



Australian Government
Commonwealth Environmental Water Office

Commonwealth Environmental Water Portfolio Management Plan

Mid Murray Region

2019–20

Acknowledgement of the traditional owners of the Murray-Darling Basin

The Commonwealth Environmental Water Office respectfully acknowledges the traditional owners, their Elders past and present, their Nations of the Murray-Darling Basin, and their cultural, social, environmental, spiritual and economic connection to their lands and waters.

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For more information about Commonwealth environmental water, please contact us at:

1800 803 772

ewater@environment.gov.au

www.environment.gov.au/water/cewo

@theCEWH

GPO Box 787, Canberra ACT 260

Commonwealth environmental water portfolio management planning

Commonwealth Environmental Water Holder

The Commonwealth Environmental Water Holder (CEWH) is a statutory position established under the *Water Act 2007* and is responsible for managing the Commonwealth's environmental water holdings. This water must be managed to protect and restore the rivers, wetlands and floodplains (and the native animals and plants they support) of the Murray–Darling Basin. Ms Jody Swirepik is the current Commonwealth Environmental Water Holder. She is supported by staff of the Commonwealth Environmental Water Office (CEWO), which employs six local engagement officers who live and work in regional centres across the Murray–Darling Basin.

Commonwealth environmental water

Commonwealth environmental water holdings are water entitlements that have been acquired by the Australian Government through investments in water-saving infrastructure and purchases on the water market. The holdings are a mix of entitlement types held across 19 catchments. The rules governing the entitlements vary across states and across catchments. Commonwealth environmental water entitlements are subject to the same fees, allocations, carryover and other rules as equivalent entitlements held by other water users.

There are broadly three options for managing Commonwealth environmental water:

- delivering water to a river or wetland to meet an identified environmental demand
- leaving water in storage and carrying it over for use in the next water year (referred to as 'carryover')
- trading water, that is, selling water and using the proceeds to buy water in another catchment or in a future year, or investing in complementary 'environmental activities'.

Purpose of the document

This document sets out the plans for managing the Commonwealth environmental water portfolio in the Mid-Murray Region for 2019–20. Efficient and effective management of Commonwealth environmental water requires the utilisation of all portfolio management options. By taking a multi-year approach to planning, portfolio management tools such as use, carryover and trade can be managed for maximising environmental outcomes.

The portfolio management plans support transparent, coordinated and adaptive management of Commonwealth environmental water, consistent with the Basin-wide environmental watering strategy and having regard to the Basin annual environmental watering priorities.

To learn more about the planning approach see *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2019–20* (available at: <http://www.environment.gov.au/water/cewo/publications> under 'Planning approach').

Delivery partners

Commonwealth environmental water is managed in conjunction with and delivered by a range of partners. This portfolio management plan has been developed in consultation with our delivery partners, including the NSW Office of Environment and Heritage, Victorian Environmental Water Holder, Victorian Catchment Management Authorities, NSW Department of Primary Industries, the Murray–Darling Basin Authority, scientists engaged in monitoring the outcomes of Commonwealth environmental water use, the Murray–Lower Darling Environmental Water Advisory Group, the Edward-Wakool Environmental Water Reference Group and various community groups and individuals.

Your input

The management of Commonwealth environmental water relies on considerable advice and assistance from others. Individuals and groups within the Murray–Darling Basin community are encouraged to submit suggestions for the management of Commonwealth environmental water. Please contact the Commonwealth Environmental Water Office via: ewater@environment.gov.au.

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Environmental watering in Mid-Murray Region

1.1. The Mid-Murray Region

The Mid-Murray planning area extends from Hume Dam to Euston (Figure 1). River Murray flows in this region are strongly influenced by the Goulburn, Ovens, Kiewa, Loddon and Campaspe Rivers.

The Aboriginal Nations associated with the Mid-Murray planning area include the Wiradjuri, extending from the River Murray to the Macquarie River in the north, and west to Balranald. The east, from the Murray and south into the Great Dividing Range, is the traditional land of the Dhudhuroa and Waywurru Nations. The region centred on Echuca, is the traditional land of the Bangerang, Barapa Barapa, Wamba Wamba and Yorta Yorta Nations. The lower stretch of the central Murray catchment includes the traditional land of the Barkindji, Maraura, Muthi Muthi, Nyeri Nyeri, Tati Tati, Wadi Wadi and Weki Weki Nations.

The region contains a number of wetlands of national and international importance including the Ramsar listed Barmah, Gunbower and the New South Wales Central Murray forests. The Barmah and Gunbower forests were recognised under the Ramsar Convention in 1982 for supporting species of conservation significance and biological diversity, providing refuge during adverse conditions, and regularly supporting large numbers of waterbirds. The Barmah and Gunbower forests are important Indigenous cultural heritage areas and are also Icon Sites in the Living Murray Program.

The NSW Central Murray Forests was listed as a Ramsar site in 2003. Comprising of three geographically discrete but interrelated units: Murray Valley National Park and Murray Valley Regional Park (formally the Millewa Forest), Werai Forests, and Koondrook-Perricoota Forests, it is the largest complex of tree-dominated floodplain wetlands in southern Australia and Australia's largest parcel of River Red Gum Forests.

The delivery of Commonwealth environmental water to the Mid-Murray Region differs depending on which part of the region water is being delivered to. For the New South Wales portion of the Mid-Murray Region, Commonwealth environmental water use is coordinated with other environmental water deliveries by the NSW Office of Environment and Heritage. Water delivery is managed by WaterNSW and/or Murray–Darling Basin Authority River Murray Operations. In some instances Murray Irrigation Limited and landholder infrastructure may also deliver environmental water, subject to separate agreements.

For the Victorian portion of the Mid-Murray Region, Commonwealth environmental water use is coordinated with other environmental water deliveries by the Victorian Environmental Water Holder. Water delivery is managed by the state water authority, Goulburn-Murray Water, and regional waterway managers including the North-Central Catchment Management Authority, Goulburn-Broken Catchment Management Authority, North-East Catchment Management Authority and the Mallee Catchment Management Authority.

Where possible, environmental water will be managed to benefit multiple sites en route, thereby maximising the efficient and effective use of environmental water. Environmental water portfolios are coordinated to maximise the effectiveness of water delivery for achieving environmental outcomes. For example, the Southern Connected Basin Environmental Watering Committee was established by the Murray–Darling Basin Ministerial Council in October 2014 to coordinate the efficient and effective delivery of all environmental water in the southern-connected Basin.

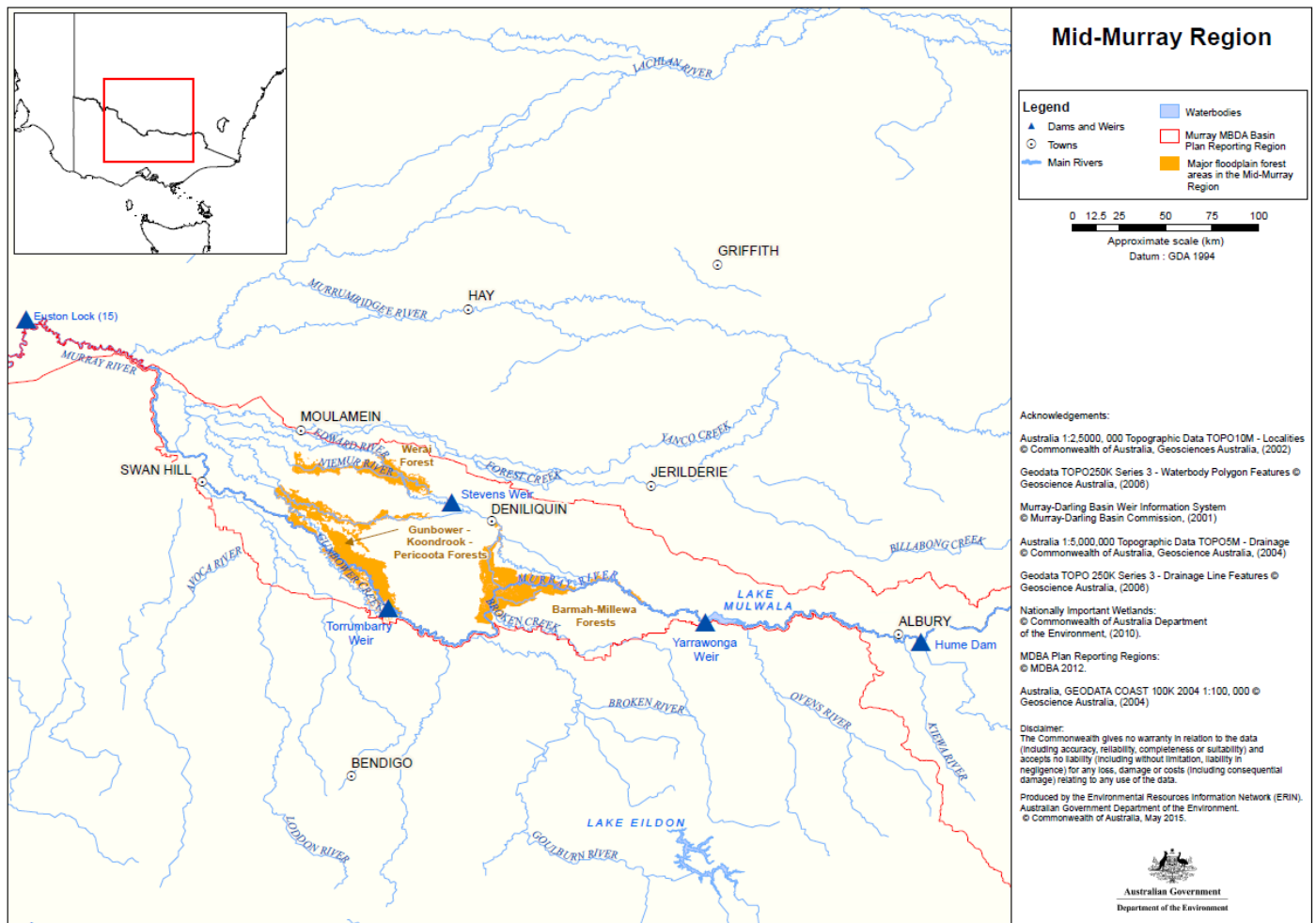


Figure 1: Map of the Mid-Murray Region.

1.2. Environmental objectives in the Mid-Murray Region

The long-term environmental objectives for the Murray–Darling Basin are described in the Basin Plan’s environmental watering plan and the Basin-wide environmental watering strategy, which includes ‘quantified environmental expected outcomes’ at both a Basin-scale and for each catchment. The expected outcomes relevant for the Mid-Murray Region are summarised in Table 1 and described in detail in [Attachment A](#).

