2020-21 Annual Water for the Environment Plan

For the South Australian River Murray

Government of South Australia
Department for Environment and Water

Foreword

The *2020-21 Annual Water for the Environment Plan for the South Australian River Murray* (the Annual Plan) is a key element in South Australia's river management framework. It builds upon actions delivered in previous annual plans, and is guided by the ecological objectives and targets in the *Long Term Environmental Watering Plan for the South Australian River Murray (2015)*.

The Annual Plan is informed by the Basin Plan prioritisation and planning processes, which determine how available environmental water will be used in the Murray-Darling Basin. 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 current outlook for 2020-21 is for moderate to near average conditions in the Murray-Darling Basin, which provides some relief from the previous three straight years of dry conditions across the Basin. 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 2020-21.

Ben Bruce, Executive Director, Water and River Murray
Department for Environment and Water
December, 2020

Pike River. Photo: Courtney Glover, DEW

Cover photo: Red-capped plover at Coombool swamp. Photo: Helga Kieskamp

Acknowledgements

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

- Banrock Station, Accolade Wines
- Chowilla Community Reference Committee
- Commonwealth Environmental Water Office (CEWO)
- Coorong, Lower Lakes and Murray Mouth Community Advisory Panel
- First Peoples of the River Murray and Mallee Region
- Local Action Planning groups and Landcare groups
- Murray-Darling Basin Authority (MDBA)
- Murraylands and Riverland Landscape Board
- Nature Foundation SA
- Ngarrindjeri Aboriginal Corporation (NAC)
- Mannum Aboriginal Community Association Incorporated (MACAI)
- Renmark Irrigation Trust (RIT)
- SA Water
- Scientific Advisory Group for the Lower Lakes, Coorong and Murray Mouth
- South Australian Research and Development Institute (SARDI)
- University of Adelaide
- Flinders University
- Other South Australian government departments through interagency reference groups

Peron's tree trog, Morgan Conservation Park. Photo: Annie Kriesl, Murraylands and Riverland Landscape Board

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The Annual Plan presents South Australia's preferences for environmental water delivery along the South Australian River Murray for the 2020-21 water year. It describes the water delivery requirements to best achieve a range of environmental outcomes along the South Australian stretch of the river, its floodplains and wetlands, through to the Murray Mouth and Coorong, consistent with requirements under the Murray-Darling Basin Plan. In doing so it identifies opportunities to maximise outcomes from watering in South Australia by using return flows from upstream watering actions. It also promotes delivery of water for the environment 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 relevant to environmental watering including recent hydrological conditions in the region.
- Section 2 summarises how environmental managers engaged with external stakeholders and Aboriginal groups to develop their environmental watering proposals, to identify and assess any potential risks, and develop the Annual Plan.
- 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, as well as the management objectives of the major environmental water holders.
- Section 4 presents the annual environmental watering priorities for the South Australian River Murray Water Resource Plan (WRP) 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 South Australian multi-site watering demonstrates how the effectiveness of environmental water delivery can be maximised through aligning the timing, magnitude and duration of watering actions at multiple locations along the South Australian River Murray.
- Section 5 provides practical information for implementing environmental watering actions, including an overview of licensing, trade, accounting and reporting mechanisms.

Coastal vegetation on the shore of the Coorong. Photo: Kirsty Wedge, DEW

1 Introduction

1.1 Purpose of this Plan

The Annual Environmental Watering Plan ("Annual Plan") guides the delivery of water for the environment in the South Australian (SA) River Murray for 2020-21, and has been developed in consultation with key stakeholders. The Annual Plan presents the priorities for environmental water delivery for a range of water availability scenarios, which are submitted to the MDBA and the Commonwealth Environmental Water Holder (CEWH) to inform whole of basin water delivery planning.

