfoil and river swamp wallaby-grass
	Provide breeding habitat for waterbirds Provide feeding and roosting habitat for waterbirds

[1] Ecological vegetation classes are the standard units for classifying vegetation types in Victoria. They are described through a combination of floristics, lifeforms and ecological characteristics and through a presumed association to particular environmental attributes. Each ecological vegetation class includes a collection of floristic communities (which is a lower level in the classification) that occurs across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.

Traditional Owner cultural values and uses

Goulburn Broken CMA sought input from Yorta Yorta Nation Aboriginal Corporation and Taungurung Land and Waters Council during the development of environmental watering plans for the Goulburn wetlands. Both groups have indicated that they support the watering action priorities planned for the year ahead and will continue to work with the CMA to implement these actions while exploring further opportunities to support their cultural values.

Waterway managers are seeking opportunities to support increased participation of Traditional Owners in environmental water planning and management. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 5.4.3 with an icon.

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

Yorta Yorta Nation Aboriginal Corporation has been involved in planning for environmental watering at Kanyapella Basin and Loch Garry, including participating in the development of environmental water management plans for the sites. Kanyapella Basin, Loch Garry and the surrounding catchment have a long history of Traditional Owner occupation by the Yorta Yorta Peoples. Kanyapella Basin particularly plays an important role in Yorta Yorta cultural and spiritual heritage. Kanyapella Basin may be partially filled in winter or spring 2020, supporting cultural values such as knowledge sharing and food and medicinal plants. Loch Garry watering is planned for autumn 2021.

Taungurung Land and Waters Council and Goulburn Broken CMA are planning to repeat the environmental watering of Horseshoe Lagoon in winter 2020, following the first delivery of environmental water to the site in winter 2019. This was celebrated by the Taungurung women as it is a significant site and the best example of working together to protect cultural values and towards healing Country. The Taungurung water knowledge group, *Baan Ganalina*, have worked closely with Goulburn Broken CMA, the VEWH and other partners to bring water back to the lagoon to restore habitats and see the birds and other animals return to the site. Taungurung Land and Waters Council also participated in the development of the Environmental Water Management Plan for the site in 2019.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.4.3, Goulburn Broken CMA considered how environmental flows could support values and uses including recreation and amenity (such as walking, photography and birdwatching).

Recent conditions

The Goulburn catchment has observed persistent dry conditions over the past few years, with 2019–20 no exception. Annual rainfall was well below average for the region for most of the year, except for a very wet autumn with above-average rainfall, which provided suitable conditions to enable watering actions and also provided natural inflows as supplements. Temperatures throughout most of the year were above the long-term average. The drier conditions resulted in increased evaporation rates for storages and wetlands alike, but water availability was good due to carryover and 80 percent allocation to high-reliability water shares in the Goulburn system.

Environmental water was delivered to Horseshoe Lagoon for the first time in winter 2019, to partially fill the wetland before drying over summer. The wetland vegetation responded well to the watering with both the rare river swamp wallaby grass and veiled fringe sedge detected during monitoring; waterbirds and turtles were also observed at the lagoon.

The timing of a planned autumn 2020 fill of Reedy Swamp was moved to spring 2019 to build on a rainfall event that partially filled the wetland. The wetland provided a much-needed refuge in the region over a very dry summer, with waterbird and woodland bird species recorded including glossy ibis, Australasian shoveler, Latham's snipe, freckled duck and the first record of crimson chats at the site.

Autumn 2020 saw two wetland watering events delivered, assisted by the above-average rainfall observed in late April/early May. The river-red-gum-dominated Doctors Swamp was filled in May 2020. The first environmental watering of Loch Garry was trialled and achieved a partial fill.

As always, planned watering actions were adaptively managed in 2019–20. The changed timing of delivery to Reedy Swamp optimised environmental outcomes and drought refuge by responding to natural conditions in spring, while the first trial delivery to Loch Garry delivered around half of the planned volume due to a slower delivery rate than expected. Gaynor Swamp was not actively watered in 2019–20 to allow it to dry, to reduce exotic vegetation cover at the site. Now the dry phase has been completed, a spring watering in 2020–21 is planned.

Scope of environmental watering

Table 5.4.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.4.3 Potential environmental watering actions and objectives for the Goulburn wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Doctors Swamp (top up or fill in spring)	• Promote vegetation growth • Provide feeding and roosting habitat for waterbirds	
Gaynor Swamp (partial fill in spring)	• Promote vegetation growth, particularly southern cane grass • Provide breeding and feeding habitat for waterbirds, in particular for brolga	
Horseshoe Lagoon (fill in winter)	• Maintain wetland vegetation communities by supporting growth and recruitment • Promote the growth of river swamp wallaby grass • Provide habitat for turtle and frog populations	
Kanyapella Basin (partial fill in spring)	• Promote different vegetation communities to establish	
Loch Garry (partial fill in autumn)	• Promote the growth and germination of native wetland vegetation communities, particularly wetland fringes • Provide feeding and breeding habitat for waterbirds	
Reedy Swamp (fill in autumn)	• Reduce the growth of exotic plants • Maintain native wetland vegetation • Provide a refuge and feeding and breeding habitat for waterbirds	

Scenario planning

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

Doctors Swamp and Gaynor Swamp are identified as high-priority watering sites in 2020–21 under all scenarios, because their drying regimes are reaching their maximum duration. Gaynor Swamp will also provide feeding and breeding habitat for threatened waterbirds (such as brolga). Horseshoe Lagoon is a high priority, because it requires follow-up watering to maintain vegetation condition.

Reedy Swamp and Loch Garry have also been identified for watering under all scenarios and Kanyapella basin under dry and average scenarios. These watering actions aim to improve environmental values at these sites, but if delivery to these wetlands cannot occur in 2020–21, no detrimental impact is expected on their environmental values in the upcoming year. Reedy Swamp is in good condition and is currently in a drying phase. An autumn watering in 2021 will aim to ensure it does not exceed its maximum dry period, and it will provide variability in the watering regime for native vegetation.

Loch Garry and Kanyapella Basin act as flood retardation basins, and watering in autumn 2020 occurred at Loch Garry as an initial trial, to observe the ecological response and help determine future management actions. Loch Garry is now planned to remain dry for the recommended duration, which will enable it to potentially be re-watered in autumn 2021 to observe the response of the ecological values of the site to a follow up watering.

It is a priority to carry over water, to allow 2021–22 top-ups to tier 1 wetlands planned to be watered in 2020–21.

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

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment runoff and natural flow into the wetlands are highly unlikely	• Catchment runoff and natural flow into the wetlands are unlikely	• Some catchment runoff and natural flow into some of the wetlands are likely, particularly in winter/spring	• Catchment runoff and natural flow into the wetlands may significantly contribute to water levels in the wetlands, particularly during winter/spring
Potential environmental watering – tier 1 (high priorities)[1,2]	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp	• Horseshoe Lagoon • Doctors Swamp • Gaynor Swamp
Potential environmental watering – tier 2 (additional priorities)[2]	• Reedy Swamp • Loch Garry	• Reedy Swamp • Loch Garry • Kanyapella Basin	• Reedy Swamp • Loch Garry • Kanyapella Basin	• Reedy Swamp • Loch Garry
Possible volume of environmental water required to achieve objectives[3]	• 1,700 ML (tier 1) • 1,600 ML (tier 2)	• 1,700 ML (tier 1) • 2,100 ML (tier 2)	• 1,500 ML (tier 1) • 2,100 ML (tier 2)	• 700 ML (tier 1) • 1,600 ML (tier 2)
Priority carryover requirements	• Up to 350 ML			

[1] Tier 1 potential environmental watering for the Goulburn wetlands is not classified as tier 1a or 1b, because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the Goulburn wetlands.

[2] Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios

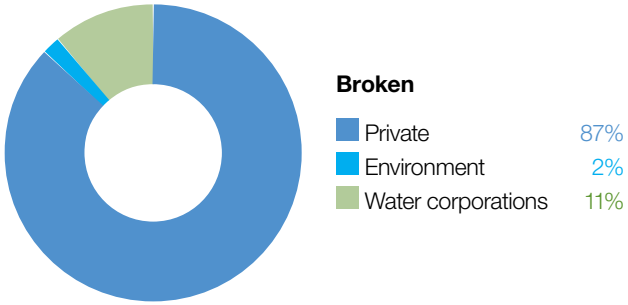
[3] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

5.5 Broken system

Waterway manager – Goulburn Broken Catchment Management Authority
Storage manager – Goulburn-Murray Water
Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

Did you know...?

Native fish populations continue to increase in the Broken River. Autumn 2019 fish surveys by the Victorian Environmental Flows Monitoring and Assessment Program showed that Murray cod, Murray-Darling rainbowfish and golden perch numbers are all up from last year! A variety of sizes of Murray cod were recorded, suggesting strong recruitment, survival and growth. That's great news for anglers!



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

Top: Broken River, by Goulburn Broken CMA
Above: Magpie geese at Black Swamp, by Goulburn Broken CMA

The Broken system includes the Broken River, upper Broken Creek, lower Broken Creek and the Broken wetlands.

5.5.1 Broken River and upper Broken Creek

System overview

The Broken River is a tributary of the Goulburn River, rising in the Wellington-Tolmie highlands and flowing north-west to Benalla and then west for a total distance of 190 km before it joins the Goulburn River near Shepparton. Lake Nillahcootie is the main storage on the Broken River. It is about 36 km upstream of Benalla and harvests water from the river to support stock and domestic supply and irrigated agriculture. The main tributaries of the Broken River are Hollands Creek, Ryans Creek and Lima East Creek.

Lake Nillahcootie has a storage capacity that is about half the mean annual flow of its upstream catchment, so it fills in most years. The operation of Lake Nillahcootie has modified the river's natural flow pattern: winter/spring flow is less than natural because a large proportion of inflow is harvested, while summer/autumn flow is higher than natural because water is released to meet downstream irrigation demands. These impacts are most pronounced in the reach between Lake Nillahcootie and Hollands Creek. Below Hollands Creek, the river retains a more natural flow pattern, due to flows from unregulated tributaries. The catchment has been extensively cleared for agriculture including dryland farming (such as livestock grazing and cereal cropping) and irrigated agriculture (such as dairy, fruit and livestock).

Water is released from Lake Nillahcootie to meet downstream demand and minimum flow requirements specified under the bulk entitlement for the Broken River system. Releases from storage may be less than 30 ML per day as tributary inflows immediately below the storage (such as from Back Creek) can supply much of minimum-flow requirements specified in the bulk entitlement.

Upper Broken Creek is defined as the 89-km stretch of creek from the Broken River (at Caseys Weir) to the confluence with Boosey Creek near Katamatite. Upper Broken Creek flows across a flat, riverine plain and has naturally low runoff from its local catchment. It receives flood flows from the Broken River, although the frequency of these floods has been reduced by earthworks and road construction.

Upper Broken Creek has been regulated for more than a century. Before 2007, water was diverted into upper Broken Creek at Casey's Weir to meet local demand, but recent water savings projects have reduced the demand on the creek. There is now low flow throughout the year between Caseys Weir and Waggarandall Weir. Flow below Waggarandall Weir is mainly influenced by rainfall and catchment runoff. These changes have reduced the amount of permanent aquatic habitat.

Delivery of water for the environment to the Broken River is primarily constrained by the availability of water. Usually, the available volume of water for the environment is insufficient to provide all recommended flows. Deliveries of water for the environment to upper Broken Creek are also restricted by channel capacity and by the need to avoid flooding low-lying adjacent land.

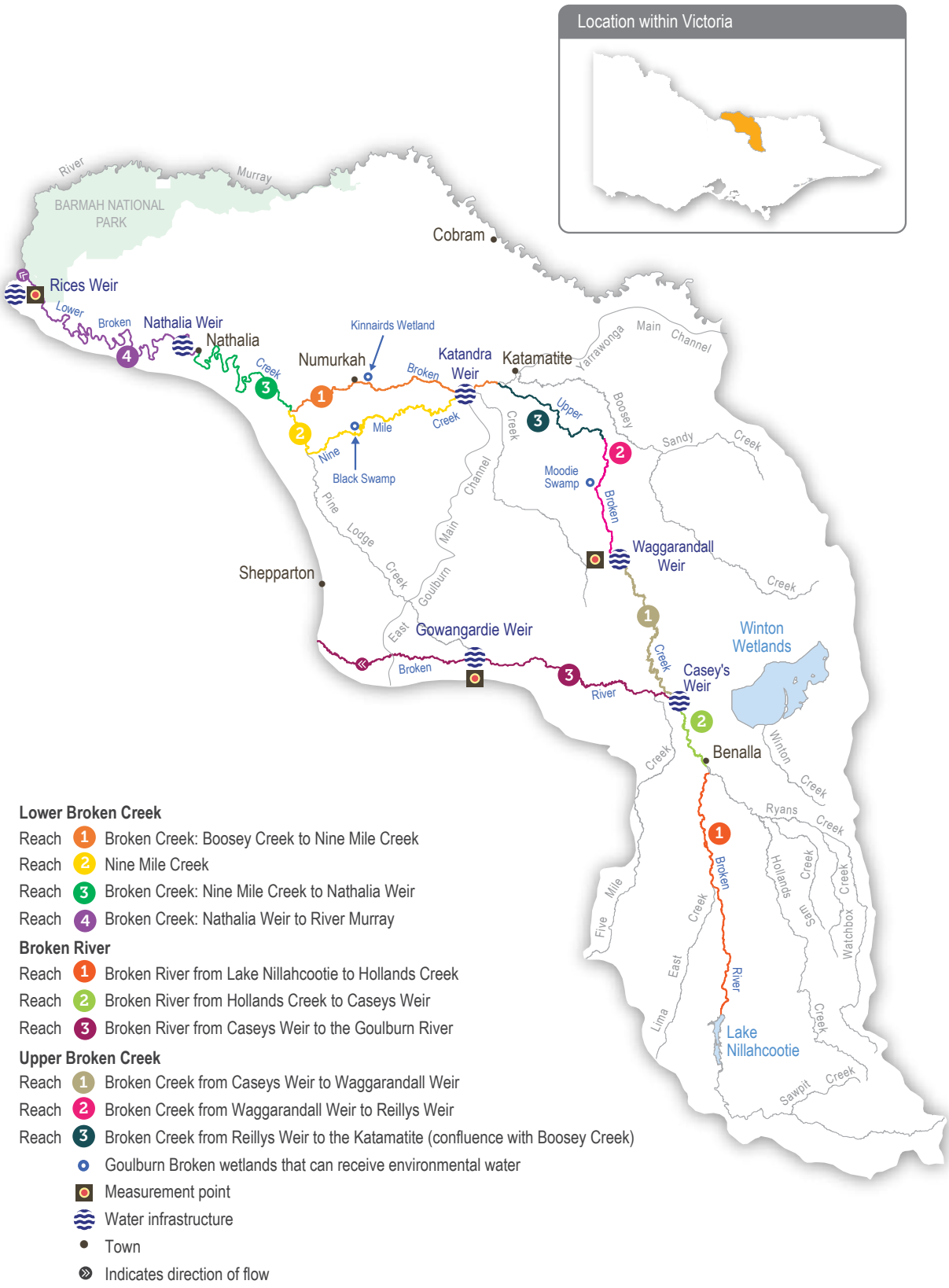
Environmental values

The Broken River retains one of the best examples of healthy in-stream vegetation in a lowland river in the region. A range of native submerged and emergent plant species including eelgrass, common reed and water ribbons populate the bed and margins of the river. These plants provide habitat for a range of animals including small- and large-bodied native fish species. Murray cod, Macquarie perch, golden perch, silver perch, river blackfish, mountain galaxias and Murray-Darling rainbowfish all occur in the Broken River. The river also supports a large platypus population.