The Victorian state government has also developed a long-term watering plan for the Victorian Murray Region (DELWP 2015). The plan identifies the priority environmental assets and ecosystem functions in the catchment, the objectives and targets for these assets and functions, and their watering requirements. The plan is available here: https://www.water.vic.gov.au/_data/assets/pdf_file/0023/53168/Victorian-Murray-LTWP_17-11-2015-FINAL.pdf. New South Wales are in the final stages of preparing a long-term environmental watering plan for the NSW Murray region, which has informed development of this portfolio plan.

Based on these strategies and plans, and in response to best available knowledge drawing on the results of environmental watering monitoring programs, the objectives for environmental watering in the Mid-Murray Region are summarised in **Table 1** below. The objectives for water-dependent ecosystems will continue to be revised as part of the CEWO’s commitment to adaptive management.

Table 1: Summary of objectives being targeted by environmental watering in the Mid-Murray Region.

BASIN-WIDE MATTERS (Matters in red link to the Basin-wide Environmental Watering Strategy)	OBJECTIVES FOR MID-MURRAY ASSETS						
	IN-CHANNEL ASSETS		OFF-CHANNEL ASSETS				
	River Murray (Hume Dam to Euston)	Edward-Wakool River System	Gunbower Creek	Barmah-Millewa Forest	Gunbower-Koondrook-Perricoota Forest	Edward-Wakool Forests (e.g. Werai, Neimur)	Off-channel wetlands and ephemeral creeks
VEGETATION	Maintain riparian and in-channel vegetation condition. Increase periods of growth for non-woody vegetation communities that closely fringe or occur within river corridors.			Maintain the current extent of floodplain vegetation near river channels and on low-lying areas of the floodplain. Improve condition of black box, river red gum and lignum shrublands. Improve recruitment of black box and river red gum communities. Increased periods of growth for non-woody vegetation communities that closely fringe or occur within the creek channels, and those that form extensive stands within wetlands and low-lying floodplains including moira grasslands in Barmah-Millewa Forest.			Maintain and improve condition of wetland vegetation.
WATERBIRDS	Provide habitat and food sources to support waterbird survival and recruitment, and maintain condition and current species diversity.						
				Support naturally triggered colonial bird breeding events.			
FISH	Provide flows to support habitat (including longitudinal connectivity and bench inundation) and food sources and promote increased movement/dispersal, recruitment and survival/condition of native fish.			Provide flows to support habitat and cues for increased movement, recruitment and survival/condition of native fish (particularly for floodplain specialists).			
INVERTEBRATES	Provide habitat to support increased microinvertebrate and macroinvertebrate survival, diversity, abundance and condition.						
OTHER VERTEBRATES	Provide habitat to support survival, maintain condition and provide recruitment opportunities for frogs and turtles.						
CONNECTIVITY	Maintain lateral connectivity by contributing to an increase in the frequency of freshes, bankfull and lowland floodplain flows.						
	Maintain baseflows and increase overall flows in the River Murray. Maintain longitudinal connectivity along the River Murray to fulfil important environmental functions such as nutrient and sediment transport, organism dispersal and water quality.			Maintain connectivity through creeks and anabranches, thereby enhancing connectivity and functioning through the length of the River Murray.			
PROCESSES	Increase primary productivity, nutrient and carbon cycling, biotic dispersal and movement. Increase transport of organic matter, salt and nutrients downstream.						
WATER QUALITY	Maintain water quality and provide refuge habitat from adverse water quality events. Increase mobilisation and export of salt from the River Murray system.						
RESILIENCE	Provide drought refuge habitat and maintenance/condition of native biota.						

Information sourced from: MDBA (2014); Department of the Environment (2014); Department of the Environment (2011a-d); MDBA (2012a-f); DELWP (2015).

1.3. Environmental flow requirements

Not all environmental demands can and will be met through the use of held environmental water. Some demands are met by regulated water deliveries for consumptive purposes and inter-valley transfers, while others are met by large unregulated/natural flows events or are beyond what can be delivered within operational constraints. Figure 2 shows the broad environmental demands that are in scope for Commonwealth environmental water. Importantly, these are broad, indicative demands and individual watering events may contribute to particular opportunities, such as using infrastructure to deliver water to individual wetlands that would otherwise not be possible due to constraints. There may be opportunities for Basin State governments to remove or modify constraints, which will improve the efficiency and/or effectiveness of environmental watering. Further information on operational delivery including constraints is described in [Attachment B](#).

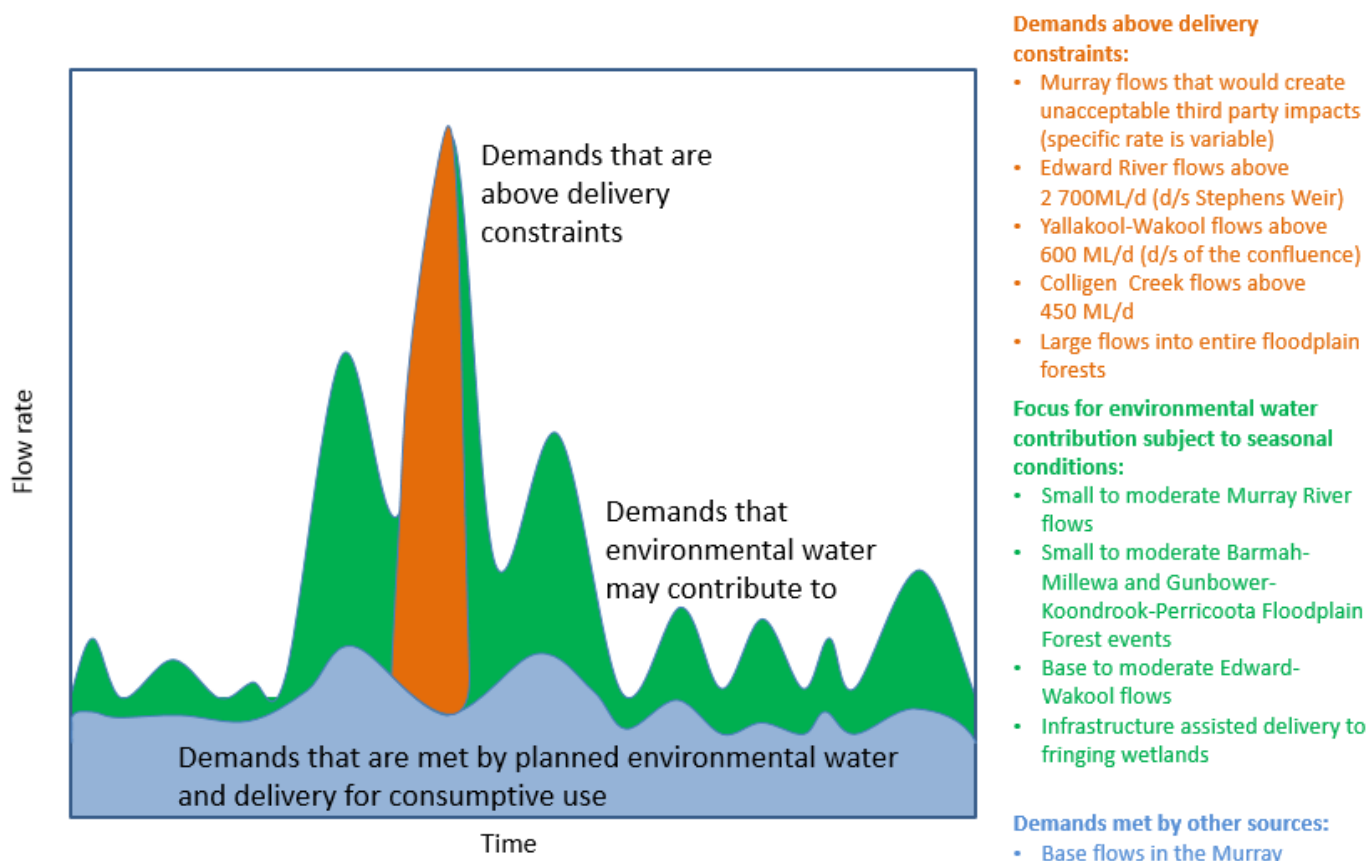


Figure 2: Scope of demands that environmental water may contribute to in the Mid-Murray Region.

Based on the above objectives and delivery constraints, specific watering requirements (flow magnitude, duration, timing and frequency) have been identified as being in scope for Commonwealth environmental water. These water requirements are described in Table 3. As with the objectives, the environmental water requirements will continue to be reviewed and revised in response to new knowledge.

2. Portfolio management in 2019–20

In planning for the management of Commonwealth environmental water, the CEWO aims to maximise the outcomes achieved from the available water. This includes consideration of the urgency of demands (based on targeted objectives and watering requirements, watering history and asset condition) and the available supply under different resource scenarios. Plans for water delivery, trade and carryover are then made in a multi-year context, with an assessment also undertaken of need for water in future years.

This planning process is outlined in full in Table 3 below and summarised in the sections below.

2.1. Lessons from previous years

Outcomes from monitoring and lessons learned in previous years is a critical component for the effective and efficient use of Commonwealth environmental water. These learnings are incorporated into the way environmental water is managed.

The CEWO works with the Murray–Darling Basin Authority, state agencies, research organisations, regional organisations, local groups and others, such as landholders to collect and collate relevant monitoring information and evaluation results that facilitates adaptive management and changing our practices where needed. This continual review of information and outcomes is helping to build knowledge about the best way to get positive outcomes on a larger scale, based on what works and what doesn't work. Key findings and recommendations from the 2018-19 watering year and latest monitoring results include:

- *Gunbower Creek*
Despite the necessary reductions in the large body native fish hydrograph due to constraints in the system, stable winter flows and a spring rise starting in mid-October are considered key for the improvement in the structure of Murray Cod populations. It will be useful to further test this through the 2019-20 hydrograph.
- *Barmah-Millewa Forest*
 - To avoid delivery constraints during the irrigation season, seek to maximise early season use of environmental water where natural cues occur.
 - Very good environmental outcomes resulted from flows through the Barmah Forest in 2018-19, including especially strong moira grass growth and flowering, native fish breeding and some waterbird breeding (mixed outcomes) where flooding occurred (Goulburn Broken CMA, 2019). These responses indicate that frequent connections between riverine and floodplain habitats is important. Environmental water (when available) should fill major wetlands such as Coppingers/Duck Lagoon, Moira Lake and Reed beds by the end of September and water levels maintained throughout the breeding season for Australasian bitterns.
 - The Barmah-Millewa forest fish populations, including Murray cod and trout cod, improved from 2017 to 2018. While the waterbird breeding was smaller in 2018 than 2017 (likely due to lower than average rainfall and higher than average temperatures), eight species of colonial waterbirds were recorded breeding in Millewa's wetlands, including the Australian bittern. The outcomes from these monitoring activities are used to inform portfolio management planning and adaptive management decision-making.