The purpose of this plan is to:

- document South Australia's priority environmental water needs and inform water holders of the preferred patterns of delivery for 2020-21;
- guide the delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian Murray system;
- identify opportunities, where appropriate, to enhance environmental outcomes through the operation of infrastructure; and
- make information on priority environmental watering activities available to stakeholders.

The Annual Plan is a part of South Australia's environmental water management framework (see Appendix A) which includes the development of the Annual Environmental Watering Priorities, the Annual Plan, the Annual Report, the SA River Murray Long Term Environmental Watering Plan (LTWP), the state's environmental watering policy and procedures, and management of South Australian environmental water and water received by South Australia from the CEWH, The Living Murray Program (TLM) and other environmental water holders. The Annual Plan integrates all of the proposed watering activities for the water year ahead and has been developed based on the best available data and science. However, water availability and delivery is subject to change depending on actual river and climatic conditions, which will inform real-time and adaptive water use.

This is the sixth annual plan to be developed since the publication of the *Long Term Environmental Watering Plan for the South Australian River Murray Water Resource Plan Area* (Department of Environment Water and Natural Resources, 2015). The LTWP is a requirement under the Basin Plan for each water resource plan area (WRP) and must identify priority environmental assets, priority ecosystem functions, ecological objectives, targets and environmental watering requirements (EWRs). The SA River Murray LTWP identifies three Priority Environmental Assets (PEAs): the Coorong, Lower Lakes and Murray Mouth (CLLMM), the River Murray Channel and the River Murray Floodplain.

The environmental watering priorities in 2020-21 identified in the Annual Plan are consistent with the assets and EWRs described in the SA River Murray LTWP, and with the Basin-Wide Environmental Watering Strategy (Murray-Darling Basin Authority, 2014a).

1.2 What is Environmental Watering?

Environmental watering is the delivery or use of water to achieve environmental outcomes, providing ecological benefits that contribute to a healthy, functioning 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 in partnership with SA Water, Murraylands and Riverland Landscape Board, environmental water holders, communities and Basin states.

DEW has responsibility for the management of a range of sites in the South Australian Murray-Darling Basin. These include three TLM icon sites (the Chowilla Floodplain, the River Murray Channel and the CLLMM) along with a range of wetland and floodplain sites. DEW also coordinates and oversees the management of infrastructure for environmental outcomes (e.g. raising/lowering weir pools, and operating flow control structures and regulators on wetlands).

Landscape Boards (previously Natural Resource Management or 'NRM' Boards), particularly the Murraylands and Riverland Landscape Board, also play a major role in managing wetlands and floodplains and implementing restoration programs.

A number of non-government organisations are involved in on-ground management of water for the environment and associated monitoring, including the Australian Landscape Trust (ALT), Banrock Station-Accolade Wines, Gerard Aboriginal Rangers, Local Action Planning and Landcare groups, Nature Foundation SA, Ngarrindjeri Aboriginal Corporation (NAC), the First Peoples of the River Murray and Mallee Region (FPRMMR), 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** (HEW) is water available under a water access right or held on a water licence for the purpose of achieving environmental outcomes. 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.
- **Planned environmental water** (PEW) is water that is not held on a water licence, but is committed or preserved for environmental purposes or environmental outcomes and cannot be used for any other purpose unless required for emergency purposes.

Potential sources and volumes of held water for 2020-21 are listed on the *Register of Held Environmental Water* which is published annually on the DEW website. PEW is further described in the South Australian River Murray Water Resource Plan (WRP) (DEW 2019b).

Swamp lily in Pilby Creek. Photo: Courtney Monk, Murraylands and Riverland Landscape Board

1.3 The 2019-20 Water Year in Review

A brief summary of the 2019-20 year is outlined below to provide some context for the conditions leading up to the 2020-21 water 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 only regulated flow throughout 2019-20, which was made up of SA Entitlement flow and environmental water. Flow to South Australia peaked at around 15,000 ML/d in October 2019 (Figure 1).

