



Australian Government

Commonwealth Environmental Water Office

Integrated planning for the use, carryover and trade of
Commonwealth environmental water

Lower Murray–Darling Region

2015–16



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Acknowledgement of the traditional owners of the Murray-Darling Basin

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Commonwealth environmental water portfolio management planning

Purpose of the document

This document consists of two parts. Part I sets out the Commonwealth Environmental Water Office's (the Office) portfolio management planning for the 2015–16 water year and for the following two years. While focussed on the Lower Murray-Darling Region, the identified use, carryover and trading intentions have been considered together with those for other catchments in a Murray-Darling Basin-wide analysis.

Part II of this document establishes the context for how the Office integrates its management of the Commonwealth environmental water portfolio in the Lower Murray-Darling and across the Murray-Darling Basin more broadly. It sets out the environmental demands that Commonwealth environmental water may contribute to in the Lower Murray-Darling, as well as the long-term supply profile for Commonwealth environmental water. Part II also explains how these two factors are considered together to inform an overall purpose for portfolio management, as well as the most appropriate mix of portfolio management options to maximise the benefits that can be achieved with the water portfolio across multiple years.

Purpose of portfolio management planning

Efficient and effective management of the Commonwealth environmental water holdings requires the utilisation of all portfolio management options (use, carryover and trade). To support improved outcomes from water use over time, carryover provides the opportunity to optimise water use across water years and to improve water availability early in a water year, while trade provides further capacity to optimise use over the long-term as well as across catchments.

Through multi-year integrated planning, portfolio management tools such as use, carryover and trade can be strategically managed for maximising environmental outcomes. Integrated portfolio management planning will also support the Office in:

- meeting Basin Plan obligations and contributing to the long-term objectives of the environmental watering plan, the expected outcomes in the Basin-wide environmental watering strategy and Basin annual environmental watering priorities
- managing the Commonwealth environmental water portfolio in response to the demands identified by Basin States in long-term environmental watering plans, once available
- applying adaptive management (including the setting of objectives, evaluating outcomes and informing future decision making)
- providing increased transparency in relation to the Commonwealth Environmental Water Holder's portfolio management (use, trade and carryover) behaviour
- coordinating water use with delivery partners, including developing long-term delivery arrangements

Scope of integrated portfolio management planning

The following portfolio management options have been determined to be in scope for integrated planning by the Office:

- use
- carryover
- trade of allocations including:
 - transfer of allocations between connected catchments
 - sale of allocations
 - purchase of allocations

The Office's portfolio management planning seeks to consider long-term demands (i.e. flow regimes) and supply, covering at least the preceding three years and out to three years.

Part I: Portfolio management planning in the Lower Murray–Darling Region

1. Purpose and portfolio management in 2015–16

1.1. Overall purpose

Demand for environmental water

Since 2010, natural flow events and environmental watering actions have resulted in improvements in the condition of many wetlands in the Lower Murray–Darling and promoted ecological recovery following the millennium drought. Drier conditions in 2013–14 and 2014–15 have seen some floodplain wetlands entering into a natural drying phase. Environmental water demands for the Lower Murray–Darling in 2015–16 are represented in Table 2 and summarised below:

Lower Darling and Great Darling Anabranch: River red gum and black box vegetation in the Great Darling Anabranch showed positive responses following natural and environmental watering events during 2011 to 2013. However, the Anabranch did not receive flows during 2014–15 resulting in a moderate demand for water in 2015–16 to support on-going vegetation recovery. Due to very low water levels in the Menindee Lakes, the Lower Darling River channel received minimum flows in 2014–15. Under dry conditions there is a likely high demand for water to manage water quality and reinstate aquatic habitat for native fish populations.

River Murray Channel: There is a moderate demand for environmental water to contribute to improved seasonality and variability of flows along the length of the river channel and to connect the river with low-lying wetlands.

Hattah Lakes: Due to the significant watering actions in 2013–14 and 2014–15 that supported floodplain vegetation, fish spawning and bird breeding, there is a low demand for environmental water in Hattah Lakes.

Floodplain and wetlands from Euston to South Australian border: These off-channel assets were watered naturally during the 2011 and 2012 river flow events. Smaller-scale inundation has also occurred since 2012–13 assisted by the use of regulating infrastructure or pumping. To maintain on-going recovery of vegetation communities there is generally a moderate demand for environmental water in these floodplain wetlands.

Floodplain and wetlands from South Australian border to Lower Lakes: Considerable parts of the South Australian Murray floodplain were watered naturally during the 2011 and 2012 river flow events. Priority wetlands have since 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 there is generally a moderate demand for environmental water in these floodplain wetlands.

Coorong, Lower Lakes and Murray Mouth: Environmental water is required to maintain base flows through the barrages to support salt export from the River Murray and Lower Lakes, and to maintain suitable habitat conditions for fish and *Ruppia* within the Coorong lagoons. With a seasonal outlook indicating dry to moderate conditions (MDBA 2015) the contribution of environmental water to achieving the minimum flow requirements throughout the year is critical.

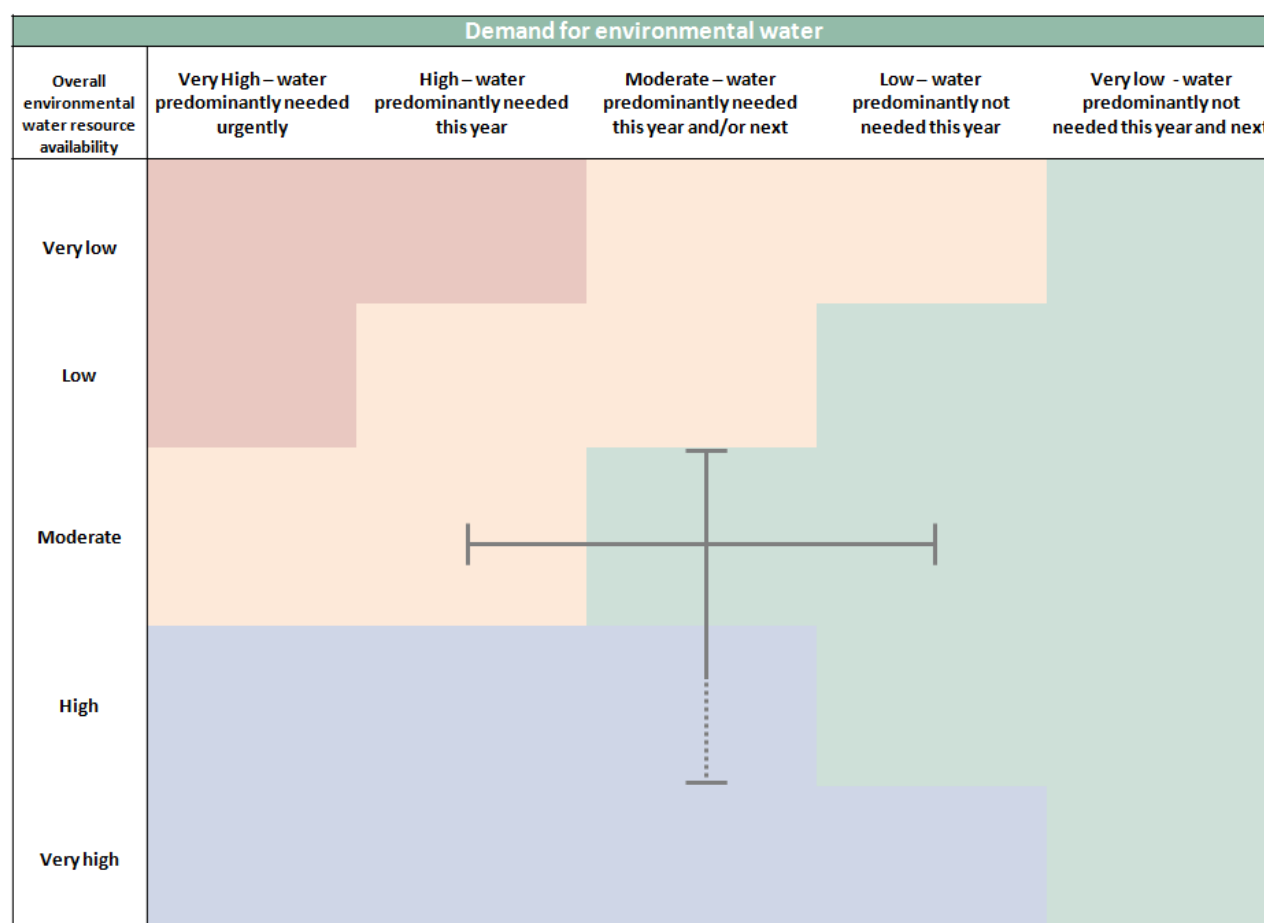
Supply

Water resource availability (supply) in the context of meeting environmental demands is contributed by allocations against entitlements held for the environment by the Commonwealth Environmental Water Holder, New South Wales Office of Environment and Heritage, Victorian Environmental Water Holder, South Australian Department of Environment, Water and Natural Resources and the Murray-Darling Basin Authority (The Living Murray), as well as natural and unregulated flows, and planned environmental water provisions. Further detail is provided in Part II, Section 4.