2.2. Antecedent and current catchment conditions and the demand for environmental water in 2019–20

Environmental water is important for the health of rivers, wetlands and floodplains, and the plants and animals they support. Ecological health is influenced by flows and conditions in the past—in some cases, this can date back many years, with parts of the environment still showing the effects of the millennium drought.

During the 2010 to 2012 period, natural flow events and environmental watering actions resulted in improvements in the condition of many sites in the Mid-Murray and promoted ecological recovery following the millennium drought. Drier conditions from 2013 to early 2016 saw some floodplain and wetland sites enter into a natural drying phase, while river flows also reduced in scale. In 2016–17, the Mid-Murray experienced widescale natural inundation. This was beneficial to wetland and floodplain vegetation and waterbird populations in many areas. However, the natural floods also caused a significant hypoxic blackwater event. While environmental water was used to mitigate the impacts on native fish populations in some localities, the hypoxic blackwater still resulted in large-scale fish kills (CEWO, 2017).

Delivery of environmental water to the Mid-Murray in 2017–18 and 2018–19 aimed to consolidate vegetation and waterbird outcomes from 2016–17 (either through natural flood or deliveries), and support the breeding and recolonisation opportunities for native fish with watering of low-lying wetlands, Barmah-Millewa and Gunbower Forests and in-channel flows delivered throughout the year.

For 2019–20 the demands for environmental water in the Mid-Murray are represented in Table 3 and summarised below:

River Murray Channel: There is a moderate to high demand for environmental water to contribute to greater hydrologic variability and more natural seasonality of in-channel flows for a range of outcomes. Deliveries will support the ongoing recovery of native fish by providing habitat, food and opportunities for spawning, recruitment and movement and connecting the river with low-lying wetlands (to promote productivity, provide habitat diversity and support ephemeral ecosystems).

Edward-Wakool system: There is a moderate to high demand for environmental water in the Edward-Wakool system. Flows would seek to support the recovery of large bodied native fish and instream aquatic plants after the 2016 flood and hypoxic blackwater event. Where possible, this includes providing winter base flows and preventing cease-to-flow conditions in the Yallakool-Wakool and Colligen-Niemur systems, and also the maintenance of breeding habitat and unobstructed movement pathways between interconnected streams and channels.

Barmah-Millewa Forest: There is a high demand in Barmah-Millewa Forest for flows to support floodplain marsh (which includes moira grass), particularly in sites that remained dry in 2018–19. Environmental water demands for the rest of the forest's vegetation is moderate. Elsewhere in Barmah-Millewa Forest there is a moderate to high demand for environmental water to provide and maintain greater connectivity between forest creeks and the main River Murray to support the recovery of large-bodied native fish populations such as Murray and trout cod, including the prevention of stranding in floodplain networks. Meeting all the above demands is also likely to support water bird outcomes such as the provision of foraging habitat and food sources for a range of species. While not targeted, should colonial bird breeding be initiated there will be a high demand for environmental water to support inundation of the nesting sites through to fledging stage.

Gunbower Creek: There is a moderate to high demand for environmental water to contribute to stable winter base flows and freshes to support the survival of native fish, encourage movement of large-bodied native fish and aquatic invertebrates, and support the mobilisation of carbon between Gunbower Creek and Gunbower Forest.

Gunbower- Forest: Following significant environmental watering actions in 2014–15 and 2015–16, natural overbank flooding in 2016–17 and environmental watering 2018–19 that supported floodplain fish spawning, bird breeding and establishment of native tree species, there is a moderate to low demand for environmental water in Gunbower Forest.

Koondrook-Perricoota Forest: There is a high demand for environmental water to build on the outcomes from recent natural inundation however any watering undertaken is pending the resolution of potential third party impacts.

Werai Forest: There is a moderate demand for environmental water to build on the outcomes from recent natural inundation however any watering undertaken, including pumping, is subject to stakeholder support, operational delivery infrastructure, assessing third party impacts and accounting arrangements being developed.

Mid-Murray off-channel wetlands and ephemeral creeks – Hume to Euston: There is a high demand for environmental water in permanent wetlands along this reach, with a particular focus for environmental water use in wetlands that contain Murray hardyhead or other threatened species. In the semi-permanent wetlands, there is a moderate need to maintain aquatic vegetation and water bird habitat, and to maintain and/or improve the condition of mature river red gum trees. There is a low demand for environmental water in the ephemeral wetlands as water has recently inundated many of these assets.

Murray–Darling Basin-wide environmental watering strategy and 2019–20 annual priorities

The Murray–Darling Basin Authority publish the Basin annual environmental watering priorities each year and have published multi-year priorities since 2017-18. Commonwealth environmental water in the Mid-Murray will contribute to the following multi-year environmental watering priorities and the 2019-20 Basin annual environmental watering priorities.

Rolling, multi-year priorities

The rolling, multi-year priorities for river flows and connectivity are to:

- Support lateral and longitudinal connectivity along the river systems.
- Support freshwater connectivity through the Lower Lakes, Coorong and Murray Mouth.

The rolling, multi-year priorities for native vegetation are to:

- Maintain the extent, improve the condition and promote recruitment of forests and woodlands.
- Maintain the extent and improve the condition of lignum shrublands.
- Expand the extent and improve the condition of moira grass in Barmah–Millewa Forest.

The rolling, multi-year priorities for waterbirds are to:

- Improve the abundance and maintain the diversity of the Basin's waterbird population.

The rolling, multi-year priorities for native fish are to:

- Support Basin-scale population recovery of native fish by reinstating flows that promote key ecological processes across local, regional and system scales in the southern connected Basin.
- Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations.

2019-20 Annual priorities

Provide flows to the Koondrook– Perricoota Forest

- to water critical understorey vegetation so waterbirds can shelter and breed
- to improve habitat for specialist fish in the forest
- use infrastructure to ensure flows reach the floodplain wetland ecosystem of the forest

NSW Office of Environment and Heritage, Victorian Environmental Water Holder and The Living Murray program, the River Murray Increased Flows, planned environmental water, natural and unregulated flows, conveyance water and consumptive water. Further detail on sources of environmental water in the mid-Murray region is provided in [Attachment C](#).

By combining the forecasts of water held by the Commonwealth with streamflow forecasts, as well as taking into account operational considerations, water resource availability scenarios can be developed ranging from very low to very high. Based on available information, low to high availability scenarios are in scope for 2019–20. Carryover from 2018-19 precludes a ‘very low’ resource availability scenario from eventuating, while ‘very high’ resource availability is not expected to eventuate even in wet conditions, given low water storage levels at the commencement of 2019-20.

2.4. Overall purpose of managing environmental water based on supply and demand

Environmental water needs (demand) and water availability (supply) both influence the overall purpose of Commonwealth environmental water management. Under different combinations, the management purpose can range from ‘avoiding damage’ to the environment to ‘improving’ ecological health. This in turn informs the mix of portfolio management options that are suitable for maximising outcomes.

Figure 3 shows how current demands and forecasted supply are considered together.

The overall ‘purpose’ for managing the Commonwealth’s water portfolio in the Mid-Murray Region for 2019–20 is to maintain the ecological health and resilience of most environmental assets.

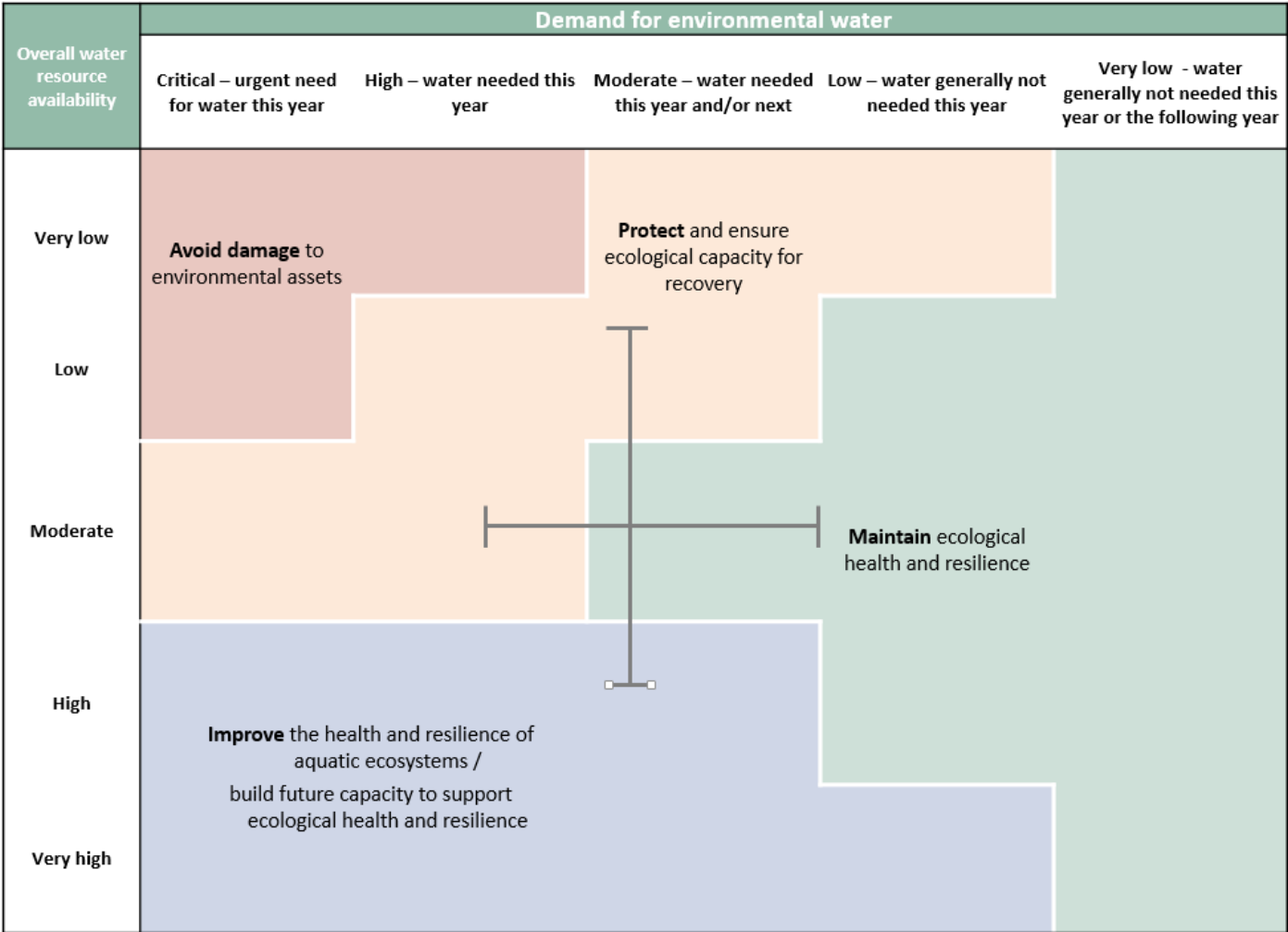


Figure 3: Determining a broad purpose for portfolio management in the Mid-Murray Region for 2019–20. Note: grey lines represent potential range in demand and water resource availability.