In total, approximately 989 GL of held environmental water was delivered to South Australia. The CEWH provided approximately 760 GL (including approximately 161 GL held on licences in South Australia) and TLM provided approximately 69 GL (including 45 GL held on licences in South Australia) in 2019-20. South Australia also received approximately 60 GL of environmental water in the form of return flows from upstream watering actions undertaken by the Victorian Environmental Water Holder (VEWH). An additional 52 GL of River Murray Increased Flow (RMIF) was also delivered. Approximately 46 GL of water held by the South Australian Minister for Environment and Water was delivered to pool-connected wetlands, temporary wetlands and the CLLMM. The monthly delivery profile is presented in Figure 2.

Table 1. The volumes of held water used for environmental purposes in South Australia in 2019-20.

Water Holders	Upstream (GL)	SA-held (GL)	TOTAL (GL)
CEW	598.4	161.4	759.8
TLM	23.5	45.0	68.5
VEWH	60.4	0	60.4
RMIF	52.4	0	52.4
SA Minister (Class 9)	0	37.6	37.6
Non-government (Class 9)	0	1.4	1.4
SA Minister (non-Class 9)	0	8.8	8.8
TOTAL	**734.7**	**254.2**	**988.9**

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

- raising Weir 2 by 50 cm and Weir 6 by 30 cm in spring;
- inundating over 40 temporary wetland and floodplain areas (including wetlands on Chowilla Floodplain and sites managed by DEW, Australian Landscape Trust, Banrock Station and Nature Foundation SA) via pumping or irrigation;
- delivering the Southern Spring Flow 2019 – an in-channel flow pulse;
- wetting and drying of pool-connected wetlands; and
- managing the CLLMM throughout the year, including manipulating water levels in the Lower Lakes and maintaining barrage and fishway releases.

Results from monitoring data indicate that some of the key ecological outcomes from these environmental watering actions were:

- improved in-stream productivity;
- improved condition of riparian and wetland 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;
- provision of habitat for waterbirds including migratory wader species at Chowilla;
- 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 upstream migration of young-of-year congolli and common galaxias in spring and summer, and upstream migration of pouched and short-headed lamprey in winter and early spring;
- large numbers of colonial waterbirds nesting in the Lower Lakes; and
- high abundances and increased distribution of Murray hardyhead in the Lower Lakes.

More information on the outcomes of the environmental watering actions in 2019-20 will be presented in the annual environmental watering report that is produced in late 2020.