The upper Broken Creek area is dominated by unique box streamside vegetation and remnant plains grassy woodland. It supports numerous threatened species including brolga, Australasian bittern, buloke and rigid water milfoil. Much of the high-quality native vegetation in the region is set aside as a natural features reserve. Upper Broken Creek supports a variety of native fish species including carp gudgeon, Murray cod, golden perch and Murray-Darling rainbowfish, as well as platypus and common long-necked turtle.

Both the Broken River and upper Broken Creek are listed in the Directory of Important Wetlands in Australia.

Figure 5.5.1 The Broken system



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

Environmental watering objectives in the Broken River and upper Broken Creek


Increase native fish populations


Maintain platypus populations


Maintain in-stream vegetation


Support a wide range and high biomass of waterbugs, to break down dead organic matter and support the river's food web


Maintain water quality

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with the Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the Goulburn River. The Traditional Owners confirmed that the environmental and ecological objectives of the environmental watering align with their Land and Water Management Plans, and the CMA is continuing to work with both groups to identify how environmental water management can support cultural values.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.5.1, Goulburn Broken CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing)
- riverside recreation and amenity (such as camping, birdwatching, picnicking and duck hunting)
- community events
- socio-economic benefits (such as supporting birds that control invasive species and providing green space and water in a dry landscape over summer).

Recent conditions

Below-average rainfall and above-average temperatures in the Broken River and upper Broken Creek in 2019–20 resulted in low inflows to the river and creek, low allocation of entitlements and low water availability for environmental flows.

In the Broken River, flow between Lake Nillahcootie and Casey's Weir in reaches 1 and 2 was very different to that below Casey's Weir in reach 3. The reaches between Lake Nillahcootie and Casey's Weir have minimal tributary inflows and flow in these reaches is predominantly shaped by operational releases from Lake Nillahcootie for entitlement demands downstream. Reaches 1 and 2 had a stable, low-magnitude flow from July to November 2019 and then higher-magnitude flow and slightly more variability from December 2019 onwards. In comparison, the flow pattern in reach 3 is mainly shaped by unregulated tributary inflows. There were several natural freshes in this reach between July and October 2019, and stable, low-magnitude flow from November till April 2020. There were some natural freshes in the Broken River in autumn 2020.

Upper Broken Creek has no significant tributaries and its flow is primarily influenced by operational releases, catchment runoff and environmental flows. Upper Broken Creek had low flow from July to December 2019 and then slightly higher and more variable flow from January 2020 onwards. Water for the environment was predominantly used to meet targets for summer/autumn low flow, which had been generally met by operational flows in previous years. This meant flows from operational releases were lower in upper Broken Creek in 2019–20 than in previous years.

Scope of environmental watering

Table 5.5.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.5.1 Potential environmental watering actions and objectives for the upper Broken Creek and Broken River

Potential environmental watering action[1]	Functional watering objectives	Environmental objectives
Upper Broken Creek		
Summer/autumn fresh (one fresh of 10-100 ML/day for 10 days during December to May as needed)	• Maintain water quality, particularly oxygen levels, in refuge pools	
Summer/autumn low flow (one to five ML/day during December to May)	• Maintain pool and riffle habitat for native fish populations and waterbugs • Maintain access to habitat and food resources for platypus • Maintain habitat for in-stream vegetation	
Winter/spring low flow (five to 10 ML/day during June to November)	• Maintain pool and riffle habitat for native fish populations and waterbugs • Maintain access to habitat and food resources for platypus • Maintain habitat for in-stream vegetation	
Broken River		
Year-round low flow (five to 15 ML/day)	• Maintain riffles, slackwater and pools to provide diverse hydraulic habitat for native fish, aquatic plants, platypus and waterbugs • Maintain habitat for in-stream and fringing vegetation, and prevent terrestrial vegetation colonising the stream bed	
Summer/autumn freshes (400–500 ML/day for two to eight days during December to May)	• Scour sediments around large wood, and turn over bed sediments to replenish biofilms and increase productivity • Provide flow cues to stimulate native fish to breed and migrate • Provide flow to maintain in-stream and fringing aquatic vegetation • Maintain longitudinal connectivity for native fish passage	

[1] Watering actions are listed in priority order and upper Broken Creek watering actions are higher priority than Broken River watering actions.

Scenario planning

Table 5.5.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. It is expected that there will be no water available for environmental flows in the Broken River and upper Broken Creek under drought and dry scenarios. It is likely under those scenarios that there will be zero to low natural flow resulting in zero allocations of entitlements.

There are two sets of watering actions: one for upper Broken Creek and another for the Broken River. Delivering flow to upper Broken Creek is a higher priority, because upper Broken Creek tends to have no inflows from tributaries and is mostly dependent on flows from operational deliveries. The potential watering actions for upper Broken Creek require less water than the potential watering actions for Broken River, and any environmental flows delivered to upper Broken Creek will pass through reaches 1 and 2 of the Broken River, where they will provide some environmental benefit.

In 2020–21, the highest priority in upper Broken Creek is to deliver a summer/autumn fresh (a tier 1a watering action under average and wet scenarios, and a tier 1b watering action under drought and dry scenarios), if required to maintain water quality. The fresh is likely to be able to be partially delivered under average and wet conditions with water for the environment. There is unlikely to be sufficient water available to deliver the fresh under drought or dry conditions. If water does become available under drought or dry conditions, the priority will be to deliver a summer/autumn fresh first, then the summer/autumn low flow to maintain critical aquatic habitat. Additional environmental deliveries for low flow and freshes are not expected to be needed under wet conditions, because flow requirements will be met by natural events.

It is expected that there will not be sufficient water available to provide any potential watering actions in the Broken River: that is, no tier 1a actions are identified. If additional water becomes available under drought and dry conditions after watering actions for upper Broken Creek have been met, the priority will be to deliver year-round low flow in the Broken River to maintain critical aquatic habitat. If further water is available, it will be used to deliver summer/autumn freshes, with dry and average conditions, to maintain habitat for macrophytes and native fish.

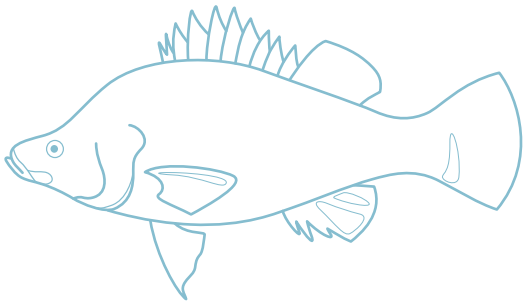


Table 5.5.2 Potential environmental watering for the upper Broken Creek and Broken River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated winter/spring flow in Broken River • No natural flow in upper Broken Creek • Low and cease-to-flow events possible throughout the year in all reaches • No back trade opportunities	• Low natural flow and odd freshes in Broken River • No natural flow in upper Broken Creek • Low and cease-to-flow events possible throughout the year in all reaches • No back trade opportunities	• High winter/spring flow in the Broken River • Some unregulated winter/spring flow in upper Broken Creek • Up to 1,500 ML back trade opportunity in Broken River in summer/autumn	• Winter/spring floods in the Broken River • Winter/spring freshes in upper Broken Creek • Up to 1,500 ML back trade opportunity available in Broken River in summer/autumn
Expected availability of water for the environment	• 0 ML	• 0 ML	• 647 ML	• 647 ML
Upper Broken Creek				
Potential environmental watering – tier 1a (high priorities)	• N/A	• N/A	• One summer/autumn fresh (partial, if required)	• One summer/autumn fresh (partial, if required)
Potential environmental watering – tier 1b (high priorities with shortfall)	• One summer/autumn fresh • Summer/autumn low flow • Winter/spring low flow	• One summer/autumn fresh • Summer/autumn low flow • Winter/spring low flow	• One summer/autumn fresh (remaining volume) • Summer/autumn low flow (remaining volume) • Winter/spring low flow	• One summer/autumn fresh (remaining volume)
Potential environmental watering – tier 2 (additional priorities)	• N/A	• N/A	• N/A	• N/A
Broken River				
Potential environmental watering – tier 1a (high priorities)	• N/A	• N/A	• N/A	• N/A
Potential environmental watering – tier 1b (high priorities with shortfall)	• Year-round low flow	• Year-round low flow	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A	• Summer/autumn fresh	• Summer/autumn fresh	• N/A
Possible volume of environmental water required to achieve objectives[1]	• 0 ML (tier 1a) • 5,510 ML (tier 1b)	• 0 ML (tier 1a) • 3,550 ML (tier 1b) • 5,800 ML (tier 2)	• 1,000 ML (tier 1a) • 2,010 ML (tier 1b) • 5,800 ML (tier 2)	• 1,000 ML (tier 1a)

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

5.5.2 Lower Broken Creek

System overview

The lower Broken Creek system includes the section of Broken Creek that flows from the confluence of Boosey Creek near Katamatite to the Murray River; and Nine Mile Creek, which is an anabranch of lower Broken Creek that flows from the East Goulburn Main Channel to below Numurkah.

Lower Broken and Nine Mile creeks have been regulated for over a century. Before regulation, the creeks would have had most of their flow in winter/spring and contracted to isolated pools or dried out during summer/autumn. The adjacent floodplain would have also flooded regularly. The creeks now have numerous weirs that maintain a relatively constant flow from mid-August until mid-May to support irrigated agriculture. These modifications have changed the way native animals use the creek. Previously, native fish would have moved into the creek when it was flowing and returned to the Murray River as it dried. Both creeks now provide year-round habitat for native fish, and fish passage structures allow fish to move between weir pools. Water for the environment is used to support these permanent fish habitats, by providing flows to trigger fish movement and support fish passage, control water quality and flush azolla as necessary.

Lower Broken Creek is operated separately to upper Broken Creek and the Broken River, because regulated water is delivered to lower Broken Creek from the Goulburn and Murray systems via the irrigation channel network, unlike upper Broken Creek and Broken River which are both supplied from Lake Nillahcootie on the upper Broken River.

Water for the environment can be provided to lower Broken Creek from the Goulburn system through the East Goulburn Main Channel and from the Murray system through the Yarrawonga Main Channel. Water is released into lower Broken Creek from several irrigation regulators along the length of lower Broken Creek. The main priority for environmental watering in the lower Broken Creek system is to maintain minimum flows throughout the year. Particular attention is given to reaches 1 and 2 during the non-irrigation season, when flow can stop. The next priority is to deliver freshes in winter/spring to trigger fish movement and spawning, maintain water quality and manage azolla blooms in reaches 3 and 4. The measurement point for environmental flows in lower Broken Creek is at Rices Weir.

Some of the environmental flow targets for lower Broken Creek are partly or wholly met by operational water releases — IVTs (from the Goulburn to the Murray) or choke bypass flows (when bypassing the Barmah choke in the Murray) — that are delivered to meet downstream demands. These operational deliveries mainly occur during peak irrigation demand between spring and autumn. Water for the environment may be used to supplement these operational releases and to deliver recommended flow components that are not met by the operational releases.

Environmental values

Lower Broken Creek and Nine Mile Creek support a diverse and abundant native fish community including the threatened Murray cod, golden perch, silver perch, unspecked hardyhead and Murray-Darling rainbowfish. Sections of lower Broken and Nine Mile creeks have been reserved as state park and natural feature reserves. The associated floodplain and wetland habitats support box-dominated grassy woodland communities and numerous species of state and national conservation significance including river swamp wallaby grass and the Australasian bittern.

Environmental watering objectives in lower Broken Creek

- Protect and increase native fish populations including the threatened Murray cod, golden perch and silver perch
- Protect platypus populations, particularly outside the irrigation season
- Protect rakali (water rat) populations, particularly outside the irrigation season
- Protect turtle populations, particularly outside the irrigation season
- Avoid the excessive build-up of azolla
- Maintain the cover and condition of native in-stream and littoral vegetation communities
- Maintain the diversity and abundance of waterbug populations
- Maintain oxygen levels suitable for aquatic animals

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the lower Broken Creek. The environmental and ecological objectives of the proposals were supported and align with the broad values of caring for Country. Goulburn Broken CMA and Yorta Yorta Nation Aboriginal Corporation will explore further opportunities to deliver environmental water to support Yorta Yorta cultural values throughout the year.

