# 2018-19 Annual Environmental Watering Plan

FOR THE SOUTH AUSTRALIAN RIVER MURRAY

August 2018

**Published by the Department for Environment and Water**
**Government of South Australia**
**August 2018**

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Preferred citing for this publication:

*2018-19 Annual Environmental Watering Plan for the South Australian River Murray*, Government of South Australia, through Department for Environment and Water, Adelaide

Download this document at: **http://www.environment.sa.gov.au**

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# Foreword

The *2018-19 Annual Environmental Watering Plan for the South Australian River Murray* (the Annual Plan) is one of the key elements in South Australia's river management framework. It builds upon work done in previous Environmental Watering Plans, as well as work completed through the development of the *Long-Term Environmental Watering Plan for the South Australian River Murray 2015*.

The Annual Plan reflects key planning and prioritisation requirements of the Murray-Darling Basin Plan. In doing so, it presents the water requirements for South Australia's priority environmental assets under a range of climatic conditions. A wide range of stakeholders have been engaged in its development, supporting a transparent process to determine environmental watering priorities.

Each year the water resource outlook is different, volumes of available environmental water change and environmental watering priorities vary. This presents a challenge to water holders and managers to maximise outcomes from the available resources. The outlook for 2018-19 is for dry conditions in the Murray-Darling Basin, which would see not only low natural flows but also a limited availability of water for the environment. Despite this, it is well understood that conditions can change rapidly; therefore the plan presents the priority needs under a wide range of conditions.

I would like to thank all those who have been involved in the planning, management and delivery of water for the environment and look forward to another successful watering year in 2018-19.

**Ben Bruce, Group Executive Director, Water**
Department for Environment and Water
August 2018

Black bream. SARDI Aquatic Sciences.

# Acknowledgements

The Department for Environment and Water acknowledges and pays respect to the Traditional owners, and their Nations, of the Murray-Darling Basin, who have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters.

In addition to staff in the Department for Environment and Water (DEW), input from representatives and employees of the following organisations has been gratefully received:

- Banrock Station
- Chowilla Community Reference Committee
- Commonwealth Environmental Water Office (CEWO)
- Coorong, Lower Lakes and Murray Mouth Community Advisory Panel (CAP)
- First Peoples of the River Murray and Mallee Regions
- Local Action Planning Groups (LAP Groups) and Landcare groups
- Murray-Darling Basin Authority (MDBA)
- Nature Foundation South Australia (NFSA)
- Ngarrindjeri Regional Authority (NRA), including the Mannum Aboriginal Community Association Incorporated
- Renmark Irrigation Trust (RIT)
- River Murray Advisory Committee (RMAC)
- Scientific Advisory Group for the Lower Lakes, Coorong and Murray Mouth (SAG)
- South Australian Murray-Darling Basin Natural Resources Management (SA MDB NRM) Board
- South Australian Research and Development Institute (SARDI), and
- Other South Australian government departments through interagency reference groups.

Royal spoonbills and black-winged stilts. Photo by Peter Mettam, DEW.

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Yellow-billed spoonbill chicks. Photo by Adrienne Rumbelow, DEW.

# Summary

The Annual Plan presents the State's preferences for environmental water delivery along the South Australian River Murray for the 2018-19 water year. It describes water delivery requirements to best achieve a range of environmental outcomes for the South Australian stretch of the river and its floodplains, consistent with requirements under the Murray-Darling Basin Authority (MDBA) Basin Plan ('the Basin Plan'). In doing so it identifies opportunities to maximise outcomes from watering in South Australia by using return flows from upstream watering actions and promotes delivery of environmental water to the Coorong, Lower Lakes and Murray Mouth (CLLMM) while providing benefits to upstream environmental assets and functions en route.

The Annual Plan is presented as follows:

Section 1 provides background information relating to environmental watering including the purpose of the document and recent hydrological conditions in the region.

Section 2 describes the process used to develop the Annual Plan with a focus on summarising how environmental managers engaged with external stakeholders and Indigenous groups, and assessed any potential risks when developing their environmental watering proposals.

Section 3 highlights the linkages between the objectives for environmental watering in South Australia and the overall environmental objectives for water-dependent ecosystems identified in the Basin Plan (Chapter 8, Part 2) as well as the management objectives of the major environmental water holders.

Section 4 presents the annual environmental watering priorities for the SA River Murray water resource plan area, which were submitted to the MDBA in accordance with Basin Plan requirements. It also describes a multi-site watering action for the use of environmental water within the South Australian River Murray region. This

SA multi-site demonstrates how the effectiveness of environmental water delivery can be maximised through aligning the timing, magnitude and duration of watering actions at multiple locations throughout the SA River Murray region.

Section 5 provides practical information for implementing environmental watering actions, including an overview of licensing, trade, accounting and reporting mechanisms.

Caspian terns. Photo by Kirsty Wedge, DEW.

# 1. Introduction

## 1.1. Purpose of this Plan

The Annual Plan guides environmental water delivery in the South Australian region of the River Murray, and has been developed in consultation with key stakeholders. The Annual Plan presents the priorities for environmental watering within the current water year and aligns with the requirements of the Basin Plan.

The purpose of this document is to:

- Define South Australia's priority environmental water needs and inform water holders of the preferred patterns of delivery for 2018-19;
- Guide the delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian Lower Murray system;
- Identify opportunities, where appropriate, to enhance environmental outcomes through the operation of infrastructure;
- Make information on priority environmental watering activities available to stakeholders; and
- Meet the requirements of the Basin Plan as well as the South Australian *Natural Resources Management Act 2004.*

The Annual Plan is a key part of South Australia's environmental water management framework (see Appendix A) and integrates the proposed watering activities of several groups. It has been developed based on the best available data and science; however, it may be subject to change depending on actual water availability and climatic conditions, which will inform real-time and adaptive water use.

This is the third Annual Plan to be developed since the publication of the Long-Term Environmental Watering Plan (LTWP) for the South Australian River Murray Water Resource Plan Area (Department of Environment Water and Natural Resources, 2015). The Basin Plan requires long-term plans to be developed by Basin States with specific content requirements, including the identification of the priority environmental assets of the region, as well as their ecological objectives, targets and environmental watering requirements (EWRs). The LTWP identifies three priority environmental assets for the region – the Coorong, Lower Lakes and Murray Mouth (CLLMM), the River Murray Channel and the River Murray Floodplain. The priorities for watering in 2018-19 identified in this Annual Plan are consistent with the assets and EWRs described in the LTWP, as well as being consistent with the Basin-Wide Environmental Watering Strategy (Murray-Darling Basin Authority, 2014a).

The South Australian environmental water planning and management framework includes the development of the Annual Environmental Watering Priorities, the Annual Plan, the Annual Report, the LTWP, the State's environmental watering policy and procedures, the State's contribution to basin-wide environmental watering policy reform, and management of the environmental water received by South Australia from the Commonwealth Environmental Water Holder (CEWH), The Living Murray Program (TLM) and other environmental water holders.

## 1.2. What is environmental watering?

Environmental watering is the delivery or use of water to achieve environmental outcomes – that is, ecological benefits that contribute to a healthy, working river. Environmental watering ensures that important values of the South Australian River Murray, its wetlands and floodplains, and the CLLMM are maintained and that environmental objectives are achieved.

Environmental water management along the River Murray in South Australia is coordinated by the Department for Environment and Water (DEW), with significant input from other government agencies, non-government organisations, scientific bodies and community stakeholders.

*On-ground management*

DEW coordinates environmental water delivery; working closely with SA Water and environmental water holders, the community and jurisdictions upstream.

DEW has responsibility for the management of TLM icon sites within South Australia – the Chowilla Floodplain, the River Murray Channel and the CLLMM. This includes management of environmental watering activities, monitoring, infrastructure and associated projects at TLM icon sites and a range of other sites in the SA MDB. DEW coordinates and oversees the management of infrastructure (e.g. raising weir pools, operating flow control structures and regulators on wetlands).

A number of non-government organisations are involved in on-ground environmental water management and monitoring including Australian Landscape Trust (ALT), Banrock Station, Local Action Planning (LAP) and Landcare Groups, Nature Foundation South Australia (NFSA), Ngarrindjeri Regional Authority (NRA) and Renmark Irrigation Trust (RIT). These organisations facilitate grass roots environmental activities with local landholders and other community groups.

*Environmental water categories*

Environmental water is generally described as 'held' or 'planned' environmental water, where:

- **Held environmental water** is water held on the licence of a water holder who determines that this water will be used for environmental watering activities. Held environmental water may be either a purchased allocation or an allocation granted under the water holder's entitlements. This can be flexibly managed and released according to demands /agreed actions; and
- **Planned environmental water** is water that is not held on a water licence, but may be committed under State water management law for environmental purposes and managed through river operations. There is little flexibility in its use.

Potential sources and volumes of held and planned environmental water for 2018-19 are described in this document and in the LTWP (Department of Environment Water and Natural Resources, 2015).

## 1.3. The 2017-18 water year in review

A brief history of the 2017-18 year is outlined below to provide some context to the conditions leading up to the 2018-19 year. More information from earlier years can be found on the DEW website at http://www.environment.sa.gov.au/managing-natural-resources/river-murray/restoring-river-health/environmental-water.

South Australia received entitlement flow throughout 2017-18 and there was only a very brief unregulated flow event in December. Flows to South Australia peaked at 17,000 ML/day between December and January.

In total, approximately 1175 GL of environmental water was delivered to South Australia. The Commonwealth Environmental Water Holder provided approximately 947 GL (including approximately 154 GL held on licences in South Australia) and the Living Murray approximately 176 GL (including 45 GL held on licences in South Australia) of environmental water to South Australia in 2017-18. South Australia also received approximately 30 GL of environmental water in the form of return flows from upstream watering actions undertaken by the Victorian Environmental Water Holder (VEWH). Approximately 44 GL of environmental water held by the then South Australian Minister for Water and the River Murray was

delivered to pool-connected wetlands, temporary wetlands and the CLLMM. An additional 53 GL of River Murray Increased Flow (RMIF) was also delivered. The monthly delivery profile is presented in Figure 1.

Environmental water delivered to South Australia was used to support numerous watering actions throughout the year, including:

- Lowering of Weir 6 by 18 cm in autumn;
- Raising of Weir 2 by 50 cm and Weir 5 by 45 cm in spring;
- Inundation of over 40 temporary wetland and floodplain areas (including wetlands on Chowilla Floodplain and sites managed by DEW, Australian Landscape Trust, Banrock Station and NFSA) via pumping or irrigation;
- Wetting and drying of pool-connected wetlands; and
- Management of the CLLMM throughout the year including manipulating water levels in the Lower Lakes, and barrage and fishway releases.

Some of the key ecological outcomes from these environmental watering actions were:

- Improved in-stream productivity;
- Improved condition of riparian vegetation communities;
- Enhanced survival of seedlings and saplings of native floodplain tree species that germinated during previous high flow and managed inundation events;
- Frog breeding, including successful metamorphosis of southern bell frogs;
- Fishway and barrage outflows throughout the year providing continuous connectivity between the River and its estuary, and significant salt export from the Murray-Darling Basin;
- Significant diadromous fish migration, including winter migration by pouched lampreys;
- Large numbers of colonial waterbirds nesting in the Lower Lakes; and
- Spawning and recruitment of black bream in the Coorong estuary due to the creation of suitable salt wedge conditions through targeted barrage releases.

More information on the outcomes of the environmental watering actions in 2017-18 will be presented in the annual environmental watering report that is produced in late 2018.

Pouched lamprey which were trapped and tagged during monitoring at the barrages. Photo by Chris Bice, SARDI Aquatic Sciences.