Considering carryover of Commonwealth environmental allocations from 2014–15 to 2015–16, the range of potential opening allocations for 2015–16, operational considerations, along with the full range of potential streamflows, moderate to high resource availability scenarios are in scope for 2015–16. The condition of the Murray–Darling Basin is likely to be dry for the 2015–16 water year (MDBA 2015). Dry conditions combined with reasonable carryover from 2015–16 and opening allocations presents a **moderate resource availability** scenario overall. High resource availability is only possible if conditions become wet, which is considered unlikely given the seasonal outlook.

Purpose

Figure 1 shows how the demand for environmental water and water supply are considered together. The overall 'purpose' for managing the Commonwealth's water portfolio in the Lower Murray-Darling for 2015–16 is to **protect** habitats within the Coorong and the lower Darling River channel (subject to being able to access environmental water allocations), while seeking to **maintain** the ecological health and resilience of other key sites in the system. If water availability becomes high there may be scope to **improve** the health and resilience of aquatic ecosystems through the Lower Murray-Darling system.



Avoid damage: Avoid damage to environmental assets

Protect: Ensure ecological capacity for recovery

Maintain: Maintain ecological health and resilience

Improve: Improve the health and resilience of aquatic ecosystems / Build future capacity to support ecological health and resilience

Figure 1: Determining a broad purpose for portfolio management in the Lower Murray-Darling for 2015–16

Note: grey lines represent potential range in demand and resource availability

1.2. Water Use

Consistent with the demands and purpose described above, the Office is considering supplying environmental water for the following watering actions for 2015–16. Table 1 summarises which of these actions are relevant to which resource availability scenarios in 2015–16, with further detail and rationale established in Table 2, including implications for future years based on assumed water use behaviour for 2015–16. Table 1 also identifies the 2015–16 Basin annual environmental watering priorities (published by the Murray-Darling Basin Authority) that the various watering actions may contribute to meeting.

Table 1: Potential Commonwealth watering actions and applicable resource availability scenarios for the Lower Murray-Darling Region in 2015–16

Watering action	2015–16 Basin annual environmental watering priority(s) ¹	Resource availability scenarios action is likely to be pursued under	
		Moderate	High
River Murray from South Australian border to Coorong, Lower Lakes and Murray Mouth	<ul style="list-style-type: none"> • Basin-wide flow variability and longitudinal connectivity • River Murray weir pool variation • Coorong, Lower Lakes and Murray Mouth • Basin-wide in-stream and riparian vegetation • Basin-wide waterbird habitat and future population recovery • Basin-wide native fish habitat and movement • Silver perch 	Yes	Yes
Lower Darling and/or Great Darling Anabranch	<ul style="list-style-type: none"> • Basin-wide flow variability and longitudinal connectivity • Basin-wide in-stream and riparian vegetation • Basin-wide native fish habitat and movement • Silver perch 	Unlikely to be feasible	Yes – high inflow conditions upstream of Menindee Lakes more likely
New South Wales Mallee Wetlands	<ul style="list-style-type: none"> • Basin-wide in-stream and riparian vegetation 	Yes	Yes
Victorian Mallee Wetlands	<ul style="list-style-type: none"> • Basin-wide in-stream and riparian vegetation 	Yes	Yes
Hattah Lakes	<ul style="list-style-type: none"> • Basin-wide in-stream and riparian vegetation • Basin-wide waterbird habitat and future population recovery 	Yes	Yes
Lindsay- Mulcra-Wallpolla Floodplain	<ul style="list-style-type: none"> • Basin-wide flow variability and longitudinal connectivity • Basin-wide in-stream and riparian vegetation • Basin-wide native fish habitat and movement • Silver perch 	Yes	Yes
South Australian Murray Wetlands	<ul style="list-style-type: none"> • Basin-wide in-stream and riparian vegetation 	Yes	Yes

¹ For full details on the Basin annual environmental watering priorities refer to the MDBA website at <http://www.mdba.gov.au/what-we-do/environmental-water/environmental-watering-priorities>

River Murray from South Australian border to Coorong, Lower Lakes and Murray Mouth

Summary: Environmental water will be used to support base flows and in-channel freshes aimed at supporting suitable aquatic habitat for native fish, support longitudinal and lateral hydrological connectivity, improve the condition of native vegetation and contribute to the transport and export of salt from the basin. The operational decisions to use environmental water for freshes and potential overbank flow events will be guided by natural hydrological cues. The effective use of environmental flows will be enhanced through the implementation of seasonally appropriate operating strategies for river, wetland and floodplain infrastructure, for example the manipulation of weir pool water levels to provide hydraulic variability and re-connect the river with temporary wetlands, and barrage releases to improve available habitat for native fish in the Coorong North Lagoon.

Timing: Year round

Operational considerations and feasibility:

- As per the standard operational considerations for watering actions 3. River Murray channel flows; and 12. Seasonal lake level variation, fishway flows, differential barrage releases (see Part II, section 3.6).
- Flows will coincide with the 'River Murray from Yarrawonga to South Australian border' action (refer to Mid- River Murray planning document) and return flows from Victorian tributaries (refer to Northern Victorian Rivers planning document).
- Minimum water levels are required to be maintained in Lakes Alexandrina and Albert to manage acid sulphate soils in the lakes and the lower River Murray swamps.
- Continuous barrage flows are required to support hydrological connectivity between the Coorong, Lower Lakes and River Murray channel and to protect habitat conditions in the Coorong lagoons.

Lower Darling and/or Great Darling Anabranh Flows

Summary: Contribution to base flows and freshes in the lower Darling River channel and/or the Great Darling Anabranh and lakes (depending on appropriate seasonal conditions and water availability) to manage water quality, restore habitat for native fish populations and maintain riparian vegetation condition.

Timing: Spring or early summer, subject to an appropriate inflow trigger.

Operational considerations and feasibility:

- Menindee Lakes water levels are very low and New South Wales has been implementing emergency contingency measures since September 2014, including releases below normal minimum flows. Unless water availability within the Menindee Lakes improves considerably as a result of inflows from northern Murray-Darling Basin catchments, the Commonwealth Environmental Water Holder will remain unable to call on water allocations held in the Menindee Lakes to supply an environmental flow in the lower Darling River.
- Otherwise as per the standard operational considerations for watering actions 1. Lower Darling River Flows and 2. Great Darling Anabranh Flows (see Part II, section 3.6).

River Murray Wetlands

Summary: Commonwealth environmental water may be provided to a number of wetlands in 2015–16, including the New South Wales and Victorian Mallee wetlands and South Australian Murray Wetlands. Expected outcomes will vary among wetlands but would typically support the recruitment, improved condition and maintenance of native vegetation, waterbirds, frogs, fish and other biota and promote salt and nutrient export through the River Murray system. Watering actions may also aim to establish self-sustaining populations of Murray hardyhead (a native fish species listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999*) within wetland refuges connected to the River Murray.

Timing: Year round

Operational considerations and feasibility:

- As per the standard operational considerations for watering actions 7. Mallee Wetlands and 10. Lower Murray Wetlands (see Part II, section 3.6).

Hattah Lakes

Summary: Commonwealth environmental water may be provided to the southern portion of the Hattah Lakes complex 2015–16, in partnership with the Mallee Catchment Management Authority, Victorian Environmental Water Holder and The Living Murray. Following a significant watering action in 2014–15, the use of environmental water is expected to result in on-going improvement in the condition of floodplain and wetland vegetation.

Timing: Winter / Spring 2015

Operational considerations and feasibility:

- As per the standard operational considerations for watering action 4. Infrastructure Delivery: Hattah Lakes (see Part II, section 3.6).

Lindsay-Mulcra-Wallpolla and/or Chowilla Floodplain

Summary: Commonwealth environmental water may be provided to a number of floodplain sites in 2015–16, in partnership with the Mallee Catchment Management Authority, Victorian Environmental Water Holder, South Australian Department of the Environment, Water and Natural Resources and The Living Murray. Expected outcomes will vary among wetlands but would typically include the provision of fast flowing water habitat to stimulate fish movement and spawning and promote riparian and aquatic plant diversity.

Timing: Year round

Operational considerations and feasibility:

- As per the standard operational considerations for watering actions 6. Infrastructure Delivery: Lindsay-Mulcra-Wallpolla Floodplain and 9. Infrastructure Delivery: Chowilla Floodplain (see Part II, section 3.6).