Yorta Yorta Nation Aboriginal Corporation raised concerns about the cultural damage water transfers are having on the lower Goulburn River and the Barmah Choke in addition to the ecological damage being caused. Using the lower Broken and Nine Mile Creeks for delivery of water (either environmental or consumptive) to the lower Murray River as a bypass mechanism may help reduce the risk of erosion on the Barmah Choke and lower Goulburn River and thus help to protect culturally significant values.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.5.3, Goulburn Broken CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing and kayaking)
- riverside recreation and amenity (such as game hunting)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and water quality including preventing algal and azolla blooms).

Recent conditions

The Goulburn Broken region had below-average rainfall and above-average temperatures for most of 2019–20. Rainfall at Numurkah during the first half of 2019–20 was just over half of the long-term average for this period, resulting in low inflows to the local catchment. Water for the environment from the Goulburn and Murray system portfolios was used in combination with operational water to meet flow targets throughout the year.

Flow in lower Broken Creek was lower than planned during winter 2019–20, due to maintenance works on the Yarrawonga Main Channel and the East Goulburn Main Channel. Consequently, fish ladders were closed in July 2019 to hold water in the system to maintain fish habitat. Some water was delivered to the creek from secondary outfall irrigation channels, but flow in reaches 3 and 4 dropped to 15 ML per day on occasions, which is well below the recommended minimum winter target of 40 ML per day.

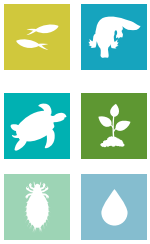
The flow increased to 250 ML per day at the start of the irrigation season in August 2019, and the rapid increase likely cued some fish movement through the system. IVTs from the Goulburn system and Murray choke bypass flows increased flow in lower Broken Creek to 500 ML per day in late October 2019, which likely cued further fish movement and spawning and flushed azolla. The average flow at Rice's Weir remained around 410 ML per day through summer and early autumn as operational water transfers to the Murray continued. Water for the environment was delivered in conjunction with operational deliveries from late March 2020 to maintain a flow of about 200 ML per day until the end of the irrigation season.

There is limited ecological monitoring in lower Broken Creek, but members of the Broken Environmental Water Advisory Group have reported a marked improvement in water quality since targeted environmental water deliveries started in 2010–11. The delivery of minimum low flow during the off-irrigation season provided winter foraging habitat and instream refuge areas, especially important for young-of-year fish, platypus, rakali (water rats) and turtles.

Scope of environmental watering

Table 5.5.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.5.3 Potential environmental watering actions and objectives for lower Broken Creek

Potential environmental watering action	Functional watering objectives	Environmental objectives
Year-round low flow (40-200 ML/day in reaches 3 and 4 and 40-100 ML/day in reaches 1 and 2)[1]	• Provide native fish with passage through fish ladders • Provide suitable foraging habitat for platypus and rakali (water rats), and support the movement of juveniles of both species • Provide habitat for turtles including protection from exposure to cold in winter • Provide flowing-water habitat and avoid winter drying of weir pools for fish, vegetation, waterbugs, platypus and turtles • Limit suspended sediment and maintain suitable oxygen concentration	
Winter/spring/summer/autumn high flow (200-250 ML/day in reaches 3 and 4 and 100-150 ML/day in reaches 1 and 2 during July to May)	• Provide habitat for fish and support fish movement, spawning and recruitment • Flush and mobilise azolla and maintain oxygen levels in summer	
Winter/spring freshes (up to three freshes of 450 ML/day during July to September)	• Flush and mobilise azolla, if it blooms • Trigger fish migration and movement	

[1] Intended to be delivered year-round, subject to supply constraints. Constraints may mean these flows cannot be delivered in the non-irrigation season between mid-May and mid-August.

Scenario planning

Table 5.5.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Due to regulation of lower Broken and Nine Mile creeks, which creates highly modified and relatively uniform conditions, environmental flow recommendations are relatively constant from year to year and independent of annual conditions.

During 2020–21, environmental flows in lower Broken Creek will be adjusted as needed to optimise the quantity of habitat and movement opportunities for native fish, maintain water quality and flush azolla through the system. The environmental flow objectives may be partly or wholly met by regulated flows to meet irrigation demand and/or by natural flow. Therefore, water for the environment will only be used to make up shortfalls. During the irrigation season, water for the environment will be mainly used to deliver high flow and freshes, because irrigation demand and the associated operational water flows are likely to meet many of the environmental low flow requirements. Outside of the irrigation season, maintaining low flow above 40 ML per day in all reaches is the primary focus to ensure ecological objectives are met.

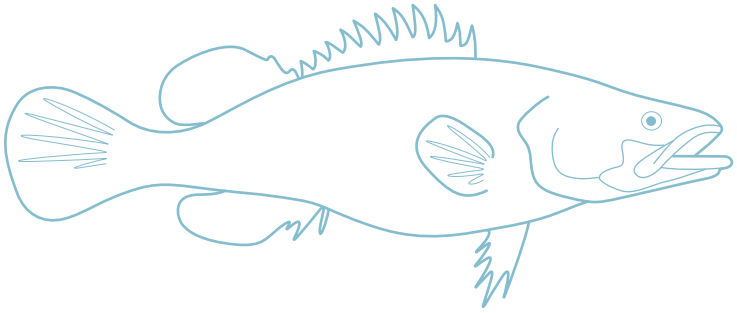
The potential environmental watering actions in Table 5.5.4 are all considered to be high priorities and are expected to meet the environmental requirements of the system. No tier 2 potential watering actions have been identified for 2020–21. Critical carryover requirements under all scenarios in 2020–21 ensure a minimum low flow and a small fresh can be delivered in 2021–22.

In addition to the deliveries of water for the environment explained in this seasonal watering plan, downstream environmental or operational demands may result in higher flows being delivered in lower Broken Creek in 2020–21. Higher flows through the lower Broken Creek system generally provide positive environmental outcomes.

Table 5.5.4 Potential environmental watering for lower Broken Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows in winter • No unregulated flows throughout the irrigation season (mid-August to May) • No diversion of unregulated Murray River flow available	• Some unregulated flows in winter • No unregulated flows throughout the irrigation season (mid-August to May) • No diversion of unregulated Murray River flow available	• Unregulated flows in winter/spring • No unregulated flows during October to May (except for an occasional unregulated fresh in spring) • Diversion of unregulated Murray River flow available during mid-August to October	• Unregulated flows in winter/spring • No unregulated flows during November to May • Diversion of unregulated Murray River flow available during mid-August to November
Potential environmental watering – tier 1 (high priorities)[1]	• Year-round low flow • Winter/spring/summer/autumn high flow • Winter/spring freshes			
Possible volume of environmental water required to achieve objectives	• 44,800 ML	• 45,680 ML	• 55,650 ML	• 43,150 ML
Priority carryover requirements	• 5,000 ML			

[1] Tier 1 potential environmental watering for lower Broken Creek is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for lower Broken Creek



5.5.3 Broken wetlands

System overview

Of some 2,000 natural wetlands in the Goulburn Broken area, only three in the Broken catchment have infrastructure that allow them to receive environmental water: Black Swamp, Kinnairds Wetland and Moodie Swamp. Kinnairds Wetland and Black Swamp are red gum swamps near Numurkah. Moodie Swamp is a cane grass wetland adjacent to upper Broken Creek at Waggarandall that provides excellent breeding habitat for brolga.

The water regimes of these wetlands are influenced by their position in the landscape. The development and operation of the Shepparton and Murray Valley irrigation districts have changed the natural flow paths and the timing, frequency, volume and duration of natural flooding to these and other wetlands in the region. Existing irrigation system infrastructure enables water for the environment to be delivered to the three nominated wetlands, but under existing agreements, irrigation deliveries have priority within the channel system. This limits the volume of water that can be delivered to the wetlands.

Environmental values

Moodie Swamp, Kinnairds Wetland and Black Swamp support a high diversity of vegetation communities ranging from river red gum to cane grass dominated. The wetlands contain state and nationally threatened vegetation communities and species including ridged water milfoil and river swamp wallaby-grass. The wetlands also provide food resources and breeding habitat for bird species of high conservation significance (such as eastern great egret, Latham's snipe, white-bellied sea eagle, Australasian bittern, brolga, royal spoonbill, yellow-billed spoonbill, Australasian shoveler and glossy ibis). Many of these species are listed in international agreements and conventions.

Environmental watering objectives in the Broken wetlands

- Increase and improve the growth of native wetland plant species consistent with the ecological vegetation class[1] benchmarks
- Reduce the cover and diversity of exotic plant species
- Maintain populations of rigid water milfoil and slender water milfoil

- Provide breeding habitat for waterbirds
- Provide feeding and roosting habitat for waterbirds

Traditional Owner cultural values and uses

Goulburn Broken CMA consulted with the Yorta Yorta Nation Aboriginal Corporation during the planning of environmental water deliveries in the Broken wetlands. Yorta Yorta confirmed support for the environmental watering actions proposed and will continue to collaborate with Goulburn Broken CMA to identify opportunities for environmental water management to support Yorta Yorta cultural values.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.5.5, Goulburn Broken CMA considered how environmental flows could support values and uses including riverside recreation and amenity (such as walking, photography and birdwatching).

[1] Ecological vegetation classes are the standard unit for classifying vegetation types in Victoria. They are described through a combination of floristics, lifeforms and ecological characteristics and through a presumed association to particular environmental attributes. Each ecological vegetation class includes a collection of floristic communities (which is a lower level in the classification) that occurs across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.

Recent conditions

The Broken River catchment continued to experience dry conditions in 2019–20 on the back of two previous dry years, receiving below-average rainfall and experiencing above-average temperatures, particularly in spring/summer. Water availability in the Broken system for Moodie Swamp was very low, with high-reliability allocations only reaching two percent. Supply was better in the Murray system, enabling planned deliveries to Black Swamp and Kinnairds Wetland – which are supplied from the Murray system via the Murray valley irrigation area — to occur.

All Broken wetlands remained dry through winter, spring and summer. Environmental water was delivered to fill both Black Swamp and Kinnairds Wetland in autumn 2020, to provide feeding and breeding habitat for a variety of waterbirds and frogs and to stimulate the growth of wetland vegetation including the listed river swamp wallaby grass at Black Swamp and rigid and slender water milfoil at Kinnairds Wetland.

A planned delivery to Moodie Swamp in autumn 2020 was postponed due to the lack of supply and the preference to maintain flow and water quality in upper Broken Creek. Moodie Swamp did however receive some natural catchment runoff as a result of above-average rainfall in April/early May 2020 that provided minimal wetting of the fringing vegetation.

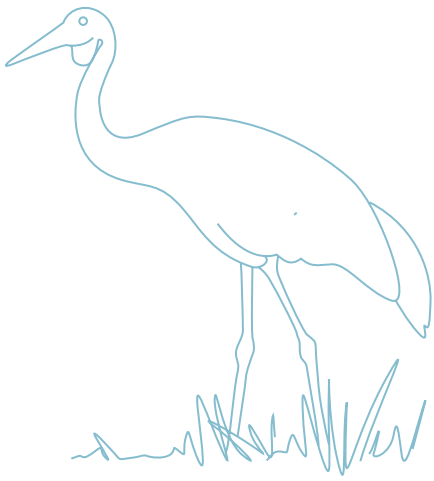
The postponement of the Moodie Swamp watering event in 2019–20 will extend the drying phase for this wetland to 31 months as of autumn 2021: the recommended drying phase is 6–9 months. Therefore, watering Moodie Swamp becomes more critical in 2020–21, to maintain threatened aquatic vegetation.

Scope of environmental watering

Table 5.5.5 describes the potential environmental watering action in 2020–21, its functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.5.5 Potential environmental watering action and objectives for the Broken wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Moodie Swamp (top up in spring as required, fill in autumn)	• Promote cane grass growth • Promote germination and growth of rigid water milfoil • Provide habitat for brolga nesting	



Scenario planning

Table 5.5.6 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Moodie Swamp has been identified as a high priority in all planning scenarios, as it remained dry throughout 2018–19 and 2019–20. If natural inflows occur over winter-spring 2020, a top-up in spring 2020 may be delivered to encourage and maintain any waterbird breeding. If the swamp remains dry, a fill in autumn 2021 is planned to promote the germination and growth of rigid water milfoil, as well as the growth of cane grass that brolga rely on for nesting. Both Black Swamp and Kinnairds Wetland received water in autumn 2020 and will enter a drying phase in 2020–21.

Low water availability in the Broken system under dry or drought conditions in 2020–21 may mean delivery to Moodie Swamp does not occur. Under average to wetter scenarios, water is likely to be available for delivery, and some natural inflow is likely under a wet scenario.

It is considered a priority to carry over water to allow 2021–22 top-ups to tier 1 wetlands planned to be watered in 2020–21.

Table 5.5.6 Potential environmental watering for the Broken wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Catchment runoff and natural flow into the wetlands are highly unlikely	• Catchment runoff and natural flow into the wetlands is unlikely	• Some catchment runoff and natural flow into some of the wetlands is likely, particularly in winter/spring	• Catchment runoff and natural flow into the wetlands may significantly contribute to water levels in the wetlands, particularly during winter/spring
Potential environmental watering – tier 1 (high priorities)	• Moodie Swamp			
Possible volume of environmental water required to achieve objectives[1]	• 1,000 ML (tier 1)			
Priority carryover requirements	• Up to 350 ML			

[1] Moodie Swamp is supplied from the Broken system. There is insufficient supply available to meet potential environmental watering requirements for Moodie Swamp under all scenarios.