Further detail on how the overall purpose for portfolio management changes under different supply and demand scenarios is provided in *Portfolio Management Planning: Approach to planning for the use, carryover and trade of Commonwealth environmental water, 2019–20* (available at: <http://www.environment.gov.au/water/cewo/publications>).

2.5. Water Delivery in 2019–20

Consistent with the demands and purpose described above (2.4), the CEWO is considering supplying environmental water to the following watering actions for 2019–20 (see also Table 3 for supporting information regarding the basis for determining these watering intentions).

River Murray Channel and Barmah-Millewa Forest 2019-20 (See Attachment B, Table 4 options 1a, 1b and 2)

Environmental water is expected to be delivered as a River Murray 'whole of system' flows in 2019–20. Watering will be guided, in part, by natural hydrological triggers (rainfall and inflows) in order to reinstate a portion of the once natural flow regime throughout the year. The 'whole of system' flows will be scalable so that the environmental watering is responsive to seasonal and operational conditions, the scale of hydrological cues and water availability. For example, environmental water may be used to prevent a rapid recession in river levels following a flow pulse, so as to support potential fish breeding that may have started in response to elevated flows.

This means if conditions are wet, environmental water may be used for modest floodplain watering events (limited to flow rates that avoid adverse third party impacts) for outcomes such as floodplain fish breeding and recruitment, full reproductive cycles of important floodplain vegetation species, such as moira grass, and completion of waterbird breeding events. Floodplain watering may also promote productivity and nutrient cycling processes and the export of floodplain carbon which may help mediate the acuteness of future blackwater events.

If conditions are dry and inflow triggers are small, environmental watering will be focused on in-stream flow variability and periodic connectivity over winter and spring with low-lying anabranches and wetlands (to support fish habitat, movement and condition and riparian and wetland floodplain vegetation, and ecological productivity). While a natural cues approach will largely guide deliveries, given the high environmental demands in Millewa Forest, targeted flows may be directed into the Forest to maximise outcomes within current constraints.

Environmental demands exist throughout the whole year. In particular, maintaining year-round variable base flows is important for providing habitat and food for native fish, and in mixing of the water column in support of suitable water quality.

Environmental flows moving through the system also support other actions that are considered seasonally appropriate, such as weir pool raising or drawdown (to promote more natural hydrological cycles and in-stream habitat qualities) or delivery to off-channel wetland sites. River Murray 'whole of system' flows are planned to be co-ordinated, where possible, with watering actions occurring in the Edward-Wakool, Goulburn, Murrumbidgee and lower Darling catchments to target system-wide environmental benefits. It is expected that flows being targeted in the Mid-Murray region will also assist in meeting watering requirements downstream in the Lower Murray.

Edward-Wakool System 2019–20 (Table 4 options 3a – 3c)

Permanent Waterways: Environmental water will contribute to year-round variable base flows and freshes to support the recovery of in-stream habitat, particularly aquatic vegetation and areas supporting the various life stages of native fish. Watering actions will be scalable depending on catchment conditions and water availability during the year. Environmental water use may also provide a more gradual recession following periods of high flow (e.g. rain rejection flows) and improve water quality to provide refuges for aquatic plants and animals if required and where feasible to do so.

Ephemeral waterways and wetlands: The purpose of these annual watering events would be to maintain ephemeral instream and wetland habitat, particularly water quality, aquatic vegetation and areas supporting the various life stages of native frogs, birds and aquatic invertebrates.

Edward-Wakool forests: The purpose of watering events may include the protection or maintenance of floodplain vegetation health, the provision of localised habitat for aquatic native plants and animals, contributing to hydrological connectivity and nutrient/carbon cycling processes. Environmental flows, including pumping, could be considered subject to stakeholder support, operational delivery infrastructure, third party impacts and accounting being addressed.

Gunbower Creek 2019–20 (Table 4 option 4)

Environmental water will contribute to winter base flows, a spring rise and stable flows to support the survival of juvenile native fish, and create connectivity between Gunbower Creek, Gunbower Forest and the Murray River for the movement of fish, aquatic invertebrates and carbon, when flow rates allow.

Consumptive water will be used to provide some of the flows, with environmental water accounting for any losses associated with the delivery of consumptive water en route in Gunbower Creek.

Gunbower Forest 2019–20 (Table 4 option 5)

Despite the high demand in Gunbower Forest, it is unlikely that Commonwealth environmental water will be delivered to this site in 2019–20. Any water needed to support the forest floodplain and wetlands is expected to be met by other environmental water holders. Commonwealth environmental water will support objectives in Gunbower Creek.

Koondrook-Perricoota Forest 2019–20 (Table 4 option 6)

While there is a high demand for water in Koondrook-Perricoota Forest, it is unlikely that Commonwealth environmental water will be delivered to this site in 2019–20. Commonwealth environmental water is unlikely to be used at the site unless issues regarding potential third party impacts are resolved.

Werai Forest 2019–20 (Table 4 options 3c)

There is a moderate demand for water in Werai Forest. Commonwealth environmental water could be delivered to this site in 2019–20. The use of CEW, including pumping, could be considered subject to stakeholder support, operational delivery infrastructure, third party impacts and accounting being addressed.

Mid-Murray off-channel wetlands and ephemeral creeks 2019–20 (Table 4 option 7)

It is anticipated that demands will be met by a number of water holders in 2019–20. Commonwealth environmental water may be provided to several wetlands, consistent with local planning processes managed by state delivery partners.

Stakeholder Feedback

The demands and watering actions have been developed based on input from and/or consultation with key partners including: NSW Office of Environment and Heritage, Victorian Environmental Water Holder, Victorian Catchment Management Authorities, NSW Department of Primary Industries – Fisheries, the Murray–Darling Basin Authority, scientists engaged in monitoring the outcomes of Commonwealth environmental water use, the Edward-Wakool Environmental Water Reference Group, the Murray-Lower Darling Environmental Water Advisory Group, and various community groups and individuals. A number of comments were received, with stakeholders supportive overall of the proposed approach. Feedback will be sought on an ongoing basis as planning transitions to implementation phase.

2.6. Trading water in 2019–20

The *Water Act 2007*, requires the CEWH to trade for the purpose of protecting and restoring the environment. In addition to the obligations of the *Water Act 2007*, the CEWH and CEWO staff are required to comply with a wide range of existing legislative requirements. This includes: financial management arrangements for Commonwealth agencies; freedom of information; and policies relating to information management, auditing, employee conduct and accountability.

Large parts of the Basin are currently experiencing pressures from water scarcity, with declining storage levels, low allocations and rainfall deficiencies evident in most catchments. It is likely that insufficient water resources will constrain proposed actions. Where the need arises to adjust the availability of allocations in any valley in the southern-connected Basin for environmental use, the transfer of allocations from another southern connected catchment would be explored as the preferred and more efficient option to allocation purchase or sale. The transfer would be undertaken consistent with the rules identified in state water resource plans that apply to all water users. Possible third party impacts from portfolio transfers are considered when trade limits apply.

In 2019-20, administrative transfers may be required between environmental water accounts in trade zones 6, 6B, 7, 10A, 10B and 11 to enable environmental water delivery. Based upon water resource availability at the time of the watering event and scale of the event, this may include:

- small transfers (<50 GL) within or between trade zones for smaller environmental watering activities
- moderate transfers (~ 50 GL) through the Barmah choke from trade zone 7, if required and allowable given the Barmah Choke trade limit
- large transfers (>100 GL) within trade zones, due to the large size of environmental watering activities.

No specific commercial trade of water in the Mid-Murray has been identified for 2019-20. Trade opportunities will be reviewed in the valley throughout the water year and as conditions change. Planning on water trade considers: supply and demand within the catchment and across the Basin. As part of the planning process, the CEWO undertakes a Basin-wide analysis to identify opportunities to use allocation trade to better match differing demands across catchments. Consideration is given to the water available to meet both current and future environmental needs. Additionally these decisions are influenced by current climatic conditions, as well as implications of trade for commercial outcomes in communities.

Further information will be provided to the market ahead of any trade of Commonwealth environmental water at: <http://www.environment.gov.au/water/cewo/trade>

For more information on the rules and procedures governing the trade of Commonwealth environmental water, see the *Commonwealth environmental water Trading Framework* available at: <http://www.environment.gov.au/water/cewo/publications/water-trading-framework-nov2016>

2.7. Carrying over water for use in 2020–21

The volume of water carried over for use in 2020–21 will depend upon resource availability and demand throughout the year. As the 2019–20 water year progresses, a carryover target will be determined for the southern connected basin, sufficient to meet early season requirements. As documented in Table 3 below, potential demands in 2020–21 that may require carryover include contributions to winter or early spring flows through the River Murray, Gunbower Creek, Yallakool-Wakool and/or Edward-Wakool River systems.

Carryover volumes will be adjusted throughout the year as the season unfolds in response to both current and future demands and the water available to meet these demands. These decisions will be based upon best information available at the time.

Given the connected nature of southern Murray–Darling Basin catchments and the varying carryover, account and use limits, carryover is considered at a broader scale than just the Mid-Murray Region.

More information on how the Commonwealth makes decisions on carryover is available at: <http://www.environment.gov.au/water/cewo/portfolio-mgt/carryover>

2.8. Identifying Investment Opportunities

Under the *Water Act 2007*, the CEWH has the flexibility to use the proceeds from the sale of water allocations to fund environmental activities in the Basin.

'Environmental activities' must be consistent with the CEWH's obligation to exercise their function to protect and restore environmental assets. Environmental activities must also improve the capacity of the

CEWH to meet the objectives of the Basin Plan environmental watering plan, and be directly linked to current or future delivery of water for the environment.

The option of investing the proceeds in environmental activities will be considered alongside other available water management options, such as purchasing water at another time or place. The CEWH is finalising an Investment Framework and an Annual Investment Plan to inform future investment in environmental activities.

Table 3: Environmental demands, priority for watering in 2019–20 and outlook for coming year in the Mid-Murray region.