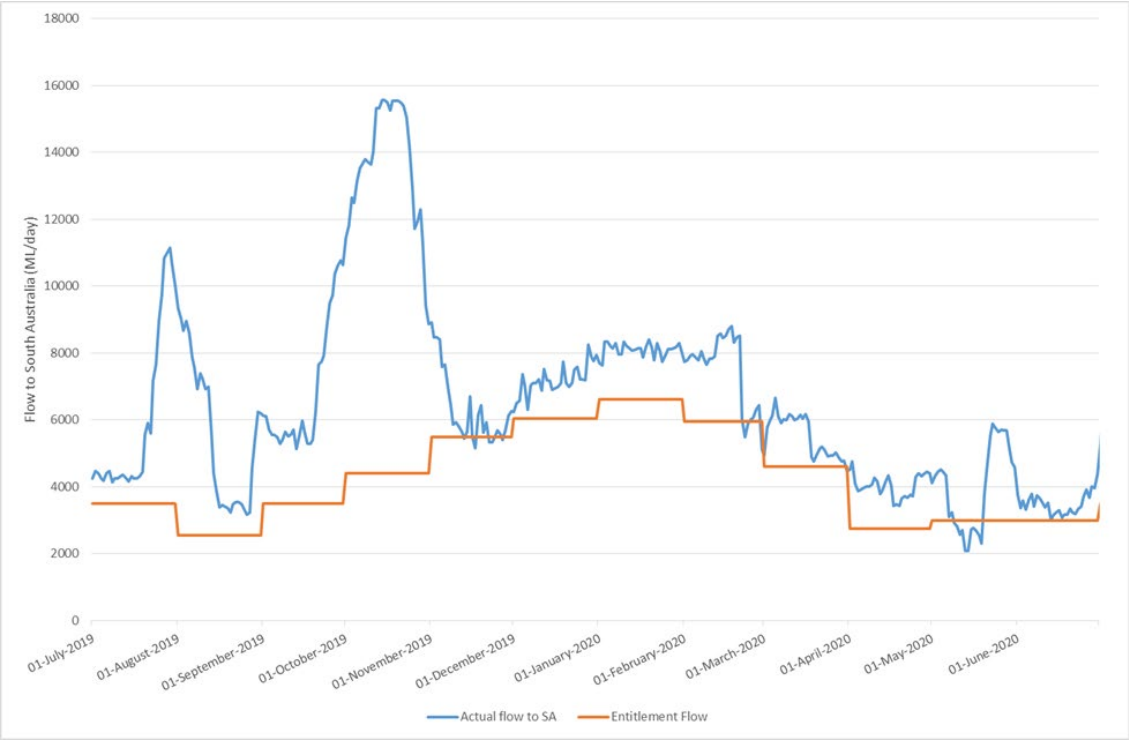


Figure 1. River Murray flows at the South Australian border throughout 2019-20.

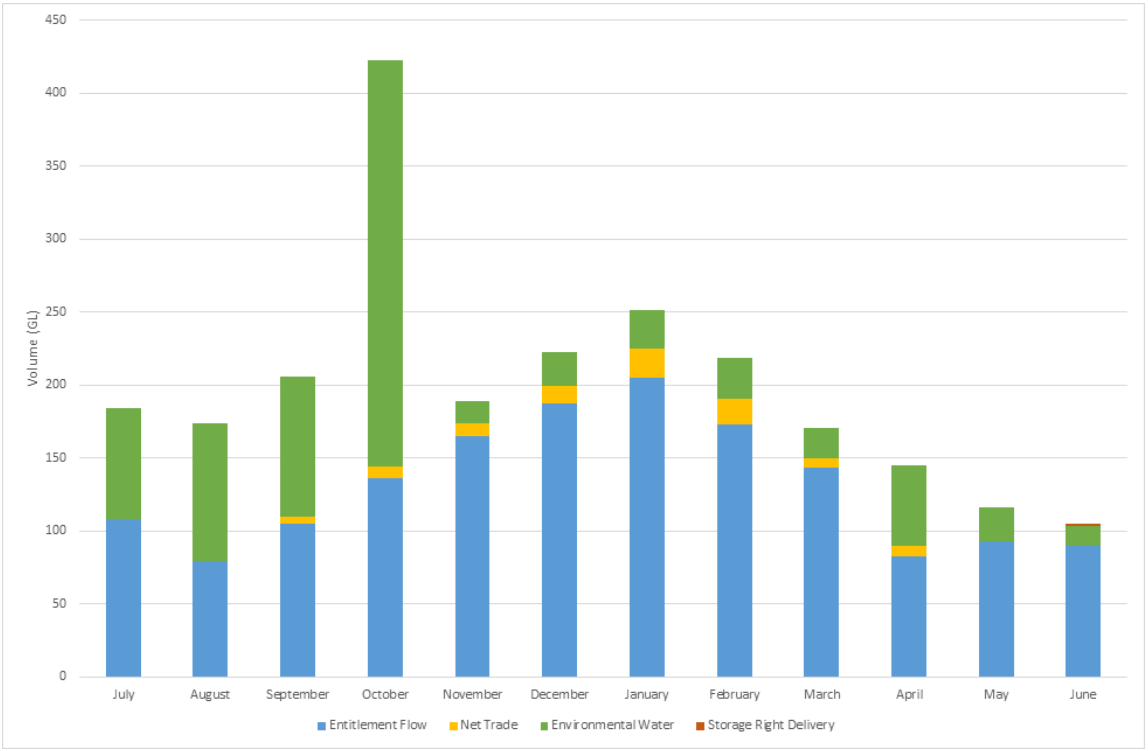


Figure 2. Monthly volumes of water delivered to South Australia in 2019-20.