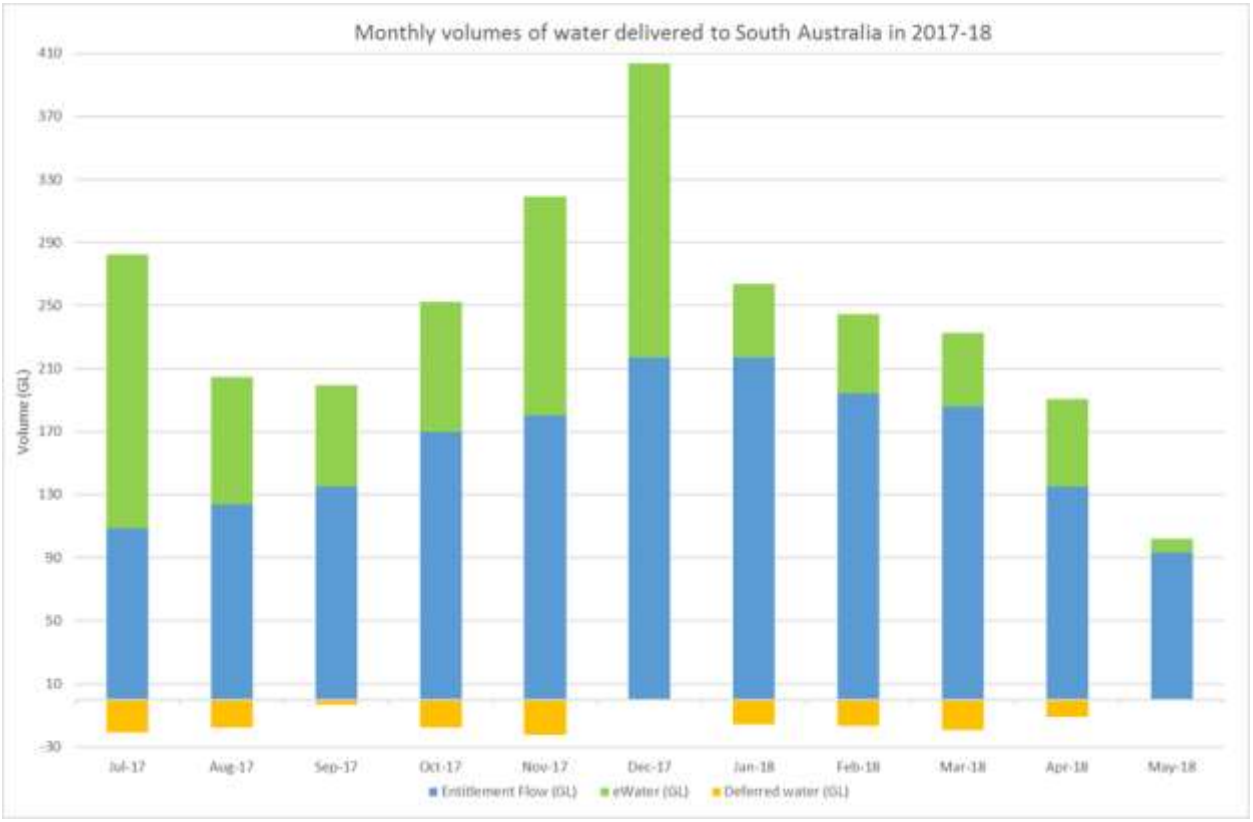


**Figure 1. Monthly volumes of water delivered to South Australia in 2017-18**

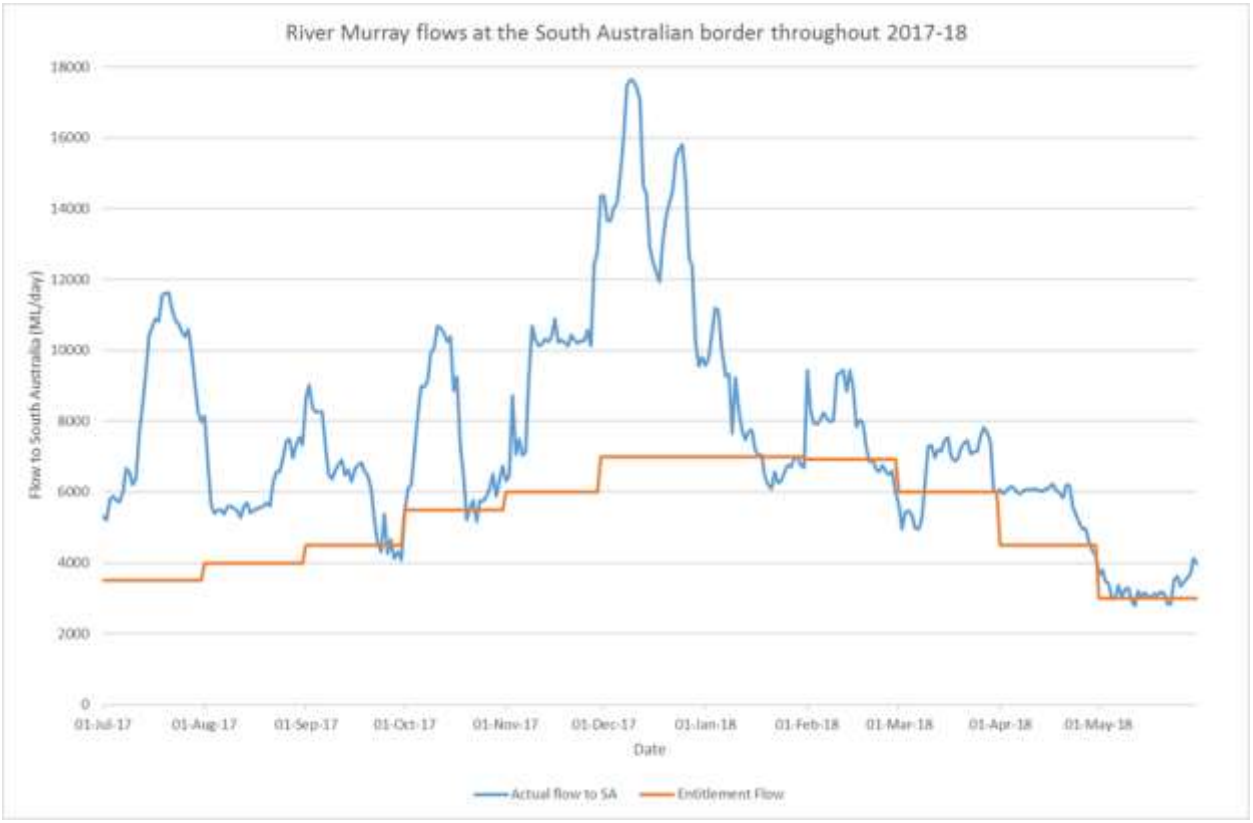


**Figure 2. River Murray flows at the South Australian border throughout 2017-18**

# 2. Annual Planning Process

## 2.1. Approach

Annual planning commences each February and incorporates the development of the State annual environmental watering priorities. Within South Australia, the annual planning and prioritisation process is led by DEW, with input from site and water managers, Traditional owners and stakeholder groups.

The Basin Plan requires Basin States to identify their annual environmental watering priorities for the upcoming water year and submit these to the MDBA by 31 May. After being submitted to the MDBA, the priorities together with additional, complementary information are compiled in the Annual Plan and published on the DEW website at a later date. Both the annual priorities and the Annual Plan are underpinned by the watering proposals developed by site managers. Watering proposals developed for sites in the South Australian River Murray region in 2018-19 and their proponents are listed in Table 1.

Preparation of the priorities provides an opportunity to consolidate the suite of watering actions proposed for the South Australian River Murray for the upcoming water year. This work is useful for coordinating watering along the Murray, informing decisions relating to water delivery and evaluating environmental outcomes.

In addition to the large scale actions identified in the annual priorities, managed wetting and drying of pool-connected wetlands and pumping to temporary wetlands will be undertaken by DEW, Nature Foundation SA, Renmark Irrigation Trust, Banrock Station and the Australian Landscape Trust.

**Table 1. Environmental watering proposals submitted to MDBA and/or CEWO for 2018-19**

| Watering Proposal | Proponent |
|---|---|
| **Lower Lakes, Coorong and Murray Mouth** | CLLMM Icon Site Coordinator (DEW) |
| **SA River Murray Channel** | Environmental Water Policy Officer (DEW) |
| **Chowilla Floodplain** | Chowilla Icon Site Coordinator (DEW) |
| **Weir Manipulation – raising and lowering** | Environmental Water Policy Officer (DEW) and SARFIIP Project Manager (DEW) |
| **Valley Wetlands, Gorge wetlands, Lower Lakes fringing wetlands, Disher Creek and Berri Disposal Basins** | SA MDB Natural Resources Floodplain and Wetland Team (DEW) |
| **Wetlands in the Renmark area** | Renmark Irrigation Trust[1] |
| **Various wetlands** | Nature Foundation SA |

## 2.2. Community Engagement

A wide range of stakeholders and community groups were consulted regarding the environmental watering actions proposed for 2018-19. This consultation is undertaken by the respective site managers through long-standing arrangements. The stakeholders consulted during the development of the proposals included the CLLMM Community Advisory Panel, CLLMM Scientific Advisory Group, Chowilla Community Reference Committee, Local Action Planning Associations, Landcare organisations, local government, private landholders, industry groups and the general public. Consultation occurred via meetings at which annual priorities were presented and discussed, and on site tours. Some groups also had the opportunity to provide comment on written watering proposals. Engagement between DEW and non-government organisations

1 Due to time constraints, NGO watering proposals were not available for inclusion in the annual priorities

(NGOs) that deliver environmental water to wetlands also occurs to coordinate wetland management activities across the region.

## 2.3. Indigenous Engagement

During development of the 2018-19 Annual Plan, Indigenous engagement was undertaken by the environmental water managers when developing their watering proposals. This included engagement with the Ngarrindjeri Regional Authority (NRA) on watering objectives and actions proposed for the CLLMM and the River Murray Channel and Floodplain, and with the First Peoples of the River Murray and Mallee Region (FPRMM) on the actions proposed for the Chowilla Floodplain, the River Murray Channel and Floodplain, wetland pumping and weir manipulation watering actions.

## 2.4. Risk Assessment

Risks related to the planned environmental watering actions for 2018-19 have been identified and assessed in accordance with DEW's Risk Management Framework for Water Planning and Management. Risk management is undertaken in accordance with Basin Plan requirements, which includes consideration of flow management targets for a number of key water quality factors (including dissolved oxygen, cyanobacteria or bio-volume and salinity). In particular, site and water managers consider potential water quality impacts during annual and real-time planning (including potential cumulative impacts from multi-site actions), manage any risks that may emerge once water is being delivered in real time, and report annually on how they have had regard for flow management targets as part of their obligations under Schedule 12, Matter 14 of the Basin Plan. Guidelines have been developed to assist South Australian river operators, environmental water managers and holders of environmental water to have regard to these targets when planning and making flow management decisions.

Wedged-tail eagle chick at Chowilla. Photo by Helga Kiescamp.

# 3. Environmental Watering Objectives

The high-level objectives of environmental watering in South Australia during 2018-19 are to:

- Coordinate the delivery of environmental water to South Australia to maximise the potential outcomes for floodplains, wetlands, the channel and the CLLMM;
- Maintain and/or improve bird, vegetation and fish communities subject to the prevailing conditions;
- Maximise outcomes from watering in South Australia by using return flows where possible;
- Deliver environmental water to the CLLMM while providing benefits to upstream environmental assets and functions en route;
- Maximise environmental outcomes through the operation of infrastructure where appropriate; and
- Deliver environmental water consistent with the EWRs of the SA River Murray LTWP and contribute to the ecological objectives for priority environmental assets and priority ecosystem functions described in the SA River Murray LTWP.

The ecological objectives for specific watering activities are summarised in Section 4 and detailed in Appendix B. The high-level and specific ecological objectives are consistent with the objectives of the Basin Plan (Table 2), and TLM and CEWH ecological watering and management objectives (Table 3).

Black box and understorey at Chowilla. Photo by Alison Stokes, DEW.

**Table 2. Basin Plan overall environmental objectives (Chapter 8, Part 2)**

| | |
|---|---|
| | **Overall Environmental Objectives** |
| 8.04 (a) | to protect and restore water-dependent ecosystems of the Murray-Darling Basin |
| 8.04 (b) | to protect and restore the ecosystem functions of water-dependent ecosystems |
| 8.04 (c) | to ensure that water-dependent ecosystems are resilient to climate change and other risks and threats |
| | **Protection and Restoration of Water-Dependent Ecosystems Objectives** |
| 8.05 (2) | to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that:<br>(a) declared Ramsar wetlands that depend on Basin water resources maintain their ecological character; and<br>(b) water-dependent ecosystems that depend on Basin water resources and support the life cycles of species listed under the Bonn Convention, CAMBA, JAMBA or ROKAMBA continue to support those species; and<br>(c) water-dependent ecosystems are able to support episodically high ecological productivity and its ecological dispersal. |
| 8.05 (3) | to protect and restore biodiversity that is dependent on Basin water resources by ensuring that:<br>(a) water-dependent ecosystems that support the life cycles of a listed threatened species or listed threatened ecological community, or species treated as threatened or endangered (however described) in state law, are protected and, if necessary, restored so that they continue to support those life cycles; and<br>(b) representative populations and communities of native biota are protected and, if necessary, restored. |
| | **Protection and Restoration of Ecosystem Functions of Water-Dependent Ecosystems Objectives** |
| 8.06 (2) | that the water quality of Basin water resources does not adversely affect water-dependent ecosystems and is consistent with the water quality and salinity management plan. |
| 8.06 (3) | to protect and restore connectivity within and between water-dependent ecosystems, including by ensuring that:<br>(a) the diversity and dynamics of geomorphic structures, habitats, species and genes are protected and restored; and<br>(b) ecological processes dependent on hydrologic connectivity…<br>(i) longitudinally along watercourses; and<br>(ii) laterally between watercourses and their floodplains (and associated wetlands); and<br>(iii)vertically between the surface and subsurface;<br>are protected and restored; and<br>(c) the Murray Mouth remains open at frequencies, for durations, and with passing flows, sufficient to enable the conveyance of salt, nutrients and sediment from the Murray-Darling Basin to the ocean; and<br>(d) the Murray Mouth remains open at frequencies, and for durations, sufficient to ensure that the tidal exchanges maintain the Coorong's water quality (in particular salinity levels) within the tolerance of the Coorong ecosystem's resilience; and<br>(e) the levels of the Lower Lakes are managed to ensure sufficient discharge to the Coorong and Murray Mouth and help prevent river bank collapse and acidification of wetlands below Lock 1, and to avoid acidification and allow connection between Lakes Alexandrina and Albert, by:<br>(i) maintaining levels above 0.4 metres Australian Height Datum for 95% of the time, as far as practicable; and<br>(ii) maintaining levels above 0.0 metres Australian Height Datum all of the time; and<br>(f) barriers to the passage of biological resources (including biota, carbon and nutrients) through the Murray-Darling Basin are overcome or mitigated. |
| 8.06 (5) | that natural in-stream and floodplain processes that shape landforms (e.g. the formation and maintenance of soils) are protected and restored. |
| 8.06 (6) | to support habitat diversity for biota at a range of scales (e.g. the Murray-Darling Basin, riverine landscape, river reach and asset class). |
| 8.06 (6) | to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (e.g. recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that:<br>(a) flow sequences, and inundation and recession events, meet ecological requirements (e.g. cues for migration, germination and breeding); and<br>(b) habitat diversity, extent, condition and connectivity that supports the life cycles of biota of water-dependent ecosystems (e.g. habitats that protect juveniles from predation) is maintained. |
| 8.06 (7) | to protect and restore ecological community structure, species interactions and food webs that sustain water-dependent ecosystems, including by protecting and restoring energy, carbon and nutrient dynamics, primary production and respiration. |
| | **Ensuring Water-Dependent Ecosystems are Resilient to Climate Change and Other Risks and Threats** |
| 8.07 (2) | that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (e.g. drought and fire). |
| 8.07 (3) | to protect refugia in order to support the long-term survival and resilience of water-dependent populations of native flora and fauna, including during drought to allow for subsequent re-colonisation beyond the refugia. |
| 8.07 (4) | to provide wetting and drying cycles and inundation intervals that do not exceed the tolerance of ecosystem resilience or the threshold of irreversible change. |
| 8.07 (5) | to mitigate human-induced threats (e.g. the impact of alien species, water management activities and degraded water quality). |
| 8.07 (6) | to minimise habitat fragmentation. |

**Table 3. TLM and CEWO ecological watering objectives under each water resource availability scenario**

| | Extreme Dry | Dry | Median | Wet |
|---|---|---|---|---|
| Objective | *Avoid catastrophic / irretrievable loss and maintain capacity for recovery* | *Improve capacity for recovery* | *Protect ecological health* | *Improve health and resilience* |
| Ecological Watering Objectives | Avoid irreversible loss of key environmental assets | Ensure priority river reaches and wetlands have maintained their basic functions | Ecological health of priority river reaches and wetlands have been protected and improved | Improve the health and resilience of aquatic ecosystems |
| Management Objectives | **TLM / CEWO**<br>Avoid critical loss of species, communities and ecosystems<br>Maintain key refuges<br>Avoid irretrievable damage or catastrophic events | **TLM**<br>Maintain river functioning with reduced reproductive capacity<br>Maintain key functions of high priority wetlands<br>Manage with dry-spell tolerances<br>Support connectivity between sites<br>**CEWO**<br>Support the survival and growth of threatened species and communities including limited small-scale recruitment<br>Maintain diverse habitats<br>Maintain low flow river and floodplain functional processes in sites and reaches of priority assets | **TLM / CEWO**<br>Enable growth, reproduction and small-scale recruitment for a diverse range of flora and fauna<br>Promote low-lying floodplain-river connectivity<br>Support medium flow river and floodplain functional processes | **TLM / CEWO**<br>Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna<br>Promote higher floodplain-river connectivity<br>Support high flow river and floodplain functional processes |

# 4. Annual Priorities

## 4.1. Priorities Process

The priority watering actions for the South Australian River Murray for 2018-19 are summarised in section 4.2 below and detailed in Appendix B. The priorities have been developed in accordance with the Basin Plan requirements and are consistent with the SA LTWP[2]. The LTWP includes a list of priority environmental assets and their ecological objectives, targets and environmental watering requirements (EWRs). It demonstrates alignment between these and the expected environmental outcomes of the Basin Wide Environmental Watering Strategy (BWEWS) (Murray-Darling Basin Authority, 2014a).