Stakeholder feedback: Consultation on long term portfolio management planning has occurred with key delivery partners (South Australian Department of Environment, Water and Natural Resources, New South Wales Office of Environment and Heritage, Victorian Environmental Water Holder, Victorian Catchment Management Authorities, New South Wales Local Land Services, New South Wales Fisheries, New South Wales Office of Water, the Murray–Darling Basin Authority, the Murray-Darling Wetlands Working Group, scientists engaged in monitoring the outcomes of Commonwealth environmental water use and various community groups and individuals. Feedback will be sought on an ongoing basis as planning transitions to implementation phase (see Section 1.6).

1.3. Carryover

A moderate proportion of allocations available in 2014–15 are expected to be carried over to 2015–16 in the southern connected basin (350–360 gigalitres). Given the moderate environmental demands in the Lower Murray-Darling for 2015–16, if water resource availability remains moderate, a moderate to high proportion of Commonwealth's available allocations for 2015–16 are expected to be used for the watering actions described above. A low to moderate proportion of allocations are expected to be carried over to support environmental demands in 2016–17 (see Table 2). The level of available allocations to be carried over to 2017–18 will depend upon resource availability and demand.

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 Region. More information on how the Commonwealth makes decisions on carryover is here [\[http://www.environment.gov.au/water/cewo/portfolio-mgt/carryover\]](http://www.environment.gov.au/water/cewo/portfolio-mgt/carryover)

1.4. Trade

At this time there is no plan to buy or sell allocations in the southern connected basin in 2015–16. Currently, there is only limited market opportunity for allocation purchase to be pursued. The moderate demands for environmental water that may extend to 2016–17 mean that the sale of allocations will be considered based on ongoing assessments of environmental demands within the southern connected basin and across the Murray-Darling Basin over the next two years (Table 2). The types of scenarios where the need to adjust the availability of Commonwealth allocations is most likely to arise in coming years include:

- If environmental demands have been met and it is determined that there is sufficient forecast allocation to meet future demands across the southern connected basin, the market will be assessed to determine if there are opportunities to sell surplus water and secure proceeds to improve the Commonwealth Environmental Water Holder's capacity to meet current or future environmental demands across the Murray-Darling Basin
- If a Basin-scale analysis identifies urgent environmental demands within a particular catchment and allocation purchase provides an opportunity to meet those demands using proceeds from the sale of water in a catchment with less urgent demands
- If conditions were to become wet while environmental demands remain high, market conditions might provide a favourable opportunity to purchase allocations to assist in meeting demands and augmenting natural flows

Refer to the [Commonwealth environmental water Trading Framework](#), which includes operating rules, procedures, and [protocols](#), for further information.

1.5. A note on transfer

Where the need arises to adjust the availability of allocations in the Lower Murray-Darling, it should be noted that the transfer of allocations from other southern connected catchments would generally be considered as the preferred and more efficient option to allocation purchase or sale, consistent with the rules identified in state water resource plans that apply to all water users.

1.6. Your input

The management of Commonwealth environmental water relies on considerable advice and assistance from local organisations, state governments and 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 Office via: ewater@environment.gov.au.

Table 2a: Environmental demands, potential in 2015–16 and outlook for coming years in the Lower Murray–Darling Region - **MODERATE WATER RESOURCE AVAILABILITY IN 2015–16**

Environmental assets	Indicative demand (for <u>all sources of water</u> in the system)		Watering history (from all sources of water)			2015–16			Implications for future demands		
						Predominant urgency of environmental demand for water	Purpose under <u>moderate</u> resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2016–17 if watering occurred as planned in 2015–16	2017–18 Range of likely demand	Met in 2016–17
	Flow/volume	Required frequency (maximum dry interval)	2012–13 wet	2013–14 moderate	2014–15 drying						Not met in 2016–17
Lower Darling River¹	Small to moderate river flow (7,000 ML/day @ Weir 32 for 10 days in summer)	1-2 in 5 years (max interval unknown)				Moderate	Maintain	Unlikely to be feasible under moderate resource availability	High	Moderate	
										Critical	
Great Darling Anabranch²	1,500-2,000 ML/day from Menindee Lakes for 30-45 days	1 in 2 years (max interval unknown)				Moderate	Maintain		High	Low	
										High	
River Murray from Euston to Lower Lakes, including pool level wetlands³	River flow of at least 10 000 ML/day @ SA border for up to 60 days in spring/summer	9 in 10 years (2 years)				Moderate	Maintain	Likely Commonwealth environmental water contribution, subject to seasonal cues	Moderate	Moderate	
										High	
	River flow of 15 000-25 000 ML/day @ SA border for up to 90 days in spring/summer	2 in 3 years (2 years)				Moderate	Protect	Potential Commonwealth environmental water contribution, subject to seasonal cues	Moderate	Low	
										Moderate	
Hattah Lakes⁴	River flow of 25 000-35 000 ML/day @ SA border for up to 60 days in spring/summer	1 in 2 years (3 years)				Moderate	Protect	Unlikely under 'moderate' resource availability	Moderate	Moderate	
										High	
	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 40-50 000 ML/day at Euston for 26-60 days ²	1 in 2-3 years (4 years)	Despite higher river flows, temporary levees prevented inundation			Very Low	Maintain	If sufficient Commonwealth water available and was required, it may be used to contribute to a smaller scale action in 2015-16.	Low	Low	
										Moderate	
Floodplain and wetlands from Euston to South Australian border⁵	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)				Very Low	Maintain	Not targeted in 2015-16 because demands met in 2014-15	Low	Moderate	
										Moderate	
	Large action targeting wetlands 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 @ Euston for 7 days anytime in the year.	1 in 8 years (12 years)				Very Low	Maintain	Not targeted in 2015-16 because demands met in 2014-15	Low	Low	
										Low	
Floodplain and wetlands from South Australian border to Lower Lakes⁶	30 000 ML/day @ Lock 8 for 30-60 days targeting low lying wetlands and anabranches, or priority areas via infrastructure	2 in 5 years (4 years)				Low	Maintain	A high potential to continue system recovery and support native vegetation and fish communities.	Moderate	Low	
										Moderate	
	50 000-60 000 ML/day @ 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)			Red gum and lignum received water in 2014-15	Met for large areas of floodplain in early 2011 floods	Maintain	Subject to seasonal cues	Low	Low	
										Moderate	
Floodplain and wetlands from South Australian border to Lower Lakes⁶	Infrastructure delivery to a priority areas of floodplain equivalent to 80 000 ML/day @ Lock 8 targeting river red gum and black box woodland and associated wetlands	1-2 in 10 years (8 years)				Met for large areas of floodplain in early 2011 floods, sequential watering may be required for establishment of black box seedling	Maintain	Subject to seasonal cues, (unlikely under 'moderate' conditions)	Moderate	Low	
										Low	
	40 000-50 000 ML/day @ South Australian border for up to 90 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)				Met for large areas of floodplain in early 2011 floods, however floodplain still recovering from drought. Demands for some individual sites lower due to managed water delivery.	Maintain	Overbank flows unlikely in a moderate scenario.	Moderate	Low	
								Commonwealth environmental water may be delivered to individual		High	

	50 000-60 000 ML/day @ South Australian border for up to 90 days targeting river red gum woodland, black box, cooba, tea tree and lignum and associated wetlands, or priority areas via infrastructure	1-2 in 5 years (3 years)				As above; sequential watering may be required for establishment of black box seedlings.	Maintain	floodplain / wetland sites using infrastructure.	Moderate	Low
	Infrastructure delivery to a priority areas 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)				As above; sequential watering may be required for establishment of black box seedlings.	Maintain	Not a focus for water use under 'moderate' resource availability.	High	Moderate-High
Coorong, Lower Lakes and Murray Mouth ⁷	Minimum barrage flow of 650 GL/yr	1 in 1 year				High	Avoid damage	Likely Commonwealth environmental water contribution	High	Low-Moderate
	Barrage flows of 2,000 GL/yr required to achieve salinity target in Lake Alexandrina	Rolling three year average				Moderate	Protect	Likely Commonwealth environmental water contribution	High	Becoming critical
	Barrage flows of at least 2,500 GL over two years to avoid damage and protect habitat conditions within the Coorong	9 in 10 years (1 year)				Moderate	Protect	Likely Commonwealth environmental water contribution	Low-moderate	Low
	Barrage flows of 6,000 GL every three to five years to maintain and improve habitat conditions within the Coorong	1 in 3 years (5 years)				5,270 GL in 2012-13	Maintain	Commonwealth likely to contribute to support natural events, should they eventuate	High	High
	Barrage flows of 10,000 GL every seven to seventeen years to improve habitat conditions within the Coorong	1 in 7 years (17 years)				Met in 2010-11	Maintain	Commonwealth likely to contribute to support natural events, should they eventuate	Low-moderate	Becoming critical
									Very low	Low
									Very low	High
									Very low	Moderate

1. Sourced from MDBA (2012b)
2. Sourced from Nias (2002)
3. Sourced from Wallace et al. (2014), Ecological Associates (2015), Ecological Associates (2010) and MDBA (2012(j))
4. Sourced from MDBA (2012g), (2012j); Roberts and Marston (2011).
5. 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. Sourced from MDBA (2014b) and MDBA (2012h)
7. Sourced from MDBA (2012i)

Key - events in previous years

	means demand was met, by Commonwealth environmental water or any other source
	means demand was partially met, by Commonwealth environmental water or any other source
	means water did not contribute to meeting demands.

