Australian Government
Commonwealth Environmental Water Office

Commonwealth Environmental Water

Portfolio Management Plan

Lower Murray-Darling Region

2019–20

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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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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 Lower Murray-Darling 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 South Australian Department for Environment and Water (including Natural Resources Management Boards), 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, the Murray–Darling Wetlands Working Group Ltd, Nature Foundation South Australia, Ngarrindjeri Regional Authority, Renmark Irrigation Trust, Australian Landscape Trust (Calperum Station), scientists engaged in monitoring the outcomes of Commonwealth environmental water use 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 CEWO via: ewater@environment.gov.au.

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1. Environmental watering in the Lower Murray–Darling

1.1. The Lower Murray–Darling Region

The Lower Murray–Darling Region consists of the River Murray downstream of Lock 15 at Euston to the Murray Mouth, the Darling River below Menindee Lakes and the Great Darling Anabranch (Figure 1). The lower River Murray contains several wetlands of ecological significance, including the internationally important Ramsar listed Coorong and Lakes Alexandrina and Albert, the Riverland (including the Chowilla floodplain), Banrock Station and Hattah Lakes.

The River Murray flows through the traditional land of many Aboriginal Nations, and the river and its floodplains have long been important for sustenance and spirituality. The Aboriginal Nations associated with land around the confluence of the Darling and Murray rivers include the Barkindji, Maraura, Muthi Muthi and Nyeri Nyeri. Upstream of the confluence of the Darling and Murray includes the land of the Barkindji and Maraura nations. Along the River Murray, from about Mildura and into South Australia is also the traditional land of the Ngintait Nation. The land of the lower reaches of the Murray, the Lakes and the Coorong is the traditional land of the Ngarrindjeri nation. The land west of the river and including the Mount Lofty Ranges, includes the country of the Kaurna and Peramanok Nations.

Environmental water is sourced via managed releases from River Murray storages including Hume Reservoir, Menindee Lakes, Lake Victoria and River Murray tributaries. Natural cues (e.g. natural flows) may be used to inform the use of environmental water in the lower River Murray, establishing a more natural flow regime and maximising the benefits of environmental water delivery. Environmental water delivery to specific sites within the lower River Murray occurs in two main ways. At low river flows, regulating structures or pumping can be used to manage the diversion of water into anabranches, creeks, wetlands and floodplains while in-channel pulses can provide benefits for native fish. At high river flows, environmental water is used to augment natural flow to influence the magnitude and duration of beneficial floodplain and wetland inundation.

Downstream of Lock 15 in the lower River Murray many wetlands, creeks and anabranches are permanently connected to the main river channel at normal weir pool levels, however, some sites are only connected through the operation of infrastructure or elevated river flows. The seasonally appropriate operation of river infrastructure, such as weirs, barrages and pumps, provides more natural patterns of inundation and drying sequences at these sites. Some wetland inundation can be achieved through weir pool manipulation, with a temporary raising of weir pools increasing the area of wetland inundation in low flow conditions whilst using much less water than the equivalent inundation from overbank flows. Water levels within the Lower Lakes and inflows into the Coorong are managed through the operation of barrages at Lake Alexandrina.

Environmental water delivery in the River Murray channel upstream of the South Australian border, including the operation of locks and storages, is managed by the Murray–Darling Basin Authority (River Murray Operations). In the lower Darling River, environmental water delivery is managed by either WaterNSW or the Murray–Darling Basin Authority (River Murray Operations) depending on who has operational control of Menindee Lakes at the time in accordance with the *Murray–Darling Basin Agreement*. Within South Australia, SA Water and the South Australian Department for Environment and Water are the responsible agencies for environmental water delivery and management of locks and barrages. Delivery of Commonwealth environmental water is undertaken in collaboration with these agencies.

Environmental water is managed by a number of water holders in the Murray, including the CEWH, The Living Murray, the Victorian Environmental Water Holder, NSW Office of Environment and Heritage and the South Australian Department for Environment and 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.

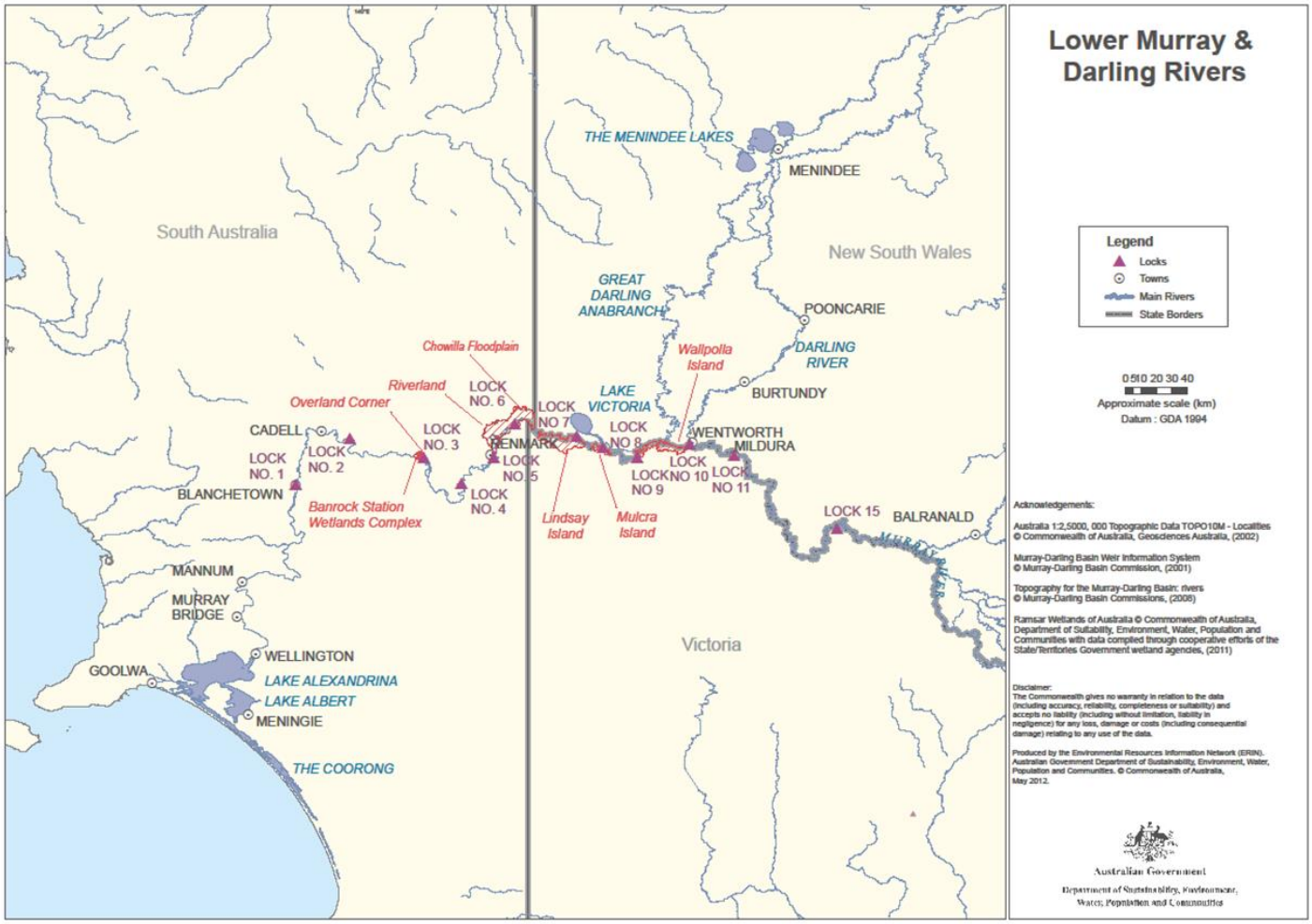

Figure 1: Map of the Lower Murray–Darling Region.

1.2. Environmental objectives in the Lower Murray–Darling 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 Lower Murray–Darling are summarised in Table 1 and described in detail in Attachment A.

The Victorian and South Australian state governments have also developed long-term watering plans for the Victorian (DELWP, 2015) and South Australian River Murray (DEWNR, 2015) regions. The plans identifies the priority environmental assets and ecosystem functions in the catchment, the objectives and targets for these assets and functions, and their watering requirements. Once developed, the New South Wales Murray and Lower Darling plans will also provide key information on the long-term environmental water demands in the catchment.

The long term environmental watering plan for the South Australian River Murray water resource plan area is available at: http://www.environment.sa.gov.au/managing-natural-resources/river-murray/improving-river-health/environmental-water/environmental-water-planning

The long term environmental watering plan for the Victorian River Murray water resource plan area is available at: https://www.water.vic.gov.au/__data/assets/pdf_file/0023/53168/Victorian-Murray-LTWP_17-11-2015-FINAL.pdf.

In addition to the long-term watering plans, the CEWO will continue to draw on existing documentation on environmental water demands developed by state governments, local natural resource management agencies and the Murray–Darling Basin Authority.

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 Lower Murray–Darling 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 Lower Murray–Darling Region

<table>
<tr><th rowspan="3">BASIN-WIDE MATTERS
(Matters in red link to the Basin-wide Environmental Watering Strategy)</th><th colspan="6">OBJECTIVES FOR LOWER MURRAY–DARLING ASSETS</th></tr>
<tr><th colspan="3">IN-CHANNEL ASSETS</th><th>END OF SYSTEM</th><th colspan="2">OFF-CHANNEL ASSETS</th></tr>
<tr><th>River Murray from Euston to Lower Lakes</th><th>Lower Darling River</th><th>Great Darling Anabranch</th><th>Coorong, Lower Lakes and Murray Mouth</th><th>Hattah Lakes</th><th>Floodplain and wetlands from Euston to South Australian border</th><th>Floodplain and wetlands from South Australian border to Lower Lakes</th></tr>
<tr><td>VEGETATION</td><td colspan="3">Maintain riparian and in-channel vegetation condition.
Increase periods of growth for non-woody vegetation communities that closely fringe or occur within river channels.</td><td>Ensure survival and promote growth and recruitment of Ruppia tuberosa in the south lagoon of the Coorong.
Maintain or improve the diversity, condition and extent of aquatic and littoral vegetation at the Lower Lakes</td><td colspan="3">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 trees within black box and river red gum communities.</td></tr>
<tr><td rowspan="2">WATERBIRDS</td><td colspan="6">Provide habitat and food sources to support waterbird survival and recruitment, and maintain condition and current species diversity.</td></tr>
<tr><td colspan="3"></td><td>Maintain habitat and food sources to support improvement in waterbird condition and populations within the Lower Lakes and Coorong lagoons (including curlew sandpiper, greenshank, red-necked stint and sharp-tailed sandpiper).
Complete seasonally appropriate colonial bird breeding events that are in danger of failing due to drying.</td><td colspan="3">Complete seasonally appropriate colonial bird breeding events that are in danger of failing due to drying.</td></tr>
<tr><td>FISH</td><td colspan="3">Provide flows to support habitat and food sources and promote increased movement, recruitment and survival/condition of native fish.</td><td>Maintain or improve diversity, condition and population for fish populations (including estuarine-dependent and diadromous fish) through providing suitable habitat conditions within the Coorong lagoons and maintaining migration pathways that supports species recruitment and survival/condition.
Provide flow cues to promote increased movement, recruitment and survival/condition of native fish.</td><td colspan="3">Provide flow cues to promote increased movement, recruitment and survival/condition of native fish (particularly for floodplain specialists).</td></tr>
</table>