A scenario-based approach was used to develop proposed watering actions for 2018-19. Five resource availability scenarios were identified. These scenarios are based on the MDBA annual operating probabilities (AOP) provided in February 2018: 90% (dry), 75% (moderate), 50% (near average), 25% (wet) and 105 very wet(Figure 3). These percentages refer to the likelihood of occurrence of different water resource conditions based on previous records, current volumes in storage and operational considerations for the upcoming year. A volume of held environmental water (HEW) potentially available for delivery to South Australia in 2018-19 under each of the resource availability scenarios was assumed for planning purposes (Table 4). For each scenario and each site/asset – objectives are defined and optimal water delivery mapped (i.e. added to hydrographs) to achieve those objectives, taking into account estimated environmental water availability.

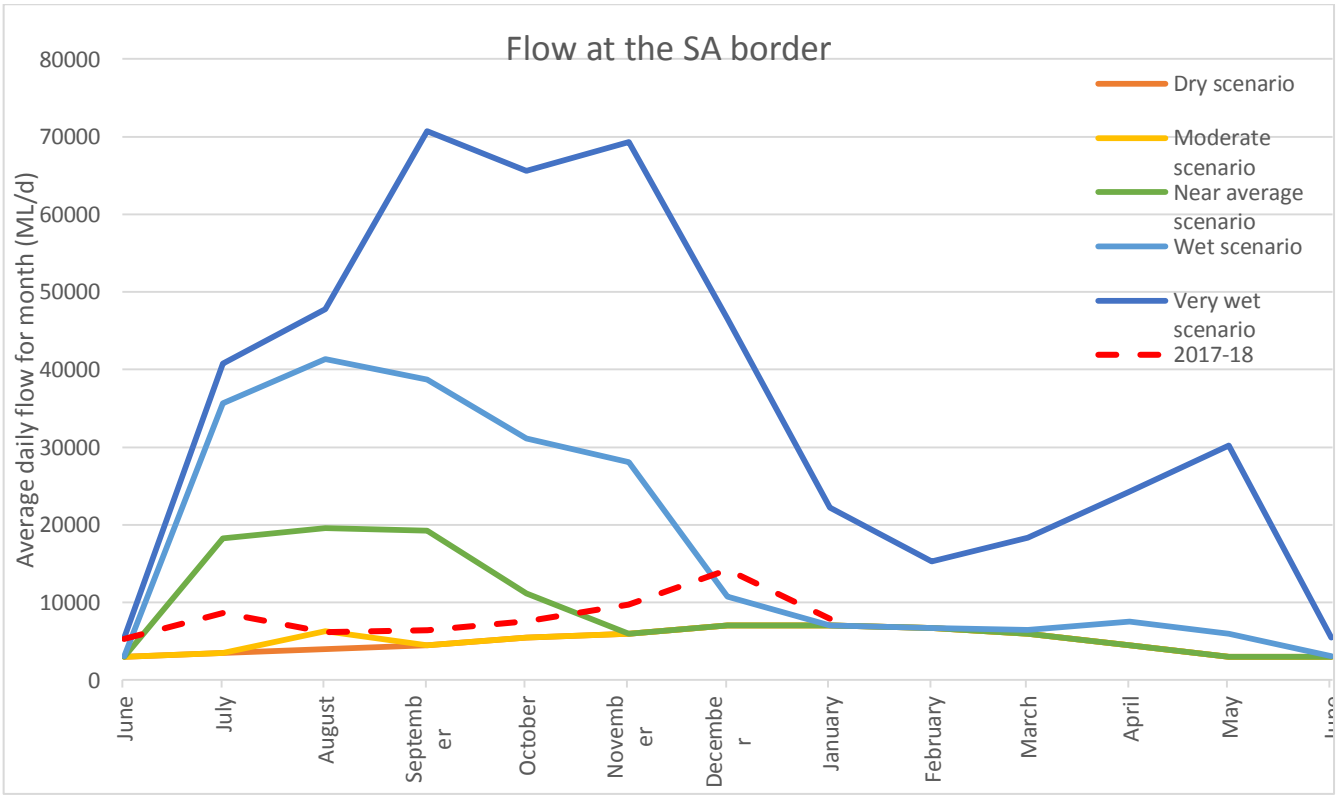


**Figure 3. Annual operating probabilities provided by MDBA in February 2018 for the purpose of informing environmental water planning for 2018-19**

[2] The Coorong is considered by the Basin Plan to be part of the SA Murray Region WRP area, however it is addressed in the priorities for the SA River Murray WRP Area as the ecological outcomes of in the Coorong are primarily driven by surface water inputs from the River Murray. This is consistent with the approach taken for the SA River Murray Long-Term Plan.

## 4.2. Priority actions for 2018-19

South Australia has developed discrete site-specific watering proposals for a number of locations throughout the South Australian River Murray system in 2018-19.

A summary of site-based actions are presented below and Appendix B provides detailed information for each scenario. Detailed descriptions of these actions and associated environmental objectives are also provided within the *2018-19 Annual Environmental Watering Priorities for the South Australian River Murray Water Resource Plan Area* (DEW, 2018).

Boggy Flat. Photo by Riverine Recovery Program, DEW.

**SA River Murray Channel and Floodplain**

The proposed environmental watering actions for the main River channel and floodplain in South Australia seek to secure environmental water delivered to the South Australian border and along the entire length of the system in South Australia to subsequently arrive in the CLLMM. The proposed environmental water delivery pattern is aimed at enhancing flow conditions to meet the environmental water requirements identified in the LTWP (Department of Environment, Water and Natural Resources, 2015). Environmental water is generally sought in spring/summer with the magnitude and duration of the action depending on climate conditions or scenarios.

In dry, moderate and near average scenarios, watering actions are focussed on creating in-channel freshes, with outcomes in the main channel and near-bank areas such as increased flow velocities, improving the food web and habitat availability to support native fish populations, and supporting native vegetation growth and survival through improved soil water availability and groundwater freshening.

In the wet and very wet scenarios, overbank flows and broad-scale floodplain inundation will occur. In addition to the outcomes in the drier scenarios, watering actions are focussed on inundation of temporary wetlands for frog and bird breeding, large recruitment events by large-bodied native fish such as Murray cod, and widespread improvement in the condition of long-lived vegetation such as lignum, River red gum and black box.

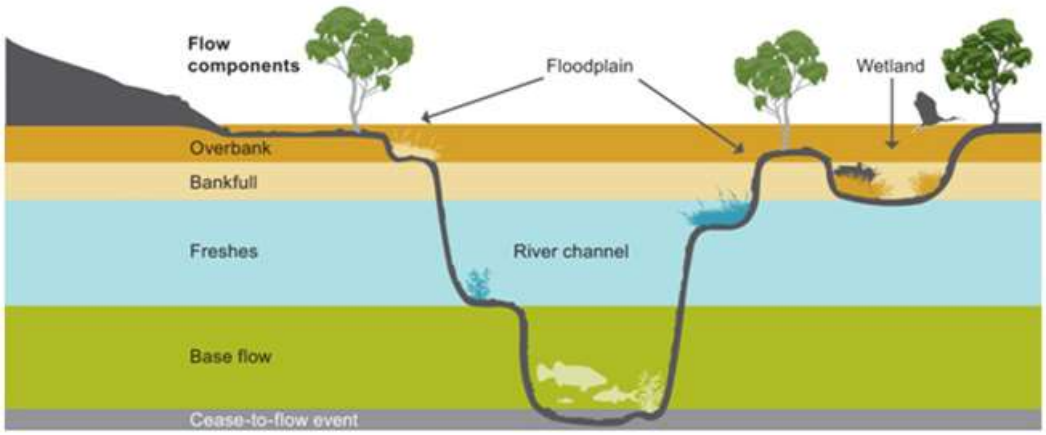


**Figure 4: Conceptual illustration of flow components and their influence on different parts of the** river channel and its floodplain (MDBA 2011)

Some areas of the channel and floodplain will also benefit from weir pool manipulations. Water levels in weir pools 2 and 5 will be increased over spring. The change in water level will depend on the weir pool and flow conditions. In a dry, moderate and near average scenario, weir pool 2 will be increased by 0.50 metres and weir pool 5 by 0.35 metres above normal pool level. If wetter conditions occur then the height of the weir pool raisings will increase to 0.75 metres at weir pool 2 and 0.50 metres at weir pool 5. Weir raisings are undertaken to support the growth and expansion of littoral vegetation, create diverse and productive biofilm and macroinvertebrate communities, and promote groundwater exchange with the river and relieve soil salinity stress in littoral zone (Lloyd et al 2010).

**Chowilla Floodplain**

The proposed Chowilla Floodplain environmental watering actions include the scaled operation of the Chowilla Creek regulator depending on the water resource availability scenario that eventuates.

Under dry to moderate water availability scenarios a low-level "in-channel rise" operation of the regulator will be undertaken. This will raise water levels in Chowilla Creek and through the anabranch by between approximately 1.6 - 2 metres and generate improvements in soil salinity and moisture availability along the creek banks and improve native vegetation growth and survival. Under these conditions the pumped delivery of water to a small number of priority wetlands is also planned.

If water availability improves to near average or wet scenarios, the scale of the operation of the regulator and associated raising of Lock 6 will be increased to enable broad-scale inundation across between approximately 4,000 to 8,000 hectares (ha) of floodplain and wetlands. The operation will provide benefits for trees and understorey vegetation, and create breeding and feeding resources for a range of wildlife. This inundation would extend into areas of black box trees, in the mid elevation areas of the floodplain to consolidate the benefits to tree health from the 2016 watering and natural flooding.

Under a very wet water availability scenario the Chowilla regulator could be operated on the rising or falling limb of natural high flows in order to extend the period of floodplain inundation to enhance the benefits for floodplain vegetation and wildlife.

River coobah at Chowilla. Photo by Alison Stokes, DEW.

**Wetlands**

Nineteen wetland sites have been identified as priorities for receiving environmental water in 2018-19 as part of the Natural Resources SAMDB watering program. Sites are located along the length of the River Murray in South Australia, and include wetlands fringing the Lower Lakes. Under dry to near average water resource scenarios up to approximately 10 gigalitres (GL) in total may be delivered to the priority sites. Water delivery will occur primarily via pumping, with the exception of Bookmark Creek and Berri Evaporation Basin, which are gravity fed. In the event that unregulated flows > 40,000 ML/day occur in South Australia, the majority of the wetlands will be inundated and will not require pumping.

The ecological objectives at many of the wetlands include supporting black box, river red gum and lignum floodplain communities. Watering at a number of sites also aims to provide habitats for waterbirds, support the nationally threatened regent parrot and provide breeding opportunities for the nationally threatened southern bell frog.

Water proposed for Disher Creek and Berri Evaporation Basin is critical for supporting populations of the nationally threatened small-bodied fish, Murray hardyhead.

One of the priority sites for watering in 2018-19 is Tolderol Game Reserve Wetlands. This is a constructed wetland complex (~200 ha) and is part of the Ramsar listed CLLMM region. This wetland is an important waterbird site, with a total of 86 wetland dependant bird species observed at Tolderol since 2014, including 22 species of conservation significant and 15 *Environment Protection and Biodiversity Conservation Act 1999* (Cth)-listed migratory wading bird species.

Wetland watering actions will also be undertaken by numerous private landholders including the Ngarrindjeri Regional Authority, First Peoples of the River Murray and Mallee, Birds SA, Conservation & Hunting Alliance of SA (CHASA), Signal Point Riverine Environment Group, Fleurieu Birdwatchers, councils, Local Action Planning groups and wetland community groups. These groups will undertake complementary environmental watering activities at sites supported by local communities.

Watering for waders at Tolderol Basin. Photo by James Donaldson, DEW.

**Lower Lakes, Coorong and Murray Mouth Icon Site**

Lakes Alexandrina and Albert

Environmental water will be used to manage water levels in the weir pool below Lock 1 within the range 0.6 – 0.85 m Australian Height Datum (AHD) during 2018-19. Maximum levels (up to 0.85 m AHD) will be prioritised between October and December 2018 to promote small-bodied fish, frog and invertebrate breeding in fringing wetlands of the Lower Lakes. Target species include EPBC-listed southern bell frog, Murray hardyhead and Yarra pygmy perch. Minimum levels (between 0.55 – 0.65 m AHD) will be prioritised in March and April 2019 to encourage sediment consolidation and aquatic plant germination.

Khian Rigney-Smith retrieving a fyke net in Dog Lake, Lake Alexandrina. Photo by Scotte Wedderburn, University of Adelaide.

Barrage Operations

Environmental water is required to maintain continuous flow at all 11 fishways on the lower Murray barrages, providing year-round connectivity between the Lower Lakes and the Coorong estuary. When conditions allow, additional barrage flows will be prioritised adjacent to fishways, to facilitate migration for native fish.

During winter (July-August 2018) barrage flows prioritised from Goolwa, Mundoo and Tauwitchere barrages will facilitate upstream migration of pouched lamprey and downstream migration of adult congolli and common galaxias (diadromous fish). During spring and early summer (October 2018 – January 2019) barrage flows prioritised from Tauwitchere and Goolwa barrages will facilitate upstream migration of young-of-year congolli and common galaxias, and the delivery of freshwater to the Coorong for salinity outcomes and the provision of freshwater-derived zooplankton and phytoplankton which are important components of the estuarine food-chain.

Tauwitchere barrage. Photo by Adrienne Rumbelow, DEW.

Coorong & Murray Mouth Estuary

A range of outcomes can be achieved in the Coorong and Murray Mouth Estuary depending on the magnitude of flow. Relatively small barrage flows in spring and early summer, typical in drier periods, can provide suitable conditions for spawning and recruitment for estuarine fish such as black bream and greenback flounder. The area of influence is the zone directly downstream of the barrages, and careful management of barrage releases is needed to create suitable salinity stratification within the water column.

Moderate barrage flows can provide a greater area of influence, and extend this spawning and recruitment zone for estuarine fish into the majority of the Coorong North Lagoon. Flows of this magnitude can also create suitable habitat to support adult estuarine fish, as well as suitable feeding habitat for waterbirds, particularly migratory waders.

High flow years can provide an even greater area of influence, extending to the Coorong South Lagoon. If high barrage flows occur between October and January, water levels in the Coorong South Lagoon may be maintained for long enough for the aquatic macrophyte *Ruppia tuberosa* to flower and set seed. High flows are also correlated to positive recruitment events for small-mouth hardyhead, an important food source in the Coorong for large-bodied fish and waterbirds.

Waterbirds at Pelican Point, Coorong North Lagoon. Photo by Sabine Dittmann, Flinders University.

### 4.2.1. 2018-19 South Australian River Murray Multi-Site Watering

The site-based watering actions presented identify the volumes of environmental water required to undertake each action and meet the site-based outcomes, with the actions and volumes related to those considered to be operationally feasible under the given scenario.