Note that not all demands require water every year, drying phases are important for floodplains and temporary wetlands or streams

Key - potential watering in 2015-16

	means a high potential for Commonwealth environmental watering (subject to seasonal and operational considerations)
	means a moderate potential for Commonwealth environmental watering, or a partial contribution may be made
	means a low potential for Commonwealth environmental watering

Key - urgency of environmental demands

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

Carryover potential	Moderate proportion of available allocations expected to be carried into 2016–17	A moderate proportion of available allocations may be carried over to 2017–18, but will depend upon resource availability and demands	Potential carryover will depend upon resource availability and demands
Trade potential	No urgency to augment available allocations, therefore limited potential for allocation purchase. Moderate to high demands means allocation sale unlikely	No expected urgency to augment available allocations, therefore limited potential for allocation purchase. Moderate demands means allocation sale unlikely	Potential to trade will be depend on environmental demands and resource availability

Table 2b: Environmental demands, potential in 2015–16 and outlook for coming years in the Lower Murray–Darling Region – **HIGH WATER RESOURCE AVAILABILITY IN 2015–16** (low likelihood of occurrence)

Environmental assets	Indicative demand (for all sources of water in the system)	Required frequency (maximum dry interval)	Watering history (from all sources of water)			2015-16			Implications for future demands		
			Predominant urgency of environmental demand for water			Purpose under high resource availability	Potential Commonwealth environmental water contribution?	Likely urgency of demand in 2016-17 if watering occurred as planned in 2015-16	2017-18 Range of likely demand	Met in 2016–17	
			2012–13 wet	2013–14 moderate	2014–15 drying					Not met in 2016–17	
Lower Darling River ¹	Small to moderate river flow (7,000 ML/day @ Weir 32 for 10 days in summer)	1-2 in 5 years (max interval unknown)				Moderate	Improve	Potential Commonwealth environmental water contribution, subject to water availability within Menindee Lakes	Low	Low	
									Moderate	Moderate	
Great Darling Anabranch ²	1,500-2,000 ML/day from Menindee Lakes for 30-45 days	1 in 2 years (max interval unknown)				Moderate	Improve		Low	Low	
									Moderate	Moderate	
River Murray from Euston to Lower Lakes, including pool level wetlands ³	River flow of at least 10 000 ML/day @ SA border for up to 60 days in spring/summer	9 in 10 years (2 years)				Moderate	Improve	Likely Commonwealth environmental water contribution, subject to seasonal cues	Moderate	Moderate	
	River flow of 15-25 000 ML/day @ SA border for up to 90 days in spring/summer	2 in 3 years (2 years)				Moderate	Improve	Likely Commonwealth environmental water contribution, subject to seasonal cues	Low	Low	
										Moderate	
	River flow of 25-35 000 ML/day @ SA border for up to 60 days in spring/summer	1 in 2 years (3 years)				Moderate	Improve	Potential Commonwealth environmental water contribution, subject to seasonal cues	Low	Moderate	
										Moderate-High	
Hattah Lakes ⁴	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 40-50 000 ML/day at Euston for 26-60 days ³	1 in 2-3 years (4 years)	Despite higher river flows, temporary levees prevented inundation			Very Low	Maintain	If sufficient Commonwealth water available and was required.	Low	Low	
	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)				Very Low	Maintain	Not targeted in 2015-16 because demands met in 2014-15	Low	Moderate	
										Moderate	
	Large action targeting wetlands 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 @ Euston for 7 days anytime in year.	1 in 8 years (12 years)				Very Low	Maintain	Not targeted in 2015-16 because demands met in 2014-15	Low	Low	
										Low	
Floodplain and wetlands from Euston to South Australian border ⁵	30 000 ML/day @ Lock 8 for 30-60 days targeting low lying wetlands and anabranches, or priority areas via infrastructure	2 in 5 years (4 years)				Low	Maintain	A high potential to continue system recovery and support native vegetation and fish communities.	Moderate	Low	
	50-60 000 ML/day @ 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)			Red Gum and lignum received water in 2014-15	Met for large areas of floodplain in early 2011 floods	Maintain	Subject to seasonal cue	Low	Low	
										Moderate	
	Infrastructure delivery to a priority areas of floodplain equivalent to 80 000 ML/day @ Lock 8 targeting river red gum and black box woodland and associated wetlands	1-2 in 10 years (8 years)				Met for large areas of floodplain in early 2011 floods, sequential watering may be required for establishment of black box seedling	Maintain	Subject to seasonal cue	Low	Low	
										Low	
Floodplain and wetlands from South Australian border to Lower Lakes ⁶	40-50 000 ML/day @ South Australian border for up to 90 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)				Met for large areas of floodplain in early 2011 floods, however floodplain still recovering from drought. Demands for some individual sites lower due to managed water delivery.	Improve	Contribution to overbank flows possible, subject to seasonal cues.	Moderate	Low	
										High	

	50-60 000 ML/day @ South Australian border for up to 90 days targeting river red gum woodland, black box, cooba, tea tree and lignum and associated wetlands, or priority areas via infrastructure	1-2 in 5 years (3 years)				As above; sequential watering may be required for establishment of black box seedlings.	Improve	Commonwealth environmental water may be delivered to individual floodplain / wetland sites using infrastructure.	Moderate	Low
	Infrastructure delivery to a priority areas equivalent to 60-70 000 ML/day @ South Australian border targeting black box, cooba, lignum and chenopod and associated wetlands	1 in 3 years (4 years)				As above; sequential watering may be required for establishment of black box seedlings.	Improve		Low	Moderate
Coorong, Lower Lakes and Murray Mouth ⁷	Minimum barrage flow of 650 GL/yr	1 in 1 year				High	Improve	Likely Commonwealth environmental water contribution	High	High
	Barrage flows of 2,000 GL/yr required to achieve salinity target in Lake Alexandrina	Rolling three year average				Moderate	Improve	Likely Commonwealth environmental water contribution	Low-moderate	Low
	Barrage flows of at least 2,500 GL over two years to avoid damage and protect habitat conditions within the Coorong	9 in 10 years (1 year)				Moderate	Improve	Likely Commonwealth environmental water contribution	Low-moderate	Moderate
	Barrage flows of 6,000 GL every three to five years to maintain and improve habitat conditions within the Coorong	1 in 3 years (5 years)				5,270 GL in 2012-13	Maintain	Commonwealth likely to contribute to support natural events, should they eventuate	Very low	Very 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)				Met in 2010-11	Maintain	Commonwealth likely to contribute to support natural events, should they eventuate	Very low	Very low
										Low

See Table 2a for footnotes

Key - events in previous years

	means demand was met, by Commonwealth environmental water or any other source
	means demand was partially met, by Commonwealth environmental water or any other source
	means water did not contribute to meeting demands.

Note that not all demands require water every year, drying phases are important for floodplains and temporary wetlands or streams

Key - potential watering in 2015-16

	means a high potential for Commonwealth environmental watering (subject to seasonal and operational considerations)
	means a moderate potential for Commonwealth environmental watering, or a partial contribution may be made
	means a low potential for Commonwealth environmental watering

Key - urgency of environmental demands

	means critical demand i.e. urgent need for water in that particular year to manage risk of irretrievable loss or damage
	means high demand for water i.e. needed in that particular year
	means moderate demand for water i.e. water needed that particular year and/or next
	means low demand for water i.e. water generally not needed that particular year
	means 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 specfic requirements that are more or less urgent within the flow regime

Carryover potential	Moderate proportion of available allocations expected to be carried into 2016–17	A moderate proportion of available allocations may be carried over to 2017–18, but will depend upon resource availability and demands	Potential carryover will depend upon resource availability and demands
Trade potential	No urgency to augment available allocations, therefore limited potential for allocation purchase. Moderate to high demands means allocation sale unlikely	No expected urgency to augment available allocations, therefore limited potential for allocation purchase. Moderate demands means allocation sale unlikely	Potential to trade will be depend on environmental demands and resource availability

Part II: Commonwealth environmental water portfolio management planning

2. Background

2.1. Commonwealth environmental water

The Commonwealth Environmental Water Holder is an independent statutory position established by the *Water Act 2007* (the Water Act) to manage the Commonwealth environmental water holdings. The Commonwealth Environmental Water Holder leads and is supported by the Commonwealth Environmental Water Office (the Office), a division of the Australian Government Department of the Environment.