BASIN-WIDE OUTCOMES (Matters in red link to the Basin-wide Environmental Watering Strategy)	OBJECTIVES FOR LOWER MURRAY–DARLING ASSETS						
	IN-CHANNEL ASSETS			END OF SYSTEM	OFF-CHANNEL ASSETS		
	River Murray from Euston to Lower Lakes	Lower Darling River	Great Darling Anabranch	Coorong, Lower Lakes and Murray Mouth	Hattah Lakes	Floodplain and wetlands from Euston to South Australian border	Floodplain and wetlands from South Australian border to Lower Lakes
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 baseflows and increase overall flows in the River Murray. Maintain longitudinal connectivity along the Lower Darling and Murray rivers, including connectivity between the two systems in order to fulfil important environmental functions, such as nutrient and sediment transport, organism dispersal and water quality. Maintain lateral connectivity through contributing to an increase in the frequency of freshes, bankfull and lowland floodplain flows.				Maintain latitudinal connectivity (within constraints) to wetlands and floodplains, by contributing an increase in the frequency of lowland floodplain flows.		
	Improve the connection of the River Murray to the Coorong and the sea, through supporting increased barrage flows and Murray Mouth openness.						
PROCESSES	Increase primary productivity, nutrient and carbon cycling, biotic dispersal and movement. Increase transport of organic matter, salt and nutrients downstream and out the Murray Mouth.						
WATER QUALITY	Maintain water quality and provide refuge habitat from adverse water quality events (e.g. blackwater).			Maintain salinity regimes below critical thresholds for key flora and fauna in the Lower Lakes and Coorong through supporting the export of salt through the Murray Mouth.	Increase mobilisation and export of salt from the River Murray system.		
RESILIENCE	Maintain drought refuge habitat and maintenance/condition of native biota (e.g. fish and other aquatic fauna).						

Information sourced from: MDBA (2014a); Department of the Environment (2011 and unpublished); MDBA (2012a-i); DELWP (2015), Department of Environment, Water and Natural Resources (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.

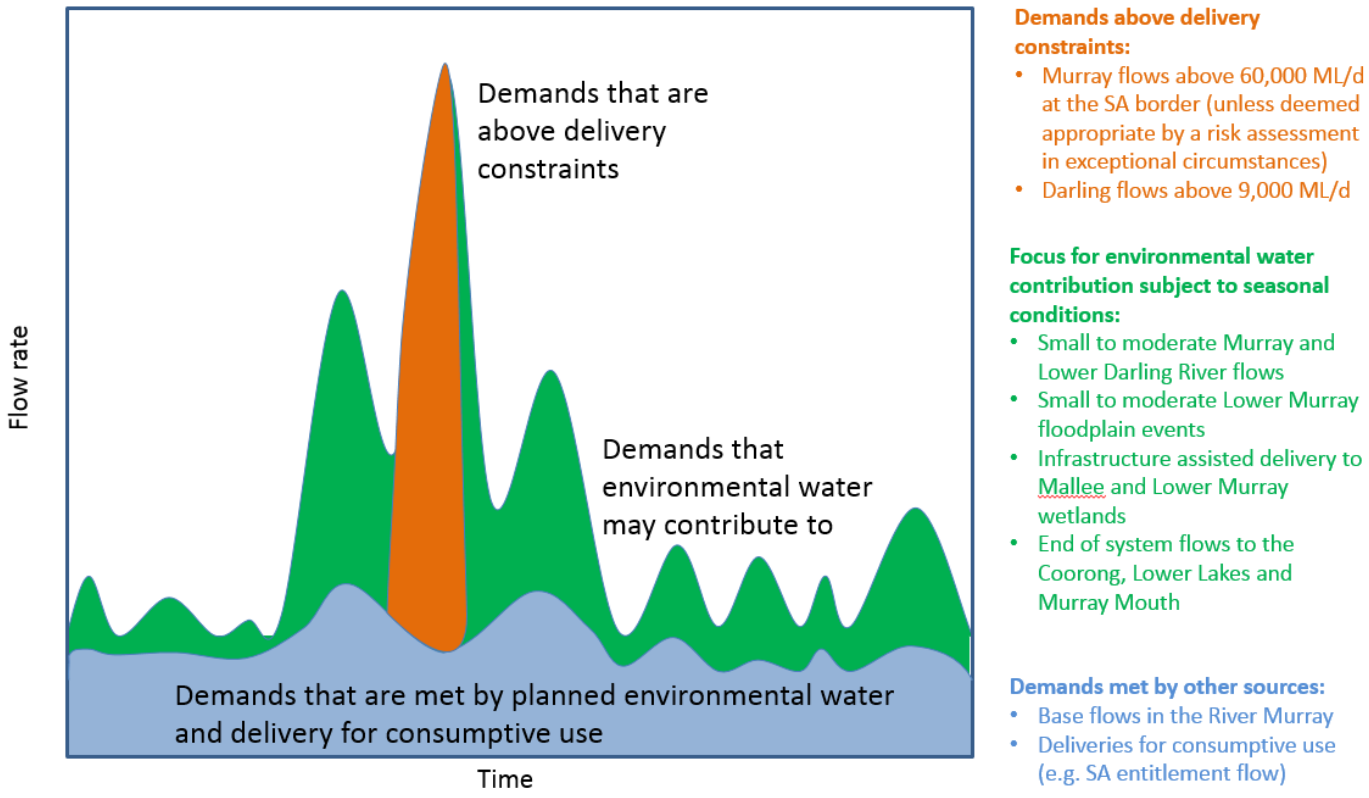

Figure 2: Scope of demands that environmental water may contribute to in the Lower Murray–Darling Region

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.

Lower Darling River

- Monitoring in the Lower Darling River (2016-17 and 2017-18) and the Great Darling Anabranch (2016–17) showed environmental flows were successful in supporting tangible and significant multi-species outcomes for native fish. Where possible, maintaining the function of the Menindee Lakes and Lower Darling River is critical for Murray cod spawning and recruitment, the dispersal and recruitment of golden perch from their nursery grounds in the Menindee Lakes and spawning of golden perch and the nationally threatened silver perch in the LDR (Sharpe, C. Stuart, I. 2018).

Recent findings from monitoring in the Lindsay and Mulcra Island anabranch systems include (Tonkin et.al, 2017):

- The results of Murray cod movement and survival, in response to the natural flooding event and associated hypoxic conditions in November/December 2016, has provided strong evidence for the importance of providing connectivity between the Murray River and anabranch systems. Specifically, it is vital that connectivity is maintained prior to, during and after these events to allow fish to disperse and seek refuge and then return to the anabranch after the event has passed.

- Similar to Murray Cod, the likelihood of Golden Perch transitioning from the Murray River to anabranch systems increased dramatically with small increases in discharge within the anabranch – further highlighting the importance of lateral connectivity.

Key findings and recommendations from the first four years (2014–2018) of the Lower Murray Long Term Intervention Monitoring Project (Ye et al, 2019; Ye et al, 2018; Ye et al, 2017; Ye et al, 2016) include:

- Environmental water has contributed to the export of a significant amount of salt from the Murray Mouth. For example, modelling estimates that Commonwealth environmental water contributed significantly to salt export in the low flow conditions of 2017-18, with 69% of the 349,892 tonnes of salt exported attributed to Commonwealth environmental water. This is the equivalent of over 12,000 semi-trailers each carrying a full load of salt (around 20 tonnes). Reducing salinity levels has benefits for native plants and animals, as well as for stock, domestic and irrigation purposes. Modelling over several years has allowed scientists to provide guidance on the timing of flow delivery with respect to oceanic, tidal and wind conditions to inform strategies for achieving particular outcomes such as water exchange between the Lower Lakes and Coorong, salt export and reducing Coorong salinities.

- Useful 'rules of thumb' for creating more flowing water habitat have been developed. For example, providing water to increase flow from 5,000 ML/day to 10,000 ML/day has a limited influence on flow velocity in the Lower Murray River. Conversely, an increase from 10,000 ML/day to 15,000 ML/day, and again to 20,000 ML/day, substantially increases flowing water habitat. More flowing water benefits native plants and animals (e.g fish) that are adapted to a riverine environment.

- Particularly in dry years, environmental water is critically important in supporting continuous flows through the barrages to the Coorong throughout the year, maintaining a connection between the river and the Coorong estuary to support a functioning river system.

- Environmental water delivered at the end of the 2016 flood event helped to slow the drop-off in water levels, extend the period of connection between the river and floodplain and maintain flowing habitat for fish. For example, over a two to three week period, environmental water kept the river 70–90 cm higher than it otherwise would have been. Also following the flood, environmental water maintained oxygen levels in the Rufus River, during a time when oxygen levels were dangerously low as a result of floodplain material breaking-down in the water at the end of the natural flood. Maintaining oxygen levels in localised areas can provide refuge habitats for aquatic organisms.

- Spawning of golden perch has been detected in several years, both locally and further upstream (with the larvae drifting downstream to South Australia). However, there is no evidence of successful 'recruitment' in the Lower Murray, i.e. survival to juvenile stage, which would have contributed to the broader population. The golden perch population in the Lower Murray is dominated by six to eight year old fish (spawned in the Lower Murray and the Darling), with negligible recruitment in the following five years. More work is needed to understand the specific flow (e.g. timing, magnitude and duration) and habitat requirements of flow-dependant species in order to inform flow management and determine how we can best influence particular ecological outcomes.

- For four consecutive years, small Murray cod have been found in the Lower Murray. This is a promising sign of improving population health of Murray cod.

- Environmental water increases primary production and consumption, and transport of nutrients and phytoplankton in the river channel. Greater primary production provides more food to aquatic food webs (e.g. for invertebrates and fish). Transported food resources from the river also benefit food webs in the Lower Lakes and the Coorong.

- Environmental water has also moved nutrients through the river system. Nutrient inputs are important for aquatic plants and underpin the food chain for animals in the Lower Murray, Lower Lakes, Coorong, and Southern Ocean, adjacent to the Murray Mouth.