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2019–20		Implications for future demands
	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely environmental demand in 2020–21 if watering occurred as planned in 2019–20
River Murray from Hume Dam to Euston and Barmah-Millewa Forest¹	2 000-5 000 ML/day at Yarrawonga Weir throughout the year for native fish habitat to improve recruitment and population structures, and water quality in main river channel and Barmah-Millewa creeks.	Annual	Continuous requirement, therefore the environmental demands has been assessed as High.	High	High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)	High
	Variable flows between 5000 and 9,500ML/day at Yarrawonga Weir from July to November	Annual	In-channel variability in 2018–19 was limited due to operational deliveries.	Moderate	High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)	Moderate
	Freshes 12,000 ML/d – 18,000 ML/variable flow rate for at least 5 days, measured d/s Yarrawonga Weir during the period July to November for native fish habitat to improve recruitment and population structures (in-channel outcomes and anabranches). Would also provide carbon/productivity benefits to Edward-Wakool system during the cooler time of the year.	5-10 in 10 years (2 years)	Has been met in 4 of the last 6 years. Therefore the environmental demand has been assessed as Moderate.	Moderate	High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)	Moderate
	Small overbank of 12,000 –15,000 ML/d for a minimum of 45 days measured d/s Yarrawonga between August to November, subject to natural cues, to improve recruitment and population structures (in-channel outcomes and giant rush wetlands). Would also provide carbon/productivity benefits to Edward-Wakool system during the cooler time of the year.	4-8 in 10 years (2 years)	Has been met or partially met in 3 of the last 6 years. Therefore the environmental demands has been assessed as Moderate.	Moderate	Option to be considered under a moderate to high water resource availability.	Moderate
	> 25 000 ML/day at Yarrawonga Weir (unregulated flow) for at least 7 days (river red gum forest) and followed by flows of up to 18 000 ML/day or greater for three to five months targeting moira grassland.	6-8 in 10 years (2-3 years) Annual (2 years) for moira grass.	For river red gum, the target has been met or partially met 2 in 6 years. For moira grass the target has been met 2 in 6 years. Therefore the environmental demand has been assessed as High.	High	Reliant on large, unregulated flows. Commonwealth environmental water may extend the depth and duration of natural floods within current constraints (i.e. < 15 000 ML/day), subject to ecological need, water availability and assessment of risk and potential, adverse third party impacts.	High
Yallakool - Wakool⁵ Maintenance of native fish habitat and instream aquatic vegetation Longitudinal connectivity	~200 ML/day base flow for ~304 days during late winter to late Autumn (~61 GL). Note: winter base flows are a separate flow component and is included below.	Annual	Has been met 8 out of the past 10 years	Low	Likely to be met by consumptive demands except in <u>a very dry year</u> when CEW may be use to prevent system from being cut off	Low

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2019–20		Implications for future demands
	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely environmental demand in 2020–21 if watering occurred as planned in 2019–20
Fish spawning, recruitment and movement Nutrient cycling Water Quality	~430 ML/day for 41 days to maintain nesting habitat for Murray cod, and inundation for aquatic vegetation growth (~10 GL in total, includes ~200 ML/day base flow). To support Murray cod recovery post 2016 hypoxic blackwater event.	Annual	Has been met 7 out of the past 10 years	High	Priority for Commonwealth environmental water to continue ecosystem recovery	High
	~540 ML/day peak for 4 days pulse/fresh over 20 days in late spring and ~530 ML/day peak for 6 days over 48 days in late spring/early summer with gradual recessions providing variability flows (~10 GL and ~17.85 GL, includes ~200 ML/day base flow). To support silver perch and Murray cod recovery	Annual	Has been met 7 out of the past 10 years	High	Priority for Commonwealth environmental water to continue ecosystem recovery	High
	~360 ML/day peak for 3 days over 25 days pulse/fresh in late summer/early autumn with a gradual recession (~7.3 GL, includes ~200 ML/day base flow). To improve variability of flows (prevent 'flat river')	2 in 3 (4 years)	Has been met 7 out of the past 10 years	Moderate	Priority for Commonwealth environmental water to continue ecosystem recovery	Moderate
	~600 ML/day peak for 4 days over 39 days pulse/fresh in mid to late autumn with a gradual recession (~16.61 GL, includes ~200 ML/day base flow). To support silver perch recovery.	Annual	Has been met 7 out of the past 10 years and partially met 1 in 10 years.	Moderate	Priority for Commonwealth environmental water to continue ecosystem recovery - seeks to link to Autumn pulses in Southern Connected Basin	Moderate
	~170 ML/day of for 30 days (July 2019, continuing on from May and June 2019) (~5.1 GL) from early winter into 2019-2020. To support aquatic vegetation and native fish recruitment during winter	Annual	Has been met 1 (winter 2017) out of the past 10 years.	High	Priority for Commonwealth environmental water to continue ecosystem recovery. Unable to provide winter 2018 flows but will aim for winter 2019 subject to delivery infrastructure availability.	High
Colligen - Niemur⁵ As per Yallakool-Wakool above	The potential flow components for the Colligen-Niemur during 2019-20, and related assessment of demands & urgency of demands are similar to the flow components outlined for the Yallakool-Wakool above. The primary difference is that the flows planned for the Colligen-Niemur have been scaled to fit within its constraint for environmental flows of up to 450 ML/day.					
Edward River downstream of Stevens Weir⁵	Pulse to be developed in consultation with WaterNSW and MDBA. Will need to work in with operations of Stevens Weir, delivery of operational flows & e-flows to Yallakool-Wakool and Colligen-Nimeur systems. To support silver perch recovery.	Annual	Various - flow variability during November & December (spawning period for Silver perch) may be able to meet this need.	Moderate	Priority for Commonwealth environmental water to continue ecosystem recovery - seeks to link to Autumn pulses in Southern Connected Basin	Moderate
Tuppall Creek⁵	Various flow/volume requirements depending on constraints of creek system. Flow objectives are also highly site specific but may include longitudinal connectivity, improving water quality, maintaining riparian habitat, instream aquatic vegetation and native fish habitat.	Autumn & Spring each year	Has been met 9 out of the past 10 years	Moderate	Priority for Commonwealth environmental water to maintain ecosystem health - undertaken in partnership with NSW.	Moderate
Merran Creek⁵		1 in 2 (2 years)	CEW was used for 1st time in 2016-17. Confirmed that operational flow can meet most needs.	Moderate	Likely to be met by operational flows. Requires Murray River to be at certain height to enable commence to flow	Moderate
Jimaringle, Cochrans and Gwynnes Creeks⁵		1 in 2 (2 years)	Last use of CEW was in 2013-14. Last significant flow was the 2016 flood event.	Moderate	Use of CEW in these systems suspended pending further advice from OEH re acid sulphate soils and salinity issues.	Moderate

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2019–20		Implications for future demands
	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely environmental demand in 2020–21 if watering occurred as planned in 2019–20
Fringing Wetlands⁵	Various flow/volume requirements depending on wetland site. Flow objectives are also site specific but may include maintaining riparian habitat for frog, waterbird and vegetation outcomes.	Site specific	Various	Moderate	Likely to be met by OEH private wetland watering program. Use of CEW potentially available if required.	Moderate
Werai Forest⁵	Water Quality, Wetland creation/maintenance, Maintenance riparian vegetation, provision of carbon (productivity) during cooler times of the year	2-3 in 5 years (6 years) for river red gums	Has been met 3 out of the past 10 years and partially met 1 in 10 years.	Moderate	Use of CEW, including pumping, could be considered subject to stakeholder support, operational delivery infrastructure, third party impacts and accounting being addressed.	Moderate
Koondrook-Perricoota Forest³	Annual watering proposals for this site are developed by Forestry NSW and can be contributed to by a number of water holders. Flow objectives may include maintaining habitat for aquatic vegetation, stimulate wetland vegetation response and the provision of carbon (productivity) during cooler times of the year.	2-3 in 5 years (6 years) for river red gums	Has been met 3 out of the past 10 years and partially met 1 in 10 years.	High	Commonwealth environmental water could be considered in future years, subject to stakeholder support, third party impacts and return flows being addressed.	High
Pollack Swamp		Annually	CEW was used for 1st time in 2018-19. Previous 3 years watered by a NSWFC, OEH and Bringan Irrigation Trust partnership	Moderate	Use of CEW only, (pumping provided by Bringan and pumping costs OEH), could be considered subject to stakeholder support, operational delivery infrastructure and accounting being addressed.	Moderate
Edward Wakool System – Recession Flows⁵ Maintenance of instream aquatic vegetation and native fish habitat	~15 GL within constraints to provide more natural recession flows off rain rejection and unregulated events in the system.	As required - usually triggered via advice from NSW agencies re anticipated flow rates in the system.	Has been met when required (3 occasions in the past 10 years).	Moderate	Commonwealth environmental water may be used to manage flow recessions associated with natural or rain-rejection events.	Moderate
Edward Wakool System - Refuge Flows⁵ Habitat flows Water quality Provision of refuges for native fish	~30-120 GL a year to manage hypoxic blackwater events and other critical habitat needs.	As required - usually triggered once dissolved oxygen levels reach 4.0 mg/l in line with Basin Plan water quality requirements.	Has been met when required (5 occasions in the past 10 years).	Critical once trigger is met	High priority for Commonwealth environmental water to abate the impact of potential fish kills if triggers are met.	Critical once trigger is met
Gunbower Creek²	Winter low flow and summer ramp down to support juvenile fish and maintain habitat connectivity during off-irrigation season: · Winter base flows (above 300 ML/day for 5 months). Net use ~8 000 ML	Annually (1 year).	Met or partially met in the last four years. Watering required on an annual basis therefore the environmental demand has been assessed as High.	High	Priority for Commonwealth environmental watering (likely to receive water even under low water resource availability, subject to flow constraints)	High

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2019–20		Implications for future demands	
	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely environmental demand in 2020–21 if watering occurred as planned in 2019–20	
	Spring pulse and stable summer flows for fish breeding: · Base-flow of up to 500 ML/day in spring. - Single fresh up to 400 ML/day for 42 days in spring/summer. Net use ~ 12 000 ML		Fish spawning fresh 2 in 3 years.	Met or partially met in the last three years. The environmental demand has been assessed as Moderate.	Moderate	Priority for Commonwealth environmental watering (likely to receive water even under low water resource availability, subject to flow constraints)	Moderate
Gunbower Forest ³	Small-moderate actions (25 000 ML/day at Torrumbarry Weir for at least 20 days and up to 150 days in winter/spring) targeting permanent and semi-permanent wetlands, or targeted infrastructure use at the sites.	~3 000 ha via Gunbower Forest infrastructure.	6-9 in 10 years (2 years)	Significant watering action in 2014-15 and 2015-16 and natural flood event in 2016-17 inundated various parts of the Forest. Drying phase in 2017-18 with the exception of high value permanent wetlands. Watering action in 2018-19. Environmental demand has been assessed as High.	High	It is anticipated that demands in Gunbower Forest will be met by other water holders in 2019 - 20.	Low
	Infrastructure delivery to Gunbower Forest targeting river red gum forest equivalent to around 27-35 000 ML/day at Torrumbarry Weir.	~4 000 ha via Gunbower Forest infrastructure.	1 in 3-4 years (3 years)	Met or partially met in the last five years. The environmental demand has been assessed as Low.	Low	It is anticipated that demands in Gunbower Forest will be met by other water holders in 2019 - 20.	Low
Mid-Murray Off-Channel Wetlands and ephemeral creeks Hume to Euston ⁴	Infrastructure delivery targeting permanent off-channel wetlands.	Annually		Met in the last three years. Annual requirement therefore the environmental demand has been assessed as High.	High	High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)	High
	Infrastructure delivery targeting semi-permanent off-channel wetlands.	3-7 in 10 years (5 years).		Met in the last three years at some sites. Therefore the environmental demand has been assessed as Moderate.	Moderate	Option to be considered under a moderate to high water resource availability.	High
	Infrastructure delivery targeting ephemeral off-channel wetlands.	1 in 5 years.		Met in the last three years at most sites. Therefore the environmental demand is Low overall.	Low	Option to be considered under a moderate to high water resource availability.	Moderate
				Carryover potential	The volume of Commonwealth environmental water likely to be carried over in Mid-Murray Region for use in 2019–20 is estimated to be between 260-280 GL.	Available allocations to be carried into 2020–21 will be identified in Lower Murray–Darling environmental water holdings at http://www.environment.gov.au/water/cewo/about/water-holdings .	