Under the Water Act, Commonwealth environmental water must be managed to protect or restore environmental assets, so as to give effect to relevant international agreements. The Water Act also requires that the Commonwealth Environmental Water Holder perform its functions and exercise its powers consistently with and in a manner that gives effect to the Basin Plan and that Commonwealth environmental water is managed in accordance with the Basin Plan's environmental watering plan.

2.2. 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. 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.

Environmental water is sourced via managed releases from River Murray storages including Hume Reservoir, Menindee Lakes, Lake Victoria and River Murray tributaries. Natural cues 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. At high river flows environmental water is used to augment natural flow to influence the magnitude and duration of floodplain and wetland inundation.

Downstream of Lock 6 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 these sites more natural patterns of inundation and drying sequences. 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. Inflows into the Lower Lakes and the Coorong are managed through the operation of barrages at Lake Alexandrina.

Environmental water delivery in the River Murray channel, including the operation of locks and storages is managed by the Murray–Darling Basin Authority (River Murray Operations). Delivery of Commonwealth environmental water is undertaken in collaboration with delivery partners, including the New South Wales Office of Environment and Heritage, Water New South Wales, the Victorian Environmental Water Holder, the Department of Environment, Water and Natural Resources South Australia, Mallee Catchment Management Authority and the Nature Foundation South Australia.

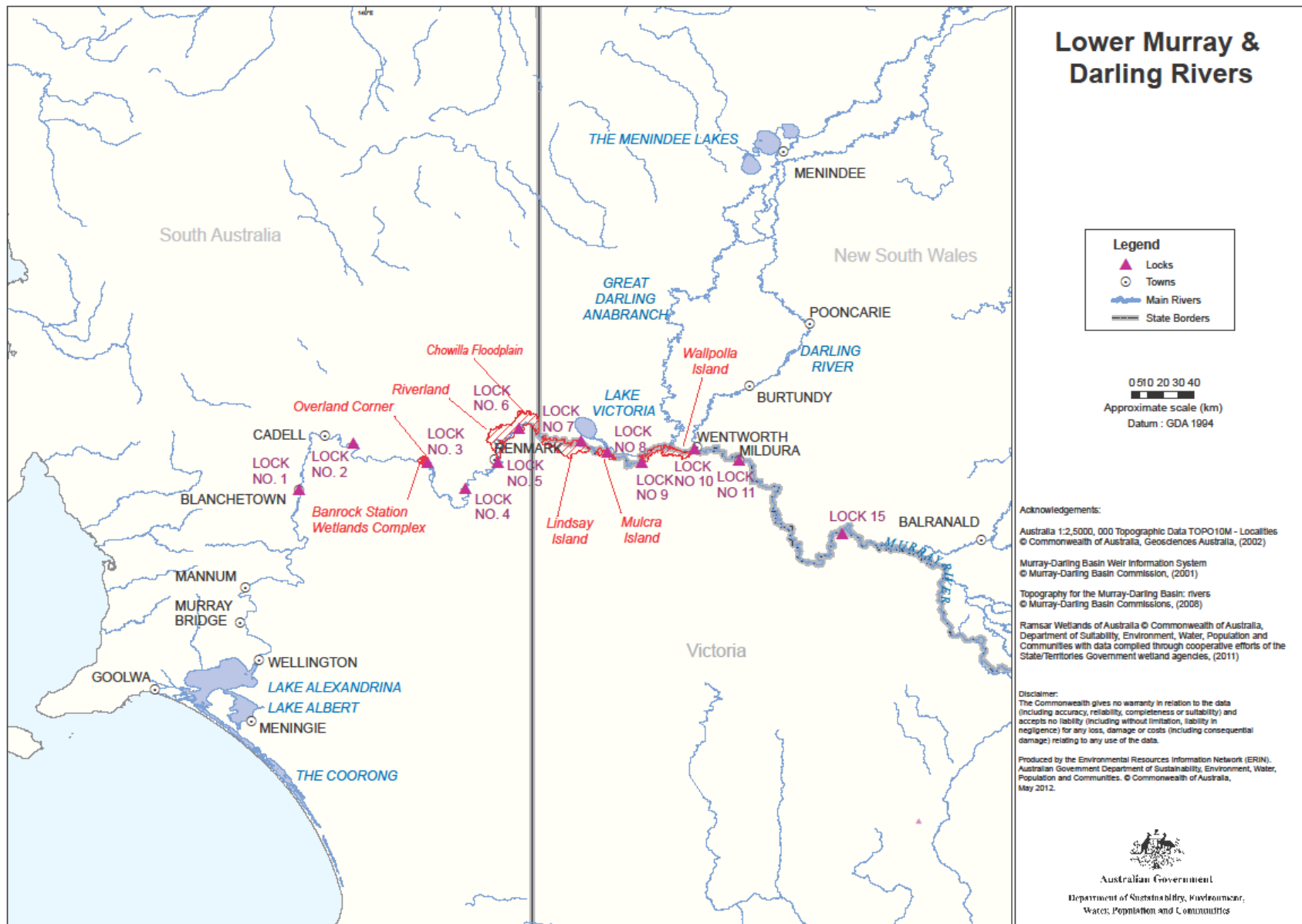


Figure 2: Map of the Lower Murray–Darling Region

3. Long-term environmental water demands in the Lower Murray–Darling Region

3.1. Basin-wide environmental watering strategy

The Murray-Darling Basin Authority has published the first Basin-wide environmental watering strategy (the Strategy, MDBA 2014). Building on Basin Plan's environmental objectives, the Strategy sets out the Authority's best assessment of the expected environmental outcomes over the next decade as a result of implementing the Basin Plan and associated water reforms. The Strategy focusses on four components: river flows and connectivity; vegetation; waterbirds; and native fish. The expected outcomes for each component are summarised below, with more specific quantified outcomes provided in [Attachment A](#).

River flows and connectivity: Improve connections along rivers and between rivers and their floodplains

Vegetation: Maintain extent and improve the condition

Waterbirds: Maintain current species diversity, improve breeding success and numbers

Native Fish: Maintain current species diversity, extend distributions, improve breeding success and numbers

3.2. Long-term watering plans

State governments are developing long-term watering plans for each catchment in the Basin. These plans will identify:

- the priority environmental assets and ecosystem functions in the catchment
- the objectives and targets for these assets and functions
- their watering requirements

In developing these plans, state governments will be consulting with environmental water holders and local communities.

Once developed, these plans will provide the key information on the long-term environmental water demands in the catchment and the Office's planning for the Lower Murray-Darling Region will be reviewed so that this information can be incorporated.

Prior to the development of long-term watering plans, the Office 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.

Key documentation includes:

- Seasonal Watering Plan 2015–16, published by the Victorian Environmental Water Holder, (2015).
- Murray and Lower Darling Valleys: Annual Environmental Watering Plan 2015–2016, published by the New South Wales Office of Environment and Heritage
- 2014–15 Annual Environmental Watering Plan for the South Australian River Murray, published by the South Australian Department of the Environment, Water and Natural Resources
- Monitoring and Evaluation Plan for the Lower Murray Selected Area, developed under the Office's Long-Term Intervention Monitoring Project (Department of the Environment 2014)

- The Office's environmental water delivery documents for the River Murray: Coorong, Lower Lakes and main channel below Lock 1 (Department of the Environment 2011) and River Murray: South Australian border to Lock 1 (unpublished)
- The assessment of environmental water requirements for the proposed Basin Plan (MDBA 2012 a-e)
- Reports on environmental watering requirements (Wallace *et al.* 2014, Ecological Associates 2015, Ecological Associates 2010)
- Plans for The Living Murray Icon Sites (MDBA 2012 f-i)
- A range of scientific literature, monitoring outcomes and on-ground knowledge (e.g. Roberts and Marston 2011).

The below section represents the Office's summary of the long-term environmental water demands, based on these documents. The objectives and expected outcomes for water-dependent ecosystems will continue to be revised and refined in response to best available knowledge, including drawing on the results of environmental watering monitoring programmes.

3.3. Expected outcomes in the Lower Murray-Darling Region

The expected outcomes from environmental watering in the Lower Murray-Darling are described below in Table 3 and how these contribute to Basin-wide outcomes. These outcomes will be refined and/or revised once the long-term watering plan for the catchment has been developed.