5.6 Campaspe system

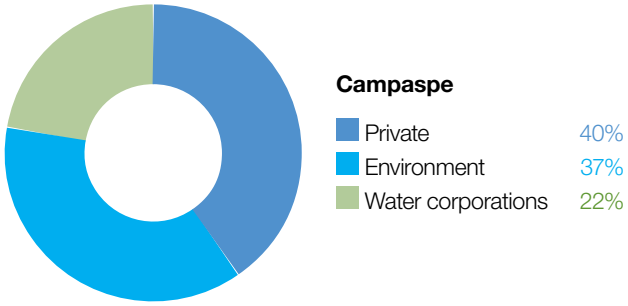
Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water

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

Did you know...?

The Arthur Rylah Institute and citizen scientists have been collecting otoliths — fish ear bones — from fish in the Campaspe River. Rather than catching extra fish, anglers have helped by extracting the fish ear bones from the fish they keep for eating. Length and data comparisons indicate that golden perch have higher growth rates in the Campaspe, compared to other northern Victorian rivers. It is likely this is a result of healthy and abundant waterbug populations in the river, a key objective of environmental flows.



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

Top: Campaspe River, by North Central CMA
Above: Campaspe vegetation, by North Central CMA

The Campaspe system includes the Campaspe River and the Coliban River.

5.6.1 Campaspe River

System overview

Natural inflows in the upper Campaspe River catchment are harvested into Lake Eppalock, which is located near the townships of Axedale and Heathcote. The main tributaries of the Campaspe River are the Coliban River, McIvor and Pipers creeks above Lake Eppalock and Mount Pleasant, Forest and Axe creeks below Lake Eppalock. Below Lake Eppalock, the major in-stream structure is the Campaspe Weir, which was built to divert water to the Campaspe Irrigation District. It is no longer used for water diversion but is a barrier to fish migration. Higher flows usually spill over the weir. The Campaspe Siphon, just below Rochester, is part of the Waranga Western Channel, which carries water from the Goulburn system to western Victoria. Water can be released from the Waranga Western Channel into the lower reaches of the Campaspe River, but the siphon is another barrier to fish migration when there is low-to-moderate flow.

The flow below Lake Eppalock is largely influenced by releases from storage and the operation of the Campaspe Weir and the Campaspe Siphon. The Campaspe's major tributary (the Coliban River) flows through the three Coliban Water storages (the Upper Coliban, Lauriston and Malmsbury reservoirs) before reaching Lake Eppalock. Water for the environment is held and released from Lake Eppalock, with some limited ability to regulate flow further downstream at the Campaspe Weir.

Water for the environment is released from Lake Eppalock to support aquatic plants and animals in and along the river. It can be supplemented by water for the environment delivered via the Waranga Western Channel at the Campaspe Siphon, which provides important flexibility to meeting reach 4 demands. Water for the environment is primarily used to improve the magnitude and variability of flows during the winter/spring. Primary flow measurement points are at Barnadown (reach 2) and below the Campaspe Siphon (reach 4).

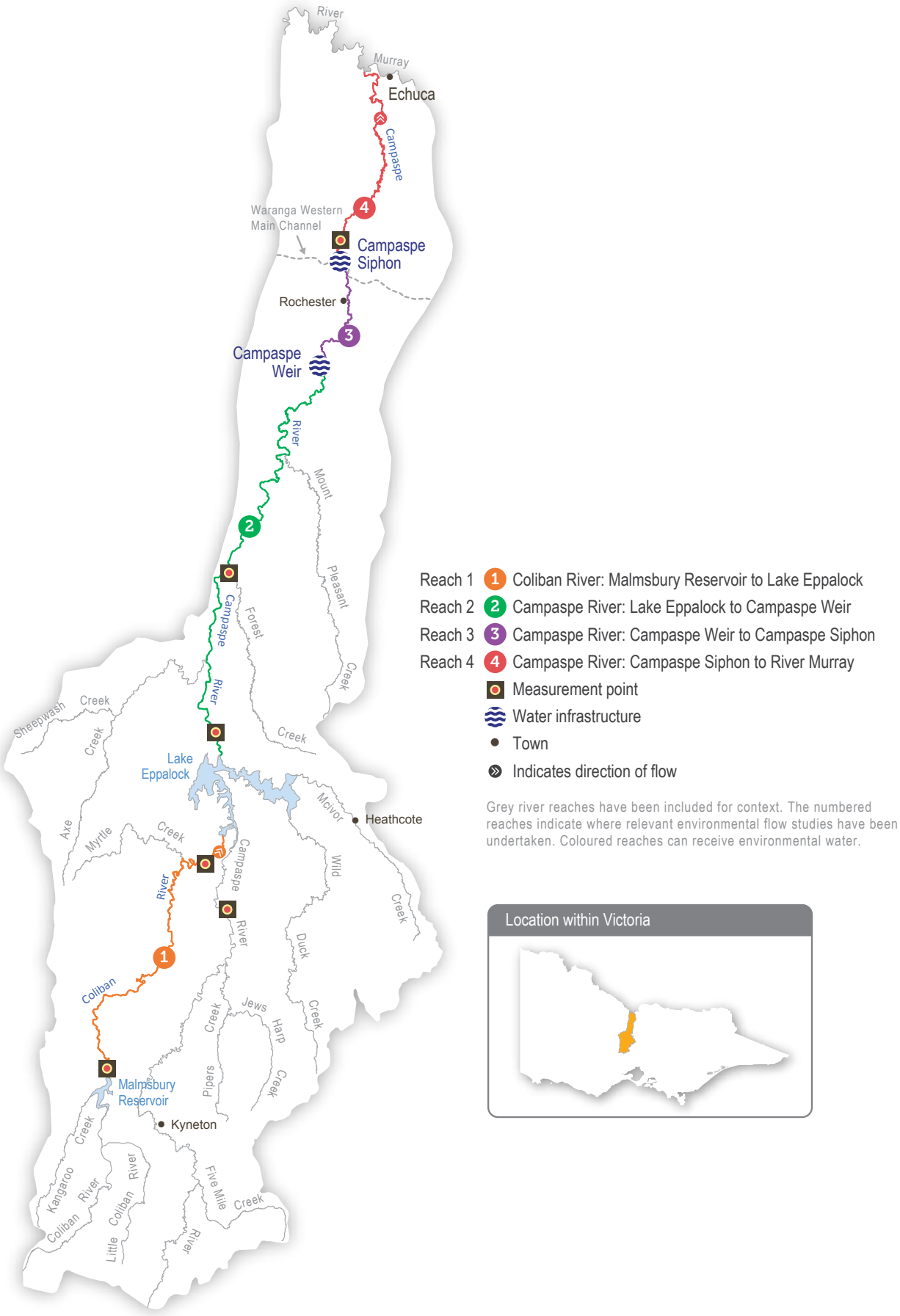
Goulburn-Murray Water transfers operational water from Lake Eppalock or through Waranga Western Channel to customers in the Murray River and to downstream storages (such as Lake Victoria). These IVTs usually occur in summer/autumn and, depending on the rate of delivery, can either support or compromise environmental watering objectives. High IVT flows delivered at a time when the Campaspe River would naturally have a low flow may reduce the amount of suitable habitat for juvenile fish, which rely on protected, shallow areas of water near the edge of the river channel. Sustained high IVT flows in summer can also drown streamside vegetation. Storage managers and the CMA have been working cooperatively to enhance the positive effects and limit the negative effects of IVTs on native plants and animals in the Campaspe River. For example, IVTs are sometimes delivered in a pattern that meets summer low flow and fresh requirements, thereby reducing demand on the environmental entitlement. IVTs have also been released in a pattern to support native fish migration from the Murray River into reach 4 of the Campaspe River, without affecting delivery to downstream users.

Environmental values

The Campaspe River below Lake Eppalock provides important habitat for several native fish species including Murray cod, silver perch, golden perch, Murray-Darling rainbowfish and flat-headed gudgeon. Murray-Darling rainbowfish were presumed lost from the system during the Millennium drought, but since 2011, they have been recorded at many sites on the Campaspe River and are now abundant below Elmore. Environmental flows help native fish migrate and disperse throughout the Campaspe system.

Platypus, rakali (water rats), turtles and frogs are also present along the length of the Campaspe River. The streamside vegetation zone is narrow and dominated by large, mature river red gum trees that support wildlife (such as the swift parrot and squirrel glider).

Figure 5.6.1 The Campaspe system



Environmental watering objectives in the Campaspe River

Provide habitat to help protect and increase populations of native fish

Facilitate recolonisation by native fish species that have been presumed lost

Maintain the resident platypus population by providing places to rest, breed and feed, as well as opportunities for juveniles to disperse

Maintain adult river red gums and provide opportunities for successful recruitment

Maintain the extent and increase the diversity of streamside vegetation

Increase the extent of in-stream aquatic plants

Increase waterbug productivity

Maintain water quality in deep pools and prevent stratification in summer

Reduce the risk of hypoxic blackwater events in summer

Traditional Owner cultural values and uses

In planning for environmental flows in the Campaspe River, North Central CMA has worked with Dja Dja Wurrung Clans Aboriginal Corporation, Taungurung Land and Waters Council and Yorta Yorta Nations Aboriginal Corporation to consider:

- valuable ways in collaboratively working together to understand how environmental values and cultural values align
- Taungurung's Baan Ganalina Advisory Group's and Dja Dja Wurrung's Kapa Gatjin Advisory Group's recently completed Aboriginal Water Assessment.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.6.1, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, kayaking and fishing)
- riverside recreation and amenity (such as birdwatching, camping, cycling, duck hunting, picnicking and walking)
- community events and tourism (such as regional visitation)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and wellbeing).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.6.1 with an icon.

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

There are many places along the Campaspe where visitors can camp. Aysons Reserve is a very popular camping site near Elmore, and it draws hundreds of campers during the summer school holiday period. Where possible, delivery of summer freshes will be timed to improve river conditions for campers and for water-related activities during peak visitation periods (such as the January long weekend).

Recent conditions

The Campaspe River catchment had below-average rainfall and above-average temperatures throughout most of 2019–20. January 2020 was the only month to record above-average rainfall. The 2019–20 season opened with 26 percent allocation of high-reliability water shares and a declared low risk of spill, which meant environmental water that was carried over from 2018–19 was available for use. Allocations against environmental entitlements in the Campaspe system steadily increased throughout 2019–20 and by April 2020 had reached 80 percent.

A combination of natural inflows, environmental flows, passing flows, operational flows and IVTs met or exceeded most of the dry-scenario watering actions that were planned for the Campaspe in 2019–20. The main deviations from the planned flow regime included a three-day cease-to-flow event in July 2019 to allow maintenance works at the Eppalock outlet tower and some periods of high IVTs between mid-October 2019 and mid-February 2020 that increased low flow by 20 ML per day above the recommended threshold. The IVT in 2019–20 was considered as low risk to the Campaspe River's health compared to previous years when IVTs were around three to four times higher than the recommended flow. Past monitoring of IVTs had indicated an impact to native fish recruitment and riverside native vegetation.

Scope of environmental watering

Table 5.6.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.6.1 Potential environmental watering actions and objectives for the Campaspe River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (10–50 ML/day during December to May)	• Maintain slackwater habitats for zooplankton and nursery habitats for native fish • Maintain the water quality and depth in deep pools in summer for native fish and platypus • Allow platypus to safely move between pools while foraging and ensure adequate food for lactating females	
Year-round fresh (five to 200 ML/day for one to 14 days, as needed)	• A fresh may be required when dissolved oxygen levels are below 5 mg/L, air temperatures are above 28°, there are high water temperatures and/or low river flows to improve water quality along the river pools and de-stratify pools in reach 4, ensuring adequate oxygen to support aquatic animals (such as native fish and platypus)	
Reduced[1] winter/spring low flow (20–40 ML/day during June to November)	• Increase longitudinal connectivity to allow native fish to access new habitats • Facilitate the long-distance movement of male platypus, especially in the August/October breeding season. Provide foraging opportunities across a wide range of habitats for females to develop fat reserves before breeding. • Maintain water quality by preventing pools stratifying	
Winter/spring freshes (two freshes of 1,100–1,600 ML/day for two to five days during June to November)	• Flush accumulated leaf litter from banks and low benches to reduce the risk of blackwater events during high river flow in summer • Maintain soil moisture for established river red gum and woody shrubs (such as bottlebrush and tea tree) • Maintain connectivity to allow native fish movement and access new habitats • Encourage females platypus to select a nesting burrow higher up the bank to reduce risk of high flow later in the year flooding the burrow when juveniles are present	
Winter/spring low flow (40–200 ML/day during June to November)	• Increase longitudinal connectivity to allow native fish to access new habitats • Facilitate long distance movement by male platypus especially in the August/October breeding season • Provide foraging opportunities across a wide range of habitats for female platypus to develop fat reserves before breeding • Maintain water quality by preventing pools stratifying • Reduce terrestrial plants colonising the lower sections of the riverbank and low benches in the channel • Maintain soil moisture in the riverbank to water established river red gums and woody shrubs • Help establish littoral vegetation	
Summer/autumn freshes (one to three freshes 100–200 ML/day for two to three days during December to May) 	• Increase longitudinal connectivity to allow native fish to access new habitats • Wet submerged wood and flush fine silt and old biofilms to promote new biofilm growth and increase waterbug productivity for native fish and platypus • Facilitate the downstream dispersal of juvenile platypus in April/May to colonise other habitat areas	

[1] Winter low flow of 20-40 ML/day is below the environmental flow recommendation of a minimum of 50 ML/day due to low water availability in the drought-dry scenario

Scenario planning

Table 5.6.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

For 2020–21, the highest-priority environmental flows are low flow in summer/autumn and winter/spring and delivering a year-round fresh (if needed) under all conditions (see tier 1a actions in Table 5.6.2).

Low flow in summer/autumn is critical for maintaining the river at a level that flushes high-salinity water from pools and maintains oxygen concentrations at a level that can support native fish and waterbugs. Under drought and dry conditions, the amount of water available for the environment is not likely to be sufficient to deliver the recommended winter/spring low flow watering action, and therefore a reduced magnitude low flow is proposed to ensure continuous flow is maintained year-round. The reduced magnitude winter/spring low flow will maintain riffle and pool habitats and water quality in all reaches but may not achieve objectives for streamside vegetation or allow fish and platypus to move freely throughout each reach. Delivering the full winter/spring low flow is a high priority under wet and average scenarios.