2 Annual Planning Process

2.1 Approach

The Basin Plan requires Basin States to identify their annual environmental watering priorities for the upcoming water year and submit them to the MDBA by 31 May. South Australia commences annual planning each February, which includes the development of site based annual environmental watering proposals. Site-based proposals are prepared by the site managers and then consolidated into an overarching priorities document. Watering proposals developed for sites in the South Australian River Murray region in 2020-21 and their proponents are listed in Table 1. DEW leads the annual planning and prioritisation process with input from site and water managers, Traditional Owners and stakeholder groups.

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 allows for the coordination of environmental watering along the River Murray, informing decisions relating to water delivery and evaluating environmental outcomes.

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

As part of the annual planning process, environmental watering proposals are provided to the Southern-connected Basin Environmental Watering Committee (SCBEWC). SCBEWC is coordinated by the Murray-Darling Basin Authority and brings together agencies from the Commonwealth, New South Wales, Victorian and South Australian governments to coordinate and manage environmental water across the southern-connected Basin within the Murray-Darling Basin. SCBEWC ensures environmental water management is consistent with the Environmental Watering Plan (Chapter 8 of the Basin Plan), including the *Basin-wide Environmental Watering Strategy,* and facilitates collective environmental water planning for the major water holders. This approach supports effective coordination while allowing different environmental water holders to make independent decisions on watering actions.

Table 2. Environmental watering proposals submitted to MDBA and/or CEWO for 2020-21

Watering Proposal	Proponent
Lower Lakes, Coorong and Murray Mouth	DEW
SA River Murray Channel and Floodplain	DEW
Chowilla Floodplain	DEW
Pike and Katarapko Floodplains	DEW
Weir Manipulation – raising	DEW
Valley Wetlands, Gorge wetlands, Lower Lakes fringing wetlands, Disher Creek and Berri Disposal Basins	Murraylands and Riverland Landscape Board
Wetlands in the Renmark area	Renmark Irrigation Trust
Various wetlands along the Murray	Nature Foundation SA
SA multi-site proposal	DEW

2.2 Community Engagement

A wide range of stakeholders and community groups were consulted regarding the environmental watering actions proposed for 2020-21. This consultation is undertaken by the respective site managers through long-standing and ongoing arrangements. The stakeholders consulted during development of the proposals included the CLLMM Community Advisory Panel, CLLMM Scientific Advisory Group, Chowilla Community Reference Committee, Katarapko Community Advisory Panel (which include representatives from Irrigation trusts, Local Action Planning associations, Landcare organisations, and local government), the Murraylands and Riverland Landscape Board, 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 that deliver environmental water to wetlands also occurs to help coordinate wetland management activities across the region.

Coorong, Lower Lakes and Murray Mouth Community Advisory Panel at Salt Creek. Photo: Stephen Madigan, DEW

Community tour at Chowilla with the Berri Agricultural Bureau members. Photo: Alison Stokes, DEW

2.3 Indigenous Engagement

During development of the 2020-21 Environmental Water Annual Plan, Indigenous engagement was undertaken by the environmental water managers when developing their watering proposals. This included engagement with the Ngarrindjeri Aboriginal Corporation (NAC) on watering objectives and actions proposed for the CLLMM and the River Murray Channel and Floodplain, and with the FPRMMR on the actions proposed for the Chowilla Floodplain, the River Murray Channel and Floodplain, wetland pumping and weir manipulation watering actions.

The FPRMMR are engaged in the delivery of water for the environment on an ongoing basis throughout the year. Engagement included:

- presentations, sharing of information, discussions and time spent on Country with the First Peoples Working Group (FPWG); and
- a two day workshop with First Peoples Indigenous Facilitator and the First Peoples Water Coordinators along with other regional Aboriginal Partnership staff.