This multi-site action demonstrates opportunity for the delivery of environmental water in a way that increases the effectiveness of delivery through aligning the timing of watering actions at multiple locations throughout the SA River Murray region. The multi-site is based on the site-specific watering proposals developed within South Australia and will meet watering objectives at these sites, while also providing additional landscape-scale outcomes such as improved connectivity, and enhanced dispersal of resources, propagules and water-dependent biota.

The multi-site is underpinned by the objectives, targets and EWRs in the LTWP, the expected outcomes in the Basin-wide Environmental Watering Strategy (MDBA 2014) and the Basin-wide annual priorities (MDBA 2018).

This multi-site will continue to be used and revised during real-time management planning, and has been circulated to environmental water holders for their consideration during delivery planning for the 2018-19 water year.

The links between the watering actions at these sites are outlined under each scenario below. The multi-site supports the proposed site-specific watering actions and objectives but also focuses on delivering additional system-wide benefits. These benefits include:

- Coordination of the delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian River Murray system;
- Provision of pathways for the dispersal, migration and movement of native water-dependent biota[3];
- Provision of pathways for the dispersal and movement of organic and inorganic sediment to maximise the delivery of resources to downstream reaches and to the ocean;
- Delivery of environmental water to the CLLMM while providing benefits to upstream environmental assets on-route;
- Maximisation of environmental outcomes through the operation of infrastructure where appropriate;
- An increase in the effectiveness of environmental watering and extent of benefits by aligning the timing, magnitude and duration of discrete actions; and
- Delivery of environmental water consistent with the EWRs of the LTWP (LTWP: DEWNR 2015) and contribution to the ecological objectives for priority environmental assets and priority ecosystem functions described in the LTWP.

### 4.2.2. Assumptions

Site-based watering proposals were developed based on the Flow to South Australia (QSA) Annual Operating Probability (AOP) scenarios provided by the MDBA in February 2018 (Figure 3). All flow rates are represented as flow at the South Australian border (QSA) unless otherwise indicated. Similarly, volumes are volumes at the South Australian border. The proposed watering actions are indicative only and the actual delivery pattern will depend on River conditions throughout 2018-19.

### 4.2.3. Environmental water demand options

For the River Murray Channel, more than one watering 'option' is identified under each AOP scenario. These options represent alternate delivery options and are not cumulative. There is an interaction between the channel and weir manipulation watering actions where the implementation of a channel action may require a change in the duration/magnitude of a weir raising, hence there is also more than one option for weir raising under some of the

[3] Modified from Basin Plan Schedule 9 - Criteria for identifying an ecosystem function

AOPs. SA's priority is to deliver the higher magnitude channel watering action in order to meet EWRs that maximise environmental benefits to the channel asset.

The estimated volume of additional environmental water required in 2018-19 to deliver the multi-site ranges from approximately 940 GL in the dry to 1300 GL in the wet. Information on the alignment and combination of actions under each scenario are discussed below. The preferred monthly delivery pattern for the multi-site is indicated in Figures 5 - 8, and has been designed to ensure that the required delivery patterns for site-based actions and outcomes are also met.

### Dry (90%) and Moderate (75%) AOP scenarios[4]

In the dry and moderate scenarios the proposed delivery captures a combination of wetland watering, in-channel rise for the Chowilla environmental regulator, continuous releases from the Lower Lakes to the Coorong plus channel and weir pool options as shown in Figure 5 and 6.

- Channel Option 1 creates a 60-day flow pulse with a median flow of 15,000 ML/day from mid-October until mid-December. Under Option 1, the duration of weir raising at weir pools 5 and 2 is shortened so that water levels will be returned to normal operating level in October and coincide with the arrival of the proposed in-channel flow pulse. This timing will ensure that any potential impacts on in-channel velocities due to weir raising is minimised.
- Channel Option 2 creates a 60-day elevated summer flow, targeting 10,000 ML/day in December and January. Under Option 2, the magnitude of raising at weir pool 2 is increased to 75cm above normal operating level and drawdown coincides with the arrival of the 10,000 ML/day elevated flows. The increased flow rate would provide dilution benefits and mitigate any potential salinity impacts that may occur on drawdown of weir pools.
- Channel Option 3 seeks to create flow conditions that replicate the 2005 QSA hydrograph between 1 October and 31 December for potential flow-cued spawning native fish outcomes. Weir raising under Option 3 is the same as option 1 with the return of weir pools 5 and 2 to normal operating level coinciding with the arrival of the flow pulse.
- For all options, the timing of weir pool water level changes will need to be adaptively managed based on real-time flow and operational considerations. Opportunities to test the impact of weir pool raisings on in-channel hydraulics when flows are above 12,000 ML/day prior to mid-October should be explored.
- There is good alignment between the months of highest demand for environmental water in the CLLMM and Channel assets (spring/early summer), and this is also the preferred timing for the return of weir pools to normal pool level. The provision of return flows due to weir pool drawdown at this time therefore assists in an increased volume of water in the system. Improved hydraulics as a result of the delivery of an in-channel pulse will also facilitate the downstream transport of resources and propagules that have been drawn into the River through weir manipulation and see them travel through the system to the CLLMM.

### Near Average (50%) AOP scenario

In the near average scenario, there will be spring inundation of fringing Lower Lake wetlands, increased barrage releases and mid-floodplain inundation using the Chowilla regulator. (See Figure 7)

- There are three options for the Channel
    - Option 1 extends the duration of high flows so that a median flow rate of 20,000 ML/day is maintained for 90-days in spring.
    - Option 2 delivers a 90-day flow pulse with a median flow of 15,000 ML/day.
    - Option 3 also delivers a 15,000 ML/day flow pulse but with a reduced duration of 60-days

[4] Dry and moderate scenarios are presented together as the AOP average monthly flows are the same apart from a small increase in August flows in the moderate AOP. As a result, proposed watering actions are the same under the dry and moderate scenarios.

- Weir pool raising is only proposed for weir pool 5 and is the same under all three options, with a return to normal operating level to occur in late September when flows are between 15,000 – 20,000 ML/day but water temperatures are likely to be relatively low. This timing will enable the impacts of weir raising on in-channel hydraulics to be tested when there is minimal risk to potential native fish breeding outcomes.
- There is good alignment between the months of highest demand for environmental water in the CLLMM and Channel assets (spring/early summer) and this coincides to the need for increased passing flows for the operation of the Chowilla Regulator.
- Drawdown of the Chowilla Regulator will occur in October-December, which aligns with the implementation of a proposed in-channel flow pulse. Improved hydraulics as a result of the in-channel pulse will also assist in facilitating the downstream transport of resources and propagules that have been drawn into the River through operation of the Chowilla regulator.

### Wet (25%) AOP scenario

In the wet scenario there will be increased barrage releases, maintenance of South Lagoon water levels and maximum floodplain inundation using the Chowilla Regulator. (See Figure 8)

- Channel Option 1 increases the magnitude of an unregulated event, and slows the recession by maintaining flows above 15,000 ML/day into December.
- Channel Option 2 extends the duration of flows at 40,000 ML/day into late spring.
- Weir pool raising is the same under both options and will maximise the area of inundation by raising water levels as high as possible during the flow peak.
- Chowilla/weir pool drawdown will provide return flows as environmental water demands for the channel and CLLMM increase.

Goolwa barrage. Photo by Kirsty Wedge, DEW.

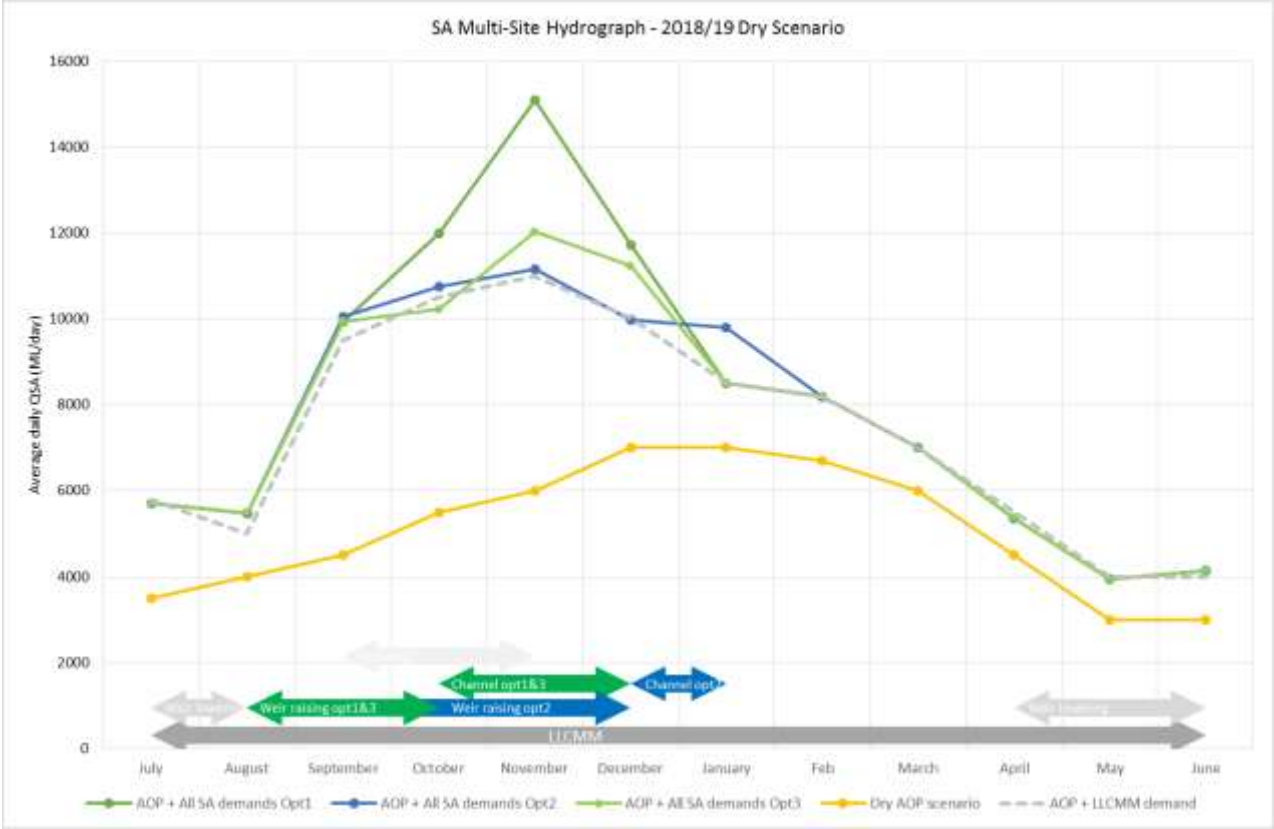


**Figure 5. Preferred delivery pattern of SA multi-site environmental water under a Dry (90%) AOP scenario. Options are exclusive not cumulative; arrows indicate timing of proposed site-based environmental watering actions; AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All SA demands'.**

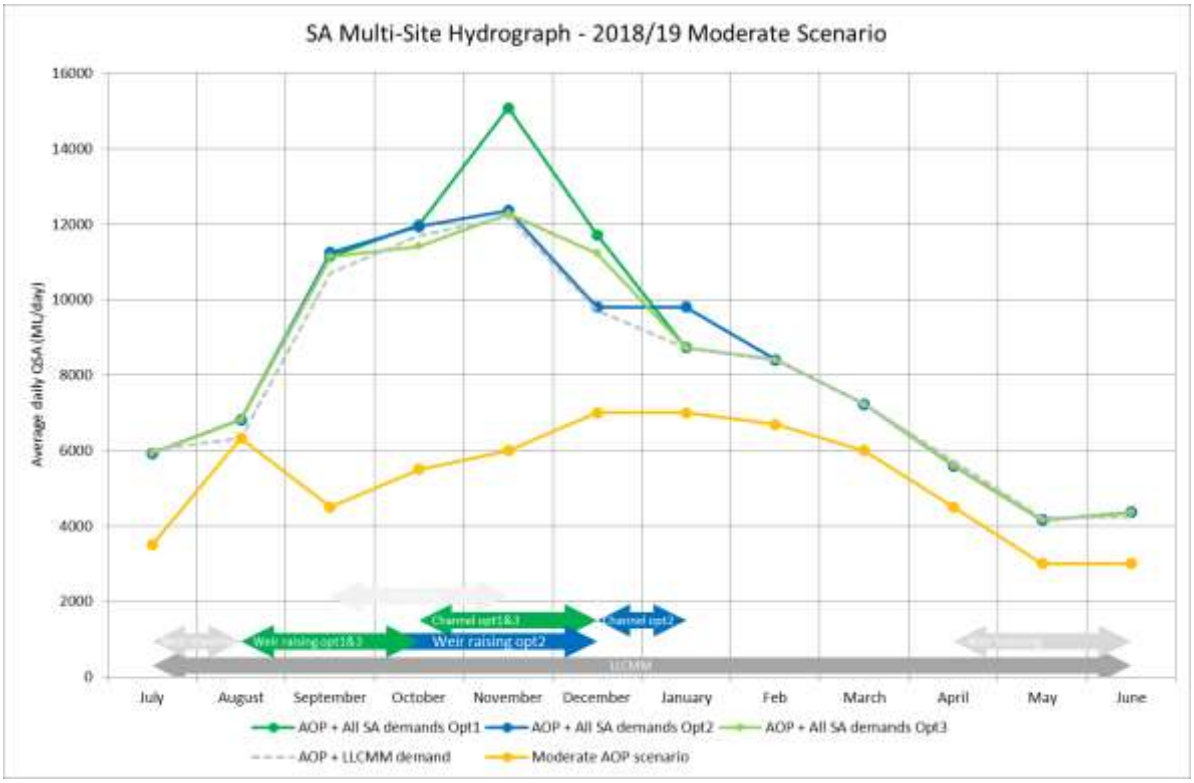


**Figure 6. Preferred delivery pattern of SA multi-site environmental water under a Moderate (75%) AOP scenario. Options are exclusive not cumulative; arrows indicate timing of proposed site-based environmental watering actions; AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All SA demands'.**