Table 3: Summary of long-term expected outcomes from environmental watering in the Lower Murray–Darling Region

BASIN-WIDE OUTCOMES (Outcomes in red link to the Basin-wide environmental watering strategy, MDBA 2014)	EXPECTED OUTCOMES 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
VEGETATION	Maintain riparian and in-channel vegetation condition. Increase periods of growth for non-woody vegetation communities that closely fringe or occur within river channels.			Promote growth and recruitment of <i>Ruppia tuberosa</i> in the south lagoon of the Coorong. Maintain or improve the diversity, condition and extent of aquatic and littoral vegetation at the Lower Lakes.	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. Improve recruitment of trees within black box and river red gum communities.		
WATERBIRDS	Provide habitat and food sources to support waterbird survival and recruitment, and maintain condition and current species diversity.						
				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).	Support naturally triggered colonial bird breeding events that are in danger of failing due to drying.		
FISH	Provide flows to support habitat and food sources and promote increased movement, recruitment and survival/condition of native fish.			Maintain or improve diversity, condition and population for fish populations (all estuarine-dependent fish families, including sandy sprat, small-mouthed hardyhead, black bream, greenback and flounder) 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 (particularly for floodplain specialists).		

INVERTEBRATES	Provide habitat to support increased microinvertebrate and macroinvertebrate survival, diversity, abundance and condition.		
OTHER VERTEBRATES	Provide habitat to support survival, maintain condition and provide recruitment opportunities for frogs and turtles.		
CONNECTIVITY	<p>Contribute to the maintenance of baseflows and an overall increase in flows in the River Murray.</p> <p>Support 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.</p> <p>Support lateral connectivity through contributing to an increase in the frequency of freshes, bankfull and lowland floodplain flows.</p>		Support latitudinal connectivity (within constraints) to wetlands and floodplains, by contributing an increase in the frequency of lowland floodplain flows.
	Contribute to improving the connection of the River Murray to the Coorong and the sea, through supporting increased barrage flows and Murray mouth openness.		
PROCESSES	<p>Support primary productivity, nutrient and carbon cycling, biotic dispersal and movement.</p> <p>Support increased transport of organic matter, salt and nutrients downstream and out the Murray Mouth.</p>		
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.	Support mobilisation and export of salt from the River Murray system.
RESILIENCE	Provide 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 (2014); Department of the Environment (2011 and unpublished); MDBA (2013a-i)

3.4. Flows in scope for Commonwealth environmental watering over the long-term

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 3 shows the broad environmental demands that are in scope for the Office to focus on contributing to in the Lower Murray–Darling Region. Importantly, these are broad, indicative demands and individual watering actions may contribute to particular opportunities, such as using infrastructure to deliver water to individual wetlands that would otherwise not be possible due to constraints. Also, there may be opportunities for Basin State governments to remove or modify constraints, which will improve the efficiency and/or effectiveness of environmental watering.

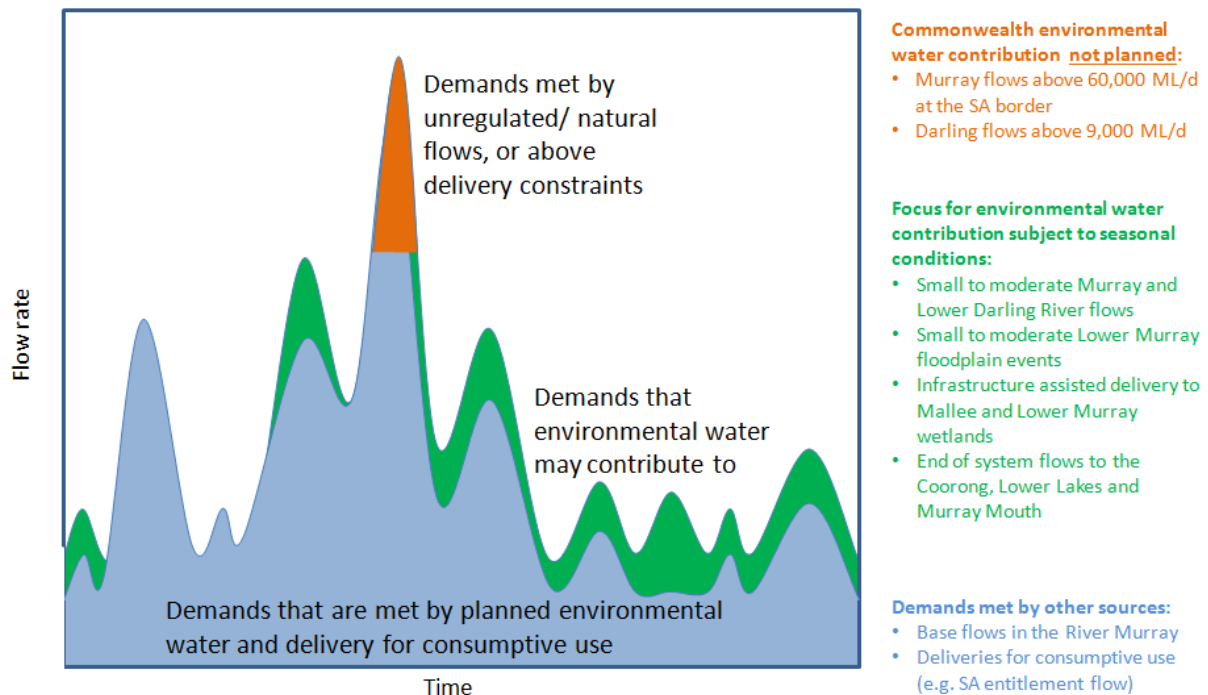


Figure 3: Scope of demands that environmental water may contribute to in the Lower Murray–Darling Region (MDBA 2013, Department of the Environment 2011 and unpublished)

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

- Menindee Lakes will be managed by New South Wales while storage levels remain 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 will revert 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 or greater are not within scope for environmental water use in 2015–16.
- 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 Murray–Darling Basin Authority, 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.

Table 4: Constraints on environmental watering for the Lower Murray–Darling Region

Inflows	Very low	Low	Moderate	High	Very high
Constraints					
Trade restrictions may limit the delivery of environmental water downstream of the Barmah Choke during periods of high consumptive/irrigation demands					
Flow thresholds to avoid third-party impacts, such as inundation of private land or crossings, or to avoid adverse environmental impacts, or impacts to river works may constrain the delivery rate of environmental water, particularly targeted peak flow rates.					
Release capacities and available volumes within storages may limit the extent that river flows may be augmented using environmental water.					

Based on the outcomes sought in Section 3.3 and these delivery constraints, Table 5 identifies flows that are in scope for Commonwealth environmental watering. Some specific watering requirements (flow magnitude, duration, timing and frequency) have also been listed, drawn from existing resources. The watering requirements for the Lower Murray–Darling Region will be developed in full by the state government as part of their long-term watering plan and will be reflected in future planning documents by the Office.

Table 5: Long-term indicative elements of a flow regime in scope for Commonwealth environmental watering in the Lower Murray–Darling Region

Environmental asset	Indicative demands / actions	Frequency (Maximum dry interval)
Lower Darling River	Small to moderate river flow (7 000 ML/day @ Weir 32 for 10 days in summer)	1-2 in 5 years (max interval unknown)
Great Darling Anabranch	1 500-2 000 ML/day from Menindee Lakes for 30-45 days	1 in 2 years (max interval unknown)
River Murray from Euston to Lower Lakes	River flow of at least 10 000 ML/day @ SA border for up to 60 days in spring/summer	9 in 10 years (2 years)
	River flow of 15 000-25 000 ML/day @ SA border for up to 90 days in spring/summer	2 in 3 years (2 years)
	River flow of 25 000-35 000 ML/day @ SA border for up to 60 days in spring/summer	1 in 2 years (3 years)
Hattah Lakes	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)
	Moderate action targeting wetlands and fringing river red gums (inundation to 43.5 m AHD for 90 days in	1 in 3 years (7 years)

	winter/spring) – up to 40 000 ML via infrastructure, equivalent to natural event of 85 000 ML/day at Euston for 7 - 30 days.	
	Large action targeting wetlands 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 @ Euston for 7 days anytime in the year	1 in 8 years (12 years)
Floodplain and Wetlands from Euston to South Australian border	30 000 ML/day @ Lock 8 for 30-60 days targeting low lying wetlands and anabranches, or priority areas via infrastructure	2 in 5 years (4 years)
	50 000-60 000 ML/day @ 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)
	Infrastructure delivery to priority areas of floodplain equivalent to 80 000 ML/day @ Lock 8 targeting river red gum and black box woodland and associated wetlands	1-2 in 10 years (8 years)
Floodplain and Wetlands from South Australian border to Lower Lakes	40 000-50 000 ML/day @ South Australian border for up to 90 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)
	50 000-60 000 ML/day @ South Australian border for up to 90 days targeting river red gum woodland, black box, cooba, tea tree and lignum and associated wetlands, or priority area via infrastructure	1-2 in 5 years (3 years)
	Infrastructure delivery to priority areas 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)
Coorong, Lower Lakes and Murray Mouth	Minimum barrage flow of 650 GL/yr	1 in 1 year
	Barrage flows of 2 000 GL/yr required to achieve salinity target in Lake Alexandrina	Rolling three year average
	Barrage flows of at least 2 500 GL over two years to avoid damage and protect habitat conditions within the Coorong	9 in 10 years (1 year)
	Barrage flows of 6 000 GL every three to five years to maintain and improve habitat conditions within the Coorong	1 in 3 years (5 years)
	Barrage flows of 10 000 GL every seven to seventeen years to improve habitat conditions within the Coorong	1 in 7 years (17 years)

Specific references identified at Table 2

3.5. 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 availability to deliver environmental water. Table 6 identifies the range of potential watering actions in Lower Murray-Darling Region and the levels of water resource availability that relate to these actions.