- A range of micro-invertebrates (tiny animals that are food for fish) have benefited, with environmental water delivery bringing species from the northern Murray-Darling Basin and other tributaries to the Lower Murray, and transferring them between the river, lakes and wetlands.

- Maintaining the integrity (the physical, chemical and biological aspects) of flow from upstream to the lower River Murray is critical to support system-scale processes and promote positive ecological outcomes.

The environmental outcomes detected by the Long-term Intervention Monitoring (LTIM) project complement the results of other monitoring projects, such as monitoring at the Coorong, Lower Lakes and Murray Mouth through The Living Murray (TLM) program and Short-term Intervention Monitoring (STIM) projects. Some of the outcomes from TLM and STIM monitoring include:

- Water for the environment delivered to the Coorong estuary in spring and summer 2017-18 for black bream breeding was successful, with 100 young-of-year black bream detected in autumn 2018, and good numbers of age 1+ black bream subsequently reported in autumn 2019.

- Pouched lamprey (53 individuals) were detected migrating in association with environmental water released through the fishways and adjacent barrage bays throughout winter and into spring 2017.

Lower numbers of pouched (6) and short-headed lamprey (1) were detected during 2018 monitoring.

- Barrage fishway monitoring detected high numbers of diadromous fish species including congolli and common galaxias, though not as high as in high flow years.

- Some small bodied threatened fish species in the Lower Lakes, such as the Southern pygmy perch are slowly recovering while other species such as the Yarra pygmy perch, have not been detected for a number of years and are now presumed locally extinct.

- The Lower Lakes continue to provide breeding grounds for colonial nesting birds including royal spoonbills, straw-necked ibis and pied cormorants. Pelicans also formed breeding colonies on North Pelican Island in the Coorong South Lagoon. The 2017 annual MDB aerial waterbird survey estimated that the breeding in the Lower Lakes was the largest across the Murray-Darling Basin, and highly important given the widespread dry conditions.

- Conditions in mudflats in the Coorong North Lagoon continue the slow process of recovery, with the highest abundances and diversity recorded at many sites out of all years of sampling. Conditions remain poor in the Coorong South Lagoon sediments with only a very thin layer of habitable conditions in the surface of the sediment profile.

- Filamentous green-algae in the Coorong in 2018-19 has not been observed in large blooms as in previous years.

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.

Lower Darling

Low inflows and very low water levels in the Menindee Lakes saw the Lower Darling River channel (downstream of the Menindee Lakes to the confluence with the Murray River) receive minimal flows in 2014–15 and ceased to flow during 2015–16. Similarly, the anabranch did not receive flows during 2014–15 or 2015–16. This led to detrimental impacts on water quality and native fish populations throughout the Lower Darling region.

Significant flows down the Barwon-Darling and into the Menindee Lakes in 2016 provided an opportunity for environmental releases to both the Lower Darling River channel and the Great Darling Anabranch. In the Lower Darling River, environmental water supported Murray cod spawning in late 2016 with monitoring demonstrating extremely high abundances of drifting larvae in October 2016. Subsequent water releases from the Menindee Lakes through 2017 for consumptive purposes were 'shaped' by ecologists and environmental water managers in collaboration with the river operators (Water NSW and the Murray-Darling Basin Authority (MDBA)) to promote recruitment of these Murray cod young, and to also promote the spawning and dispersal of other large-bodied native fish species such as golden perch and silver perch.

In the Great Darling Anabranch, environmental water releases contributed to positive responses in river red gum and black box vegetation communities fringing the anabranch, and facilitated the successful dispersal of native fish, particularly Golden perch juveniles, from Lake Cawndilla to the anabranch and ultimately to the River Murray(pers comm. P. Brown May 2017). These juveniles, which were spawned in the northern Barwon-Darling catchment during the 2016 flooding event, drifted downstream in flood waters into the Menindee lakes including Lake Cawndilla, from which the Darling anabranch environmental flows were released (pers comm. I. Ellis, May 2018).

Due to dry conditions, there were no flows in the Lower Darling River or the Great Darling Anabranch in 2017–18 or 2018–19 watering years. Significant fish deaths associated with low and cease-to- flows and pool stratification occurred in the Menindee lakes and the Lower Darling River below Weir 32 in 2018–19.

Lower Darling River: There is a critical demand for environmental water in 2019–20. Native fish population studies in past years have demonstrated the importance of the Darling River for providing source populations of golden perch and other species, which then disperse throughout other rivers of the southern-connected Basin (Sharpe, C. 2018; Ye et al, 2017; Zampatti et al, 2015). In light of extensive fish kills during 2018–19, supporting native fish populations in the Lower Darling and preventing deterioration in habitat and water quality, associated with cease-to-flow events, will be of high importance in 2019–20.

Great Darling Anabranch: Following a significant environmental water release down the anabranch in 2016–17 and no flows in 2017–18 and 2018–19, there is a high demand for environmental water in this system for the coming year. The environmental flows released to the anabranch in summer-autumn 2017 generated a range of positive vegetation and water quality outcomes for this asset, and enabled dispersal of thousands of Golden perch juveniles from Lake Cawndilla (pers comms. I. Ellis, May 2018). These fish may otherwise have been stranded in Lake Cawndilla which is expected to dry out without substantial rain in the northern catchment and inflows to the Menindee Lakes. Should substantial inflows to the Menindee Lakes eventuate in winter 2019, there may be an opportunity for environmental flows to the anabranch.

River Murray

Since 2010, three high river flow events provided overbank flooding and a large flow volume to the Lower River Murray (2010-11, 2012-13 and 2016-17). The years between the floods, and since the 2016 flood, have been moderate or dry. Environmental flows during these drier sequences have contributed to in-channel base flows and 'freshes' and enabled extended flow recession following the 2016 flood event to promote downstream transfer of productivity benefits derived from overbank flooding.

While the natural flood in 2016 provided a range of benefits for the environment, the floods also caused a significant hypoxic blackwater event which resulted in large-scale fish kills; particularly for older, large-bodied native fish species. Environmental water was used to mitigate the impacts on native fish populations in small areas where it was feasible. A positive result of the higher flows in 2016 is that there are early indications that river channel specialist fish species (e.g Murray cod, trout cod and catfish) as well as generalist species (e.g. bony herring, Australian smelt and gudgeons) have successfully spawned with evidence for subsequent recruitment (survival to juvenile life stages) in several parts of the southern-connected Basin (pers comms. I. Ellis, May 2018).

Although flow-cued spawning fish species, such as golden and silver perch, are likely to have experienced spawning opportunities from 2014-18 in the southern connected rivers, limited recruitment (survival of young) has been detected to date. More work is needed to understand the specific flow (e.g. timing, magnitude and duration) and habitat requirements of flow-dependant species in order to inform flow management and determine how we can best influence recruitment outcomes.

In the River Murray catchment, natural inundation of many wetlands occurred following a wet May–December 2016. This supported wetland and floodplain vegetation and waterbird populations, and additional environmental water deliveries in 2017–18 were undertaken to consolidate these outcomes.

While environmental water promoted pulses of flow (up to ~40% bank level) in the Lower Murray River during spring–summer 2017–18, the magnitude and duration of these flow pulses were well below modelled flow under natural (pre-regulation) conditions.

River Murray Channel: There is a high demand for environmental water to contribute to in-channel flows for a range of outcomes (including the recovery of native fish by providing flowing habitat, food, flow cues and opportunities for spawning and movement) and where possible to connect the river with low-lying wetlands and floodplain, such as via weir pool manipulation or operation of floodplain regulators where they exist.

The LTIM monitoring team advises that reinstating key features of the natural flow regime in the river channel, such as high, in-channel spring–early summer flow pulses (>20,000 ML/d) will improve river

habitat conditions and should be considered a priority for management. Environmental water holders and jurisdictions are currently preparing a combined channel watering proposal which aims to coordinate releases in the River Murray and tributaries and generate a spring flow pulse in 2019. This proposal will be progressed via the Southern Connected Basin Environmental Watering Committee.

Hattah Lakes: There is a low demand for environmental water for wetlands and river red gum at Hattah Lakes in 2019–20 following watering during 5 of the last 6 years. In 2018-19 no water was delivered as the lakes were in a drying phase. The southern lakes will be dry by November 2019. Lake Kramen has not received water for five years and has been completely dry for two years. There is a moderate demand for water in Lake Kramen to maintain condition of black box woodland and resilience of individual trees (Mallee CMA, 2019).

Floodplain and wetlands from Euston to South Australian border: Many off-channel assets were watered naturally during the 2010–11, 2012 and 2016–17 high river flow events. This was complemented by smaller-scale inundations in 2012–13, 2015–16 and 2017–18 that were assisted by using water regulating infrastructure or pumping. Across this reach there is generally a low demand for environmental water in the coming year. However, there is a moderate to high demand for environmental water in certain permanent wetlands, particularly on those containing habitat for Murray hardyhead or other threatened species. There is a moderate need to maintain aquatic vegetation and water bird habitat in semi-permanent and ephemeral wetlands, with those providing habitat for threatened species, like the Southern Bell Frog, having a higher need to maintain drought refuge.

Floodplain and wetlands from South Australian border to Lower Lakes: Considerable parts of the South Australian Murray floodplain were watered naturally during the 2012 and 2016 high river flow events. Between and following inundation events, priority wetlands have received water via infrastructure to support on-going ecosystem recovery (e.g. use of infrastructure within the Chowilla floodplain and pumping to individual wetland sites). To maintain on-going recovery of vegetation communities and key fauna populations such as Murray hardyhead, there is generally a moderate demand for environmental water in these floodplain wetlands.

Coorong, Lower Lakes and Murray Mouth: Despite generally low flows in recent years, environmental water has contributed to improved conditions in the Lower Lakes and parts of the Coorong. Following unregulated flow conditions in 2016–17, environmental water in 2017-19 provided consistent flows between the Coorong, Lower Lakes and Murray Mouth, maintaining a continuous connection between the river and the estuary and benefiting water quality across the site.

While noting recent improvements, demands in the Coorong remain critical. Barrage flows in 2018-19 were significantly below the 650GL Basin Plan minimum target (to be exceeded 95% of the time). Impacts such as declining water quality, localised algae outbreaks and invertebrate deaths were observed in summer 2018-19. The south lagoon of the Coorong is still showing limited recovery from the Millennium Drought and the future survival of *Ruppia tuberosa* (a keystone aquatic vegetation species at the site) remains at risk due to a lack of successful flowering and seed set. In low flow conditions such as 2018-19, the modest environmental water releases from the barrages are not sufficient to make a significant impact on water levels or salinity in the south lagoon (50+ km away). However, salinity benefits have been observed in the south lagoon following flows from the South East Flows Restoration Project and this project is expected to complement environmental water and make a valuable contribution to Coorong salinity management in dry periods.