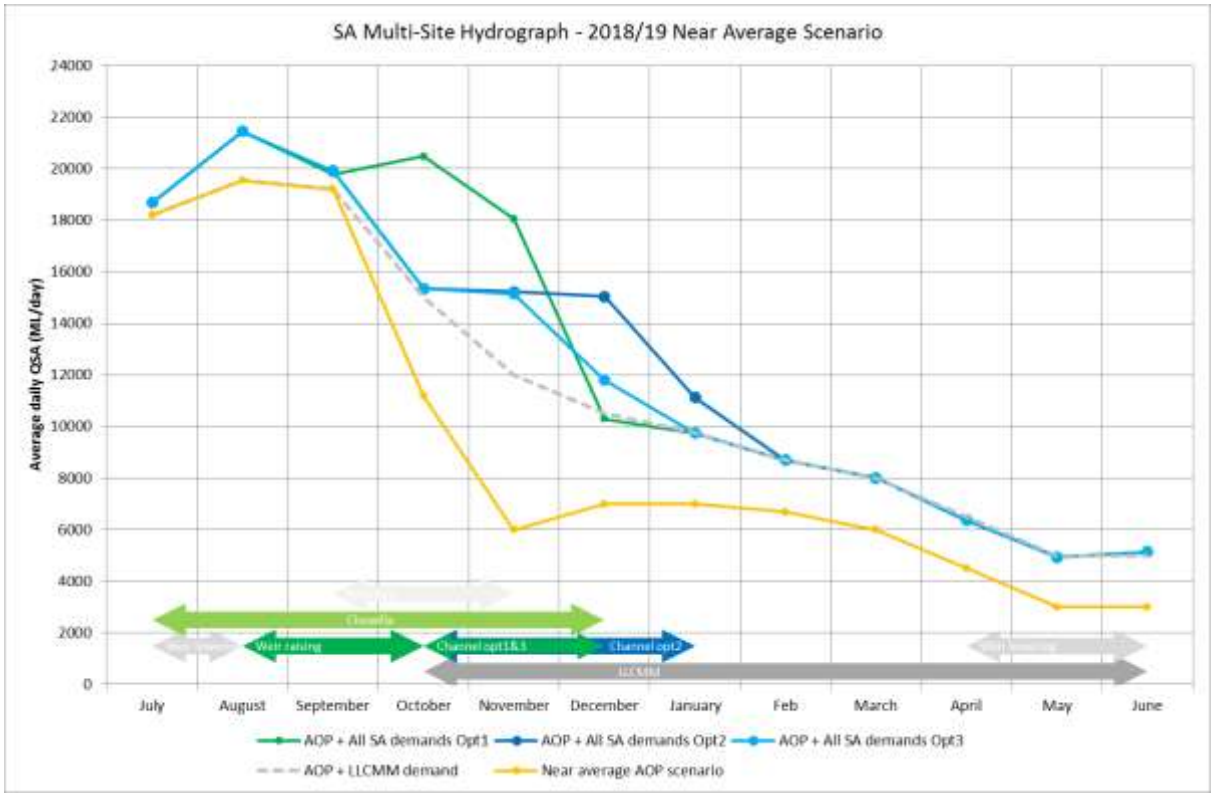


**Figure 7. Preferred delivery pattern of SA multi-site environmental water under a Near Average (50%) AOP scenario. Options are exclusive not cumulative; arrows indicate timing of proposed site-based environmental watering actions; AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All SA demands'.**

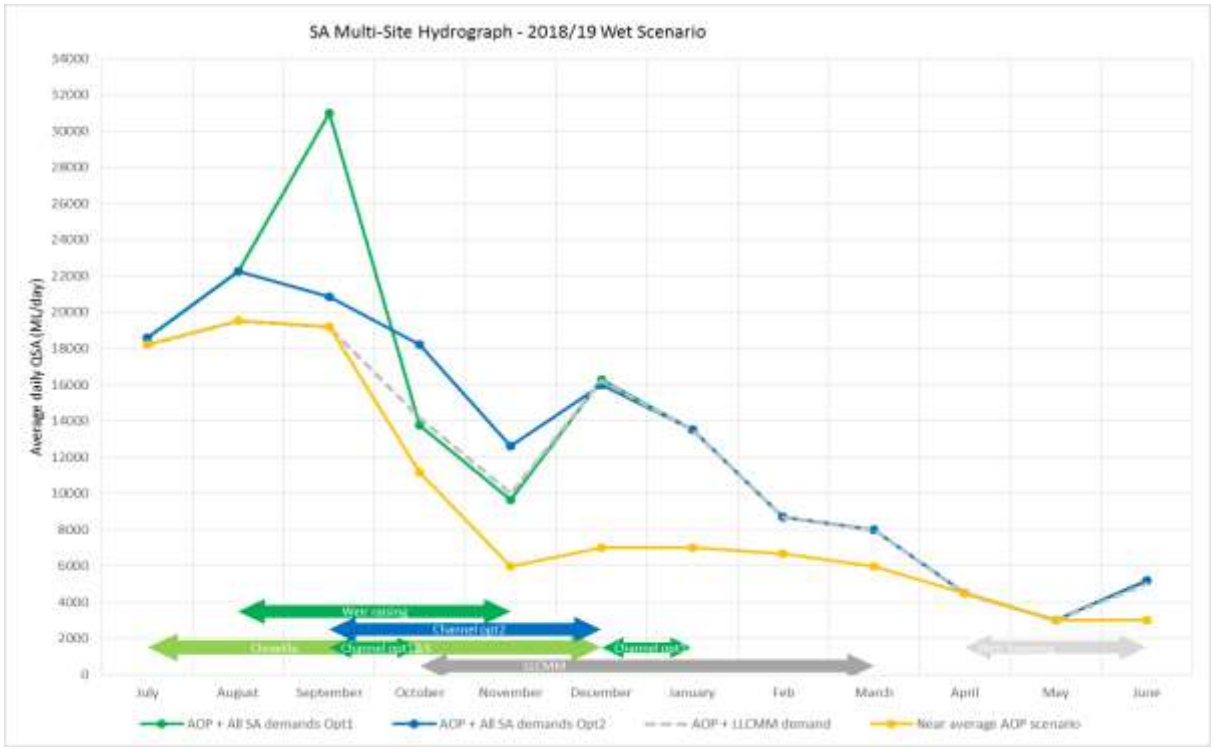


**Figure 8. Preferred delivery pattern of SA multi-site environmental water under a Wet (25%) AOP scenario. Options are exclusive not cumulative; arrows indicate timing of proposed site-based environmental watering actions; AOP + CLLMM demand is presented as a reference point only and is incorporated into the 'All SA demands'.**

Samphire at the Coorong. Photo by Rebecca Turner, DEW.

## 4.3. Environmental Water Availability

### 4.3.1. Held Environmental Water

The work required to inform the development of the priorities was undertaken between February and April 2018, which is prior to water allocation announcements being made. As a result of this timing, environmental water holders were unable to provide accurate advice on Held Environmental Water (HEW) availability in 2018-19. For the purposes of planning and prioritisation, an estimate of potential HEW availability under each resource availability was made based on environmental water delivery in recent years (Table 4). Potential HEW availability is taken into account during planning so that the proposed actions and associated outcomes consider the feasibility of delivery.

**Table 4. Estimate of held environmental water available in 2018-19 under each resource availability scenario**

| Scenario | Estimate of HEW available (GL) |
|---|---|
| Dry 90%) | **1000 GL** |
| Moderate (75%) | **1290 GL** |
| Near average (50%) | **1500 GL** |
| Wet (25%) | **1600 GL** |
| Very wet (10%) | **1600 +** |

HEW is available from the following sources – the CEWH, TLM, Victorian Environmental Water Holder (VEWH), South Australian Minister for Environment and Water, and non-government organisations. For each water holder, information relating to volumes of registered entitlements and long-term average annual yield (LTAAY) is presented below.

#### 4.3.1.1. Commonwealth Environmental Water

Total Commonwealth environmental water holdings within the Southern Connected Basin are approximately 1,984 GL (at 9 April 2018), with varying levels of security and a LTAAY of 1,489 GL. Of this volume, approximately 155 GL

registered entitlement (140 GL LTAAY) is held in South Australia and forms part of South Australia's entitlement. Some carry-over from 2017-18 may be available, although the CEWH is yet to confirm a volume.

#### 4.3.1.2. The Living Murray Environmental Water

TLM holdings approximately 480 GL long-term cap equivalent (LTCE), of which approximately 45 GL is held in South Australia and forms part of South Australia's entitlement. Increased flows from the Snowy Agreement (up to 200 GL) are also available.

#### 4.3.1.3. Victorian Environmental Water Holder

The VEWH manages environmental water holdings in the following rivers: Murray, Goulburn and Campaspe. Under some circumstances, the VEWH may trade HEW to South Australia, as a result of return flows from upstream environmental watering actions.

#### 4.3.1.4. South Australian Minister for Environment and Water

The South Australian Minister for Environment and Water holds approximately 44 GL of water access entitlements in South Australia that are committed to environmental purposes and form part of South Australia's entitlement.

Of this total volume, approximately 37 GL belongs to the Wetlands Consumptive Pool. This water is tied to the management of specific pool-connected wetlands within the Water Resource Plan area so there is limited flexibility in the location of use.

The remaining volume of approximately 6 GL has been committed for environmental use through the *Implementation Plan for Augmentation of the Adelaide Desalinisation Plant* and the location of its use is flexible (within the South Australian portion of the Murray-Darling Basin).

Decisions on the use of environmental water held by the South Australian Minister for Environment and Water are made within DEW consistent with the annual priorities.

#### 4.3.1.5. Non-Government Organisations

NFSA holds 0.037 GL of Class 3A Water Access Entitlement on licence that is irrigation water purchased for environmental use.

The Murray Darling Association, through its Murray Darling Foundation, has established 'Water Bank' that receives donations for purchasing and holding water for future environmental activities. It holds 60 ML of Class 3A Water Access Entitlement.

For 2018-19, Banrock Station has approximately 1.38 GL of Class 9 (Wetlands) water for the management of the pool-connected areas of Banrock Station Wetland Complex.

## 4.4. Managed wetlands

The WAP establishes 200 GL of Wetlands water with approximately 42 GL held on licence. The remaining 158 GL can be considered to be planned environmental water. This volume is 'used' as it replaces the evaporative losses from unmanaged, pool-connected wetlands during normal river operations. This water is not available for other uses.

## 4.5. Planned Environmental Water Availability

Planned environmental water also includes the remaining Dilution and Loss volume, the unallocated water, the Lindsay River Allowance, Additional Dilution Flow, River Murray Increased Flow and unregulated flow.

### 4.5.1. Unregulated flow

Under the WAP, no provisions exist for the allocation and use of unregulated flow for non-environmental consumptive purposes in South Australia. Therefore, when an unregulated flow event occurs, it is protected from being taken for consumptive uses within South Australia. Unregulated flow generally occurs in response to high rainfall events upstream from South Australia. The MDBA Southern Connected Basin Environmental Water Committee (SCBEWC) has delegated authority from the Basin Officials Committee (BOC) to authorise use of River Murray Unregulated Flow (RMUF) for environmental purposes in the River Murray.

### 4.5.2. Additional Dilution Flow

South Australia receives 3 GL/day above the daily equivalent of the monthly Entitlement Flow, whenever certain conditions set out in the Murray-Darling Basin Agreement are satisfied. This water may not be used for consumptive use.

## 4.6. Co-operative Watering Arrangements

### 4.6.1. Between jurisdictions

For several years, holders and managers of environmental water have worked together to plan and coordinate annual multi-site environmental watering trials (trials). The trials attempt to maximise the use of environmental water by re-using return flows as the water moves through the Southern Connected Basin. In 2013, BOC agreed that the long-term objective of the trials is to work towards incorporating environmental delivery into normal River Murray operations. This is occurring by identifying and analysing issues and potential changes to current operational practices and rules.

The trials have tested a range of actions including new accounting methods, addition of environmental water to unregulated flows, use of loss factors and coordination of environmental releases with natural flow peaks. Each trial builds on lessons learned from the previous year and enhances understanding of the key elements for a successful outcome. In 2018-19 the outcomes of the trials will be documented for codification into the existing framework for managing Basin river flows.

Interjurisdictional groups supported by the MDBA (Southern Connected Basin Environmental Watering Committee – SCBEWC and Water Liaison Working Group – WLWG) contribute to the development of the multi-site planning each year. Real-time operations groups hold regular teleconferences to ensure coordination and communication during the event and rapid response to any issues that may arise, such as black water events. Membership of these groups includes holders of held environmental water as well as managers of planned environmental water, managers of environmental assets and River operators. South Australia has representatives on these cross-jurisdictional committees and is participating in the planning for the large scale environmental watering event for 2018-19.

### 4.6.2. Within South Australia

Existing mechanisms to assist with coordinating environmental watering within the South Australia are described in Section 4.2.1 of the LTWP (Department of Environment Water and Natural Resources, 2015).

# 5. Implementation of the Annual Plan

## 5.1. Overview

Implementation of the Annual Plan involves many steps and is undertaken throughout the year at a local, State and Basin level, as illustrated in **Error! Reference source not found.**9 below. The policies and processes currently in place to guide coordinated management of environmental water management along the River Murray in South Australia are described in the LTWP (Department of Environment, Water and Natural Resources, 2015).

Fishway catch from the Lower Murray barrages. Photo by SARDI Aquatic Sciences.

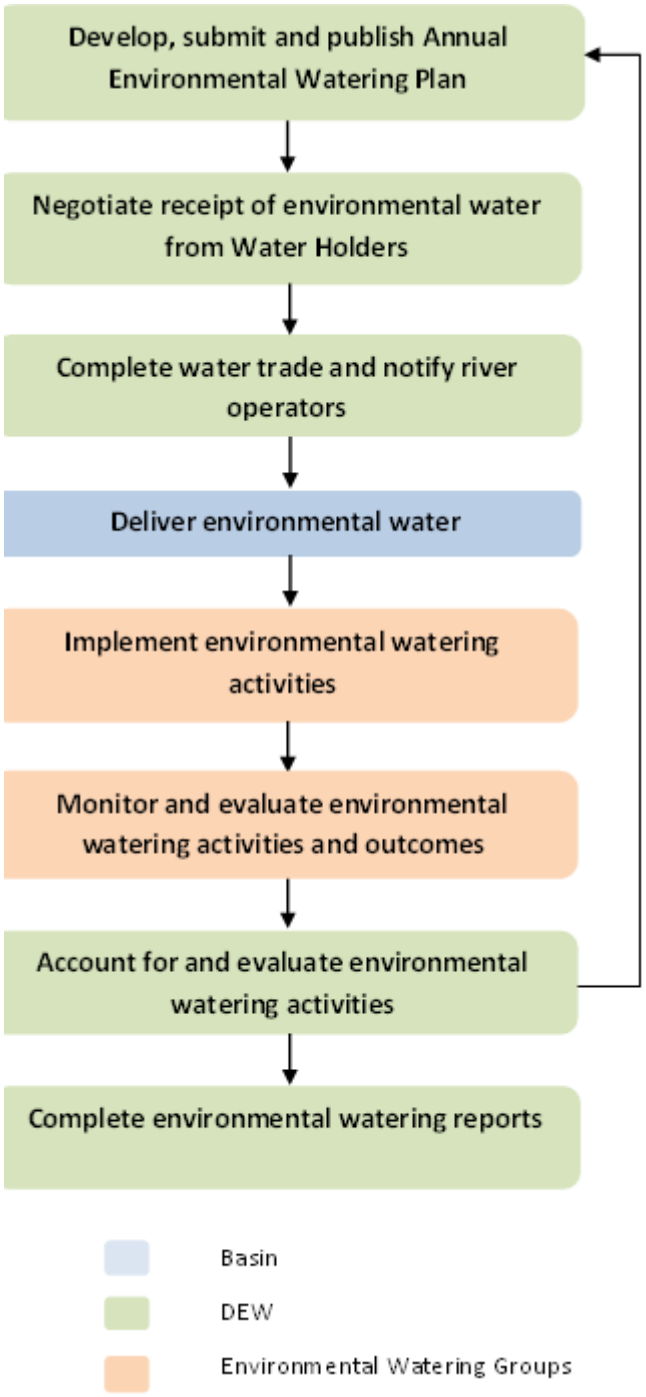


**Figure 9. Implementation process for the Annual Environmental Watering Plan**

## 5.2. Securing environmental water

### 5.2.1. Coordinating receipt of environmental water

Three sites within South Australia are eligible to access water from the TLM portfolio. These TLM icon sites are Chowilla Floodplain, the River Channel and the CLLMM. Icon site managers provide watering proposals that are used to develop the State's annual environmental watering priorities and these are also submitted to the MDBA Southern Connected Basin Environmental Watering Committee (SCBEWC) to inform the planning and prioritisation of the use of the TLM portfolio. Decisions on the use of the TLM portfolio are made jointly by the partner governments. SCBEWC seeks to coordinate the delivery of TLM water with other environmental water holders where possible.