Table 6: Summary of potential watering actions for the Lower Murray–Darling Region

Environmental Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
Lower Darling River	Small to moderate river flow (7 000 ML/day @ Weir 32 for 10 days in summer)			1: Lower Darling River Flows: Contribute to baseflows and freshes in the Lower Darling River		
Great Darling Anabranch	1 500-2 000 ML/day from Menindee Lakes for 30-45 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 its lakes		
River Murray channel from Euston to Lower Lakes, including fringing wetlands	River flow of at least 10 000 ML/day @ SA border for up to 60 days in spring/summer River flow of 15-25 0000 ML/day @ SA border for up to 90 days in spring/summer River flow of 25-35 0000 ML/day @ SA border for up to 60 days in spring/summer		3. River Murray Channel Flows: Contribute to in-channel baseflows 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 22 000 ML via infrastructure, equivalent to natural event of 40-50 000 ML/day at Euston for 26-60 days 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 30 days. Large action targeting wetlands 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 @ 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: Wetlands and Fringing River Red Gums: Contribute flows via pumping to inundate wetlands and fringing river red gum communities.			
				4c. Infrastructure Delivery: Wetlands and Floodplain: Contribute flows via pumping targeting red gum woodlands on the lower floodplain and black box on higher level floodplain. 5. Hattah Lakes Overbank Flows: use infrastructure (pumping and regulators) to increase extent and duration of inundation of wetlands and floodplain.		
Floodplain and wetlands from Euston to South Australian border	30 000 ML/day @ Lock 8 for 30-60 days targeting low lying wetlands and anabranches, or portion via infrastructure		6. 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			
	50-60 000 ML/day @ Lock 8 for 60-120 days targeting river red gum forest, lignum shrubland and associated wetlands, or portion via	7. Infrastructure Delivery: Mallee Wetlands: Contribute flows via wetland regulators and/or pumping to inundate semi-permanent, temporary and ephemeral wetlands				

Environmental Asset	Indicative demand	Applicable level(s) of resource availability				
		Very Low	Low	Moderate	High	Very High
	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			8. <i>Contribution to Overbank Flows</i> : Contribute to flows to re-connect river with river red gum forest and lignum shrubland, subject to appropriate trigger		
Floodplain and wetlands from South Australian border to Lower Lakes	40-50 000 ML/day @ South Australian border for up to 90 days targeting river red gum forest, tea tree, lignum, river cooba and associated wetlands, or portion via infrastructure			9. <i>Infrastructure Delivery: Chowilla Floodplain</i> : Use Chowilla Floodplain infrastructure to deliver pulse flows to creeks and inundate parts of the floodplain		
	50-60 000 ML/day @ South Australian border for up to 90 days targeting river red gum woodland, black box, cooba, tea tree and lignum and associated wetlands, or portion via infrastructure	10. <i>Infrastructure Delivery: Lower Murray Wetlands</i> : Contribute flows via wetland regulators and pumping to inundate semi-permanent, temporary and ephemeral wetlands				
	Infrastructure delivery to a portion equivalent to 60-70 000 ML/day @ South Australian border targeting black box, cooba, lignum and chenopod and associated wetlands			11. <i>Contribution to Overbank Flows</i> : Contribute to flows to re-connect river with river red gum forest and lignum shrubland, subject to appropriate trigger		
Coorong, Lower lakes and Murray Mouth	Minimum barrage flow of 650 GL/yr Barrage flows of 2 000 GL/yr required to achieve salinity target in Lake Alexandrina Barrage flows of at least 2 500 GL over two years to avoid damage and protect habitat conditions within the Coorong Barrage flows of 6 000 GL every three years to maintain and improve habitat conditions within the Coorong	12a. <i>Seasonal Lake Level Variation</i> : Between 0.40 m AHD and 0.70 m AHD annually. <i>Fishway Flows</i> : Maintain minimum fishway flows. <i>Differential Barrage Releases</i> : To provide for seasonally appropriate water levels in the Coorong and connectivity between the Lower Lakes and the Murray Mouth.				
	Barrage flows of 10 000 GL every seven years to improve habitat conditions within the Coorong			12b. <i>Seasonal Lake Level Variation</i> : Between 0.50 m AHD and 0.85 m AHD one in three years. <i>Fishway Flows</i> : Maintain minimum fishway flows. <i>Differential barrage releases</i> : To provide for seasonally appropriate water levels in the Coorong and connectivity between the Lower Lakes and the Murray Mouth.		

Information sourced from: MDBA 2014; Department of the Environment 2014; Department of the Environment 2011 and unpublished; MDBA 2013 (a-i); Wallace *et al.* 2014, Ecological Associates 2015, Ecological Associates 2010

3.6. Potential watering actions – standard operational considerations

Table 6 above identifies the range of potential watering actions in the Lower Murray-Darling that give effect to the long-term demands and flow regime identified as being in scope for the Office to contribute environmental water to in any given year. Some of 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.
- Due to the low volume of entitlements held in the Lower Darling, Commonwealth environmental water held elsewhere in the southern connected basin needs to be transferred for this action to be feasible.

Typical extent: Lower Darling River (in-channel channel flow) from Menindee Lakes to the confluence with River Murray.

Approvals: This option would be implemented with state and regional authorities who will play a key role in liaising with local landholders and water resource managers, and undertaking the relevant approvals to implement the watering action.

Watering action 2: Great Darling Anabranh flows

Standard operational considerations

- Commonwealth environmental water may be provided to contribute to baseflows and freshes in the Great Darling Anabranh providing connectivity between the Anabranh channel and the River Murray, and between the Anabranh 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 Anabranh channel.
- Operational consideration as for Action 1.

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

Approvals: This option would be implemented with state and regional authorities who will play a key role in liaising with local landholders and water resource managers, and undertaking the relevant approvals to implement the watering action.

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, 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.

Typical extent: River Murray from Euston to the Lower Lakes, up to a flow rate within the operational constraints identified in Figure 4 to avoid impacting landholders on the Lower Darling and at Morgan in South Australia. This option can also contribute to the Coorong, Lower Lakes and Murray Mouth (Actions 13-15). Regulators may also be used to allow flows to enter low lying anabranches and fringing wetlands (Actions 8 and 11).

Approvals: This option would be implemented with local delivery partners, who will play a key role in engaging with the local community and third parties and implementing the action. As this option may be constrained by other demands in the system, the Office will seek advice from river operators on the timing, magnitude and duration of a proposed action.

Watering action 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 5 000 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 achieve 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 facilitated 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 magnitude, 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 to 120 000 ML is possible via infrastructure, equivalent to a natural event of 150 000 ML/day @ Euston for 7 days anytime in the year.

Approvals: This option would be implemented with local delivery partners, who will play a key role in engaging with the local community and third parties and implementing the action.

Watering actions 5, 8 and 11: Contribution to Overbank Flows (within constraints)

Standard operational considerations

- Environmental water may be contributed to channel flows to connect the River Murray with areas of floodplain from Euston through to Wellington (subject to flow constraints at Figure 3). Elevated natural flows are required for environmental water to piggy-back on and resource availability may often 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 releases 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 in Figure 4. Actions 4, 6, 7, 9 and 10 can use infrastructure to provide inundation of higher elevation areas on the floodplain that are not currently achievable by overbank flows within current operational constraints.

Approvals: This option would be implemented by river operators, with local delivery partners performing a key role in engaging with the local community and private landholders to implement a high flow action.

Watering action 6: 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.

Approvals: This option would be implemented by regional authorities and water managers, who will play a key role in engaging with the local community and third parties and implementing the action. Potentially affected landholders (as a result of inundation of private land or access tracks, or on pumping infrastructure that relies on the weir pools) are consulted as part of weir pool manipulation activities.