Overall there remains a very high demand for environmental water for the Coorong in 2019-20.

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 Lower Murray-Darling 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 resilience of ruppia in the southern Coorong.

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

- Improve the abundance and maintain the diversity of the Basin's waterbird population.
- Maintain the abundance of key shorebird species in the Lower Lakes and Coorong.

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

Coordinate management of the Lower Lakes, Coorong and Murray Mouth to:

- support and build up populations of large–bodied native fish in the southern connected Basin
- supply flows to the Coorong and keep the Lower Lakes above 0.4m
- ensure spring flows reach *Ruppia tuberosa* — an important water plant
- maintain and improve habitat for waterbird breeding and maximise food for shorebirds
- maintain and improve habitat for threatened native fish

2.3. Water availability in 2019–20

Forecasts of Commonwealth water allocations

The volume of Commonwealth environmental water likely to be carried over in Lower Murray-Darling Region for use in 2019–20 is estimated to be between 260-280 GL. Total carryover in the southern-connected Basin is estimated to be 410-430 GL.

Allocations against Commonwealth water entitlements in the Murray and lower Darling catchments are determined by state governments and will vary depending on inflows. The following forecasts in Table 2 are based on the best available information including State forecasts and historical inflow scenarios.

Table 2: Forecasts of Commonwealth water allocations (including carryover) in 2019–20 in the Lower Murray–Darling Region as at 31 May 2018.

Entitlement type	**Forecasts of Commonwealth water allocations (including carryover) in 2019–20 (GL)[1,2]**					
	Very dry ◄					► **Very wet**
	95 percentile	**90 percentile**	**75 percentile**	**50 percentile**	**25 percentile**	**10 percentile**
NSW Murray (High/Conveyance /General security)	31	31	58	148	194	411
NSW lower Darling (High/General security)	6	9	25	25	25	25
Murray[3] (Victorian High/ low reliability)	324	458	513	605	598	594
Murray (South Australian High security)	73	132	150	161	161	161
Total – Murray (includes lower Darling)	**434**	**631**	**746**	**939**	**977**	**1192**
Total – Southern-connected Basin[3]	**543**	**697**	**853**	**928**	**1049**	**1176**

Notes:

1. The southern-connected Basin includes the Murrumbidgee, Murray, Lower Darling, Goulburn, Campaspe (excluding Coliban) and Loddon entitlements.
2. Forecasts for regulated catchments are given to the nearest whole gigalitre except where the entitlement held by the Commonwealth is below 1 GL.
3. Total forecast water available in the southern-connected Basin assumes that in Victoria 100 per cent of water held in spillable accounts becomes available under a median or dry scenario and 50 per cent or less becomes available under wetter scenarios. These figures do not include supplementary, unregulated or ground water accruals in the southern-connected Basin.

Information on allocations to Commonwealth environmental water holdings can be found at http://www.environment.gov.au/water/cewo/portfolio-mgt/holdings-catchment and is updated monthly.

Water resource availability scenarios

Commonwealth environmental water is not managed in isolation. When considering the available resource to meet environmental demands, it is necessary to also factor in the resources managed by other entities and available to contribute to environmental objectives. Relevant resources include portfolios held by NSW

Office of Environment and Heritage, Victorian Environmental Water Holder, Department for Environment and Water (SA), The Living Murray program, the River Murray Increased Flows program, planned environmental water, natural and unregulated flows, conveyance water and consumptive water. Further detail on sources of environmental water in the Lower Murray-Darling 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 resource 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 Lower Murray Region for 2019–20 is to protect the condition of most environmental assets, while seeking to primarily protect and/or avoid damage or decline in the Lower Darling Region.

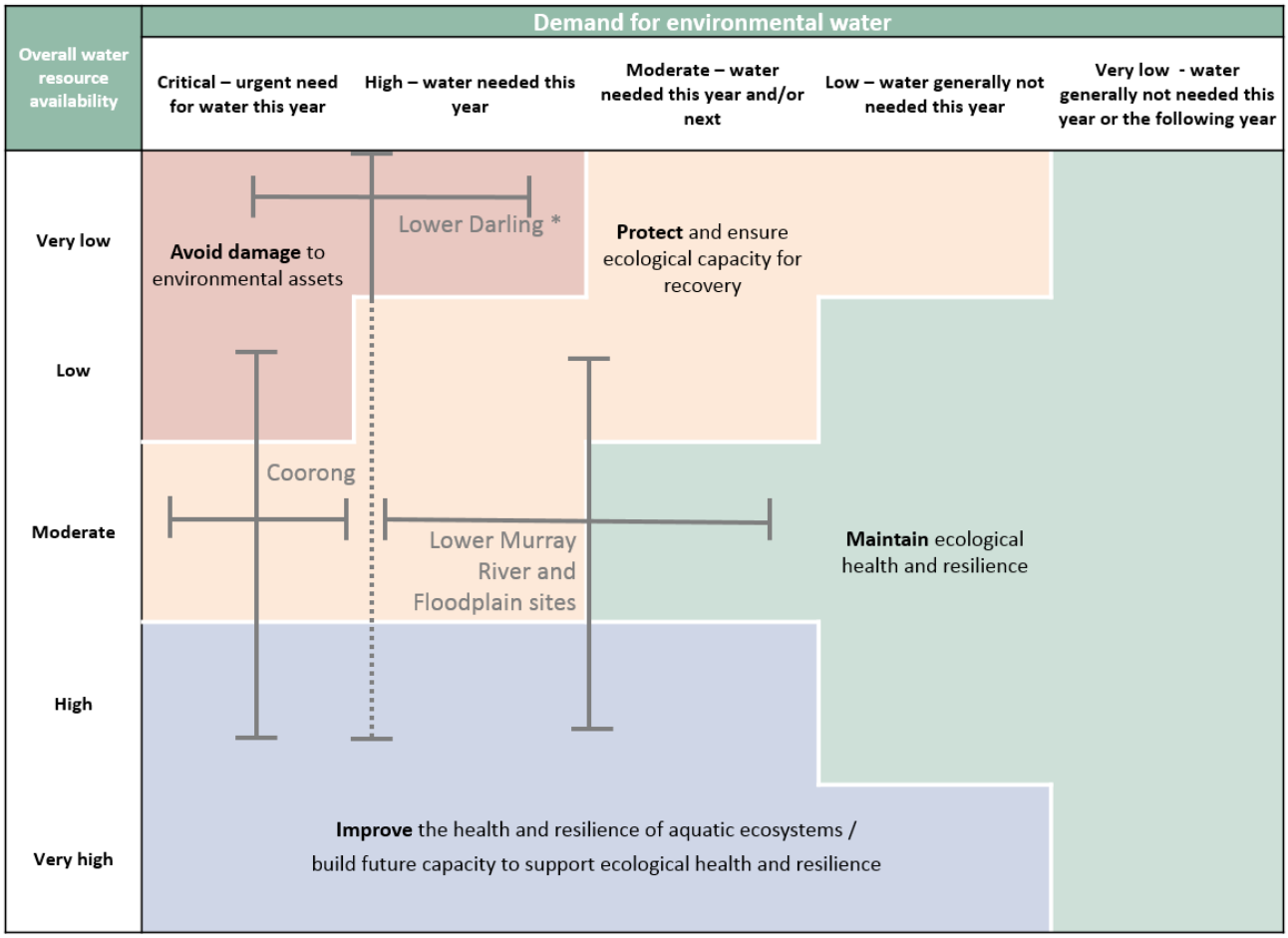

Figure 3: Determining a broad purpose for portfolio management in the Lower Murray–Darling Region for 2019–20. Note: grey lines represent potential range in demand and water resource availability.
(***** Water resource availability displayed is indicative of when Menindee Lakes is under NSW management. If the Lakes return to MDBA control, water resource availability is the same as for the rest of the Lower Murray).

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, 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). These watering actions have been developed drawing from a range of information sources, including environmental demands and potential water availability (described above), watering proposals developed by site managers and discussions via the Southern Connected Basin Environmental Watering Committee.

Lower Darling River and Great Darling Anabranch 2019–20 (See Attachment B, Table 4 options 1 and 2)

The ability for Commonwealth environmental water to be delivered to the Lower Darling River and the Great Darling Anabranch will be dependent on inflows, and subsequent water resource conditions, into the Menindee Lakes in 2019–20. In the absence of inflows, Commonwealth environmental watering in the Lower Darling is unlikely to occur. If available, environmental water use will be prioritised to maintain sufficient baseflows in the Lower Darling River channel to provide critical habitat for native aquatic fauna, in particular large-bodied native fish species that are likely to have recruited in 2016–17 and 2017–18.

Opportunities to provide pulses targeting spawning and dispersal of native fish in the Lower Darling and the Great Darling Anabranch will be considered if water availability significantly improves. The resumption of any releases following a prolonged dry period will also need to include a risk assessment and mitigation regarding the potential for adverse outcomes, associated with environmental flows mixing with poor quality water in the remnant pools in the Lower Darling.

River Murray channel, including weir pool manipulation, fringing wetlands and floodplain sites 2019–20 (Table 4, options 3 to 10)

Environmental water is expected to be delivered as a River Murray 'whole of system' flow in spring 2019–20. 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. Environmental flows moving through the system will be able to be used for other activities such as weir pool raising or drawdown, or delivery to off-channel wetland sites, as long as activities are seasonally appropriate and have considered potential impacts on flow velocities targeted through in-channel pulses. River Murray 'whole of system' flows are planned to be coordinated through the length of the River Murray(with states working together on a whole of River Murray channel plan), and across the southern Basin with actions occurring in the Edward-Wakool, Goulburn, and if conditions improve, the Murrumbidgee and lower Darling catchments to target connectivity and system-wide environmental benefits.

If conditions remain dry and inflow triggers are low, environmental watering will be focused on in-stream watering, such as providing flow variability and connectivity with low-lying anabranches and wetlands for fish movement and condition, and riparian and wetland floodplain vegetation. Larger floodplain events in the Lower River Murray would be out of scope in dry conditions.

If conditions become moderate, a high priority will be to provide appropriate conditions for spawning and recruitment of golden and silver perch, given these species have demonstrated limited recruitment success in the Murray in in recent years. In moderate to wet conditions, environmental water may also be used for modest floodplain watering events (within constraints to avoid adverse third party impacts) for encouraging fish movement between the river channel and wetlands, complete reproductive cycles of important floodplain vegetation communities, completion of waterbird breeding events and overall productivity outcomes utilising carbon stores on low lying floodplain areas.