Presentations are also provided to the FPRMM Working Group and at NAC Water Statement of Commitment meetings throughout the year regarding water for the environment planning and delivery across the region.

Chowilla Floodplain tour with the First People of the River Murray and Mallee. Photo: Alison Stokes, DEW

2.4 Risk Assessment

Risks related to the planned environmental watering actions for 2020-21 have been identified and assessed and are addressed within specific site watering plans, event plans and within the SCBEWC watering proposals. Risks related to the integration of the site based watering actions, and their impact on the water quality and hydrology of the main River channel, have also been assessed. Risk management is undertaken in accordance with Basin Plan requirements, and includes consideration of flow management targets for a number of key water quality factors (including dissolved oxygen, cyanobacteria, 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 the Basin Plan.

3 Environmental Watering Objectives

The high-level objectives of environmental watering in South Australia for 2020-21 are to:

- protect and restore water-dependent ecosystems of the Lower Murray in SA, including those that support threatened species and Ramsar-listed wetlands
- protect and restore the ecosystem functions within the Lower Murray in SA, including lateral and longitudinal connectivity and end-of-system flows
- ensure that water-dependent ecosystems are resilient to climate change and other risks and threats, including provision of refugia during dry periods
- support habitat diversity and maintain and/or improve bird, vegetation and fish communities;
- deliver environmental water consistent with the environmental watering requirements (EWRs) of the priority environmental assets and priority ecosystem functions to support a healthy, functioning SA River Murray (DEWNR, 2015)
- maximise environmental outcomes through the operation of infrastructure where appropriate.

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 overall environmental objectives of the Basin Plan (Appendix C).

Fish monitoring in the Lower Lakes. Photo: Scotte Wedderburn, University of Adelaide

4 Annual Priorities

4.1 Priority Identification Process

A scenario-based approach was used to develop proposed watering actions for 2020-21. Six resource availability scenarios were identified. These scenarios are based on the MDBA Annual Operating Outlooks (AOO) 'without e-water' model runs provided in March 2020. The scenarios used were - 99 per cent (extreme dry), 95 per cent (very dry), 90 per cent (dry), 75 per cent (moderate), 50 per cent (near average), and 25 per cent (wet) (Figure 3). These percentages refer to the likelihood of exceeding different water availability conditions based on the analysis of historical inflows, current storage volumes, and operational considerations for the upcoming year. A volume of held environmental water (HEW) potentially available for delivery to South Australia in 2020-21 under each of the resource availability scenarios was assumed for planning purposes (Table 3). For each scenario and each site/asset, objectives are defined and optimal water delivery determined (i.e. added to hydrographs) to achieve those objectives, taking into account estimated environmental water availability.