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history	2019–20		Implications for future demands
	Flow/Volume	Required frequency (maximum dry interval)	(from all sources of water)	Environmental demands for water	Potential Commonwealth environmental water contribution?	Likely environmental demand in 2020–21 if watering occurred as planned in 2019–20
				Trade potential	<p>It is expected that zero dollar administrative transfers of Commonwealth water allocations will be undertaken between trade zones in the southern connected Basin to support environmental water delivery throughout the 2019-20 water year.</p> <p>No specific commercial trade of water has been identified for 2019-20. Trade opportunities will be reviewed throughout the water year and as conditions change.</p>	Potential to trade will depend on environmental demands, resource availability and market conditions.

Key - potential watering in 2019–20

	High priority for Commonwealth environmental watering (likely to receive water even under low water resource availability)
	Secondary priority for Commonwealth environmental watering (watering to occur only if natural trigger is met, or under moderate – high water resource availability); or water demand likely to be met via other means
	Low priority for Commonwealth environmental watering (under high – very high water resource availability)
	Unable to provide Commonwealth water due to constraints

Key - environmental demands

	critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage
	high demand for water i.e. needed in that particular year
	moderate demand for water i.e. water needed that particular year and/or next
	low demand for water i.e. water generally not needed that particular year
	very low demand for water i.e. water generally not needed that particular year or the following year

Note that demand is considered at a generalised scale; there may be specific requirements that are more or less urgent within the flow regime

1. Murray and Barmah-Millewa Forest indicators adapted from Department of the Environment (2011a), MDBA (2012d).

2. Gunbower Creek indicators sourced from North Central CMA (2013; 2014b; 2015b; 2016b; 2017).

3. Gunbower-Koondrook-Perricoota Forest indicators adapted from MDBA (2012c), MDBA 2012 (f) and Department of the Environment (2011d).

4. Mid Murray Off-Channel Wetlands and ephemeral creek indicators sourced from North Central CMA (2014a; 2015a; 2016a).

5. Edward-Wakool indicators compiled from multiple sources (Hale & SKM 2011; Watts et al 2013; Watts et al 2014; Watts et al 2015; Watts et al 2016; Watts et al 2017; Webster 2010). Previous watering actions and their outcomes have also been used for all indicators.

3. Next steps

3.1. From planning to decision making

It is important to distinguish between planning and operational decision making. As shown in Figure 4, planning allows the CEWO to manage the environmental water portfolio in a holistic manner and is an exercise in developing a broad approach or intention, based on the key drivers (demand and supply).

Decision making throughout each year builds on the intention by considering in more detail the specific prevailing factors and additional factors such as costs, risks, and constraints to water delivery and market conditions.

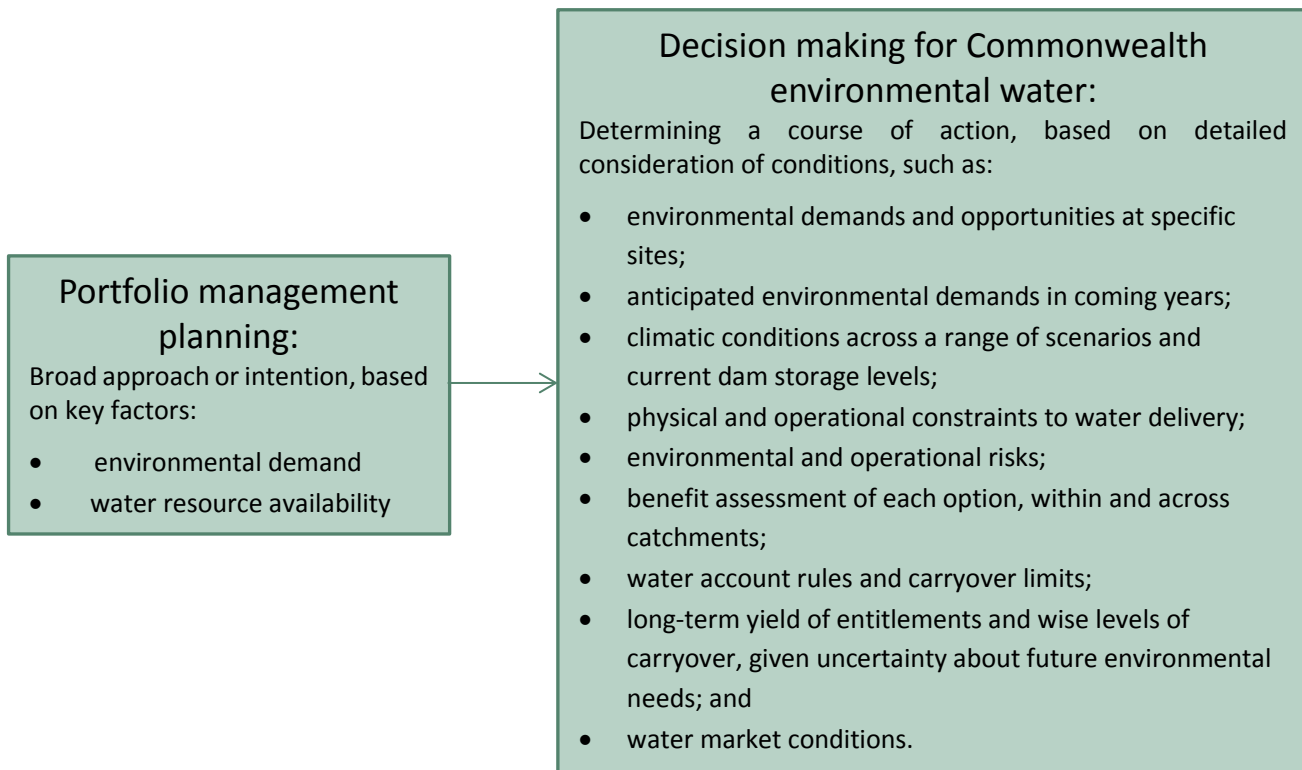


Figure 4: Planning and decision making for Commonwealth environmental water use

3.2. Monitoring

Operational monitoring is undertaken for all Commonwealth environmental watering actions and involves collecting on-ground data with regard to environmental water delivery such as volumes delivered, impact on the river systems hydrograph, area of inundation and river levels. It can also include observations of environmental outcomes.

The Long-term Intervention Monitoring (LTIM) Project has the Edward-Wakool region as a focus area. It aims to understand the environmental response from Commonwealth environmental watering with respect to the targeted objectives by carrying out monitoring of site condition over many years.

In addition, some components of the Mid-Murray Region are included as icon sites in The Living Murray program. The Living Murray program aims to improve the ecological condition of significant forests, wetlands and lakes along the River Murray as part of helping to deliver the Basin Plan objectives and outcomes.

Information on the monitoring activities is available at <http://www.environment.gov.au/water/cewo/catchment/mid-murray/monitoring>

3.3. Further information

For further information on how the CEWO plans for water use, carryover and trade, please visit our web site: <http://www.environment.gov.au/water/cewo> or the sites below:

- Water use: www.environment.gov.au/topics/water/commonwealth-environmental-water-office/assessment-framework
- Carryover: <http://www.environment.gov.au/topics/water/commonwealth-environmental-water-office/portfolio-management/carryover>
- Trade: <http://www.environment.gov.au/water/cewo/trade/trading-framework>

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Attachment A – Expected outcomes from the Basin-wide environmental watering strategy

Expected outcomes from the Basin-wide environmental watering strategy (MDBA 2014) that are relevant to the Mid-Murray Region are described below.

RIVER FLOWS AND CONNECTIVITY

Base flows are at least 60 per cent of the natural level.

Contributing to a 30 per cent overall increase in flows in the River Murray.

A 30–60 per cent increase in the frequency of freshes, bankfull and lowland floodplain flows.

VEGETATION

Maintain the current extent of water-dependent vegetation near river channels and on low-lying areas of the floodplain.

Improve condition of black box, river red gum and lignum shrublands.

Improved recruitment of trees within black box and river red gum communities.

Increased periods of growth for non-woody vegetation communities that closely fringe or occur within the river and creek channels, and those that form extensive stands within wetlands and low-lying floodplains including moira grasslands in Barmah–Millewa Forest.

Vegetation extent

Region	Area of river red gum (ha)	Area of black box (ha)	Area of coolibah (ha)	Shrublands	Non-woody water dependent vegetation
Murray (assessment is for entire Murray catchment)	90 600*	41 700*	-	Lignum along the River Murray from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes	Closely fringing or occurring within the Murray, Edward, Kiewa, Mitta Mitta, Niemur and Wakool rivers and Tuppall Creek; moira grasslands in the Barmah–Millewa Forest

Black box condition

Region	Vegetation condition score		Per cent of vegetation assessed (within the managed floodplain)
	0–6	>6–10	
Murray (assessment is for entire Murray catchment)	33 per cent	65 per cent	28 per cent

River red gum condition

Region	Vegetation condition score					Per cent of vegetation assessed (within the managed floodplain)
	0–2	>2–4	>4–6	>6–8	>8–10	
Murray (assessment is for entire Murray catchment)	2 per cent	1 per cent	10 per cent	51 per cent	35 per cent	51 per cent

WATERBIRDS

Maintain current species diversity.

Increase Basin-wide abundance of waterbirds by 20–25 per cent by 2024.

A 30–40 per cent increase in nests and broods (Basin-wide) for other waterbirds.