Where infrastructure or works (such as pumps) are available to support the watering of floodplain wetlands, decisions will be guided by the urgency of the ecological demand and/or natural cues. For example, at sites with low to moderate ecological demands, the contribution of Commonwealth environmental water will be informed by natural hydrological triggers—that is, if the site would have received water under natural conditions, subject to resource availability, water may be contributed to maintain the health of the site.

Where wetlands have high ecological demands (in terms of urgency), such as those still in a recovery phase or maintaining critical populations of threatened species such as Murray hardyhead, regent parrot and southern bell frog, Commonwealth environmental water may be provided in the absence of hydrological cues.

Coorong, Lower Lakes and Murray Mouth 2019–20 (Table 4, option 11)

Under dry conditions, Commonwealth environmental water will be required to maintain minimum flows through the barrages to the Coorong, throughout the year. Over spring-summer, additional environmental water may be used to provide increased flows to the Coorong to improve water quality and target estuarine fish recruitment outcomes.

Commonwealth environmental water delivered to the Lower Murray River (including 'return flows' from upstream watering events) for outcomes in the Coorong will also provide benefits to the Lower Lakes and Murray Mouth region. In winter, return flows from upstream actions may be used to provide attractant flows through the barrages for the migration of diadromous fish between the Lower Lakes and Murray Mouth, and to support lake levels conducive to small-bodied threatened fish survival.

Should natural high flow events eventuate, Commonwealth environmental water may be used to extend the duration of the event to maximise benefits to the Coorong. Where possible, flow regimes and flow integrity will be maintained from the source of delivery throughout the system, which is important for nutrient and biotic material transport and providing migration cues for fish. Should conditions become drier over 2019–20, the contribution of environmental water to achieving the minimum flow requirements throughout the year will become more critical.

Stakeholder Feedback

The demands and watering actions have been developed based on input from and/or consultation with key delivery partners (including: South Australian Department for Environment and Water (including Natural Resource Management Boards), 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, a number of non-government, irrigation, community and traditional owner organisations, scientists engaged in monitoring the outcomes of Commonwealth environmental water use and various other community groups and individuals). A range 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 Commonwealth Environmental Water Holder 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 Commonwealth environmental water accounts in trade zones 6, 7, 11, 12 and 14 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 (~20 GL) within lower Murray 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 or between trade zones below the choke, due to the large size of environmental watering activities.

No specific commercial trade of water in the Lower Murray-Darling 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 minimum demands in 2020–21 include baseflows in the River Murray; minimum water levels in the Lower Lakes to support water quality, habitat for threatened fish species and ongoing barrage releases into the Coorong; along with maintaining critical refuge at wetland sites that support threatened species. As water availability improves, the scale of watering actions and scope of environmental outcomes that may be achieved will increase.

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 Lower Murray-Darling.

More information on how the Commonwealth makes decisions on carryover is here: 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 Lower Murray-Darling 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
Lower Darling River[1] **· Native fish spawning** **· Only connection between Northern and Southern Basin**	Elevated baseflows above minimum releases through to River Murray for water quality and fish habitat requirements (400 ML/d at Weir 32).	Continuous (if limited water, focus on baseflows during spring, summer and autumn).	Very low and cease-to-flow conditions in 2014-15 and 2015-16. Small to moderate River pulse achieved in 2016-17 and baseflows maintained mostly in 2017-18. Cease to flow in 2018–19. Therefore the environmental water demand has been assessed as High.	Critical	Unlikely to receive Commonwealth environmental water due to limited resource availability, and potential delivery constraints in consideration of low lying infrastructure.	Critical
	Small to moderate river pulse (up to 7000 ML/d at Weir 32 for 10 days in summer)	1-2 in 5 years (max interval unknown)				High
Great Darling Anabranch[2]	~1100 ML/day from Menindee Lakes for ~60+ days	2 in 10 years (7 years)	A significant watering event occurred in 2016-17, allowing for dispersal of large bodied native fish and improved water quality and vegetation condition.	High	Low priority for Commonwealth environmental water. Lower Darling is a higher priority, particularly given a very low to low resource availability forecast for 2019-20.	High
River Murray from Euston to Lower Lakes, including pool level wetlands[3]	Elevated river baseflow of at least 10,000 ML/d @ SA Border for up to 60 days in spring/summer for in-channel aquatic vegetation, fish and water quality.	9 in 10 years (2 years)	All indicators met in 2012-13 and 2016-17 (the two recent floods). The years following the floods (2013-14 and 2017-18) also saw high baseflows and moderate freshes. The drier years (2014-15, 2015-16 and 2018-19) saw contributions only to the baseflows. All indicators have a high demand for 2019-20	High	A very high priority for watering in 2019–20, even in low resource availability.	High
	Moderate fresh of 15,000-25,000 ML/day SA Border for up to 90 days in spring/summer for perch spawning and survival and other ecological benefits.	2 in 3 years (2 years)			A very high priority for watering in 2019–20, noting that at least moderate resource availability (and potentially multiple water holder contributions) would be required and the full 90 day duration may be challenging.	Moderate
	Large fresh of 25,000-35,000 ML/day @ SA Border for up to 60 days in spring/summer for fish populations and other in-channel biota.	1 in 2 years (3 years)			High resource availability and tributary inflows would be required to deliver flows of this magnitude	Moderate
Hattah Lakes[4] **· Ramsar site**	Small action targeting temporary wetlands (inundation to 42-43 m AHD in winter/spring) - up to 22,000 ML via infrastructure equivalent to natural event of 40,000-50,000 ML/day at Euston for 26-60 days.	1 in 2-3 years (4 years)	All indicators met in 2016-17 (flood). Environmental water also delivered to 44.85 m AHD in 2017-18 to consolidate outcomes achieved from 2016-17 flood event. Following Hattah Lakes receiving water 5 of	Moderate	Environmental needs likely to be met by other sources of environmental water.	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
	Moderate action targeting wetlands and fringing river red gums (inundation to 43.5 m AHD for 90 days in winter/spring) - up to 40,000 ML via infrastructure equivalent to natural event of 85,000 ML/day at Euston for 7-30 days.	1 in 3 years (7 years)	the last 6 years, the floodplain and lakes needed time to dry.	Moderate	Only likely to be delivered under moderate to high water resource availability	Moderate
	Large event targeting wetland and river red gum/black box woodlands on floodplain (inundation to 45 m AHD for 90 days) - up to 120,000 ML via infrastructure equivalent to natural event of 150,000 ML/day at Euston for 7 days anytime in the year.	1 in 8 years (12 years)		Low	Only likely to be delivered after a large natural overbank flow event	Low
Floodplain and wetlands from Euston to South Australian border	30,000 ML/day at Lock 8 for 30-60 days targeting low lying wetlands and anabranches, or priority areas via infrastructure.	2 in 5 years (4 years)	All indicators met in 2016-17 (flood). Environmental water also delivered to targeted wetland sites in 2017-18 and 2018–19 across a range of floodplain elevation levels. Therefore the environmental water demand has been assessed as moderate for small to medium overbank flows and low for larger overbank flows.	Moderate	Commonwealth environmental water is able to contribute to overbank flows only in high resource availability years with significant tributary inflows. Water is likely to be delivered to priority wetland sites via infrastructure.	Moderate
	50,000-60,000 ML/day at Lock 8 for 60-120 days targeting river red gum forest, lignum shrubland and associated wetlands, or priority areas via infrastructure.	1 in 5 years (5 years)		Low		Low
Floodplain and wetlands from South Australian border to Lower Lakes[6]	Small overbank flow of 40,000-50,000 ML/day @ South Australian border for at least 30 days targeting river red gum forest, tea tree, lignum, river cooba and associated wetlands, or priority areas via infrastructure	1 in 2 years (3 years)	Indicators were last met in 2016-17 (flood), with small overbank flow also achieved via the 2012-13 flood. Environmental water also delivered to targeted wetland sites each year, across all floodplain elevation levels. A moderate to high demand for overbank flows in 2019-20.	High	While all indicators are due or overdue to be met, Commonwealth environmental water is able to contribute to overbank flows only in high resource availability years with significant tributary inflows. Water is likely to be delivered to priority wetland sites via infrastructure.	Moderate
	Moderate overbank flow of 50,000-60,000 ML/day @ South Australian border for at least 30 days targeting river red gum forest, tea tree, lignum, river cooba and associated wetlands, or priority areas via infrastructure	1 in 2 years (5 years)		Moderate		Low
	Infrastructure delivery to a priority area equivalent to 60,000-70,000 ML/day @ South Australian border targeting black box, cooba, lignum and chenopod and associated wetlands.	1 in 3 years (4 years)				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
Coorong, Lower Lakes and Murray Mouth[7] **· Ramsar site**	Minimum barrage flow of 650 GL/yr to provide suitable conditions and refuge habitat in the north lagoon for native fish, plants and internationally important migratory birds	1 in 1 year	Lower Lakes and Coorong north lagoon in generally good condition, with some impacts of decline in the north lagoon due to two successive low-flow years (invertebrate deaths, localised algae outbreaks). Coorong south lagoon still in poor health and is a priority asset for Commonwealth environmental water, noting that Commonwealth environmental water can only have an impact in high resource availability years in which sufficiently high barrage outflows are provided to reach the south lagoon. Minimum flow (1 in 1 year) was not met in 2015-16 or 2018-19. Large unregulated flow events in 2010-11 (15,000+ GL), 2012-13 (6797 GL) and 2016-17 (6484 GL).	Critical	A very high priority for watering in 2019–20, even in low resource availability.	Very High
	Barrage flows of 2000 GL/yr required to provide suitable conditions and refuge habitat for native fish, plants and internationally important migratory birds	Rolling three year average		Very High	A high priority for watering in 2019–20, even in low resource availability, noting that due to low outflows in 2017-18 and 2018-19, >4500GL would be required to meet this target in 2019-20. Commonwealth water likely to contribute significantly, however target cannot be met by Commonwealth water alone.	Very High
	Barrage flows of 6000 GL every three to five years to maintain and improve habitat conditions within the Coorong	1 in 3 years (5 years)		Moderate (met in 2016-17)	Commonwealth water will contribute to meeting this demand (see above), however the volumes required make it unlikely that Commonwealth water alone would meet these indicators.	Low
	Barrage flows of 10,000 GL every seven to seventeen years to improve habitat conditions within the Coorong	1 in 7 years (17 years)		Moderate (met in 2010-11)		Low
				Carryover potential	The volume of Commonwealth environmental water likely to be carried over in Lower Murray-Darling 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.
				Trade potential	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. It is likely that insufficient water resources in Menindee Lakes will be a major constraint on achieving proposed actions in the Lower Darling. It is unlikely to be feasible for the Commonwealth to purchase or transfer allocations into the Lower Darling. 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.	Potential to trade will depend on environmental demands, resource availability and market conditions.