Each year, the CEWO undertakes portfolio management planning for commonwealth owned environmental water, which includes multi-year planning for water delivery, trade and carryover. The SA River Murray region is included in the Commonwealth Environmental Water Portfolio Management Plan: Lower Murray-Darling 2018-19, which is available on the CEWH website.

Watering schedules are developed that give effect to this portfolio management plan and outline the intended use of CEW in 2018-19 at the CLLMM, the River Murray Channel and low-lying floodplain, and at Weir pools 2, 5 and 6. These watering schedules are agreed by the Commonwealth Environmental Water Holder and DEW.

The Commonwealth Environmental Water Holder also has established Partnership Agreements with several non-government organisations for the delivery of CEW along the River Murray in South Australia. There organisations include:

- Nature Foundation South Australia (NFSA);
- Ngarrindjeri Regional Authority (NRA);
- Renmark Irrigation Trust (RIT); and
- South Australian Murray-Darling Basin Natural Resources Management Board (SAMDBNRM Board).

Copies of these partnership agreements are available on the Commonwealth Environmental Water Holder website. Decisions on the use of Commonwealth environmental water are made by the CEWH throughout the year based on seasonal, operational and management considerations (Commonwealth Environmental Water Office, 2013).

### 5.2.2. Completing water trades

Once an environmental water holder has committed water to an environmental watering action then the water allocation may be traded onto a water account in South Australia. An alternative mechanism to facilitate delivery may be used such as Bulk Environmental Delivery (BED).

## 5.3. Delivering environmental water

DEW, SA Water and MDBA work cooperatively to manage arrangements for the delivery of water to South Australia for all purposes including environmental water. The annual environmental watering priorities and watering actions are incorporated into the South Australian River Murray Annual Operating Plan (DEW, 2018). Therefore, the water delivery required to support these priorities and actions is integrated with broader river operations planning.

The implementation of environmental watering actions is coordinated by water managers in consultation with other interested parties. There are several methods available for implementing environmental watering actions, including:

- The addition of environmental water to flows that come across the South Australian border and subsequent downstream delivery provides water to the River Murray channel and CLLMM assets, and potentially to the floodplain if flows are sufficiently high;
- Operation of the barrages to influence water levels in the Lower Lakes, and water movement into the Coorong and out to sea through the Murray Mouth;
- Operation of the Chowilla Regulator and raising of the main channel weirs to increase the extent of inundation;
- Operation of anabranch inlet regulators to manage in-channel flow and water level;
- Pumping to discrete temporary wetland basins, which generally involves the installation of temporary embankments to retain water;
- Application of water to floodplain vegetation through drip irrigation or sprinklers; and
- Operation of flow control structures to implement wetting and drying regimes at pool-connected wetlands.

Proposed actions, delivery mechanism and cost are described by managers in their watering proposals. Real time environmental management groups operate to adapt watering actions in response to changing conditions and provide advice on the preferred pattern of delivery for environmental outcomes. These groups include the Barrage Operations Advisory Group, Chowilla Operations Group and the Environmental Flows Reference Group.

Before implementing environmental watering actions that extract or use water from the River Murray, managers need to submit an Action Request form to the River Murray Operations Working Group. The Action Request form is used to consider impacts on the operation of the River, potential risks and water quality impacts, including cumulative impacts where multiple actions are to be undertaken at similar times. This process also assists in the coordination of environmental watering activity and for DEW to have oversight of environmental watering activities being undertaken throughout the region.

## 5.4. Monitoring and evaluation

Operational and ecological monitoring undertaken in association with environmental watering actions is outlined in the watering proposals developed by the environmental managers.

The TLM Program funds long-running condition and annual intervention monitoring at the Chowilla and CLLMM icon sites, with results used to inform water planning and delivery and the operation of environmental infrastructure. This monitoring is coordinated by the icon site managers in DEW and will continue in 2018-19.

The CEWO identifies any specific monitoring and reporting requirements in their watering schedules for the use of CEW. In addition, the CEWO Long Term Intervention Monitoring (LTIM) Project was established in 2014, with the Lower Murray River as one of the selected areas. This project collects data in the River Murray Channel asset. The project has been designed to evaluate outcomes at the Basin-scale, demonstrate environmental outcomes from the delivery of CEW at the regional scale and help with the adaptive management of CEW holdings. SARDI has been contracted by CEWO as the lead agency for the LTIM project in the Lower Murray River. Other key monitoring programs associated with environmental water management along the River Murray in South Australia are:

- Ongoing monitoring of selected South Australian River Murray wetlands and floodplain areas, undertaken by the DEW Natural Resources SAMDB wetlands and floodplain team in partnership with Local Action Planning associations, Landcare associations and community groups; and
- Monitoring the ecological response from the weir pool lowering, which is coordinated by DEW and funded by the Australian Government.

DEW utilises information gathered through a range of monitoring programs as described above. These programs have been established with specific purposes that generally relate to site-specific management plans and enable adaptive management of these sites. Information on the type of information gathered through each of these programs can be found in DEWNR 2017 and Wallace *et al*. 2014 and from relevant site managers.

NFSA undertake operational monitoring (volumes, delivery dates, inundation extent and photo points) at all their watering sites. Ecological monitoring includes vegetation response of target species at all sites, as well as bird and frog observations at selected sites.

As the volumes of environmental water and number of watering sites grow, it will become increasingly important to undertake strategic and regionally integrated evaluation and reporting. This work is currently being progressed through the development of a reporting and evaluation plan to enable the state to meet its ecological reporting obligations under the Basin Plan (Schedule 12, Matter 8), which requires Basin States to report every five years on the achievement of environmental outcomes at an asset scale. The first report is due in 2020.

Coorong mudflat monitoring. Photo by Sabine Dittmann, Flinders University.

## 5.5. Accounting and reporting

Environmental water reporting requirements are described in the LTWP (DEWNR 2015).

In 2018-19, DEW is responsible for managing and maintaining records for all actions managed by DEW including allocations, trades, water availability and water delivery. This data is used to report to water holders, reconcile the Minister's licences and water accounts, meet state obligations to report annually against Matter 9 of the Basin Plan (the identification of environmental water and the monitoring of its use), and report on environmental water management to stakeholders and other interested parties.

The non-government organisations will generally operate through their own water licences and accounts, and will have their own record keeping and water accounting arrangements in place to ensure that water use remains within availability and to fulfil reporting requirements. Operational and ecological reporting requirements will be agreed between the delivery partners and the water holder.

Reporting on the benefits and ecological outcomes of environmental watering events occurs through individual site reports. Key ecological outcomes are consolidated into the Annual Environmental Watering Report which is published on the DEW website each year.

Coorong sand dunes. Photo by Kirsty Wedge, DEW.

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**Legislation / Legislative Instruments**

*Basin Plan 2012* (Cth)

*Environment Protection and Biodiversity Conservation Act 1999* (Cth)

*Natural Resources Management Act 2004* (SA)

*Water Act 2008* (Cth)

Chestnut rumped Thornbill feeding Horsefield's Bronze-Cuckoo. Photo by Helga Kiescamp.

# Glossary: Selected Terms and Acronyms

*Units of measurement commonly used (SI and non-SI Australian legal)*

| Name of unit | Symbol |
|---|---|
| day | d |
| gigalitre | GL |
| megalitre | ML |

**AHD** – Australian Height Datum

**AOP** – Annual Operating Probabilities

**Barrage** — specifically any of the five low weirs at the mouth of the River Murray constructed to exclude seawater from the Lower Lakes

**Basin** — the area drained by a major river and its tributaries

**Black water** – water with high levels of organic matter that may cause a drop in oxygen levels in the water and lead to fish kills

**BED** – Bulk Environmental Water Delivery

**CEW** – Commonwealth Environmental Water

**CEWH** – Commonwealth Environmental Water Holder; the person charged with responsibility for the Commonwealth Government's water that is held for environmental purposes

**CEWO** – Commonwealth Environmental Water Office; the office that supports the CEWH

**CLLMM** – Coorong, Lower Lakes and Murray Mouth. One of three priority environmental assets identified in the Long-Term Environmental Watering Plan for the SA River Murray Water Resource Plan Area, and equivalent to the Lower Lakes, Coorong and Murray Mouth TLM Icon site. The names 'Coorong, Lower Lakes and Murray Mouth' and 'Lower Lakes, Coorong and Murray Mouth' are used interchangeably.

**DEW** — Department for Environment and Water (Government of South Australia)

**Diadromous** – fish that spend part of their lifecycle in both seawater and freshwater

**Diversity** — the distribution and abundance of different plant and animal species and communities within a specified area

**EC** — electrical conductivity; 1 EC unit = 1 micro-Siemen per centimetre (µS/cm) measured at 25°C; commonly used as a measure of water salinity as it is quicker and easier than measurement by TDS

**Ecosystem** — any system in which there is an interdependence and interaction between living organisms and their immediate physical, chemical and biological environment

**Endangered species** — any species in danger of extinction throughout all or a significant portion of its range

**Entitlement Flow** — minimum monthly River Murray flow to South Australia agreed in the Murray-Darling Basin Agreement 1992

**Environmental water requirements** — the water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk

**EPBC** – Environment Protection and Biodiversity Conservation Act (Commonwealth)

**Fishway** — a generic term describing all mechanisms that allow the passage of fish along a waterway. Specific structures include fish ladders (gentle sloping channels with baffles that reduce the velocity of water and provide resting places for fish as they 'climb' over a weir) and fishlifts (chambers, rather like lift-wells, that are flooded and emptied to enable fish to move across a barrier)

**Floodplain** — Of a watercourse means: (1) floodplain (if any) of the watercourse identified in a catchment water management plan or a local water management plan; adopted under the Act; or (2) where (1) does not apply — the floodplain (if any) of the watercourse identified in a development plan under the *Development (SA) Act*

*1993*; or (3) where neither (1) nor (2) applies — the land adjoining the watercourse that is periodically subject to flooding from the watercourse

**Flow bands** — flows of different frequency, volume and duration

**Flow regime** — the character of the timing and amount of flow in a stream

**Habitat** — the natural place or type of site in which an animal or plant, or communities of animals and plants, live

**Indigenous species** — species that occur naturally in a region

**Infrastructure** — artificial lakes; dams or reservoirs; embankments, walls, channels or other works; buildings or structures; or pipes, machinery or other equipment

**LAP** – Local Action Planning

**LLCMM** – Lower Lakes, Coorong and Murray Mouth; one of TLM icon sites. Equivalent to the Coorong, Lower Lakes and Murray Mouth which is identified as a priority environmental assets in the Long-Term Environmental Watering Plan for the SA River Murray Water Resource Plan Area. The names 'Coorong, Lower Lakes and Murray Mouth' and 'Lower Lakes, Coorong and Murray Mouth' are used interchangeably.

**LTAAY –** long term average annual yield

**LTIM –** Long Term Intervention Monitoring

**MDBA** — Murray-Darling Basin Authority

**Model** — a conceptual or mathematical means of understanding elements of the real world that allows for predictions of outcomes given certain conditions. Examples include estimating storm run-off, assessing the impacts of dams or predicting ecological response to environmental change

**Monitoring** — (1) The repeated measurement of parameters to assess the current status and changes over time of the parameters measured (2) Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals and other living things

**NFSA** – Nature Foundation of South Australia

**NGO** – Non-government organisation

**QSA** – River flow to South Australia, as measured at the State border

**Ramsar Convention** —an international treaty on wetlands titled The Convention on Wetlands of International Importance Especially as Waterfowl Habitat

**Return flow** – environmental water used upstream for an event returns to the river and can be used for another event downstream

**SA MDB NRM Board** – South Australian Murray-Darling Basin Natural Resources Management Board

**Threatened species** — any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range

**TLM –** The Living Murray (MDBA program)

**Water allocation** — (1) In respect of a water licence means the quantity of water that the licensee is entitled to take and use pursuant to the licence. (2) In respect of water taken pursuant to an authorisation under s.11 means the maximum quantity of water that can be taken and used pursuant to the authorisation.

**WAP** — Water Allocation Plan; a plan prepared by a CWMB or water resources planning committee and adopted by the Minister in accordance with the *Natural Resources Management Act 2004* (SA)

**Water dependent ecosystems** — those parts of the environment, the species composition and natural ecological processes that are determined by the permanent or temporary presence of flowing or standing water, above or below ground. The in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems

**Water licence** — a licence granted under State legislation entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area. This grants the licensee

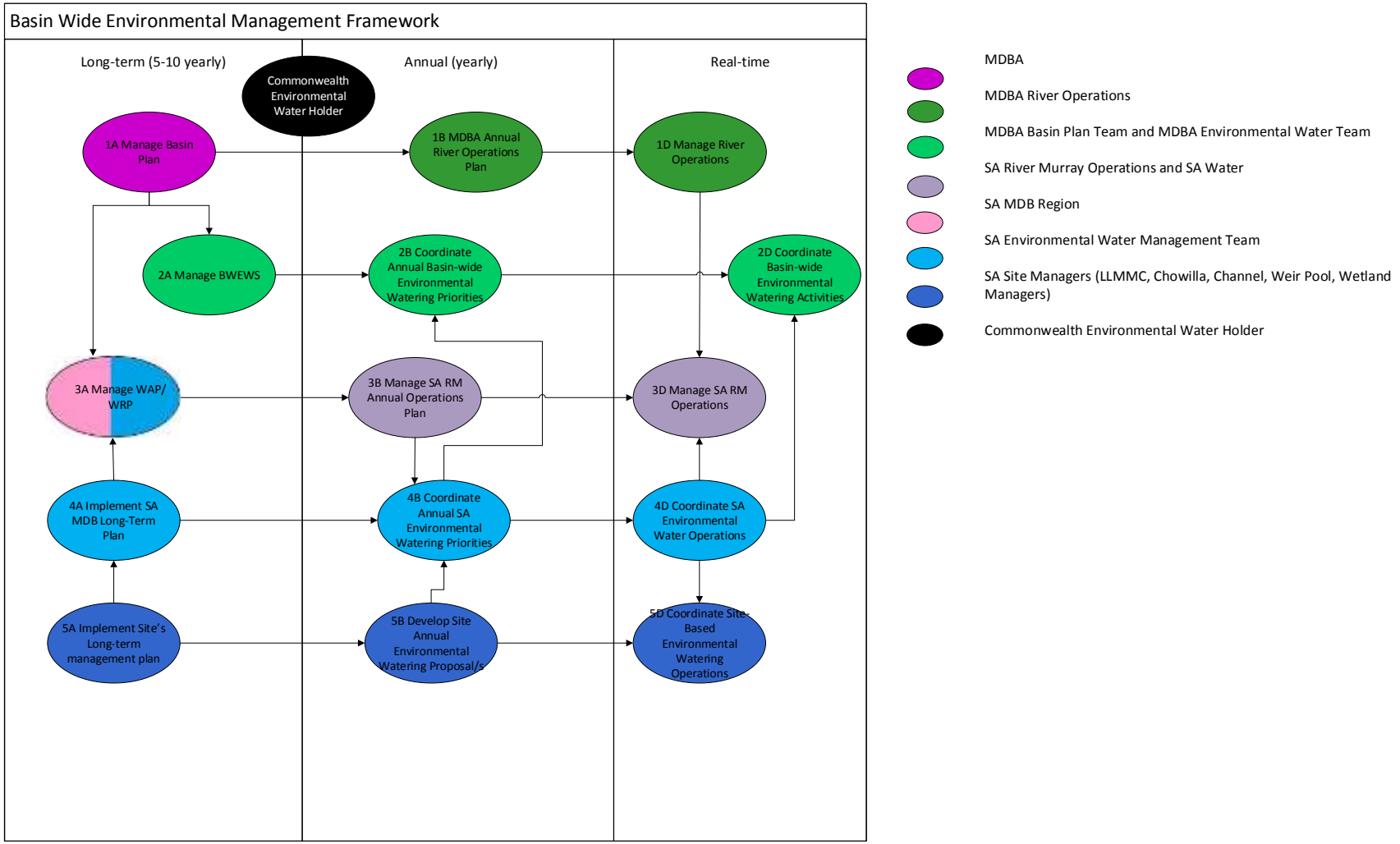
a right to take an allocation of water specified on the licence, which may also include conditions on the taking and use of that water. A water licence confers a property right on the holder of the licence and this right is separate from land title

**Water year** - The period between 1 July in any given calendar year and 30 June the following calendar year; also called a licensing year or a water-use year

Martins Bend re-filling. Photo by Rebecca Turner, DEW.