The other potential watering actions under average and wet scenarios are summer/autumn freshes and winter/spring freshes. Year-round freshes are a potential watering action as well; when there are low oxygen levels in the river, these will help improve water quality and help de-stratify pools in reach 4, to support aquatic animals.

Any additional water available under the drought or dry scenarios should be used to increase the magnitude of winter/spring low flow (tier 1b). Winter/spring freshes have been identified as tier 2 priorities under the drought and dry scenarios, and an additional winter/spring fresh is identified as a tier 2 watering action under the average scenario. These freshes will improve the condition of environmental values in the Campaspe River, but if there is insufficient water to deliver these freshes, that will not be to the detriment of the system's environmental values in 2020–21. Carryover into 2021–22 is not a priority this year, because sufficient allocation from a very high-reliability entitlement is expected to be available on 1 July 2020 to meet minimum critical demands.

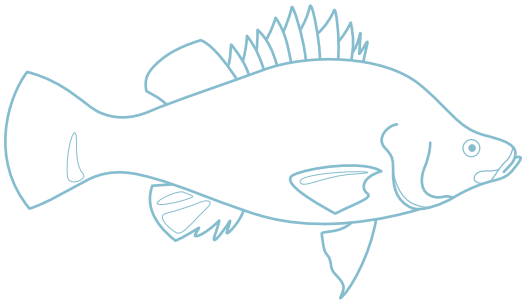


Table 5.6.2 Potential environmental watering for the Campaspe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Little or no natural flow • No passing flows in winter • Operational water deliveries	• Some natural flow • Increased passing flows • Operational water deliveries	• Some natural flow • Increased passing flows	• Some natural flow • Increased passing flows • Spills from storage
Expected availability of water for the environment	• 9,700 ML		• 20,300 ML	• 35,400 ML
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flow • Reduced winter/spring low flow • Year-round fresh (if needed)		• Summer/autumn low flow • One winter/spring fresh • Winter/spring low flow • One to three Summer/autumn freshes • Year-round fresh (if needed)	• Summer/autumn low flow • One to two winter/spring freshes • Winter/spring low flow • One to three Summer/autumn freshes • Year-round fresh (if needed)
Potential environmental watering – tier 1b (high priorities with shortfall)	• Increased magnitude winter/spring low flow		• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• One winter/spring fresh		• Additional winter/spring fresh	• N/A
Possible volume of environmental water required to achieve objectives[1]	• 9,700 ML (tier 1a) • 3,200 ML (tier 1b) • 4,100 ML (tier 2)		• 18,200 ML (tier 1a) • 4,100 ML (tier 2)	• 27,700 ML (tier 1a)

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

5.6.2 Coliban River

System overview

The Coliban River is the major tributary of the Campaspe River, and it flows into Lake Eppalock. It is highly regulated with three storages harvesting water primarily for urban use.

Flow in the Coliban River below Malmsbury Reservoir is regulated by the operation of the Malmsbury, Lauriston and Upper Coliban storages. An important distinction between the Coliban River and other regulated Victorian systems is the lack of irrigation demand. Therefore, flow in the river is influenced by the passing flow entitlement, which depends on catchment inflows and major flood events in the catchment.

Reach 1 of the Coliban River below Malmsbury Reservoir to Lake Eppalock can benefit from environmental watering. The VEWH does not have any environmental entitlements in the Coliban system, but passing flows can be managed — for example, they can be accumulated and released when most needed — to help mitigate some risks associated with critically low summer/autumn flow including low oxygen levels. A small volume of Commonwealth environmental water is held in the system, but the high cost of delivery means there is no plan to use it in 2020–21.

Environmental values

The Coliban River provides important habitat for platypus, rakali (water rats) and small-bodied native fish (such as flat-headed gudgeon and mountain galaxias). The Coliban River also contains a diverse range of waterbugs supported by stands of emergent and submergent aquatic vegetation. It is bordered by remnant patches of stream bank shrubland vegetation and woodland containing river red gum, callistemon, woolly tea-tree and inland wirilda, which provide habitat for terrestrial animals.

Environmental watering objectives in the Coliban River

- Increase the abundance and diversity of small-bodied native fish
- Increase platypus communities by providing opportunities for successful breeding and dispersal
- Increase the cover and diversity of aquatic plants
- Increase the cover and diversity of fringing vegetation, while limiting encroachment into the middle of the channel
- Maintain adult streamside woody vegetation and facilitate recruitment
- Maintain an adequate diversity and biomass of waterbugs, to break down dead organic matter and support the river's food chain
- Improve water quality and maintain healthy levels of oxygen in pools

Traditional Owner cultural values and uses

In planning for environmental flows in the Coliban River, Dja Dja Wurrung Clans Aboriginal Corporation and North Central CMA have considered how environmental water management assists with preservation of historical and contemporary cultural values including promoting a sense of place and spiritual connection.

The Dja Dja Wurrung Country Plan describes their aspirations around the management of rivers and waterways and articulates Dja Dja Wurrung peoples' support for the reinstatement of environmental flows as an overall objective for the management of water on Country. The North Central CMA and Dja Dja Wurrung Clans Aboriginal Corporation continue to work towards increased engagement on planning and delivery of environmental watering activities, including identifying opportunities for Dja Dja Wurrung involvement.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.6.3, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing)
- riverside recreation and amenity (such as birdwatching, camping, cycling and walking)
- community events and tourism (such as visitation)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, community wellbeing and benefits to the local economy from visitors).

Recent conditions

Rainfall in the Coliban River catchment was below the long-term average for every month during 2019–20, except in November and January. Daily maximum temperatures were generally above average, and December 2019 was exceptionally hot. Carryover from the previous year, along with some unregulated inflows in the Coliban River from July to September 2019, facilitated the accumulation of passing flows.

The flow varied along the length of the Coliban River throughout 2019–20. The Coliban River began contracting above Lake Eppalock towards Malmsbury Reservoir from October 2019 onwards, as the flow dried up along the river. Inflows from unregulated tributaries delivered several natural freshes to the whole system between July and September 2019. Passing flows that were accumulated in winter/spring were used to maintain low flow between Malmsbury Reservoir and Lake Eppalock throughout summer/autumn. Accumulated passing flows were also used to deliver a fresh to improve water quality for aquatic biota in this section of the river in March 2020.

In 2019–20, the priority pulsed low flow in summer and autumn for maintaining water quality was not required, as there was enough water to maintain a reduced summer/autumn low flow in the upper sections of the river. However, the water available was insufficient to maintain full connectivity of the river to Lake Eppalock, and the lower reaches contracted to a series of pools in summer.

Scope of environmental watering

Table 5.6.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.6.3 Potential environmental watering actions and objectives for the Coliban River

Potential environmental watering action	Functional watering objectives	Environmental objectives
Pulsed summer/autumn low flow (five to 15 ML/day for one to 14 days during December to May)	• Maintain water quality including oxygen levels • Maintain refuge habitat for aquatic animals, including fish and platypus	
Summer/autumn low flow (one to 10 ML/day during December to May)	• Maintain aquatic habitat that support waterbugs, native fish, platypus and fringing vegetation • Maintain water quality including oxygen levels	

Summer/autumn freshes (one to two freshes of 25-160 ML/day for one to three days during December to May)	• Maintain the water depth through rifle-run habitats of five to 20 cm for a 25-50 ML/day event to maintain water quality and habitat for waterbugs
	• Maintain water depth through rifle-run habitats of 45–55 cm for a 160 ML/day event to:
	  • increase water depth to facilitate fish and platypus movement
	  • clean sediment and biofilms from river substrates
	  • wet benches and low banks to promote the growth and recruitment of fringing vegetation
		

Scenario planning

Table 5.6.4 outlines the potential environmental watering and expected water use under a range of planning scenarios. Watering actions have only been considered for drought to average scenarios, because the storage is likely to spill under wet conditions, and therefore it will not be possible to accumulate passing flows to deliver environmental flows.

Low flow in summer/autumn is the highest-priority potential watering action across all (drought to average) scenarios, to support aquatic habitats for fish, platypus and waterbugs, and to support aquatic and fringing vegetation in the river. It should be possible to maintain continuous low flow targets under dry and average conditions, but less water will be available under drought conditions, so it may only be possible to deliver pulsed low flow to maintain refuge habitats

Under dry and average conditions, accumulated passing flows are planned to be used to deliver summer/autumn freshes to support vegetation recruitment, maintain aquatic habitats and clean river substrates. The number of freshes delivered will depend on the available water and observed conditions in the river.

If more water is available under drought conditions, it is planned to be set aside to support critical watering actions in 2021–22 and/or used to increase the magnitude or duration of low flow if conditions in the river deteriorate. Additional water will go to delivering tier 2 priorities which are freshes in summer/autumn (across all scenarios) and in winter/spring (in the drought scenario).

The carryover priority is to bank passing flows in the river for 2021–22 watering actions (700 ML).

Table 5.6.4 Potential environmental watering for the Coliban River under a range of planning scenarios

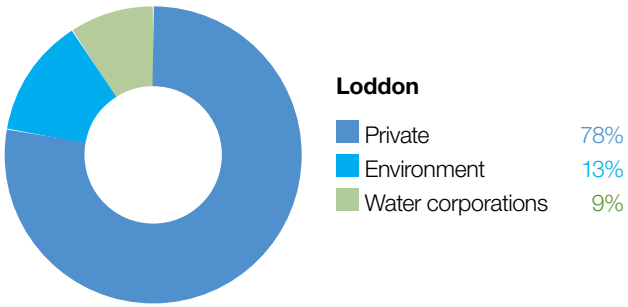
Planning scenario	Drought	Dry	Average
Expected river conditions	• Little or no natural flow	• Some natural flow	• Some natural flow
Expected availability of water for the environment	• Little passing flow accumulated for use in other times of the season • Reliant on carryover from 2019–20 year	• Increase in passing flows, with minimal risk of storage spills • Maximum accumulation of passing flows • Withheld flows for use at other times in the season	• Moderate to high passing flows but reduced ability to accumulate flows due to possible storage spills
Potential environmental watering – tier 1a (high priorities)	• Pulsed summer/autumn low flow • Summer/autumn low flow (reduced magnitude)	• Summer/autumn low flow (reduced magnitude) • One to two summer/autumn freshes	• Summer/autumn low flow (reduced magnitude) • One to two summer/autumn freshes
Potential environmental watering – tier 1b (high priorities with shortfall)	• Set aside 2021–22 carryover • Increased magnitude of summer/autumn low flow	• Increased magnitude of summer/autumn low flow	• Increased magnitude of summer/autumn low flow
Potential environmental watering – tier 2 (additional priorities)	• Two winter/spring freshes • Two summer/autumn freshes	• Increased magnitude of two summer/autumn freshes	• Increased magnitude of two summer/autumn freshes
Possible volume of environmental water required to achieve objectives	• 1,200 ML (tier 1a) • Tier 1b and 2 – dependent on water resources and river conditions	• 1,600 ML (tier 1a) • Tier 1b and 2 – dependent on water resources and river conditions	• 2,500 ML (tier 1a) • Tier 1b and 2 – dependent on water resources and river conditions
Priority carryover requirements	• Accumulate passing flows for 2021–22 (700 ML)		

5.7 Loddon system

Waterway manager – North Central Catchment Management Authority
Storage manager – Goulburn-Murray Water
Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

Did you know...?

Lake Boort is a highly significant area for Dja Dja Wurrung. The floodplain not only contains some of the highest densities of scarred trees in the world but numerous cooking mounds and other remainders of past productivity. The connection continues through to this day and is embedded in the plants, animals, *Gatjin* (water), *Wi* (fire) and *Djandak* (land).



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

Top: 12 Mile Creek in the lower Loddon catchment, by Kathryn Roosje, VEWH
Above: Loddon system vegetation, by North Central CMA

The Loddon system includes the Loddon River (including Tullaroop, Serpentine and Pyramid creeks), the Boort wetlands and Birchs Creek.

5.7.1 Loddon River system (including Tullaroop, Serpentine and Pyramid creeks)

System overview

The Loddon River flows from the Great Dividing Range in the south to the Murray River in the north. Tullaroop Creek is the main tributary in the upper Loddon River system. The middle section of the Loddon River is characterised by many distributary streams and anabranches that carry water away from the river onto the floodplain. The lower Loddon River is joined by Pyramid Creek at Kerang, at which point the Loddon becomes part of the Murray River floodplain.

Two main storages are located on the Loddon River: Cairn Curran and Tullaroop reservoirs, with Lake Laanecoorie used to regulate water from the main storages to the Loddon River. Below Laanecoorie Reservoir, the flow is regulated by the operation of the Bridgewater, Serpentine, Loddon and Kerang weirs.

Water for the environment can be delivered to the Loddon River from Cairn Curran or Tullaroop reservoirs or from the Goulburn system via the Waranga Western Channel, which intersects with the Loddon River at Loddon Weir. Water is provided to Pyramid Creek through releases from Kow Swamp, which receives water diverted from the Murray River at Torrumbarry Weir. Water is diverted from the Loddon River to Serpentine Creek and to the Loddon Valley Irrigation Area to supply agriculture.

The highly regulated nature of the Loddon system provides both challenges and opportunities for effective management of water for the environment. The ability to manipulate the timing of releases at multiple locations provides opportunities to accomplish environmental outcomes at discrete locations. However, coordinating environmental flows and consumptive flows is difficult through the irrigation season, especially when irrigation demand is high or flow in the river is highly variable. This can lead to constraints in the timing and delivery of water for the environment or higher-than-recommended flows above Loddon Weir. The structures used for managing irrigation water form barriers in the waterway, restricting continuity and the ability to achieve outcomes for native fish and possibly platypus.