1. Lower Darling indicators sourced from MDBA (2012b); DPI Fisheries (2016)
2. Great Darling Anabranch indicators sourced from Nias (2002)
3. River Murray Channel indicators sourced from Wallace et al. (2014), Ecological Associates (2015), Ecological Associates (2010), DEWNR (2015) and MDBA (2012(j))
4. Hattah Lakes indicators sourced from MDBA (2012g), (2012j); Roberts and Marston (2011).
5. Floodplain from Euston to SA indicators sourced from MDBA (2012c): 40 000 ML/day for 45-60 days or 50 000 ML/day for 26-45 days. Total duration of natural flows can include multiple discreet flow pulses above 40-50 000 ML/day with a minimum duration of individual pulses of 7 days.
6. Floodplain from SA to Lower Lakes indicators sourced from MDBA (2014b), MDBA (2012h) and DEWNR (2015)
7. Coorong, Lower Lakes and Murray Mouth indicators sourced from MDBA (2012i) and DEWNR (2015)
8. Electrical Conductivity (EC) as a measure of salinity

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

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.

A key aspect of planning and implementing watering actions in the Lower Murray-Darling region is the opportunity for coordinating watering actions between the River Murray and key tributaries to maximise environmental benefits. Development of a coordinated River Murray Channel proposal and discussions via the Southern Connected Basin Environmental Watering Committee are key to allowing these opportunities to be realised.

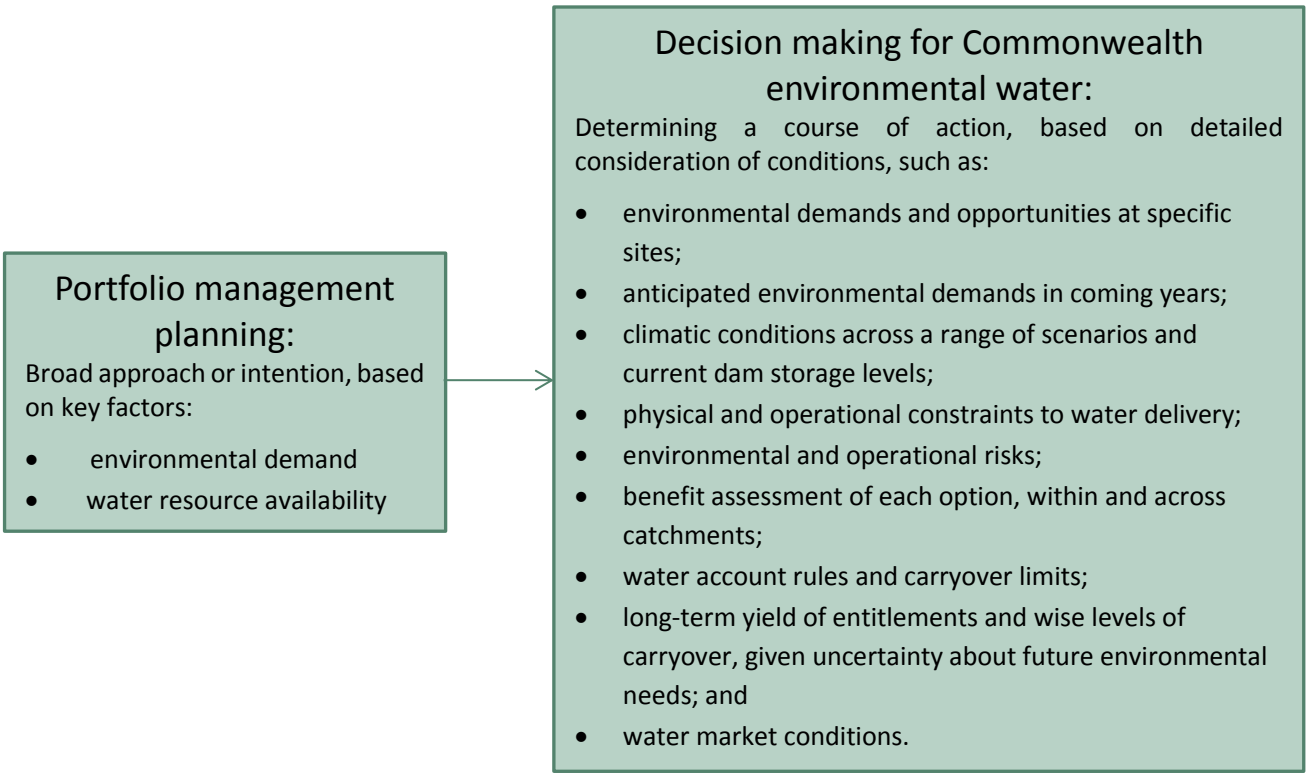

Figure 4: Planning and decision making for Commonwealth environmental water use

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 Lower Murray and Goulburn regions as focus areas. 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.

Information on the monitoring activities is available at http://www.environment.gov.au/water/cewo/catchment/lower-murray-darling/monitoring and http://www.environment.gov.au/water/cewo/catchment/northern-victorian-rivers/monitoring.

Monitoring information is also provided by state governments and The Living Murray program.

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 2014a) that are relevant to the Lower Murray-Darling Region are described below.

RIVER FLOWS AND CONNECTIVITY

Baseflows are at least 60 per cent of the natural level.

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

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

A 30 to 40 per cent increase in flows to the Murray mouth.

Along with local management, improve the connection of the river to its estuary (the Coorong) and to the sea. The minimum outcomes expected are:

- the barrage flows are greater than 2000 GL/year on a three-year rolling average basis for 95 per cent of the time, with a two year minimum of 600 GL at any time
- the water levels in the Lower Lakes are maintained above sea level (0 m AHD) and for 95 per cent of the time, above 0.4 metres AHD, as far as practicable, to allow for barrage releases
- salinity in the Coorong and Lower Lakes remains below critical thresholds for key flora and fauna including: salinity in Lake Alexandrina is lower than 1000 EC 95 per cent of the time and less than 1500 EC all the time; salinity in the Coorong's south lagoon is less than 100 grams per litre 95 per cent of the time
- the Murray mouth is open 90 per cent of the time to an average annual depth of one metre.

VEGETATION (Note: figures are for total Murray catchment)

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 Murray.

A sustained and adequate population of *Ruppia tuberosa* in the south lagoon of the Coorong, including:

- by 2019, *R. tuberosa* to occur in at least 80 per cent of sites across at least a 50 km extent
- by 2029, the seed bank to be sufficient for the population to be resilient to major disturbances.

Vegetation extent

Region	Area (ha)			Shrublands	Non–woody water dependent vegetation
	River red gum	Black box	Coolibah		
Murray (assessment is for entire Murray catchment)	90,600*	41,700*	-	Lignum along the Murray River from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes	Closely fringing or occurring within the Murray *Ruppia tuberosa* in the Coorong

Region	Area (ha)			Shrublands	Non–woody water dependent vegetation
	River red gum	Black box	Coolibah		
Lower Darling	10,300	38,600		Lignum swamps in the Lower Darling region	Closely fringing or occurring within the Darling River and Great Darling Anabranch

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%	65%	28%
Lower Darling	72%	28%	85%

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%	1%	10%	51%	35%	51%
Lower Darling	11%	5%	7%	41%	35%	92%

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.

By 2019, at a minimum, to maintain populations in the Coorong, Lakes Albert and Alexandrina of the following four key species: curlew sandpiper, greenshank, red-necked stint and sharp-tailed sandpiper, at levels recorded between 2000 and 2014.

Important Basin environmental assets for waterbirds in the Lower Murray

Environmental asset	Total abundance and diversity	Drought refuge	Colonial waterbird breeding	Shorebird abundance	In scope for C'th watering
Coorong, Lower Lakes and Murray Mouth	*		*	*	Yes
Pyap Lagoon		*			No
Noora evaporation Basin	*				No
Lindsay–Wallpolla–Chowilla	*				Yes
Hattah Lakes			*		Yes
Darling Anabranch	*				Yes
River Murray and Euston Lakes		*			Yes
Kerang Wetlands	*		*		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.

For estuarine species – additional outcomes are:

- detection of all estuarine-dependent fish families throughout 2014–2024
- maintenance of annual population abundance (Catch Per Unit Effort – CPUE) of key estuarine prey species (sandy sprat and small-mouthed hardyhead) throughout the Coorong
- detection of a broad spatial distribution of black bream and greenback flounder; with adult black bream and all life stages of greenback flounder present across >50 per cent of the Coorong in eight out of 10 years
- detection in nine out of 10 years of bi-directional seasonal movements of diadromous species through the barrages and fishways between the Lower Lakes and Coorong
- increased rates of native fish passage in 2019–2024 compared to 2014–2019
- improved population structure of mulloway, including spawning aggregations at the Murray mouth in six out of 10 years and recruitment in at least five out of 10 years.

Specific outcomes for key species for the Lower Murray include:

Species	Specific outcomes	In-scope for C'th watering?
Diadromous species (Congolli, Common galaxias, short-headed and pouched lamprey)	Upstream expansion facilitated through flows to operate fishways	Yes
Estuarine species (Small-mouthed hardyhead, sandy sprat, black bream and greenback flounder)	Increased population resilience as a result of more diverse population structure	Yes
Flathead galaxias (*Galaxias rostratus*)	Expand the core range in the wetlands of the River Murray	Yes
Freshwater catfish (*Tandanus tandanus*)	-	Yes
Golden perch (*Macquaria ambigua*)	A 10–15 per cent increase of mature fish (of legal take size) in key populations	Yes
Murray cod (*Maccullochella peelii peelii*)	A 10–15 per cent increase of mature fish (of legal take size) in key populations	Yes
Murray hardyhead (*Craterocephalus fluviatilis*)	Expand the range of at least two current populations: Establish 3–4 additional populations, with at least two of these to be within the lower Murray conservation unit and a further population potentially within the Kerang Lakes region	Yes
Olive perchlet (*Ambassis agassizii*)	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
Silver perch (*Bidyanus bidyanus*)	Improve core range in at additional locations, with candidate sites including lower Darling	Core range is within Mid-Murray region. Only in scope if additional populations are established
Southern purple-spotted gudgeon (*Mogurnda adspersa*)	Expand the range of current populations (including Jury Swamp)	Yes
Southern pygmy perch (*Nannoperca australis*)	Establish additional populations in the Lower Lakes	Only if additional populations are established
Trout cod (*Maccullochella macquariensis*)	For the connected population of the Murrumbidgee–Murray–Edwards, continue downstream expansion	Yes
Two-spined blackfish (*Gadopsis bispinosus*)	Establish additional populations (no specific locations identified)	Yes
Yarra pygmy perch (*Nannoperca obscura*)	Expand the range of current populations including the Lower Lakes/Coorong region	Yes