# 7. Appendices

## Appendix A. Basin Wide Environmental Management Framework



## Appendix B: Summary of environmental watering actions proposed for 2018-19 by environmental asset/site managers under five scenarios

**Dry (90% AOP) Scenario**

| Site | Action | Details | Objectives | Vol GL |
|---|---|---|---|---|
| **CLLMM** | Spring inundation of fringing Lower lakes wetlands: raising lake levels in spring to ~0.8m AHD and barrage releases | 120 days – Sept - Dec | ○ Lower Lakes fringing vegetation, threatened fish and frog species<br>○ Movement and recruitment of congollis and galaxias<br>○ Localised estuary for estuarine fish, macroinvertebrates<br>○ Encourage spawning and recruitment of black bream where feasible | 548.5 |
| | 8 month continuous barrage releases for fish passage | 240 days – Jan – Jun and Jul-Aug | ○ Provide continuous fishway/barrage releases & localised estuarine conditions<br>○ Provide continuous connectivity between river & estuary<br>○ Maintain lake levels >0.4-0.5m AHD all year | 272.5 |
| | Winter flows through barrages/Murray Mouth | July-Aug | ○ Provide freshwater signal through Goolwa barrages to ocean<br>○ Provide for upstream migration of adult lamprey<br>○ Minimise accumulation of sediment in Murray Mouth | 40 |

| | | | | |
|---|---|---|---|---|
| **Channel and Floodplain** | Target partially delivery EWR-IC2 described in the SA River Murray LTWP (Median discharge QSA 15,000 ML/day) with reduced duration | 60-days - mid-Oct to mid-Dec | ○ Increase availability of moderate-fast (0.18 – 0.25 m/s) velocity habitat<br>○ In near-bank areas of upper weir pools, freshen groundwater and maintain/improve adult river red gum tree condition<br>○ Support spawning and recruitment of golden perch and silver perch by creating conditions conducive to reproductive activity when temperature thresholds (20 degrees) are exceeded | 610 |
| | Target EWR-IC1 described in the SA River Murray LTWP (Median discharge QSA 10,000 ML/day with +/- 2,000 ML/day variability | 60-days - Dec-Jan | ○ Prevent persistent thermal stratification and conditions conducive to harmful algal blooms from occurring<br>○ Improved biofilm community composition in upper weir pools (due to variations in water levels in weir pool tailwaters)<br>○ Facilitate recruitment of emergent vegetation in upper weir pools (due to variations in water levels in weir pool tailwaters)<br>○ Promote annual recruitment by foraging generalist native fish species | 174 |
| | Replicate the 2005 QSA hydrograph between 1/10/2005 and 31/12/2005 by maintaining a median QSA of at least 12,000 ML/d (no less than 8,000 ML/d) for at least 70 days with a peak of >15,000 ML/d for at least 20 days | 70 days – Oct to Dec | ○ Improve hydraulic habitat conditions in the River channel<br>○ Stimulate fish breeding and recruitment<br>○ Improve variation in water levels<br>○ Improvements in vegetation health by freshening of near bank groundwater<br>○ Inundate small areas of temporary wetlands below Locks | 418 |

| | | | | |
|---|---|---|---|---|
| | | | ○ Maximise ecological benefits for the River system through the delivery of water to the Lower Lakes, Coorong and Murray Mouth<br>○ Increase flow rates through anabranch systems | |
| **Weir Pool Manipulation** | Lower weir pool 2 by 15-25 cm below normal pool level | 40 days – mid July –mid August | ○ To test procedures and validate models<br>○ Increase bank habitat<br>○ Improve soil condition<br>○ Improve littoral zone cycling and soil condition<br>○ Improve riparian habitat<br>○ Enhance flow velocity and matter transport | 24.8 |
| | Weir 2 pool raised by up to 50 cm above normal pool level | 105 days – Sept-mid Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 6.3 |
| | Weir 2 pool raised by up to 50 cm above normal pool level but reduce duration if QSA >15,000 ML/d from mid Oct | 45 days - Sept-mid Oct | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 5.7 |
| | Weir pool 2 raise by up to 50 cm above normal pool level and further raise to 75 cm above normal pool level if QSA 10,000 ML/d in Dec | 105 days – Sept-mid Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 10.3 |
| | Lower weir pool 5 by 12-15 cm below normal pool level following lowering in June of 8-12 cm | 30 days - July | ○ To test procedures and validate models<br>○ Increase bank habitat<br>○ Improve soil condition<br>○ Improve littoral zone cycling and soil condition<br>○ Improve riparian habitat<br>○ Enhance flow velocity and matter transport | 1.8 |
| | Weir 5 pool raised by up to 35 cm above normal pool level | 130 days – Aug to early Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 14.4 |
| | Weir 5 pool raised by up to 35 cm above normal pool level but reduce duration if QSA >15,000 ML/d from mid Oct | 75 days – Aug to late Oct | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 14.4 |

| | | | | |
|---|---|---|---|---|
| | Raise weir pool 6 up to 20 cm above normal pool level | 28-42 days – Sept –early Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>Diverse and productive biofilm and macroinvertebrate communities<br>Relieve soil salinity stress in littoral zone | 2.8 |
| | One or more of weir pool 1, 2, 5 and 6 by 15-30 cm below normal pool level over 60 days | April - Jun | ○ TBA | TBA |
| **Chowilla** | Pump to up to 8 priority wetlands | Sept-Nov | ○ Fringing vegetation – support seedlings<br>○ Habitat for biota<br>○ Reduce soil salinity<br>○ Improve soil moisture | 4 |
| | Pulse flows through Chowilla anabranch via Pipeclay & Slaney Creek weirs in conjunction with raising weir pool 6. | 140 days – Oct - Feb | ○ Provide fast flowing habitat for large bodied fish<br>○ Mobilise carbon and nutrients to support aquatic food webs via increase flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds)<br>○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. | N/A |
| | Operate Chowilla Regulator to generate in-channel rise. Regulator up to 18.5 mAHD; L6 – 19.45 mAHD | Sept-Dec | ○ Instate variability in hydraulic conditions (depth, velocity, turbulence)<br>○ Reduce salinity of near-bank groundwater due to lateral infiltration of low salinity surface water<br>○ Reduce soil salinity and improve soil moisture availability in inundated and adjacent zones<br>○ Promote bacterial-dominated biofilm communities with higher nutritional value (compared to algal biofilms) benefiting higher consumers that use biofilms as a food resource<br>○ Improve vegetation growth in riparian zone<br>○ Create lateral connection and inundation of early commence to flow wetlands connected *(depending on height of operation*.<br>○ Assist in achieving the Ecological Target for trees adjacent to anabranch creeks<br>○ Support ongoing growth of seedlings and saplings of river red gum, black box and cooba that have established in response to flooding and environmental watering recent years<br>○ Assist in achieving the Ecological Target for lignum in inundated areas<br>○ Provide conditions conducive to achieving ecological targets for flood dependent and aquatic understorey vegetation in inundated and riparian zones | 24.7 |

**Moderate (75% AOP) Scenario**

| Site | Action | Details | Objectives | Vol GL |
|---|---|---|---|---|
| **CLLMM** | Spring inundation of fringing Lower lakes wetlands: raising lake levels in spring to ~0.8m AHD and barrage releases | 4 months – Sept - Dec | ○ In addition to objectives under 90% AOP:<br>○ Provide barrage outflows for fish migration, connectivity & localised estuarine conditions<br>○ Maintain lake levels ~0.8 m AHD October to December<br>○ Improve fringing & submerged aquatic vegetation health<br>○ Provide for Southern Bell frog & small threatened fish recruitment<br>○ Suitable conditions in Coorong North lagoon for benthic invertebrates<br>○ Feeding habitat for migratory waders<br>○ Encourage spawning and recruitment of black bream | 649 |
| | 8 month continuous barrage releases for fish passage | 8 months – Jan - June & Jul-Aug | ○ Provide continuous fishway/barrage releases & localised estuarine conditions<br>○ Provide continuous connectivity between river & estuary<br>○ Maintain lake levels >0.5m AHD all year | 288.5 |
| | Winter flows through barrages/Murray Mouth | July-August | ○ Provide freshwater signal through Goolwa barrages to ocean<br>○ Provide for upstream migration of adult lamprey<br>○ Minimise accumulation of sediment in Murray Mouth | 40 |
| **Channel and Floodplain** | Target partially delivery EWR-IC2 described in the SA River Murray LTWP (Median discharge QSA 15,000 ML/day) with reduced duration (note reduced duration may mean a reduced certainty of achieving outcomes) | 60-days - mid-Oct to mid-Dec | ○ Increase availability of moderate-fast (0.18 – 0.25 m/s) velocity habitat<br>○ In near-bank areas of upper weir pools, freshen groundwater and maintain/improve adult river red gum tree condition<br>○ Support spawning and recruitment of golden perch and silver perch by creating conditions conducive to reproductive activity when temperature thresholds (20 degrees) are exceeded | 610 |
| | Target EWR-IC1 described in the SA River Murray LTWP (Median discharge QSA 10,000 ML/day with +/- 2,000 ML/day variability | 60-days - Dec-Jan | ○ Prevent persistent thermal stratification and conditions conducive to harmful algal blooms from occurring<br>○ Improve biofilm community composition in upper weir pools (due to variations in water levels in weir pool tailwaters)<br>○ Facilitate recruitment of emergent vegetation in upper weir pools (due to variations in water levels in weir pool tailwaters)<br>○ Promote annual recruitment by foraging generalist native fish species | 174 |
| | Replicate the 2005 QSA hydrograph between 1/10/2005 and 31/12/2005 by maintaining a median QSA of at least 12,000 ML/d (no less than 8,000 ML/d) for at least 70 days with a peak of >15,000 ML/d for at least 20 days | 70 days – Oct to Dec | ○ Improve hydraulic habitat conditions in the River channel<br>○ Stimulate fish breeding and recruitment<br>○ Improve variation in water levels<br>○ Improvements in vegetation health by freshening of near bank groundwater<br>○ Inundate small areas of temporary wetlands below Locks<br>○ Maximise ecological benefits for the River system through the delivery of water to the Lower Lakes, Coorong and Murray Mouth<br>○ Increase flow rates through anabranch systems | 418 |
| **Weir Pool Manipulation** | Lower weir pool 2 by 15-25 cm | 22 days – mid July –mid August | ○ Increase bank habitat<br>○ Improve soil condition<br>○ Improve littoral zone cycling<br>○ Improve riparian habitat | 17.8 |

| | | | | |
|---|---|---|---|---|
| | Weir 2 pool raised by up to 50 cm above normal pool level | 105 days – Sept-mid Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Provide breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 6.3 |
| | Weir 2 pool raised by up to 50 cm but reduce duration if QSA >15,000 ML/d from mid Oct | 45 days - Sept-mid Oct | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Provide breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 5.7 |
| | Weir pool raise by up to 50 cm above normal pool level and further raise to 75 cm above normal pool level if QSA 10,000 ML/d in Dec | 105 days – Sept-mid Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Provide breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 10.3 |
| | Lower weir pool 5 by 12-15 cm following lowering in June of 8-12 cm | | ○ Test procedures and validate models<br>○ Increase bank habitat<br>○ Improve soil condition<br>○ Improve littoral zone cycling and soil condition<br>○ Improve riparian habitat<br>○ Enhance flow velocity and matter transport | 1.8 |
| | Weir 5 pool raised by up to 35 cm above normal pool level | 130 days – Aug to early Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Provide breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 14.4 |
| | Weir 5 pool raised by up to 35 cm above normal pool level but reduce duration if QSA >15,000 ML/d from mid Oct | 75 days – Aug to late Oct | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Provide breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 12.3 |
| | Raise weir pool 6 up to 20 cm above normal pool level | 28-42 days – Sept –early Dec | ○ Growth and expansion of littoral vegetation<br>○ Understorey plant community sustained and productive<br>○ Diverse and productive biofilm and macroinvertebrate communities<br>○ Provide breeding habitat for small fish and reed dependent waterbirds<br>○ Relieve soil salinity stress in littoral zone | 2.8 |
| | One or more of weir pool 1, 2, 5 and 6 by 15-30 cm below normal pool level over 60 days | April - Jun | ○ TBA | TBA |
| **Chowilla** | Pump to up to 8 priority wetlands | Sept-Nov | ○ Improve fringing vegetation<br>○ Provide habitat for biota | 4 |
| | Pulse flows through Chowilla anabranch via Pipeclay & Slaney Creek weirs in conjunction with raising weir pool 6. | 140 days – Oct - Feb | ○ Provide fast flowing habitat for large bodied fish<br>○ Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds) | N/A |

| | | | | |
|---|---|---|---|---|
| | | | ○ Provide breeding and feeding habitat for waterbirds, amphibians and invertebrates. | |
| | Operate Chowilla Regulator to generate in-channel rise. Regulator up to 18.5 mAHD; L6 – 19.45 mAHD | Sept-Dec | ○ Instate variability in hydraulic conditions (depth, velocity, turbulence)<br>○ Reduced salinity of near-bank groundwater due to lateral infiltration of low salinity surface water<br>○ Reduce soil salinity and improved soil moisture availability in inundated and adjacent zones<br>○ Promote bacterial-dominated biofilm communities with higher nutritional value (compared to algal biofilms) benefiting higher consumers that use biofilms as a food resource<br>○ Improve vegetation growth in riparian zone<br>○ Create lateral connection and inundation of early commence to flow wetlands connected *(depending on height of operation*.<br>○ Assist in achieving the Ecological Target for trees adjacent to anabranch creeks<br>○ Support ongoing growth of seedlings and saplings of river red gum, black box and cooba that have established in response to flooding and environmental watering recent years<br>○ Assist in achieving the Ecological Target for lignum in inundated areas<br>○ Provide conditions conducive to achieving ecological targets for flood dependent and aquatic understorey vegetation in inundated and riparian zones | 24.7 |