Environmental values

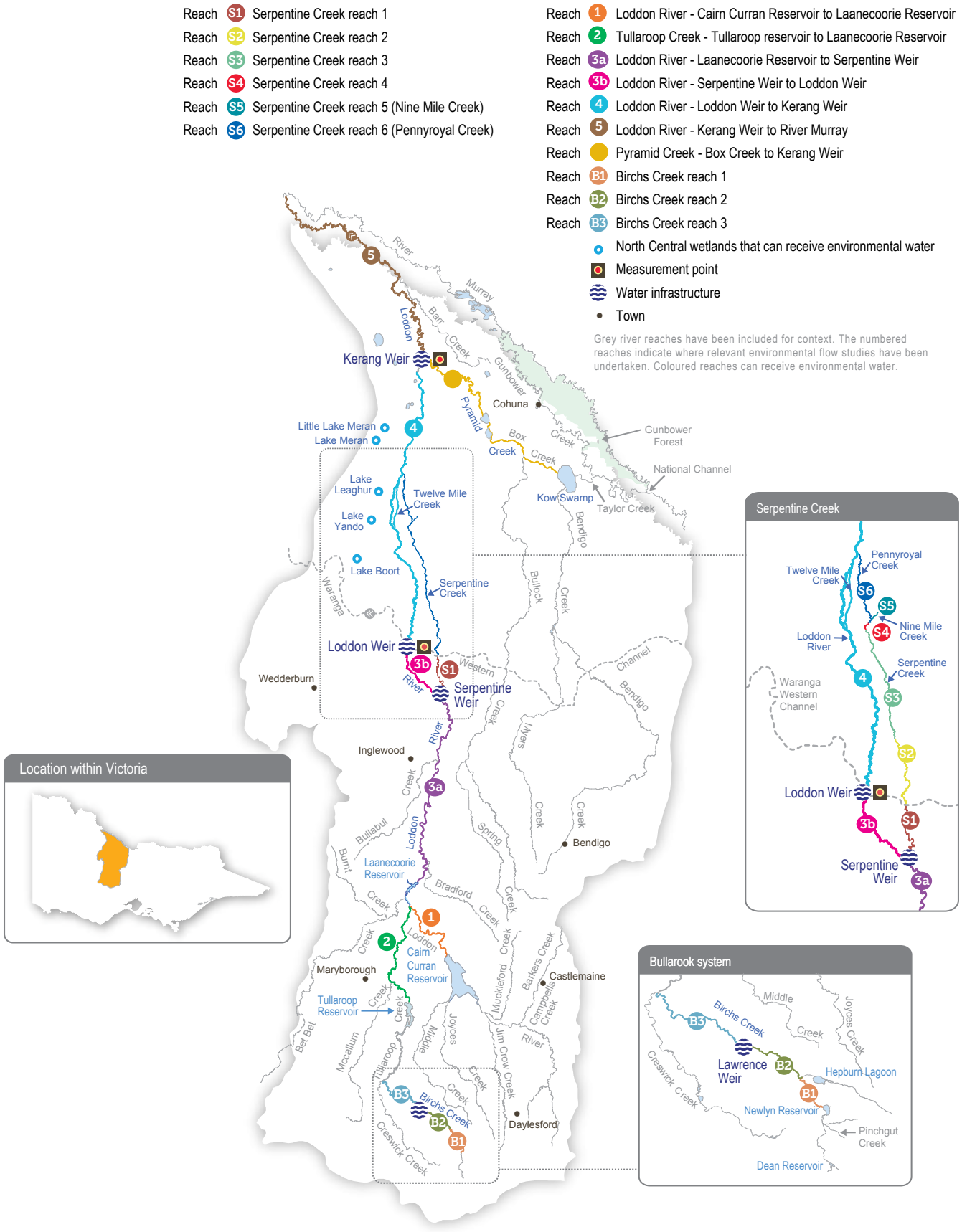
The Loddon River system supports platypus, rakali (water rats) and several species of native fish. Streamside vegetation varies in condition depending on the recent water regime, the extent of clearing and historic and current land management practices. Those areas remaining relatively intact support a variety of woodland birds and other native animals. Important plant species across the system include cane grass, tangled lignum, black box and river red gum.

Although fish populations in the Loddon system are affected by the many barriers caused by weirs and reservoirs, a large range of species are still found through the catchment. Native fish are most abundant and diverse in the upper catchment. River blackfish are found in Serpentine Creek and rare Murray-Darling rainbow fish are found in the middle and lower sections of the Loddon River.

The highest-priority reach for environmental watering is from Loddon Weir to Kerang Weir. The reach does not carry irrigation water, and it relies heavily on environmental flows to maintain its environmental condition. Environmental flows to this reach aim to improve the condition of streamside vegetation, maintain water quality and increase the abundance and diversity of native fish. Environmental flows are delivered to the upper Loddon River, Tullaroop Creek and Serpentine Creek to maintain or increase populations of river blackfish and platypus.

Pyramid Creek and the lower Loddon River support large-bodied fish (such as golden perch, Murray cod and silver perch) and are important corridors for fish migration between the Loddon and Murray systems. Engineering works to provide fish passage at the Chute, Box Creek regulator, Kerang Weir, Fish Point Weir and Little Murray Weir on the Little Murray River in recent years have been important in reopening these migration routes. The Arthur Rylah Institute has monitored fish movement and populations in Pyramid Creek and the lower Loddon River since 2017, and results have indicated that the combined Loddon-Pyramid flow is stimulating native fish movement through the fishways.

Figure 5.7.1 The Loddon system



Environmental watering objectives in the Loddon River system

Increase populations of small and large-bodied native fish

Provide habitat for fish to feed and breed and opportunities for movement between habitats

Enhance the channel form and features including deep pools and benches

Maintain the condition of suitable substrate, to maintain ecosystem processes

Engage floodrunners, distributary channels, anabranches and backwaters

Increase the population and recruitment of resident platypus

Maintain a stable rakali (water rat) population in the long term

Maintain the streamside and floodplain vegetation

Maintain and increase the extent of in-stream vegetation

Maintain/increase the diversity and productivity of waterbugs, including biofilms and waterbug functional feeding groups, to drive productive and dynamic food webs

Maintain water quality, to support aquatic animals and minimise the risk of blackwater events

Traditional Owner cultural values and uses

In planning for environmental flows in the Loddon River, Dja Dja Wurrung, Barapa Barapa and Wamba Wemba and North Central CMA have considered how environmental flows in the Loddon system can be managed to support their respective values and uses.

The Dja Dja Wurrung Traditional Owners have expressed an interest in seeing a return of species to the river that were, within peoples' living memory, more abundant. This includes species such as platypus, turtles and yabbies. Restoring a natural flow regime and improving water quality are overall cultural aspirations of the Dja Dja Wurrung for management of waterways.

The Barapa Barapa and Wamba Wemba are the Traditional Owners in the northern part of the Loddon catchment, and artefacts of cultural practices are present throughout the Loddon and Pyramid system and its floodplain. The river and floodplain are valued as food and fibre sources and sites of cultural significance such as scar trees, camp sites, meeting places and other important sites.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.7.1, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing, kayaking, water skiing and swimming)
- riverside recreation and amenity (such as camping, cycling, picnicking and walking)
- community events and tourism (such as local visitation)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 5.7.1 with an icon.

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

If possible, North Central CMA will work with Goulburn-Murray Water to manage the delivery of low flow over summer/autumn, which supports optimum conditions for annual water-skiing competitions on the Loddon River at Bridgewater.

Recent conditions

The mid-Loddon catchment had above-average rainfall in July 2019, but the middle and upper Loddon catchments were significantly drier than average during spring and for the first half of summer. Rainfall throughout the Loddon catchment was above average during late summer/autumn 2020, but that did not significantly affect storage levels. Seasonal determinations did not reach 100 percent in the Loddon or Goulburn systems during 2019–20, but carryover, used of allocated water and environmental water transferred into the Loddon system from entitlements in the Goulburn system ensured that enough water was available to deliver all required environmental flows.

Rainfall in the Bet Bet Creek catchment caused spills at Laanecoorie Reservoir and Loddon Weir during July and August 2019, which provided a series of natural freshes and minor overbank flows in the Loddon River below Loddon Weir during early winter. Following the winter spills, flow in the Loddon system returned to the usual regulated conditions for the remainder of the year. Flow in the Loddon River above Loddon Weir, Serpentine Creek and Pyramid Creek exceeded the recommended environmental flow rates at various times during summer/autumn, due to consumptive water deliveries.

The planned environmental watering regime for reach 4 of the Loddon River under dry and average scenarios was entirely achieved in 2019–20. Following the winter high flow, the priority for the year was to continue year-round low flow in the Loddon River and provide summer-autumn freshes to protect water quality and refuge habitat in the Loddon River and Serpentine Creek. Carryover and water transferred into the system made it possible to deliver a spring fresh, combining water from the Loddon River and Pyramid Creek during November 2019.

Monitoring stations continuously monitor temperature and oxygen in reach 4 of the Loddon River. Low oxygen and high water temperatures have occurred in the Loddon River under low flow conditions in previous years, but environmental flows and relatively cool conditions throughout the second half of summer/autumn prevented poor water quality during 2019–20. Environmental water will continue to be used in future, to reduce the risk of dangerously low levels of oxygen.

Scope of environmental watering

Table 5.7.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

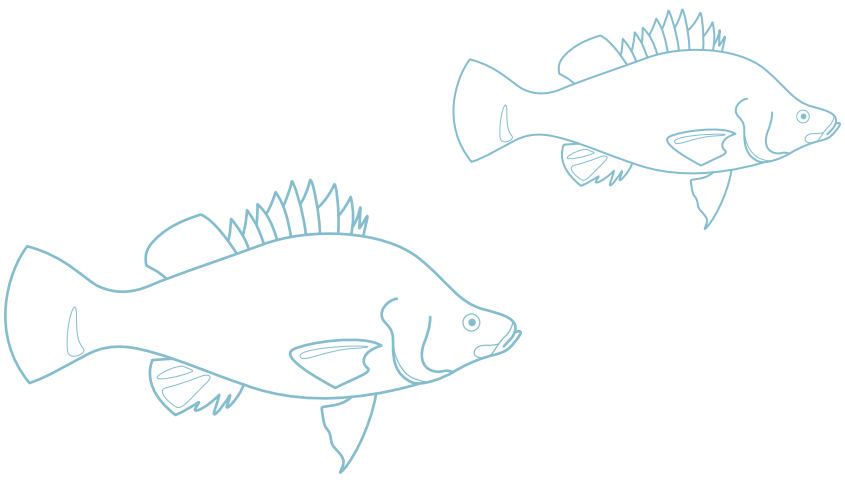


Table 5.7.1 Potential environmental watering actions and objectives for the Loddon River system

Potential environmental watering action	Functional watering objectives	Environmental objectives
Loddon River (targeting reach 4)		
Summer/autumn fresh (one to three freshes of 50–100 ML/day for three to four days during December to May)[1]	• Flush fine sediment from hard surfaces • Increase the water level, to promote the growth of fringing emergent macrophytes • Increase connectivity to promote the local movement of fish and platypus including juvenile dispersal in autumn • Freshen water quality and re-oxygenate pools	
Winter/spring high flow (one high flow of 450–750 ML/day for six to 10 days during August to November)[2]	• Scour accumulated sediment from pools and scour biofilms • Flush accumulated organic matter from the bank and benches, to increase productivity and reduce the risk of a hypoxic blackwater event in summer • Increase the wetted area, to promote the recruitment and growth of streamside and emergent vegetation • Stimulate native fish movement and breeding	
Summer/autumn low flow (25–50 ML/day during December to May)[3] 	• Maintain an adequate depth in pools for aquatic plants and to provide habitat for waterbugs, fish and rakali (water rats) • Provide continuous flow through the reach, to maintain water quality • Maintain connecting flows to support in-stream and fringing non-woody vegetation	
Winter/spring low flow (50[4]–100 ML/day during June to November)	• Increase the water depth for fish, platypus and rakali (water rats) dispersal and to provide foraging habitat • Prevent silt and fine sediment settling on submerged wood and other hard surfaces • Water the native fringing bank vegetation and prevent the growth of exotic terrestrial plants in the river channel	
Autumn high flow (one high flow of 400 ML/day for six to 10 days during March to May)	• Trigger and facilitate the upstream movement of golden perch, silver perch and Murray cod older than one year • Facilitate platypus dispersal	

Table 5.7.1 Potential environmental watering actions and objectives for the Loddon River system *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Serpentine Creek[5]		
Summer/autumn fresh (one to three freshes of 30–40 ML/day for one to three days during December to May)	• Maintain the channel form by inundating benches • Flush fine sediment and scour biofilms, to replenish the food supply • Transport organic matter that has accumulated in the channel • Provide flow variability to maintain the diversity of fringing vegetation • Wet exposed woody habitat for waterbugs and provide a sufficient depth of water and variability of flow to maintain microbial biofilms • Freshen water quality by diluting salt and oxygenating pools	
Winter/spring fresh (one fresh of 40–150 ML/day for two days during August to November)	• Maintain the channel form and scour pools • Provide connectivity for fish and waterbugs to access different habitat areas • Transport organic matter that has accumulated in the channel, to increase productivity and reduce the risk of a hypoxic blackwater event in summer • Provide a cue for adult platypus to construct burrows above the higher water level	
Summer/autumn low flow (10–20 ML/day during December to May)	• Provide flow variability to prevent notching of riverbanks • Provide connectivity between pools to allow the dispersal of small-to-medium-bodied native fish • Wet exposed roots, leaf packs and woody debris, to provide habitat for aquatic animals • Provide sufficient flow to maintain water quality by oxygenating pools • Maintain foraging habitat for platypus • Maintain the wetted area to support in-stream aquatic vegetation (such as water ribbons, eel weed and milfoil)	
Winter/spring low flow (20–30 ML/day during June to November)	• Maintain spawning habitat for native fish • Wet exposed roots, woody debris, emergent vegetation and leaf packs, to provide habitat for aquatic animals • Maintain water quality by preventing stagnation • Provide flow variability, to prevent notching of riverbanks and maintain diversity of fringing vegetation • Provide a sufficient depth of water and variability of flow to maintain microbial biofilms	

Table 5.7.1 Potential environmental watering actions and objectives for the Loddon River system *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Pyramid Creek and Loddon River (reach 5)		
Spring high flow (one high flow of 700 ML/day for 10 days during September to October)	• Trigger the migration, spawning and recruitment of native fish species including Murray cod • Maintain connectivity between habitats and improve water quality	
Autumn/winter low flow (90–200 ML/day during May to August)	• Maintain connectivity between pools and provide habitat for fish and waterbugs outside of the irrigation season • Improve water quality by reducing salinity levels • Enhance the wetted area to maintain and promote the growth of fringing emergent (non-woody) vegetation along the lower banks of the channel • Redistribute fine sediment on benches and bars	
Autumn high flow (up to one high flow of 700–900 ML/day for 10 days during March to May)	• Trigger the migration, spawning and recruitment of native fish species including Murray cod • Facilitate the upstream movement of golden perch, silver perch and Murray cod older than one year • Maintain connectivity between habitats and improve water quality • Facilitate platypus dispersal	

[1] The recommended magnitude and duration may be increased if needed to prevent a decline in oxygen levels.