Up to 50 per cent more breeding events (Basin-wide) for colonial nesting waterbird species.

Important Basin environmental assets for waterbirds in the Mid-Murray

Environmental asset	Total abundance and diversity	Drought refuge	Colonial waterbird breeding	Shorebird abundance	In scope for C'th watering
Gunbower–Koondrook–Perricoota			*		Yes
Kerang wetlands	*				Yes
Barmah–Millewa	*		*		Yes

FISH

No loss of native species.

Improved population structure of key species through regular recruitment, including:

- Short-lived species with distribution and abundance at pre-2007 levels and breeding success every 1–2 years.
- Moderate to long-lived with a spread of age classes and annual recruitment in at least 80 per cent of years.

Increased movements of key species.

Expanded distribution of key species and populations.

Key species for the Mid-Murray

Species	Specific outcomes	In-scope for C'th water in the Mid-Murray?
Flathead galaxias (<i>Galaxias rostratus</i>)	Expand the core range in the wetlands of the River Murray.	Yes
Freshwater catfish (<i>Tandanus tandanus</i>)	Expand the core range in Columbo-Billabong Creek and Edward-Wakool system.	Yes
Golden perch (<i>Macquaria ambigua</i>)	A 10–15 per cent increase of mature fish (of legal take size) in key populations.	Yes
Murray cod (<i>Maccullochella peelii peelii</i>)	A 10–15 per cent increase of mature fish (of legal take size) in key populations.	Yes
Murray hardyhead (<i>Craterocephalus fluviatilis</i>)	Expand the range of at least two current populations. Establish 3–4 additional populations, with at least one in the Mid-Murray conservation unit.	Yes
Olive perchlet (<i>Ambassis agassizii</i>)	Olive perchlet are considered extinct in the southern Basin. Reintroduction using northern populations is the main option for recovery. Candidate sites may result from improved flow that reinstates suitable habitat in the River Murray.	Restoration of flow to River Murray could support the future reintroduction of the species.

Species	Specific outcomes	In-scope for C'th water in the Mid-Murray?
River blackfish (<i>Gadopsis marmoratus</i>)	Expand the range of current populations from the Mulwala canal.	Yes
Silver perch (<i>Bidyanus bidyanus</i>)	Expand the core range within the River Murray (Yarrowonga–Euston including the Edward-Wakool system).	Yes
Southern purple-spotted gudgeon (<i>Mogurnda adspersa</i>)	-	Yes
Southern pygmy perch (<i>Nannoperca australis</i>)	Expand the range of current populations at Barmah-Millewa and other Mid-Murray wetlands.	Yes
Trout cod (<i>Maccullochella macquariensis</i>)	Expand the range of trout cod up the Murray upstream of Lake Mulwala and into the Kiewa River. For the connected population of the Murrumbidgee–Murray–Edward systems: continue downstream expansion.	Yes
Two-spined blackfish (<i>Gadopsis bispinosus</i>)	Establish additional populations (no specific locations identified).	Yes

Important Basin environmental assets for native fish in the Mid-Murray

Environmental asset	Key movement corridors	High Biodiversity	Site of other significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge	In-scope for C'th water
Koondrook–Perricoota	*	*	*	*	*		Yes
Gunbower	*	*	*	*	*		Yes
Barmah–Millewa	*	*	*	*	*	*	Yes
Edward–Wakool system	*	*	*	*	*	*	Yes
Werai Forest			*	*			Yes
Billabong–Yanco–Columbo Creeks		*	*	*	*	*	Yes
Lake Mulwala	*		*	*	*	*	Yes

Attachment B – Operational details for watering

Operational considerations in the Mid-Murray Region catchment

The delivery of environmental water in the Mid-Murray is currently constrained by the release capacities from storages, channel capacities and system constraints. Relevant constraints to be considered include:

- To avoid unseasonable inundation of Barmah-Millewa Forest during summer, delivery through the Barmah Choke is limited to approximately 9,300 ML/day downstream of Yarrawonga (MDBA, 2017).
- The delivery of Commonwealth environmental water in the Mid-Murray is affected by constraints in the tributaries of the Mid-Murray, particularly the Goulburn River. Releases on major tributaries (to avoid unacceptable third party impacts) may limit the delivery of water to Mid-Murray Region sites.
- Channel capacity may limit the delivery of Commonwealth environmental water in certain parts of the Mid-Murray Region. On the River Murray main channel there are various flow constraints to avoid the inundation of property and privately owned infrastructure. At Deniliquin, flows in the Edward River above 17 100 ML/day result in minor flood events (MDBA 2013).

Further information about constraints in the Mid-Murray Region can be found in the *Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* (NSW) (pt 10 cls 51) and *Constraints Management Strategy 2013 to 2024* (MDBA 2013).

Potential watering actions under different levels of water resource availability

Under certain levels of water resource availability, watering actions may not be pursued for a variety of reasons, including that environmental demand may be met by unregulated flows and that constraints and/or risks may limit the ability to deliver environmental water. Table 4 identifies the range of potential watering actions in the Mid-Murray Region and the levels of water resource availability that relate to these actions.

Table 4: Summary of potential watering actions for the Mid-Murray Region (See Table 3 for supporting information regarding these potential watering actions)

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
River Murray from Hume Dam to Euston	Minimum 2000 – 5000 ML/day at Yarrawonga Weir throughout year for fish habitat and water quality in main river channel and Barmah-Millewa creeks. Variable flows between 5000 and 9,500ML/day at Yarrawonga Weir from July to November.	1a. Mid River Murray Channel Flow: Contribute to low-level in-stream flows where required to provide fish habitat and water quality outcomes, and to re-connect river with low-lying wetlands and creeks, subject to appropriate trigger. Includes the Murray River winter flow component.				
	Large spring freshes of up to 15,000 ML/d - 18,000 ML/d for a minimum of 5-10 days measured d/s Yarrawonga between July to November, subject to natural cues. 12,000 ML/d variable flow rate (+/- 2,000 ML/d), for at least 5 days, measured d/s Yarrawonga Weir during the period July to November.		1b. Mid River Murray Channel Flow: Contribute to in-stream flows to promote fish movement, condition, spawning and recruitment of flow specialists and floodplain fish species and to re-connect river with low-lying wetlands and creeks, subject to appropriate trigger.			
Barmah-Millewa Forest	Maximum target 15,000 – 18,000 ML/day at Yarrawonga Weir up to 100 days in July – November following the recession of a natural high flow or operational transfers above channel		2. Barmah-Millewa Forest Flow: Contribute to an overbank flow (15 000–18 000 ML/day following large unregulated peak) to inundate up to 35 000 ha of marshland and river red gum forest; to promote fish movement, condition, spawning and recruitment of some fish species (flow and floodplain specialists); and to support completion of naturally triggered bird breeding events.			
Edward-Wakool River System	Permanent waterways.	3a. Maintain critical habitat flows to prevent cease to flow.	3a. To support the recovery of in-stream habitat after the 2016 flood, particularly aquatic vegetation and areas supporting the various life stages of native fish. Environmental water use is most likely to contribute to in-channel base flows and freshes. It may also be used to provide a more gradual recession to periods of high flow (e.g. rain rejection flows) and improve water quality.			3a. Provide refuge flows to maintain critical habitat flows.
	Ephemeral waterways and wetlands.		3b. To maintain ephemeral in-stream and wetland habitat, particularly water quality, aquatic vegetation and areas supporting the various life stages of native fish, frogs, birds and aquatic invertebrates.			
	Forests.			3c. To maintain vegetation health and to contribute to hydrological connectivity and nutrient/carbon cycling processes. Flows into the Werai forest system should ideally be synchronised/integrated with flows from Barmah-Millewa Forest (see also Koondrook-Perricoota forest below).		

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Gunbower Creek	<p>Winter baseflows of above 300 ML/day for 5 months and summer/autumn ramp down 300 ML/day for 90 days.</p> <p>Spring rise and stable summer flows to support fish breeding:</p> <ul style="list-style-type: none"> • Baseflow of up to 500 ML/day in spring. • Single fresh up to 400 ML/day for 42 days in spring/summer. 	<p>4. Gunbower Creek Channel Flow: Contribute to in-stream flows to support the survival and condition of juvenile fish and stimulate lateral movement of large-bodied native fish, aquatic invertebrates and carbon between Gunbower Creek and Gunbower Forest.</p>				
Gunbower-Koondrook-Perricoota Forest	<p>Small-moderate action (25 000 ML/day) at Torrumbarry Weir for at least 20 days and up to 150 days in winter/spring targeting permanent and semi-permanent wetlands or:</p> <ul style="list-style-type: none"> • ~3000 ha via Gunbower Forest infrastructure. • ~8000 ha via Koondrook-Perricoota Forest infrastructure. <p>Infrastructure delivery to Gunbower and Koondrook-Perricoota Forests targeting river red gum forest equivalent to around 27 000–35 000 ML/day at Torrumbarry Weir, or:</p> <ul style="list-style-type: none"> • 4000 ha via Gunbower Forest infrastructure. • Up to 16 000 ha via Koondrook-Perricoota Forest infrastructure. 				<p>5. Gunbower Forest Flow: Deliver water to inundate river red gum forest; support survival, condition and spawning of native fish (floodplain specialists) and/or supporting the completion of a bird breeding event.</p>	
					<p>6. Koondrook-Perricoota Forest Flow: Subject to potential third party impacts being addressed, use infrastructure to provide flows to inundate river red gum forest; support bird breeding and/or support survival, condition and spawning of native fish (floodplain specialists), and the provision of carbon (productivity) during cooler times of the year. Flows into the Koondrook-Perricoota forest system should ideally be synchronised/integrated with flows from the Murray (e.g. Barmah-Millewa Forest and/or the Goulburn River system to mimic the natural movement of flows through the mid-Murray at a systems-landscapes scale.</p>	

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Mid-Murray Off-Channel Wetlands Hume to Euston	Permanent Wetlands.	7. Water a range of annual, semi-annual, intermittent Mid-Murray wetlands across all scenarios, subject to seasonal cues.				
	Semi-permanent Wetlands.					
	Ephemeral Wetlands.					

Note: Under certain resource availabilities, option may not be pursued for a variety of reasons including that environmental demand may be met by unregulated flows and that constraints and/or risks may limit the ability to deliver environmental water.

Potential watering actions – standard operating arrangements

Error! Reference source not found. identifies the range of potential watering actions in the Mid-murray Region in the Murray-Darling Basin that give effect to the long-term demands and flow regime identified as being in scope for the contribution of Commonwealth environmental water in any given year. The standard considerations associated with these actions are set out below.

Watering Action 1a, 1b, 2, 5 and 6: Mid River Murray channel flow; Barmah-Millewa Forest flow; and Gunbower-Koondrook-Pericoota Forest high flow (within constraints).