Important Basin environmental assets for native fish in the Lower 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 watering?
Coorong, Lower Lakes and Murray Mouth	*	*	*		*	*	Yes
Swamps on the lower Murray channel, between Wellington and Mannum (swamp geomorphic region		*			*		Yes
Kerang lakes					*	*	Yes
Katarapko anabranch	*			*			Yes
Pike anabranch	*			*			Yes
Lower River Murray main channel (from Darling junction downstream)	*	*	*		*	*	Yes
Murray main channel (from Hume dam to Darling junction)	*	*	*	*	*	*	Yes
Chowilla anabranch	*	*	*	*	*	*	Yes
Lindsay–Wallpolla–Mullaroo Creek	*	*	*	*	*	*	Yes
Lower Darling main channel	*	*	*	*	*	*	Yes
Darling anabranch			*			*	Yes
Hattah Lakes			*			*	Yes
Euston Lakes (including Washpen and Taila Creeks)					*		Yes

Attachment B – Operational details for watering

Operational considerations in the Lower Murray-Darling Region

The delivery of environmental water in the Lower Murray–Darling is currently constrained by the following:

- Menindee Lakes are managed by New South Wales when storage levels fall below 480 GL. During this period stored water is used to supply essential stock and domestic water to local Menindee and Lower Darling River communities. Control over the Lakes reverts to Murray–Darling Basin Authority once storage levels increase to above 640 GL.
- Flows greater than 60,000 ML/day result in overbank inundation of floodplain throughout the lower River Murray, including the inundation of privately owned land and private infrastructure. The risk of impacting on public and private infrastructure through the use of environmental water requires further investigation prior to environmental water being used to target these higher flow rates. Flow rates of this magnitude may be considered in exceptional circumstances and subject to appropriate risk assessment.
- Operational and physical constraints in upstream catchment areas may potentially limit the delivery of environmental water in the lower River Murray. Environmental operations in the lower River Murray will need to remain flexible and complement the timing of upstream flows.

Further information about constraints in the Lower Murray–Darling Region is provided by the MDBA, and can be found in the *Constraints Management Strategy 2013 to 2024* (MDBA 2013).

Operational considerations such as delivery methods, opportunities, physical constraints and risks will differ depending on inflows and are summarised in Table 4. Constraints as they relate to specific watering options are described in the standard operating considerations listed in section 3.6 below.

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 Lower Murray- Darling region and the levels of water resource availability that relate to these actions.

Table 4: Summary of potential watering actions for the Lower Murray-Darling Region

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Lower Darling River	Small to moderate river flow (7000 ML/day at Weir 32 for 10 days in summer)			1. *Lower Darling River flows:* Contribute to base flows and freshes in the Lower Darling River.		
Great Darling Anabranch	500 – 1500 ML/day from Menindee Lakes for 30 – 60 days			2. *Great Darling Anabranch Flows:* Contribute to a flow along the Anabranch, or extend the recession from a flood event and/or connect the Anabranch with main River channel and/or Lakes.		
River Murray channel from Euston to Lower Lakes, including fringing wetlands	River flow of at least 10,000 ML/day at SA border for up to 60 days in spring/summer River flow of 15,000-25,0000 ML/day @ SA border for up to 90 days in spring/summer River flow of 25,000-35,0000 ML/day @ SA border for up to 60 days in spring/summer	3. *River Murray Channel Flows:* Contribute to in-channel base flows and freshes, complemented by seasonally appropriate operation of river (weirs) and wetland infrastructure.				
Hattah Lakes	Small action targeting temporary wetlands (inundation to 42-43 m AHD in winter/spring) - up to 15,000 ML via infrastructure, equivalent to natural event of 40-50,000 ML/day at Euston for 26-60 days Large action targeting wetlands and river red gum/black box woodlands on floodplain (inundation to 45 m AHD for 90 days), up to120,000 ML via infrastructure - equivalent to natural event of 150,000 ML/day @ Euston for 7 days anytime in the year.	4a. *Infrastructure Delivery:* Low-lying Wetlands: Contribute flows via pumping to inundate wetlands and waterways within the Hattah Lakes system.				
				4b. *Infrastructure Delivery:* Contribute flows via pumping targeting black box woodland on higher level elevations.		

<table>
<tr><th rowspan="2">Broad Asset</th><th rowspan="2">Indicative demand</th><th colspan="5">Applicable level(s) of resource availability</th></tr>
<tr><th>Very Low</th><th>Low</th><th>Moderate</th><th>High</th><th>Very High</th></tr>
<tr><td rowspan="3">Floodplain and wetlands from Euston to South Australian border</td><td rowspan="3">30,000 ML/day @ Lock 8 for 30-60 days targeting low lying wetlands and anabranches, or portion via infrastructure

50,000-60,000 ML/day @ Lock 8 for 60-120 days targeting river red gum forest, lignum shrubland and associated wetlands, or portion via infrastructure

Infrastructure delivery to a portion equivalent to 80,000 ML/d @ Lock 8 targeting river red gum and black box woodland and associated wetlands</td><td colspan="5">5 Delivery via Lindsay-Mulcra-Wallpolla Floodplain works: Contribute flows via works to inundate low lying wetlands and anabranches, river red gum forest and/or black box woodland.</td></tr>
<tr><td colspan="5">6. Infrastructure Delivery: Mallee Wetlands: Contribute flows via wetland regulators and/or pumping to inundate semi-permanent, temporary and ephemeral wetlands</td></tr>
<tr><td colspan="2"></td><td colspan="3">7. Contribution to Overbank Flows: Contribute to flows to reconnect river with river red gum forest and lignum shrubland, subject to appropriate trigger</td></tr>
<tr><td rowspan="3">Floodplain and wetlands from South Australian border to Lower Lakes</td><td rowspan="3">40,000 – 50,000 ML/day @ South Australian border for at least 30 days targeting river red gum forest, tea tree, lignum, river cooba and associated wetlands, or priority areas via infrastructure

50,000 -60,000 ML/day @ South Australian border for at least 30 days targeting river red gum forest, tea tree, lignum, river cooba and associated wetlands, or priority areas via infrastructure

Infrastructure delivery to a priority area equivalent to 60 – 70,000 ML/day @ South Australian border targeting black box, cooba, lignum and chenopod and associated wetlands</td><td></td><td colspan="3">8. Infrastructure Delivery: Chowilla Floodplain: Use Chowilla Floodplain infrastructure to deliver pulse flows to creeks and inundate parts of the floodplain</td><td></td></tr>
<tr><td colspan="5">9. Infrastructure Delivery: Lower Murray Wetlands: Contribute flows via wetland regulators, pumping and/or weir pool manipulation to inundate semi-permanent, temporary and ephemeral wetlands</td></tr>
<tr><td colspan="3">10a. Contribution to weir pool raising and lowering: Contribute to weirpool manipulation events to increase diversity in hydrology and connect the river with low-lying floodplain, subject to appropriate trigger</td><td colspan="2">10b. Contribution to Overbank Flows: Contribute to flows to re-connect river with river red gum forest and lignum shrubland, subject to appropriate trigger and risk assessment</td></tr>
</table>

Broad Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Coorong Lower Lakes and Murray Mouth	Minimum barrage flow of 650 GL/yr Barrage flows of 2000 GL/yr required to achieve salinity target in Lake Alexandrina	*11a. Seasonal Lake Level Variation:* Between 0.40 m AHD and 0.80 m AHD annually. *Fishway Flows*: Maintain minimum fishway flows *Barrage releases*: To provide for connectivity between the Coorong, Lower Lakes and the Murray Mouth, improve Coorong water quality and maintain suitable estuarine conditions in the North lagoon and Murray Mouth				
	Barrage flows of 6000 GL/yr every three years to maintain and improve habitat conditions within the Coorong. Barrage flows of 10,000 GL every seven years to improve habitat conditions within the Coorong			*11b. Seasonal Lake Level Variation*: Between 0.50 m AHD and 0.85 m AHD one in three years *Fishway Flows*: Maintain minimum fishway flows *Barrage releases*: To provide for seasonally appropriate water levels in the Coorong and connectivity between the Lower Lakes and the Murray Mouth		

Potential watering actions – standard operating arrangements

Table 4 identifies the range of potential watering actions in the Lower Murray-Darling region of 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 1: Lower Darling River flows

Standard operational considerations

Commonwealth environmental water may be provided to contribute to baseflows and freshes in the Lower Darling River or to contribute water to the recession of higher flow events in this system and in the River Murray. The contribution of environmental water to augment high River Murray flows will have regard to other operational releases, storage management and delivery arrangements.

The magnitude, duration and timing of environmental releases will be dependent on available environmental water allocations within the water resource area and guided by natural flow cues upstream of the Menindee Lakes.

When Menindee Lakes storage levels are low (<480 GL) resources within the lakes are managed by New South Wales for critical human needs. Under these conditions options for environmental watering are likely to be limited. Addtionally, there are some low lying bridges that are subject to inundation at flows above ~2,000 ML/d.

Watering action 2: Great Darling Anabranch flows

Standard operational considerations

Commonwealth environmental water may be provided to contribute to baseflows and freshes in the Great Darling Anabranch, providing connectivity between the anabranch channel and the River Murray, and between the anabranch and its lakes.

Planning the timing and magnitude of watering actions needs to consider risks associated with water quality and potential adverse environmental impacts. Delivery channel capacity limitations and potential third party impacts may limit flows to the anabranch channel.

Operational considerations as for Watering action 1.

Typical extent: Anabranch channel from Lake Cawndilla (via Tandou Creek, Packer's Crossing Regulator and Redbank Creek) to the confluence with River Murray.

Watering action 3: River Murray channel flows

Standard operational considerations

Environmental water will contribute to providing higher base flows and freshes to support in-stream aquatic communities (for example, native fish spawning and recruitment), increase the export of salt and nutrients, contribute to hydrological connectivity with fringing wetlands and support habitat conditions within the Coorong and Lower Lakes.

Benefits that can be achieved from environmental flows within the river channel can be enhanced through the seasonally appropriate operation of river, wetland and floodplain infrastructure. Complementary operations may include the manipulation of weir pools, wetland regulators and barrage operations.

This action would typically source water from upstream storages and tributaries, subject to operational feasibility and opportunities to achieve multiple benefits using Commonwealth environmental water across the southern-connected Basin, and may require alignment of the timing of releases from multiple sources.

Watering actions 4: Infrastructure Delivery to Hattah Lakes

Standard operational considerations

The pump station supplying water to the Hattah Lakes and Lake Kramen only operates when the River Murray water level is greater than 38.3 m AHD (above 5000 ML/day at Euston). Any impending or ongoing pumping into the Hattah complex would need to be postponed or suspended if River Murray water levels fall below this limit.