[2] Due to the potential wetting of private land, environmental flows above 450 ML per day in reach 4 will not be provided without the agreement of landholders who could potentially be affected.

[3] Recommended magnitude may be increased if needed to prevent adverse declines in oxygen levels.

[4] Winter/spring low flow of 50 ML per day is below the passing flow magnitude and will result in the VEWH banking passing flows savings, for use in other potential watering actions.

[5] Flows in Serpentine Creek will be allowed to either return to the Loddon River or continue down Pennyroyal/Bannacher Creek or Nine Mile Creek with the agreement of landholders.

Scenario planning

Table 5.7.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Up to three summer/autumn freshes and continuous low flow are planned to be delivered in the Loddon River under all scenarios. These flows are critical for providing connectivity for aquatic animals and freshening water quality. A winter/spring high flow, timed to combine with increased flow in Pyramid Creek, is also planned to be delivered under all scenarios to trigger upstream movement of native fish from the Murray system for feeding and breeding.

Low flow is important for wetting bank vegetation and providing foraging habitat for aquatic animals. In the Loddon River, the magnitude of low flow is expected to vary between 25 to 100 ML per day, depending on conditions (and therefore changes in expected supply) and the time of year. During winter/spring, continuous low flow of 50 ML per day is planned under a drought scenario. This will result in the accumulation of passing flows (as passing flows increase to 77 ML per day in May to October), for use later in the season. Under dry conditions, passing flows are expected to meet the winter low flow requirement, whereas under average and wet conditions, low flow will likely be increased to 100 ML per day. During summer and autumn, continuous low flow is planned to be as low as 25 ML per day in a drought-dry year but may be increased to 50 ML per day if conditions are average to wet. Contingency has been factored in to supply volumes under drought and dry scenarios to temporarily increase summer/autumn low flow magnitudes or the duration of freshes if required, to prevent dangerously low oxygen declines if extended heatwaves are forecast. If more water is available, it is planned to be used to further increase the magnitude of planned freshes and low flow to better align with the environmental flow recommendations. Autumn high flow to cue and support fish movement is a lower priority under a drought scenario compared to dry, average and wet scenarios.

Freshes and low flow are priorities across all seasons for Serpentine Creek under all scenarios. Lower anticipated supply under drought and dry conditions will likely restrict the number of summer/autumn freshes that can be delivered and restrict low flow to the lower end of the recommended range. The full number of recommended freshes and higher-magnitude low flow should be delivered if more water becomes available under these scenarios.

In Pyramid Creek, the highest-priority action under all scenarios is to deliver a spring high flow, which is intended to be timed to meet the peak of the high flow in the Loddon River at Kerang Weir. Coordinating these events provides flow of a sufficient magnitude to trigger native fish to move upstream from the Murray River toward Kow Swamp and Gunbower Creek for spawning and recruitment. Pyramid Creek carries a large volume of consumptive water during the irrigation season, but the flow can drop significantly outside the irrigation season. Under all scenarios, water for the environment will likely be used to supplement flow in late autumn and winter, to maintain habitat for fish and other aquatic animals during this period. Autumn high flow should be delivered under average and wet conditions, if sufficient water is available.

Up to 6,500 ML is prioritised for carryover into 2021–22. This water will help meet winter/spring low flow in all waterways and the spring high flow in the Loddon River.

Table 5.7.2 Potential environmental watering for the Loddon River system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Negligible contributions from unregulated reaches and tributaries of the Loddon River, consumptive water deliveries in the irrigation season • Reduced passing flows in autumn/ winter likely	• Small inflows from unregulated reaches and tributaries of the Loddon River contributing to low flow, consumptive water deliveries in the irrigation season	• Natural flow will provide low flow and multiple freshes, most likely in winter/ spring • Consumptive water deliveries in the irrigation season • No spill likely	• Spills from Loddon system storages will provide extended-duration high flow and overbank flow most likely in late winter/spring
Expected availability of water for the environment[1]	• Up to 15,600 ML	• 17,700 ML	• 20,700 ML	• 20,700 ML
Loddon River (targeting reach 4)				
Potential environmental watering – tier 1a (high priorities)	• One to three summer/autumn freshes • One winter/spring high flow • Summer/autumn low flow • Winter/spring low flow at lower magnitude (accumulating passing flows savings)	• One to three summer/autumn freshes • One winter/spring high flow • Summer/autumn low flow	• One to three summer/autumn freshes • One winter/spring high flow • Summer/autumn low flow • Winter/spring low flow	
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn fresh delivered at upper magnitude • Winter low flow delivered at upper magnitude	• Winter low flow delivered at upper magnitude[2] • One autumn high flow	• One autumn high flow	
Potential environmental watering – tier 2 (additional priorities)	• One autumn high flow	• N/A		
Serpentine Creek				
Potential environmental watering – tier 1a (high priorities)	• One to three summer/autumn freshes • One winter/spring fresh • Summer/autumn low flow • Winter/spring low flow		• Three summer/autumn freshes • One winter/spring fresh • Summer/autumn low flow • Winter/spring low flow	
Potential environmental watering – tier 1b (high priorities with shortfall)	• Low flow delivered at upper magnitude • Winter/spring fresh delivered at upper magnitude		• N/A	

Table 5.7.2 Potential environmental watering for the Loddon River system under a range of planning scenarios *(continued)*

Pyramid Creek and Loddon River (reach 5)				
Potential environmental watering – tier 1a (high priorities)	• One spring high flow (coordinated with Loddon River high flow) • Autumn/winter low flow			
Potential environmental watering – tier 1b (high priorities with shortfall)	• N/A		• Autumn high flow	
Possible volume of environmental water required to achieve objectives[3]				
Loddon River (reach 4) and Serpentine Creek	• 11,300 ML (tier 1a) • 4,300 ML (tier 1b) • 4,100–6,800 ML (tier 2)	• 12,000–15,700 ML (tier 1a) • 6,800–13,600 ML (tier 1b)	• 24,500 ML (tier 1a)[4] • 4,100–6,800 ML (tier 1b)	
Pyramid Creek and Loddon River (reach 5)	• 4,000 ML (tier 1a)[5]		• 4,000 ML (tier 1a)[5] • 2,000 ML (tier 1b)[5]	
Priority carryover requirements	• 6,500 ML			

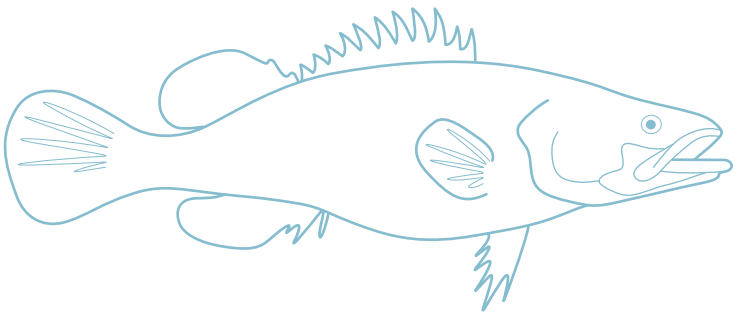
[1] Water holdings available for demands in the Loddon River system are also used to source demands in the Boort wetlands.

[2] Under a dry scenario, winter low flow is planned to otherwise be delivered at the passing flow rate (77 ML per day) for tier 1a.

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

[4] This tier 1a volume is the supply required to meet all potential watering actions with water for the environment. While it is higher than the expected availability of environmental water holdings, it is likely that some actions may be achieved with natural flows in the system reducing the actual volume required.

[5] Consumptive water en route to downstream sites is diverted through Pyramid Creek to meet these events, with the associated losses debited to the VEWH. A volume of 2,000 ML per event is required to underwrite these losses, however the actual use debited is likely to be less than this volume.



5.7.2 Boort wetlands

System overview

The Boort wetlands are on the floodplain west of the Loddon River, below Loddon Weir. They consist of temporary and permanent freshwater lakes and swamps: Lake Boort, Lake Leaghur, Lake Yando, Little Lake Meran and Lake Meran. Together, the Boort wetlands cover over 800 ha. There are numerous other wetlands in the district, but they are currently not managed with water for the environment.

The natural watering regimes of wetlands throughout the broader Loddon system have been substantially modified by the construction of levees and channels across the floodplain and by the construction and operation of reservoirs and weirs along the Loddon River. Water is delivered to the Boort wetlands through Loddon Valley Irrigation Area infrastructure.

The availability of water for the environment for the Boort wetlands is closely linked to water available for the Loddon River system. The ability to deliver water for the environment to the wetlands is sometimes limited by channel capacity constraints. The VEWH and North Central CMA work with the storage manager (Goulburn-Murray Water) to best meet environmental objectives within capacity constraints.

Environmental values

The Boort wetlands provide habitat for a range of plant and animal species. At Lake Yando, 12 rare plant species have been recorded including the jerry-jerry and water nymph. Bird species recorded at Lake Boort, Lake Leaghur and Lake Meran include the white-bellied sea eagle, Latham's snipe and eastern great egret. Little Lake Meran is a swampy woodland with black box trees on the highest wet margins and river red gums fringing the waterline.

Environmental watering objectives in the Boort wetlands

- Increase the population of large and small-bodied fish species
- Increase the diversity and population of native frogs including by enhancing breeding opportunities
- Maintain the population of freshwater turtles, in particular Murray River turtles
- Rehabilitate and increase the extent of emergent and aquatic vegetation (aquatic herblands, tall marsh), intermittent swampy woodland and riverine chenopod woodland
- Maintain the health and restore the distribution of river red gums and associated understorey species
- Maintain the extent and restore the health of black box vegetation
- Support a high diversity of wetland birds by enhancing feeding and breeding conditions

Traditional Owner cultural values and uses

In planning for environmental flows in the Boort wetlands, North Central CMA has worked with Barapa Barapa and Wamba Wemba Traditional Owners and Dja Dja Wurrung Clans Aboriginal Corporation to identify opportunities to engage on environmental water planning and delivery now and in future.

The wetlands and surrounding land in the Boort region are rich in cultural heritage, with sites and artefacts of cultural practices present throughout the landscape. The rivers and floodplains are valued as food and fibre sources and contain many sites of significance such as camp sites and meeting places. Environmental watering supports values such as native fish, waterbirds and turtles, and promotes the growth of culturally-important plants that provide food, medicine and weaving materials. The presence of water itself can be a cultural value, as well as the quality of the water, as healthy water promotes a healthy Country.

A key priority for Barapa Barapa and Wamba Wemba Traditional Owners in the Boort and central Murray region wetlands is maintaining or improving the condition of wetland vegetation health. North Central CMA and Barapa Barapa Traditional Owners are collaborating to deliver the DELWP-funded Decision Support Tool (DST) project which focuses on McDonalds Swamp (central Murray wetlands, see section 5.2.3), Lake Leaghur and Lake Yando. The project involves the delivery of revegetation works and vegetation monitoring. Environmental watering decisions at these wetlands have been able to support the DST project by aligning watering actions with the watering requirements of the revegetation and enabling monitoring to be completed by Barapa Barapa.

The Dja Dja Wurrung Country Plan describes their aspirations around the management of rivers and waterways and articulates Dja Dja Wurrung peoples' support for the reinstatement of environmental flows as an overall objective for the management of water on Country. The North Central CMA and Dja Dja Wurrung Clans Aboriginal Corporation continue to work towards increased engagement on planning and delivery of environmental watering activities, including identifying opportunities for Dja Dja Wurrung involvement.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.7.3, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing and kayaking)
- riverside recreation and amenity (such as birdwatching, camping, duck hunting and walking)
- community events and tourism (such as supporting Aboriginal cultural heritage and history-based tours)
- socio-economic benefits (such as ecosystem services like groundwater recharge, flood mitigation, nutrient treatment and carbon storage).

Recent conditions

Rainfall across the Boort wetlands during 2019–20 was close to the long-term average, but there were no floods in the Loddon River catchment and therefore no significant inflows to the wetlands. The Boort wetlands last flooded in 2016, and since then water for the environment has been delivered to Lake Meran and Little Lake Meran, which, at the end of 2019–20, both continued to hold water. Lake Yando and Lake Leaghur are completely dry and are due for filling under their recommended watering regimes. Lake Boort is also dry and is preferred to remain dry in 2020–21 to maintain its optimal regime.

Water for the environment was used to top up water levels in Lake Meran between spring 2019 and autumn 2020 as recommended in the *Lake Meran Environmental Water Management Plan*, to maintain habitat for aquatic animals and promote the growth of fringing vegetation. A planned partial fill at Lake Yando did not proceed in 2019–20, due to delivery constraints and channel blockage when the water was needed. Consequently, a fill of Lake Yando will be a high priority in 2020–21, which will require the channel to be cleared before filling.