**Near Average (50% AOP) Scenario**

| Site | Action | Details | Objectives | Vol GL |
|---|---|---|---|---|
| **CLLMM** | Spring inundation of fringing Lower lakes wetlands: raising lake levels in spring to ~0.8m AHD and extend duration of unregulated flow for increased barrage releases | Sept-Dec | ○ In addition to objectives under 75% AOP:<br>○ Increase estuarine conditions further into North Lagoon and South Lagoon<br>○ Estuarine fish utilise both north and south lagoons for growth and recruitment<br>○ Improve benthic macroinvertebrate, migratory birds and attractant flows for migration of fish<br>○ Provide feeding habitat for migratory waders<br>○ Open Murray Mouth & salt/nutrient export | 460 |
| | Increase in barrage releases to 1-2 GL/d baseflows for remainder of year for fish passage | Jan - June | ○ Provide fish passage and localised estuarine conditions<br>○ Minimise sand accumulation in Mouth | 332 |
| **Channel and Floodplain** | Target EWR-IC3 (Median discharge QSA 20,000 ML/day) | 90-days - Oct to Dec | ○ Abundant fast flowing habitat (>0.25 m/s) available<br>○ Improve soil water availability and reduced soil salinity<br>○ Growth of emergent aquatic plants in temporary wetlands inundated by high flows<br>○ Improve river red gum population demographics in inundated areas and areas adjacent due to lateral recharge of groundwater<br>○ Improve survival of Murray cod and catfish larvae | 656 |
| | Target EWR-IC2 described in the SA River Murray LTWP (Median discharge QSA 15,000 ML/day) | 90-days - mid-Oct to mid-Dec | ○ Increase availability of moderate-fast (0.18 – 0.25 m/s) velocity habitat<br>○ In near-bank areas of upper weir pools, freshen groundwater and maintain/improve adult river red gum tree condition<br>○ Support spawning and recruitment of golden perch and silver perch by creating conditions conducive to reproductive activity when temperature thresholds (20 degrees) are exceeded | 712 |
| | Target partially delivery EWR-IC2 described in the SA River Murray LTWP (Median discharge QSA 15,000 ML/day) with reduced duration (note reduced duration may mean a reduced certainty of achieving outcomes) | 60-days - mid-Oct to mid-Dec | ○ Increase availability of moderate-fast (0.18 – 0.25 m/s) velocity habitat<br>○ In near-bank areas of upper weir pools, freshen groundwater and maintain/improve adult river red gum tree condition<br>○ Support spawning and recruitment of golden perch and silver perch by creating conditions conducive to reproductive activity when temperature thresholds (20 degrees) are exceeded | 485 |
| **Weir Pool Manipulation** | Lower weir pool 2 by 15-25 cm | 40 days – mid July –mid August | ○ Increase hydraulic complexity<br>○ Flush salt<br>○ Improve water quality | 3.8 |
| | Lower weir pool 3 by 8-10 cm | 20 days – Jul-Aug | ○ Increase bank habitat<br>○ Improve soil condition<br>○ Improve littoral zone cycling<br>○ Improve riparian habitat | 3.5 |
| | Lower weir pool 5 by 12-15 cm following lowering in June of 8-12 cm | 30 days - July | ○ Test procedures and validate models<br>○ Increase bank habitat<br>○ Improve soil condition | 1.8 |

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| | | | ○ Improve littoral zone cycling and soil condition<br>○ Improve riparian habitat<br>○ Enhance flow velocity and matter transport | |
| | Weir 5 pool raised 50 cm above normal pool level | 45 days – Aug-mid Sept | ○ Monitor flow velocity and hydraulic complexity during a winter weir pool raising when flows are between 15,000 and 25,000 ML/day to inform future management decisions | 14.3 |
| | 1 or more of weir pool 1, 2, 5 and 6 by 15-30 cm below normal pool over 60 days | April - Jun | ○ TBA | TBA |
| **Chowilla** | Operate Chowilla Regulator to generate a mid-floodplain inundation. Lock 6 is raised to 19.85 mAHD; Chowilla Regulator is raised up to a maximum of 19.45 mAHD | 130 days Aug - Dec | ○ Improve soil moisture availability to within ranges conducive to active tree growth to reduce potential for loss of tree condition, and support progressive improvement of long-lived vegetation<br>○ Generate an increase in the proportion of trees for which condition scores are above the Ecological Target – specifically targeting re-watering mid-level elevation Black Box to consolidate benefits from 2016 managed inundation and unregulated flow event<br>○ Instate connectivity to mid-elevation floodplain and all key wetlands<br>○ Contribute to ensuring the long-term sustainability of floodplain tree community by support ongoing growth of seedlings and saplings of River red Gum, Black Box and Cooba that have established in response to flooding and environmental watering recent years<br>○ Improve condition of Lignum in inundated areas<br>○ Provide breeding habitat for waterbirds, amphibians and invertebrates.<br>○ Create conditions conducive to germination and growth of flood dependent and flood responsive vegetation<br>○ Mobilise carbon and nutrients to support aquatic food webs via increased flux of resources through microbial and invertebrate pathways to higher trophic levels (fish water birds)<br>○ Improve condition of floodplain habitat for dependent species including reptiles, woodland birds and mammals<br>○ Establish a flow regime with distinct variability in components of the flood pulse | 75.5 |

**Wet (25% AOP) Scenario**

| Site | Action | Details | Objectives | Vol GL |
|---|---|---|---|---|
| **Channel and Floodplain** | Target EWR-FP1 described in the SA River Murray LTWP (Median discharge OSA 50,000 ML/d) | 30 days - Sep | All SA River Murray Channel targets are relevant but in addition:<br>o Inundation of the SA River Murray Floodplain PEA commences<br>o Large Murray cod recruitment event<br>o Support large-scale breeding by eight riparian frog species | 383 |
| | Target EWR-IC7 described in the SA River Murray LTWP (Median discharge QSA 40,000 ML/day | 90 days - Sep-Nov | o Inundate the entire SA River Murray Channel priority environmental asset (PEA)<br>o Heterotrophic productivity becomes dominant<br>o Connect significant areas of temporary wetland to the River<br>o Support growth, condition and recruitment of native vegetation from emergent, amphibious and flood-dependent functional groups across the entire elevation gradient of the SA River Murray Channel PEA | 591 |
| **Weir Pool Manipulation** | Raise weir pool 2 up to 75 cm above normal pool level | 120 days – Aug-Nov | o Promote wetland inundation, connectivity and production<br>o Promote the health, growth and reproduction of floodplain vegetation<br>o Provide access for aquatic fauna to floodplain and wetland habitats, particularly during key breeding and foraging periods<br>o Transfer particulate organic matter from the floodplain to the river channel | 10 |
| | Lower weir pool 3 by 8-10 cm | 20 days – Jul-Aug | o Increase bank habitat<br>o Improve soil condition<br>o Improve littoral zone cycling<br>o Improve riparian habitat | 3.5 |
| | Raise weir pool 5 up to 50 cm above normal pool level | 120 days – Aug-Nov | o Promote wetland inundation, connectivity and production<br>o Provide for the health, growth and reproduction of floodplain vegetation<br>o Provide access for aquatic fauna to floodplain and wetland habitats, particularly during key breeding and foraging periods<br>o Provide for the transfer of particulate organic matter from the floodplain to the river channel | 13.5 |
| | One or more of weir pool 1, 2, 5 and 6 by 15-30 cm below normal pool level over 60 days | April - Jun | TBA | TBA |
| **Chowilla** | Operate Chowilla regulator around natural high flows to generate a max- floodplain inundation. Lock 6 is raised up to 19.85 m AHD; CR is raised to a max of 19.85 mAHD | 157 days – July-Dec | o *As for Near Average action above. and*<br>o Potentially test regulator and ancillary structures to higher operating levels | 92.5 |
| **CLLMM** | Add to back of unregulated flow, increase barrage releases into summer | Oct-Nov | o In addition to objectives under 50% AOP:<br>o Improve salinity levels in Coorong<br>o Influence water levels in South Lagoon for *Ruppia tuberosa* recruitment<br>o Provide for estuarine fish growth and recruitment<br>o Provide food for waterbirds | 213 |

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| | | | ○ Provide for an open Murray Mouth and salt export and minimise sand accumulation | |
| | Add to height of unregulated flow; maintain elevated barrage releases to maintain Coorong South Lagoon water levels | Dec-Jan | ○ Provide barrage flows<br>○ Increase size of estuary<br>○ Influence water levels in South Lagoon for *Ruppia tuberosa* | 487 |
| | (g) Increase barrage releases to 2 GL/d for remainder of year for fish passage | Feb-May | ○ Provide fish passage<br>○ Maintain estuary | 178 |

**Very Wet Scenario (10% AOP)**

| Site | Action | Details | Objectives | Vol GL |
|---|---|---|---|---|
| **CLLMM** | (h) Action f plus add to back of unregulated flow, increase barrage releases into summer | Jan-Feb | ○ In addition to objectives under 25% AOP:<br>○ Improve salinity levels in Coorong<br>○ Influence water levels in South Lagoon for *Ruppia tuberosa*<br>○ Provide for estuarine fish growth and recruitment<br>○ Provide food for waterbirds<br>○ Contribute to open Murray Mouth and salt export and minimise sand accumulation | 411 |
| **Channel and Floodplain** | Target EWR –FP5 target described in the SA River Murray LTWP (Median discharge QSA 80,000 ML/day for 60-days) | 60 days – Sep - Oct | ○ Inundate entire SA River Murray Floodplain PEA<br>○ Maintain/improve condition of adult river red gum and black box trees across the entire elevation gradient of the SA River Murray Floodplain PEA<br>○ Maintain/improve condition of lignum shrublands across the entire elevation gradient of the SA River Murray Floodplain PEA<br>○ Maintain inundation of habitat for breeding by a range of waterbird species<br>○ Improve river red gum and black box population demographics by supporting recruitment due to extended inundation of the entire elevation gradient of the SA River Murray Floodplain PEA | 589 |
| | Target EWR-FP4 target described in the SA River Murray LTWP (Median discharge QSA 80,000 ML/day for 30-days) | 30 days - Sep | ○ Inundate the entire SA River Murray Floodplain PEA<br>○ Maintain/improve condition of adult river red gum and black box trees across the entire elevation gradient of the SA River Murray Floodplain PEA<br>○ Maintain/improve condition of lignum shrublands across the entire elevation gradient of the SA River Murray Floodplain PEA<br>○ Maintain inundation of habitat for breeding by a range of waterbird species | 227 |
| **Weir pool manipulation** | *No additional actions* | | | |
| **Chowilla** | Operate Chowilla regulator around natural high flows to generate a max- floodplain inundation. Lock 6 is raised to 19.85 m AHD; CR is raised to a max of 19.85 mAHD *either before or following a flow peak (or both).* Operation of the Chowilla Regulator on rising or falling limb of natural high flow to extend period of inundation | 157 days – July-Aug | *As for near average action above, and*<br>○ Potentially test regulator and ancillary structures to higher operating levels | 78.4 |

## Appendix C. Temporary wetlands for pumping

| Watering proposal | Wetland Name | Watering Objectives | Volume (ML) |
|---|---|---|---|
| **Lower Lakes fringing wetlands** | Tolderol | Provide water levels and suitable habitat for Migratory Birds<br>Provide suitable breeding habitat for frogs; in particular Southern Bell Frogs | 1200 |
| | Jenny's Lagoon | Provide suitable breeding habitat for frogs; in particular Southern Bell Frogs | 20 |
| | | | |
| **Gorge Wetlands** | Overland Corner – Main Basin and Lignum Basin | Support a range/mosaic of wetland habitats including lignum and river red gum habitats | 760 + 150 |
| | Wigley Reach | Support a range/mosaic of wetland habitats including lignum and river red gum habitats | 315 |
| | Akuna | Support a range/mosaic of wetland habitats including lignum and river red gum habitats | 175 |
| | Maize Island | Support a range/mosaic of wetland habitats including river cooba and river red gum habitats | 155 |
| | Markaranka – Main Basin | Support a range/mosaic of wetland habitats including black box and river red gum habitats<br>Provide frog breeding opportunities, particularly for the Southern Bell Frog<br>Provide Regent Parrot habitat (including nesting) | 1950 |
| | Hogwash Bend – North and South Basin | Support a range/mosaic of wetland habitats including lignum and river red gum habitats<br>Provide frog breeding opportunities, particularly for the Southern Bell Frog<br>Provide Regent Parrot habitat (including nesting) | 570+30 |
| | | | |
| | Molo Flat – Western and Eastern Basin and Channel | Support a range/mosaic of wetland habitats including river red gum and open water habitats<br>Provide frog breeding opportunities, particularly for the Southern Bell Frog | 500+46+90 |
| | Morgan East | Support a range/mosaic of wetland habitats including Lignum and river red gum habitats<br>Provide frog breeding opportunities, particularly for the Southern Bell Frog | 200 |
| | Nikalapko | Support tree health (river red gum) and waterbirds | 950 |
| | Morgan CP (South Lagoon and North Lagoon – Birds and Carparks) | Support a range/mosaic of wetland habitats including Lignum and river red gum habitats<br>Provide frog breeding opportunities, particularly for the Southern Bell Frog<br>Provide Regent Parrot habitat (including nesting) | 170+270 |
| **Valley Wetlands** | Gerard lignum basins | Support a range of floodplain vegetation communities including river red gum, black box, cooba and lignum<br>Provide frog breeding opportunities, particularly for the Southern Bell Frog | 140 |

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| | Wiela | Support a range of floodplain vegetation communities including river red gum and black box seedlings | 375 |
| | Bookmark Creek | Support a range of floodplain vegetation communities including fringing river red gum<br>Provide frog breeding opportunities, particularly for the Southern Bell Frog<br>Provide flowing habitat | 450 |
| | | | |
| **Murray hardyhead sites** | Disher Creek | Maintain suitable habitat to support a healthy breeding population of Murray hardyhead.<br>Maintain water quality and levels within the ranges to enable healthy Murray hardyhead population to be sustained (including breeding events). | 200 |
| | Berri Evaporation Basin | | 1200 |
| | | | |