Watering actions 7 and 10: 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 the Mallee Catchment Management Authority, Victorian Environmental Water Holder, New South Wales Office of Environment and Heritage and Murray-Darling Wetlands Working Group. In South Australia, water is delivered via Natural Resources South Australian Murray-Darling Basin, the Nature Foundation South Australia and site managers (e.g. Banrock Station).
- Key operational considerations including 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.

Approvals: Wetland watering occurs on a range of public and private land and input and/or consent of landholders, community groups and other agencies is important.

Watering action 9: 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 infrastructure 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.
- Adequate flows need to be maintained through fishways to ensure suitable velocities for effective operation.
- Saline water 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 in anabranches and creeks through to supporting the inundation of large areas of floodplain and high elevation wetlands.

Approvals: This option would be implemented with local delivery partners, who will play a key role in engaging with the local community and other third parties to implement a watering action.

Watering action 12: Seasonal lake level variation, differential 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 barrage operations are managed complementarily 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 by seasonally appropriate water level ranges that are appropriate for lake vegetation outcomes accommodating higher water levels in spring and lower water levels in summer-autumn. The effects of wind seiche can have a dramatic impact on water levels in the Lower Lakes including up to Lock 1. Minimum water levels of at least 0.45-0.40 mAHD for managing acid sulphate soils in the Lower Murray Swamps will be maintained for pump access to support management of floodplains in the lower Murray swamps.
- Flows into the Coorong are managed through the barrages situated on Lake Alexandrina. Barrage releases are managed to maintain minimum fishway flows, manage water quality and water levels within the Coorong, with reference to seasonally appropriate lake water levels.
- Commonwealth environmental water will provide continuous barrage flows to contribute to maintaining an open Murray Mouth which is especially important for 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) within the Coorong Southern Lagoon.
- Specific target lake levels and barrage release rates will reflect seasonal conditions and be agreed by all parties as part of a short term operating plan for the Coorong, Lower Lakes and Murray Mouth.

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

Approvals: These watering actions will be implemented in conjunction with the South Australian Department of Environment, Water and Natural Resources, SA Water and the Murray-Darling Basin Authority.

4. Long-term water availability

4.1. 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)

In addition the Commonwealth holds entitlements in the Southern Connected Basin that can be used to deliver environmental water to the Lower Murray-Darling Region. 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.

4.2. 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 of Environment, Water and Natural Resources
- South Australian environmental water reserve – South Australian Department of Environment, Water and Natural Resources
- Bulk Entitlement – Victorian Environmental Water Holder
- New South Wales Adaptive environmental water entitlement – New South Wales Office of Environment and Heritage

4.3. 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 2003* (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

5. Next steps

5.1. From planning to decision making

It is important to distinguish between planning and operational decision making. As shown in Figure 4, planning allows the Office 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).

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

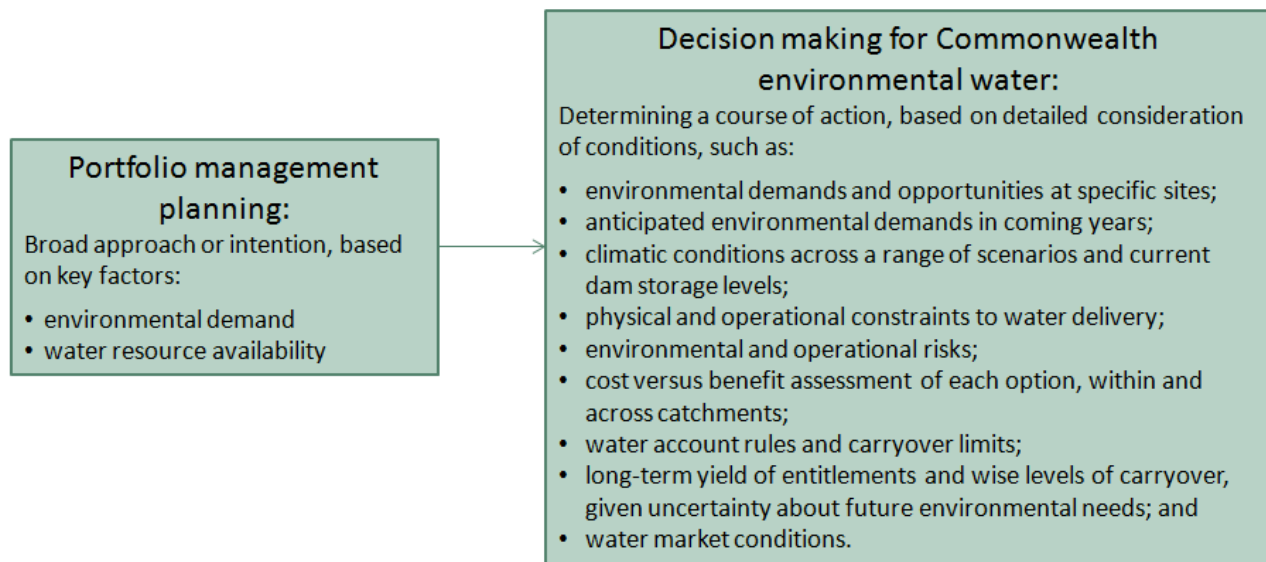


Figure 4: Planning and decision making for Commonwealth environmental water use

5.2. Further information

For further information on how the Office plans for water use, carryover and trade, please visit our web site www.environment.gov.au/topics/water/commonwealth-environmental-water-office

- 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: *Discussion Paper – Trade of Commonwealth Environmental Water and Commonwealth Environmental Water Trading Framework*: <http://www.environment.gov.au/water/cewo/trade/trading-framework>

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

Expected outcomes from the Basin-wide Environmental Watering Strategy (MDBA 2014) that are relevant to the Lower Murray 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 2 000 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 (0m 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 1,000 EC 95 per cent of the time and less than 1,500 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 <i>Ruppia tuberosa</i> in the Coorong
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		Percent of vegetation assessed (within the managed floodplain)
	0 – 6	>6 – 10	
Murray (assessment is for entire Murray catchment)	33 per cent	65 per cent	28 per cent
Lower Darling	72 per cent	28 per cent	85 per cent

River red gum condition

Region	Vegetation condition score					Percent of vegetation assessed (within the managed floodplain)
	0 – 2	>2 – 4	>4 – 6	>6 – 8	>8 – 10	
Murray (assessment is for entire Murray catchment)	2 per cent	1 per cent	10 per cent	51 per cent	35 per cent	51 per cent
Lower Darling	11 per cent	5 per cent	7 per cent	41 per cent	35 per cent	92 per cent

WATERBIRDS

Maintain current species diversity

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

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

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

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		*			Yes
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 mullocky, including spawning aggregations at the Murray mouth in six out of 10 years and recruitment in at least five out of 10 years.

Key species for the Lower Murray include:

Species	Specific outcomes	In-scope for C'th watering?
Diadromous species (Congolli, short-headed and pouched lamprey)	Upstream expansion facilitated through flows to operate fishways.	Yes
Flathead galaxias (<i>Galaxias rostratus</i>)	Expand the core range in the wetlands of the River Murray.	Yes
Freshwater catfish (<i>Tandanus tandanus</i>)	-	Yes
Golden Perch (<i>Macquaria ambigua</i>)	A 10–15 per cent increase of mature fish (of legal take size) in key populations	Yes
Murray cod (<i>Maccullochella peelii peelii</i>)	A 10–15 per cent increase of mature fish (of legal take size) in key populations	Yes
Murray hardyhead (<i>Craterocephalus fluviatilis</i>)	Expand the range of at least two current populations: Establish 3–4 additional populations, with at least two of these to be within the lower Murray conservation unit and a further population potentially within the Kerang Lakes region.	Yes
Olive perchlet (<i>Ambassis agassizii</i>)	Olive perchlet are considered extinct in the southern Basin. Reintroduction using northern populations is the main option for recovery. Candidate sites may result from improved flow that reinstates suitable habitat in the River Murray.	Restoration of flow to River Murray could support the future reintroduction of the species.
Silver perch (<i>Bidyanus bidyanus</i>)	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 (<i>Mogurnda adspersa</i>)	Expand the range of current populations (including Jury Swamp).	Yes
Southern pygmy perch (<i>Nannoperca australis</i>)	Establish additional populations in the Lower Lakes	Only if additional populations are established
Trout cod (<i>Maccullochella macquariensis</i>)	For the connected population of the Murrumbidgee–Murray–Edwards, continue downstream expansion.	Yes
Two-spined blackfish (<i>Gadopsis bispinosus</i>)	Establish additional populations (no specific locations identified)	Yes
Yarra pygmy perch (<i>Nannoperca obscura</i>)	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–Mularoo Creek	*	*	*	*	*	*	Yes
Lower Darling main channel	*	*	*	*	*	*	Yes
Darling anabranch			*			*	Yes
Hattah Lakes			*			*	Yes
Euston Lakes (including Washpen and Taila Creeks)					*		Yes

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