Standard operational considerations:

- In-stream environmental watering seeks to target improved seasonality of flows to promote spawning of flow specialist fish species and to re-connect rivers with low-lying wetlands. As such, an action will generally be in response to an appropriate flow triggers, such as rainfall events and flows upstream of Hume Dam and in tributaries (e.g. Ovens, Kiewa, Goulburn and Murrumbidgee rivers).
- Larger channel flows will naturally enter creeks and anabranches, low lying wetlands (e.g. Coppingers Lagoon, Duck Lagoon, Douglas Swamp, Boals-Deadwoods, St Helena Swamp, Black Swamp, Walthours Swamp, Moira Lake, Barmah Lake and Gulpa Creek Complex). In some cases infrastructure may be used to provide flow conditions for fish outcomes (e.g using Mary Ada regulator to provide flows for native fish in Toupna Creek).
- Barmah-Millewa Forest:
 - To create significant flows into Barmah-Millewa Forest, significant natural flows are required, with Commonwealth environmental water only provided to extend the duration of flows once the flow rate recedes to a level that does not create unacceptable third party impacts. Regulators may be opened or closed on either side to influence the extent and duration of flows into Barmah and Millewa forests.
 - The action would typically occur during winter or spring, consistent with natural seasonality. Unless otherwise agreed, Commonwealth environmental water will be delivered to target a maximum water level of 3.0 m at the Tocumwal Gauge (which corresponds to about 15 000 ML/day). From December to May, flows downstream of Yarrawonga Weir are managed as required to avoid unseasonal inundation of Barmah-Millewa Forest (around 9,500 ML/d).
 - Higher flows that enter anabranches and creeks in Millewa Forest may connect with the Edward-Wakool system and provide further benefits.
 - With other factors influencing the extent of floodplain marsh species such as moira grass, complementary natural resource management activities will be important if Commonwealth environmental water is to be provided to extend Barmah-Millewa Forest flows, such as managing the encroachment by river red gums and grazing by vertebrate pests.
- Gunbower-Koondrook Pericoota Forest:
 - Environmental water may be contributed to channel flows to connect the River Murray with Gunbower and Koondrook-Perricoota forests.
 - A suitable flow trigger is required for environmental water to piggy-back on and resource availability may often be a limiting factor. The action would likely occur as part of a multi-site connected flow action through the Mid-Murray.
 - The use of Commonwealth environmental water in Koondrook-Perricoota Forest will depend on necessary State approvals being in place and an assessment of risks including, but not limited to, water quality issues and potential third party impacts.

- Environmental water delivery may be constrained by other demands on the system, especially during irrigation season, and capacity to release and coordinate releases from multiple storages.

Typical extent:

- Flow rates will be dependent on flow conditions, target outcomes and the operational considerations described above. Releases from Hume Dam will have most impact (in terms of flow variability) on flows in the upper Mid-Murray channel (from Hume to the Barmah Choke). Significantly influencing flow variability in the River Murray downstream of the Barmah Choke requires coordination of water delivery from other tributaries (e.g. the Goulburn and Murrumbidgee rivers).
- In Barmah-Millewa Forest, the extent would generally be sufficient in terms of magnitude (initial unregulated trigger of at least 20 000 – 25 000 ML/day) and duration (at least three months) to water large areas of floodplain marsh including moira grassland and allow the open wetland vegetation to complete its flowering. Less frequently, and following a larger unregulated trigger, flows may inundate broader areas of river red gum forest. This action may also contribute to outcomes in the Edward-Wakool system (Action 3).
- For Gunbower Forest, the extent will be determined by the watering scenario agreed to by the site manager and water holders.
- For Koondrook-Perricoota Forest the extent will be subject to the advice of the forest manager (Forestry NSW), Koondrook-Perricoota Operating Committee and delivery partners.

Watering Action 3a, 3b and 3c: Edward-Wakool River system

Standard operational considerations:

- WaterNSW is responsible for managing flows in the Edward-Wakool River system, which is highly regulated. Depending on the location and purpose of the action, water may also be sourced from either Murray Irrigation and/or private landholder irrigation infrastructure. Commonwealth environmental water may be delivered in combination with natural, consumptive or other held or planned environment water.
- Forest and ephemeral waterway actions will be timed for winter/spring and late autumn to minimise the risk of hypoxic blackwater impacts. Operational considerations for Werai Forest are being reviewed to improve the potential for watering to be undertaken, particularly synchronising flows into the Werai with flows targeting Millewa Forest.
- Contingency flows may be made available, if required, to provide critical refuge habitat for aquatic species such as large bodied native fish during hypoxic events.
- Planning for actions will take into consideration the potential impacts of inundating areas that have acid sulphate soils and/or deep pools that may result in the movement of salt.
- Maintenance work will be undertaken on Stevens Weir and other delivery infrastructure in the Edward-Wakool River system during May, June and July 2018. This will prevent the delivery of flows into the Yallakool-Wakool and Colligen-Niemur systems during the winter 2018 period. The recommencement of delivering winter flows will be sought for winter 2019.

Typical extent: Flows will be delivered within constraints, unless otherwise agreed with potentially impacted landholders and state government agencies. During August 2018, following discussions with the landholder representatives and relevant NSW agencies, an 800 ML/d flow trial in the Yallakool-Wakool is planned, targeting productivity, native fish, and instream aquatic vegetation outcomes.

Watering Action 4 and 5: Gunbower Creek channel flow and Gunbower Forest flow

Standard operational considerations:

- Environmental water can be delivered to Gunbower Creek in combination with consumptive flows to the Torrumbarry Irrigation Area. Water levels in Gunbower Creek are largely driven by irrigation demand. Commonwealth environmental water will be used to account for the losses associated with the delivery of consumptive water en route through Gunbower Creek.
- High flows in Gunbower Creek can also be used to push water into Gunbower Forest using the Hipwell Road regulator. The native fish population in the highly regulated Creek can be enhanced by delivering targeted environmental flows to provide improved conditions for native fish year-round.
- When delivering water during the irrigation season, the environment shares the capacity of Gunbower Creek with irrigation flows. As such, there is potential for system capacity constraints to interrupt the supply of environmental water to Gunbower Forest.
- Unless otherwise agreed, Commonwealth environmental water will not be used to contribute to flow rates above 700 ML/day at Cohuna Weir to avoid unplanned inundation of private land.
- Due to infrastructure limitations when watering both the Gunbower Forest and Creek, winter baseflows in Gunbower Creek (as part of the large bodied fish hydrograph) may be limited to approximately 200 ML/day (50 ML/day over the Hipwell Weir fishway and 150 ML/day delivered via the 6/1 channel). This will impact upon the deliverability of the full fish hydrograph in Gunbower Creek.
- A number of planned infrastructure works are scheduled between 2017–18 to 2021–22 that will require Gunbower Creek water levels to be lowered. This has the potential to impact upon the deliverability of the full fish hydrograph and therefore presents a possible threat to the vulnerable native fish population in Gunbower Creek.

Typical extent: In-channel flows through to inundation of up to 4 800 ha of river red gum forest.

Watering Action 6: Koondrook-Perricoota Forest via infrastructure works

Standard operational considerations:

- Commonwealth environmental water provided to Wakool River-Yallakool Creek (in the Edward–Wakool system) may assist with managing outflows from Koondrook-Perricoota Forest into the Wakool River.
- Water would be delivered to Koondrook–Perricoota Forest via the Torrumbarry Weir pool and inundation managed using a series of regulators. Outfalls to the Wakool River may need to be managed to prevent third party impacts and water quality issues.

Typical extent: To be determined by the watering scenario agreed to by the site manager and water holders.

Approvals: Commonwealth environmental water may be used in this area subject to potential third party impacts being resolved.

Watering Action 7: Mid-Murray off-channel wetlands – Hume to Euston

Standard operational considerations:

- The Mid-Murray wetlands are scattered along the River Murray on the New South Wales side, while almost wholly contained within the Torrumbarry Irrigation Region in Victoria. Many of the wetlands are now cut-off from natural inundation and are reliant on the managed delivery of environmental water. The delivery of environmental water to these wetlands is constrained by a number of factors such as restrictions to delivery outlets and channel capacity.
- Multiple wetlands having similar watering regimes and requiring water at the same time results in competition for resource availability, particularly in drier years. Prioritisation and ultimately trade-off decisions may be required during low resource availability periods.

- As most of the Mid-Murray wetlands in Victoria are now managed to maintain permanent or semi-permanent saline water habitats, the decision to provide environmental water may not only relate to lake levels, but also active management of salinity concentrations conducive to salt-tolerant species.

Typical extent: Individual wetland sites in the Mid-Murray region, from Hume Dam to Euston.

Attachment C – Long-term water availability

Commonwealth environmental water holdings

The Commonwealth holds the following entitlements in the Mid-Murray Region:

- NSW Murray High Security
- NSW Murray General Security
- NSW Murray Conveyance
- NSW Murray Supplementary
- Victorian Murray High Reliability
- Victorian Murray Low Reliability

The full list of Commonwealth environmental water holdings can be found at www.environment.gov.au/topics/water/commonwealth-environmental-water-office/about-commonwealth-environmental-water/how-much and is updated monthly.

Other sources of environmental water

Other potential sources of held environmental water that may be used to complement Commonwealth environmental water delivery in the Mid-Murray Region include:

- Environmental Entitlement: The Living Murray Program – Murray–Darling Basin Authority
- Environmental Entitlement: New South Wales – New South Wales Office of Environment and Heritage
- Bulk Entitlement – Victorian Environmental Water Holder
- River Murray Increased Flows entitlements: Jointly managed by New South Wales Office of Environment and Heritage and Victorian Environmental Water Holder

Planned environmental water

In addition to water entitlements held by environmental water holders, environmental demands may also be met via natural or unregulated flows and water provided for the environment under rules in state water plans (referred to as 'planned environmental water').

- Barmah-Millewa Environmental Allowance:
 - Provides an annual allocation of up to 150 GL (100 GL high security and 50 GL low security allocation). This water can be used to deliver flows to meet ecological objectives in the Barmah-Millewa Forest in accordance with specific rules.
 - A maximum of 700 GL of water can be carried over from one water year to the next. Responsibility for the Barmah-Millewa Environmental Water Allowance is shared between NSW and Victoria. More information about this water allowance is available from the Barmah-Millewa Forest Environmental Water Management Plan (MDBA 2012e).
- New South Wales Murray Regulated River Water Source Additional Environmental Allowance:
 - the maximum volume held is calculated as 0.15 ML multiplied by the total number of regulated river (high security) unit shares
 - releases of water from the Murray Regulated River Water Source Additional Environmental Allowance can be made for the purpose of contributing to any of the objectives (a) to (i) outlined in the Water Sharing Plan (Section 2, Clause 10).