The recently commissioned environmental works (i.e. pumping infrastructure) can acheive a maximum inundation of 45 m AHD. Any inundation beyond this level would need to be via natural flooding.

Return flows from Hattah Lakes to the River Murray can be faciliated via two regulators located on north and south Chalka Creeks. Adaptive management of return flows will be important to maintain acceptable water quality in Hattah Lakes and provide additional environmental benefit downstream.

Typical extent: Infrastructure allows for simulated natural watering actions of higher magntiude, requiring lower volumes of environmental flow contribution. Small scale temporary wetland inundation to 42-43 m AHD in winter/spring requiring up to 22,000 ML is possible via infrastructure, equivalent to a natural event of 40,000-50,000 ML/day at Euston for 26-60 days. Moderate inundation targeting wetlands and fringing river red gums with inundation to 43.5 m AHD for 90 days in winter/spring requiring up to 40,000 ML is possible via infrastructure, equivalent to a natural event of 85,000 ML/day at Euston for 30 days. Large-scale inundation targeting wetlands and river red gum/black box woodlands on the floodplain with inundation to 45 m AHD for 90 days, requiring up to120,000 ML is possible via infrastructure, equivalent to a natural event of 150,000 ML/day at Euston for 7 days anytime in the year.

Watering action 5: Delivery via Lindsay-Mulcra-Wallpolla Floodplain works

Standard operational considerations

In addition to large floods (via high River Murray flows influenced by upper Murray tributaries and flows in the Darling River), permanent infrastructure, weir pool manipulation and temporary pumping can facilitate delivery of environmental water to Lindsay, Mulcra and Wallpolla islands.

Specific flow rates and weir pool levels in the River Murray are required to facilitate environmental watering to Lindsay, Mulcra and Wallpolla islands.

Some floodplain wetland watering may occur in conjunction with weir pool manipulation to provide wetland inundation in conjunction with higher river water levels and to contribute to fast flowing fish habitat.

Typical extent: Lindsay Island - to provide flowing water habitat for fish spawning, winter/spring freshening flows to Lindsay River and Mullaroo Creek would be accomplished by targeting a raising of Lock 7 up to 500 mm above normal operating height during winter. *Wallpolla Island* - to promote wetland condition and aquatic plant diversity, spring inundation of Wallpolla Horseshoe and Finnigans Creek would be accomplished by targeting a raising of Lock 9 up to 500 mm above normal operating height and provision of inflows during September to October. *Mulcra Island* - to restore linkages between river and floodplain habitats, and support lignum communities, winter inundation of Mulcra Island would be accomplished by surcharging Lock 8 up to 800 mm above full supply level during July to August.

Watering actions 6 and 9: Infrastructure Delivery: Mallee Wetlands and Lower Murray Wetlands

Standard operational considerations

Commonwealth environmental water is delivered to wetlands in the New South Wales and Victorian Mallee in partnership with a number of government, non-government, irrigation, community and traditional owner organisations.

Key operational considerations include the infrastructure required to deliver water, access arrangements, required approvals and delivery costs (i.e. cost effectiveness).

Watering may be in conjunction with weir pool manipulation to provide wetland inundation in conjunction with higher river water levels and to contribute to fast flowing fish habitat.

Drying cycles are a natural characteristic of floodplain wetlands along the River Murray. The watering of wetlands may be undertaken in relation to seasonal conditions.

Saline water discharged from Mallee sites will need to be carefully monitored as per the water quality and salinity management plan (Basin Plan Chapter 9) and any potential adverse impacts on river water quality mitigated by coordination with adequate dilution flows in the River Murray (including possibly from other environmental watering actions). The Murray–Darling Basin Authority has salinity forecasting tools available to assist.

Acid sulphate soils and potential groundwater influences are important considerations.

Typical extent: Individual wetland sites in the Mallee region and from the South Australian border to and adjoining the Lower Lakes.

Watering actions 7 and 10b: Contribution to Overbank Flows (within constraints)

Standard operational considerations

Environmental water may contribute to flows to connect the River Murray with areas of floodplain (subject to flow constraints at Figure 3). Elevated natural flows are required for environmental water to piggy-back on and resource availability may be a limiting factor.

Environmental water delivery may be constrained by other demands on the system, especially during periods of limited channel capacity, and the ability to release and coordinate flows from multiple storages.

This option will be managed by river operators to avoid unacceptable impacts on land managers and other water users.

Typical extent: Low lying parts of the lower River Murray floodplain that can be inundated by managed flows and that do not create unacceptable third party impacts. Overbank flow actions are managed within the flow constraints identified above. Actions 4, 6, 7, 9 and 10 can use infrastructure to provide inundation of higher elevation areas on the floodplain that are not currently achieveable by overbank flows within current operational constraints.

Watering action 8: Infrastructure Delivery: Chowilla Floodplain

Standard operational considerations

Water can be delivered to a portion of the Chowilla Floodplain using infrastructure such as recently constructed regulators, fishways and upgraded weirs.

The action needs to be managed in consideration of Action 3 in particular, to ensure there are adequate flows within the river channel to operate the infrasturcture and mitigate water quality issues as flows return from the floodplain to the river.

Infrastructure needs to be operated in conjunction with Lock 6 weir pool raising.

Adequate flows need to be maintained through the anabranch to maintain critical fish habitat values.

Water qualtiy will need to be carefully monitored (as per action 7 above).

Typical extent: The infrastructure can be operated in a range of ways, including to vary water levels within anabranch and creeks, through to supporting the inundation of large areas of floodplain and high elevation wetlands.

Watering Action No 10a: Weir pool raising and lowering

Standard operational considerations:

Commonwealth environmental water may be used to support the raising and lowering of weir pools for a range of objectives, including returning vegetation to wetlands that have been disconnected from the river (by weir pool raising) and allowing vegetation to recolonise bare river banks (by weir pool lowering); improving the health of floodplain trees; providing habitat for fish, birds and frogs in wetlands that would otherwise not be connected to the river; increasing the amount of flowing habitat (preferred by native fish species) in the river channel; bringing important food for fish into the river from low-lying floodplain and wetlands; and improving water quality in wetlands and groundwater

This option will be managed by river operators to avoid unacceptable impacts on land managers and other water users, as well as negative impacts on channel pulse outcomes.

Typical extent: Weir pools along the length of the River Murray, where the extent and impact of weir pool lowering and raising has been tested and does not create unacceptable third party impacts. Where weir pools have only been raised, weir pool lowering could be undertaken in conjunction with a raising to further diversify the environmental flow of the watering action. Weir pool raising and lowering should be seasonably appropriate and undertaken where possible in conjunction with neighbouring weir pools.

Watering action 11: Seasonal lake level variation, barrage releases including fishway flows – Coorong, Lower Lakes and Murray Mouth

Standard operational considerations

Commonwealth environmental water is delivered to the Lower Lakes for supporting outcomes within the lakes and the Coorong. The water levels of the Lower Lakes and the complimentary barrage operations are managed for multiple environmental and socio-economic outcomes in the Coorong, Lower Lakes and Murray Mouth.

The management of lake water levels throughout the year will be guided primarily by seasonal water level ranges that are appropriate for lake vegetation and small-bodied fish outcomes, accommodating higher water levels in spring and lower water levels in summer-autumn. Raising the lake levels higher in spring also ensures continuous connectivity between the Coorong and Lower Lakes thorughout Summer and into Autumn, when deliverability of additional water can be uncertain due to upstream channel constraints.

The effects of wind seiching can have a dramatic impact on water levels in the Lower Lakes including up to Lock 1. Minimum water levels of at least 0.40 m AHD for managing acid sulphate soils in the Lower Lakes and Murray Swamps will be maintained. Pump access and sluice gate operation in the Murray Swamps, which are required to support management of floodplains in the area, also require a minimum of 0.4 m AHD which may require targeting an average Lake Alexandrina water level of 0.50 m AHD.

Flows into the Coorong are managed through the barrages situated on Lake Alexandrina. Barrage releases are managed to maintain fishway flows, and manage water quality and water levels within the Coorong, with reference to seasonally appropriate lake water levels.

Where possible Commonwealth environmental water will provide continuous barrage flows to contribute to exporting salt from the Basin in lower flow years. It is also critical for maintaining tidal exchange between the Southern Ocean and the Coorong which helps maintain suitable habitat condition (water quality).

Specific target lake levels and barrage release rates will reflect seasonal conditions and environmental water availability and be agreed by all parties as part of a short term operating plan for the Coorong, Lower Lakes and Murray Mouth.

When conditions permit, Commonwealth environmental water may be delivered to the Coorong via a barrage configuration that creates a 'salt wedge', to promote breeding and recruitment of estuarine fish species (specifically black bream in Nov-Jan and greenback flounder in August).

Commonwealth environmental water delivered to the Lower Lakes and Coorong during winter may target diadromous fish migration (e.g. lamprey). Where possible the integrity of the water will be preserved, to provide chemical cues from upstream catchments.

Water provided to the Coorong in late summer/early autumn is typically intended to lower the salinity in the north lagoon and subsequently provide a freshening effect to the south lagoon on reconnection as water levels rise.

Water provided specifically for the south lagoon may be 'pulsed' through a large number of automated barrage gates, opened on an incoming tide and subsequently closed on an outgoing tide, to maximise efficiency of water delivery to the site.

Typical extent: Coorong North and South lagoons, Lakes Alexandrina and Albert, fringing floodplain wetlands, and the Murray Mouth.

Attachment C – Long-term water availability

Commonwealth environmental water holdings

The Commonwealth holds the following entitlements in the Lower Murray–Darling Region:

- Lower Darling High Security
- Lower Darling General Security
- Murray High Security (South Australia)

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 Lower Murray- Darling Region include:

- Environment Entitlement – The Living Murray Program (Murray–Darling Basin Authority)
- South Australian Class 9 Wetlands – South Australian Department for Environment and Water
- South Australian environmental water reserve – South Australian Department for Environment and Water
- Bulk Entitlement – Victorian Environmental Water Holder
- New South Wales Adaptive environmental water entitlement – New South Wales Office of Environment and Heritage
- River Murray Increased Flows – New South Wales and Victorian Governments.

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').

Rules for the use of planned environmental water in the lower Murray–Darling Region can be found in the *Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016* (NSW) and the *Water Allocation Plan for the River Murray Prescribed Water Course 2002* (SA). Planned environmental water relevant to the lower Murray–Darling Region includes:

- Additional Dilution Flow
- New South Wales Lower Darling Environmental Contingency Allowance
- New South Wales Murray Regulated River Water Source Additional Environmental Allowance