Scope of environmental watering

Table 5.7.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

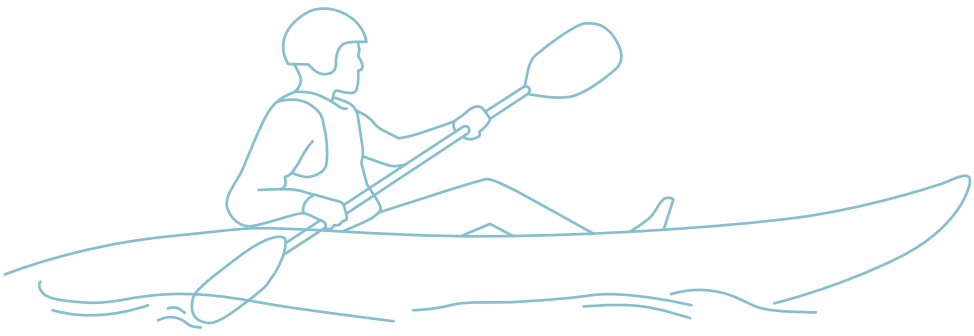


Table 5.7.3 Potential environmental watering actions and objectives for the Boort wetlands

Potential environmental watering action	Functional watering objectives	Environmental objectives
Lake Meran (top-ups as required to maintain water level between 77.30 and 77.80m AHD)	• Increase the water depth to maintain an appropriate water temperature for aquatic animals and provide a refuge for freshwater turtles, waterbirds and fish • Provide dry areas (above 77.8 m AHD) to promote the growth and increase the extent of herbland vegetation around the wetland fringe • Top-ups will most likely be required in late winter, spring and autumn, but may be delivered year-round to maintain minimum water depth requirements for aquatic animals	
Lake Meran (fill, if required in response to natural flooding)	• Provide moisture to maintain mature trees in the intermittent swampy woodland on the wetland fringe • Provide deep, open water to support the feeding of deep-water foraging waterbirds and support breeding of colonial nesting birds	
Lake Yando (fill in late winter/spring)	• Wet the wetland fringe to promote the germination and recruitment of river red gums and maintain the existing mature trees • Support the growth of aquatic and semi-aquatic plants • Provide habitat and food resources for aquatic animals • Grow zooplankton and waterbug communities to provide food for waterbirds and frogs	
Lake Leaghur (fill in winter/spring)	• Wet the wetland fringe to promote the germination and recruitment of fringing vegetation (such as river red gums and cane grass) • Support the growth of aquatic and semi-aquatic plants • Provide habitat and food resources for aquatic animals • Grow zooplankton and waterbug communities to provide food for waterbirds and frogs	
Lake Yando and Lake Leaghur (top-ups as required, if significant waterbird breeding occurs)	• Maintain shallow-water habitat under tree canopies to ensure adequate food resources for nesting waterbirds and their chicks • Top-ups will most likely be required over late spring/summer but may be delivered at other times if required	

Scenario planning

Table 5.7.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Topping up Lake Meran to maintain the water level between 77.3 and 77.8 m AHD is a high priority under all scenarios, to manage the lake's salinity for aquatic animals and provide permanent refuge for fish and Murray River turtles. If under a wet scenario natural flows raise the water level in Lake Meran significantly above 77.8m AHD, water for the environment may be used to achieve a complete or near-complete fill for the remainder of 2020–21. Waterway managers will respond adaptively depending on the level of natural inflow, climatic forecasts and environmental conditions.

Lake Yando has been dry for over two years and filling it in 2020–21 is a priority under all scenarios, to support vegetation germination and growth.

A fill of Lake Leaghur is planned to be provided between late winter and spring under average and wet scenarios, to maintain the health of mature streamside vegetation and to promote seedling recruitment. Deliveries will be subject to planned channel infrastructure upgrades being completed before optimal filling times. While desirable under an optimal watering regime, this delivery is less of a priority compared to other sites under drought and dry scenarios, as one more year of drying is tolerable under its environmental management plan. However, if Lake Leaghur remains dry in 2020–21, filling the wetland in 2021–22 will become a high priority to meet minimum watering recommendations. Where applicable, additional top-ups may be provided to Lake Yando and Lake Leaghur to ensure adequate food resources for nesting waterbirds if significant waterbird breeding occurs.

Lake Boort is currently dry and is planned to be allowed to remain dry to prevent over-watering trees and to allow them to grow. Unless filled naturally, Little Lake Meran is planned to continue to be drawn down to a minimum level or to dry completely. This will provide an important dry period, to promote the growth of herbland plants and fringing vegetation.

Most wetlands are expected to fill naturally from large overland floods under a wet scenario.

Table 5.7.4 Potential environmental watering for the Boort wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural inflows to wetlands	• Minimal natural inflows to wetlands from local catchment runoff possible	• Periods of high flow combined with localised catchment contributions, which are expected to provide minor inflows to wetlands	• Extended durations of high flow and overbank flow from creeks and flood runners, which fill most wetlands
Potential environmental watering – tier 1[1] (high priorities)[2]	• Lake Meran (top-ups) • Lake Yando (fill) • Lake Yando (top up, if triggered)	• Lake Meran (top-ups) • Lake Yando (fill) • Lake Yando (top up, if triggered)	• Lake Meran (top-ups) • Lake Yando (fill) • Lake Leaghur (fill) • Lake Yando and Lake Leaghur (top up, if triggered)	• Lake Meran (top-ups) • Lake Meran (fill, if required) • Lake Yando (fill) • Lake Leaghur (fill) • Lake Yando and Lake Leaghur (top up, if triggered)
Potential environmental watering – tier 2 (additional priorities)[2]	• Lake Leaghur (fill) • Lake Leaghur (top up, if triggered)	• Lake Leaghur (fill) • Lake Leaghur (top up, if triggered)	• N/A	
Possible volume of environmental water required to achieve objectives[3]	• 3,400 ML (tier 1) • 2,000 ML (tier 2)	• 3,400 ML (tier 1) • 2,000 ML (tier 2)	• 5,400 ML (tier 1)	• 5,400–11,400 ML (tier 1)

[1] Tier 1 potential environmental watering for the Boort wetlands is not classified as tier 1a or 1b because the water available for use is shared across various systems and it is not possible to reliably determine the supply specifically available for the Boort wetlands

[2] Wetlands are listed in priority order for tier 1 and tier 2 under all scenarios.

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

5.7.3 Birchs Creek

System overview

Birchs Creek is a tributary of the Loddon River located in the southern-most part of the catchment. The creek rises in the ranges north-east of Ballarat and flows north-west through Newlyn and Smeaton before joining Tullaroop Creek near Clunes. The lower parts of the catchment are extensively cleared where the creek meanders through an incised basaltic valley. The creek contains a regionally significant platypus community and a vulnerable river blackfish population.

Birchs Creek is part of the broader Bullarook system which contains two small storages — Newlyn Reservoir and Hepburn Lagoon — which provide water for irrigation and urban supply. The storages fill and spill during winter or spring in years with average or above-average rainfall.

Birchs Creek receives tributary inflows from Rocky Lead, Langdons, Lawrence and Tourello creeks. Groundwater provides reliable baseflows to the downstream reaches of Birchs Creek in most years.

The VEWH is allocated 100 ML in Newlyn Reservoir on 1 December each year, provided that seasonal determinations in the Bullarook system are at least 20 percent. Any unused allocation from 1 December can be carried over until 30 November of the following water year, but if Newlyn Reservoir spills from 1 July to 30 November, the volume held in carryover is lost. Any water remaining on 30 November is forfeited. When seasonal determinations are below 20 percent, the VEWH does not receive an allocation, and the system's resources are shared equitably to protect critical human and environmental needs.

Environmental values

Birchs Creek supports threatened aquatic plants and its deep pools provide habitat for aquatic animals during dry periods. The creek contains native fish including regionally-significant populations of river blackfish and mountain galaxias as well as flat-headed gudgeon and Australian smelt. Recent monitoring indicates that platypus are present throughout the entire creek.

The removal of willows along the creek in 2018 has led to observed improvements in in-stream vegetation and the presence of small-bodied fish.

Environmental watering objectives in Birchs Creek

- Increase the population and diversity of small to medium-bodied native fish including river blackfish, mountain galaxias, flat-headed gudgeon and Australian smelt
- Re-establish populations of small to medium-bodied native fish in reaches 1 and 2 of Birchs Creek

- Maintain the breeding population of platypus and increase the number of individuals to improve the population's resilience to future droughts and floods
- Provide opportunities for platypus dispersal to Creswick and Tullaroop creeks

- Maintain and improve the diversity and abundance of in-stream aquatic plants
- Maintain a diverse variety of fringing and streamside native vegetation communities

- Increase the population of waterbugs and the diversity of functional groups to drive productive and dynamic food webs

- Maintain water quality to support aquatic life and ecological processes

Traditional Owner cultural values and uses

In planning for environmental flows in Birchs Creek, Dja Dja Wurrung Clans Aboriginal Corporation and North Central CMA have identified the creek as a potential site for future projects.

The Dja Dja Wurrung Country Plan describes their aspirations around the management of rivers and waterways and articulates Dja Dja Wurrung peoples' support for the reinstatement of environmental flows as an overall objective for the management of water on Country. The North Central CMA and Dja Dja Wurrung Clans Aboriginal Corporation continue to work towards increased engagement on planning and delivery of environmental watering activities, including identifying opportunities for Dja Dja Wurrung involvement.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 5.7.5, North Central CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing and fishing)
- riverside recreation and amenity (such as improving amenity at key community spaces like Anderson's Mill)
- community events and tourism (such as education activities like school groups and River Detectives)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses).

Recent conditions

The Birchs Creek catchment experienced below-average rainfall and above-average temperatures throughout 2019–20. High rainfall in August 2019 caused Newlyn Reservoir to fill and spill, which meant the VEWH forfeited allocation that was carried over from 2018–19. Newlyn Reservoir is a very small water storage and modest inflows cause it to spill in most years. The VEWH received a full allocation of 100 ML in December 2019, and that water will be available for use until 30 November 2020 unless Newlyn Reservoir spills again.

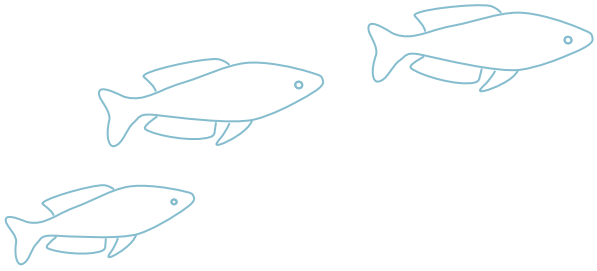
The combination of spills from Newlyn Reservoir, tributary inflows, consumptive water orders and groundwater discharge met and at times exceeded the dry scenario environmental flow recommendations for Birchs Creek during 2019–20.

Scope of environmental watering

Table 5.7.5 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological functions.

Table 5.7.5 Potential environmental watering actions and objectives for Birchs Creek

Potential environmental watering action	Functional watering objectives	Environmental objectives
Spring fresh (one fresh of 30 ML/day for three days during September to November)	• Maintain and support the growth of streamside vegetation by increasing soil moisture and depositing sediment on the bank and benches • Scour organic matter that has accumulated in the channel and cycle nutrients throughout the creek • Wet benches and smaller channels, to increase habitat and refuge for small fish • Freshen refuge pools and provide connectivity between pools for fish and platypus movement	
Autumn freshes (up to three freshes of 10 ML/day for three days during March to April)	• Increase the water depth, to maintain and support the growth of in-stream aquatic vegetation • Expand riffle/run areas to provide waterbug habitat • Top up pools to refresh water quality (particularly oxygen levels) and enhance connectivity between pools for fish and platypus movement	



Scenario planning

Table 5.7.6 outlines the potential environmental watering and expected water use under a range of planning scenarios.

In 2020–21, delivering a spring fresh is a priority under all scenarios, to bolster the condition of the creek in the lead-up to summer. The spring fresh is planned to be delivered under drought and dry conditions using water that the VEWH will carry over from 2019–20. Under average and wet conditions, it is more likely that these flows will occur naturally.

The forecast water resource outlook indicates that the VEWH will not receive allocation in the Bullarook system during 2020–2021 under drought conditions. Under such conditions, the storage manager, Goulburn-Murray Water, will consult with water entitlement holders in the system to manage available resources with consideration of critical human and environmental needs. Under dry, average and wet scenarios, full allocation is forecast. If available, allocated water is most likely to be used to deliver one to three autumn freshes between March and April 2021. If not required due to natural variation in the system meeting flow requirements, any unused water for the environment that was allocated on 1 December 2020 will likely be carried over to the 2021–22 water year, for use up to 30 November 2021.

Table 5.7.6 Potential environmental watering for Birchs Creek under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Reservoir spill unlikely • Flows extremely low in winter/spring • Limited irrigation releases due to low allocations	• Reservoir spill possible • Low flow in winter/spring if no spills occur • Moderate irrigation releases	• Reservoir spills certain in winter/spring • Some natural flow through summer/autumn	
Expected availability of water for the environment	• 100 ML (carryover)	• 100–200 ML (carryover and allocation)	• 100 ML (allocation)[1]	
Potential environmental watering – tier 1a (high priorities)	• One spring fresh	• One spring fresh • One to three summer/autumn freshes	• One to three summer/autumn freshes	
Possible volume of environmental water required to achieve objectives	• 100 ML (tier 1a)	• 100–200 ML (tier 1a)	• 100 ML (tier 1a)	
Priority carryover requirements	• If the 100 ML allocation is received on 1 December 2020 and Birchs Creek is in good condition over summer/autumn, carry over 100 ML allocation into 2021–22 water year for use by 30 November 2021			

[1] Under an average or wet scenario, it is likely that Newlyn Reservoir will spill before 30 November 2020, losing the 100 ML carryover from December 2019.