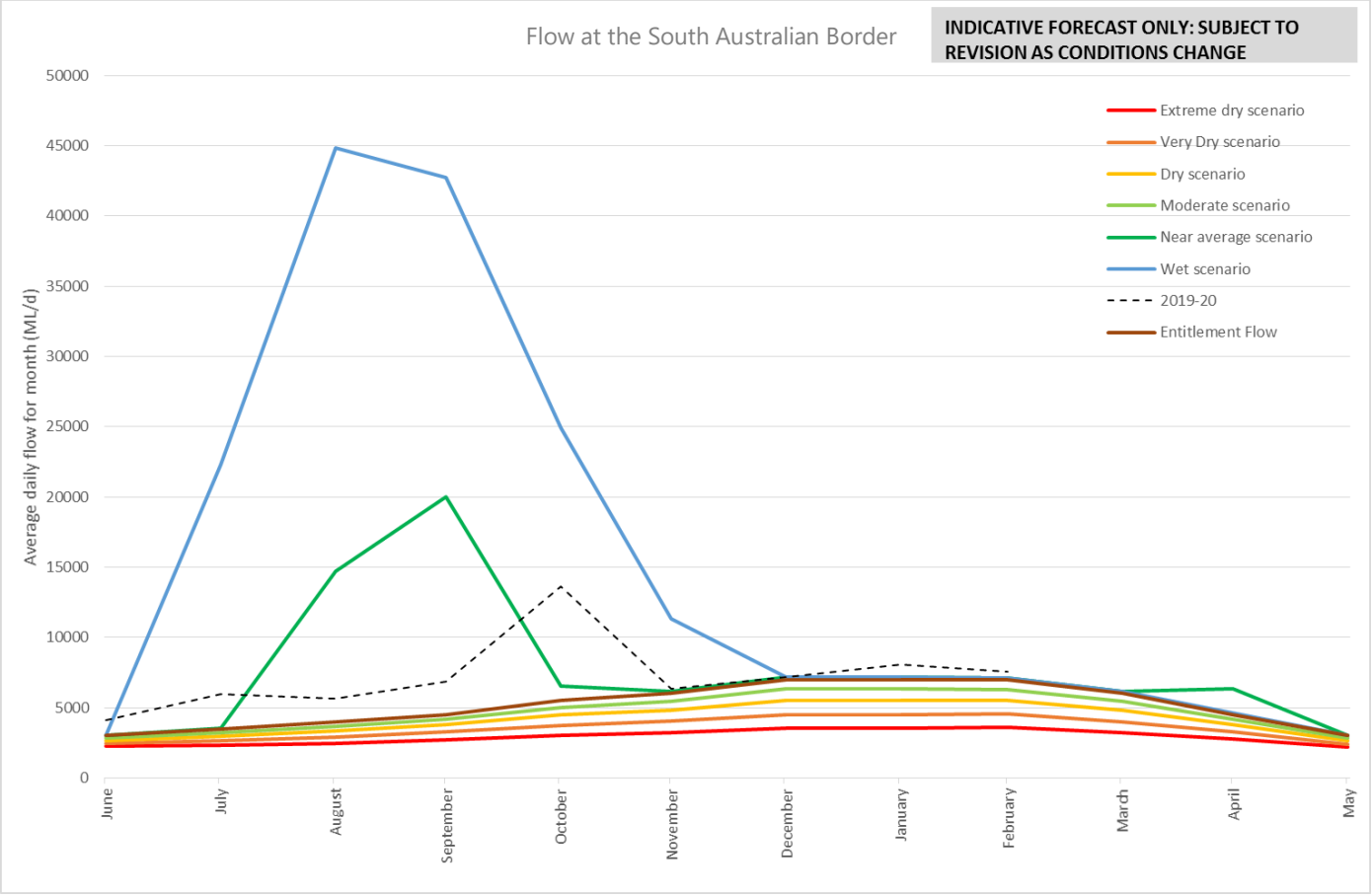


Figure 3. Annual operating outlooks (AOOs) provided by MDBA in March 2020 for the purpose of informing environmental water planning for 2020-21.

Table 3. South Australian priority actions per Annual Operating Outlook (AOO) scenario

AOO Scenario	Watering actions	Volume (GL)
Extreme Dry - 99%	Maintain Lower Lake levels above 0.4 mAHD and provide fishway releases throughout November and December. Boost QSA to 6,000 ML/day during summer. Manage inflows via Pipeclay Creek and Slaney Creek weirs at Chowilla. Meet water for the environment demands for pumping to wetlands (including Chowilla). (See Section 4.2 for details)	475.37
Very Dry - 95%	Maintain Lower Lake levels above 0.4 mAHD and provide fishway releases throughout the year. Boost QSA to 7,000 ML/day during early summer and 6,500 ML/day during late summer. Manage inflows via Pipeclay Creek and Slaney Creek weirs at Chowilla. Meet water for the environment demands for pumping to priority wetlands. (See Section 4.2 for details)	484.00
Dry - 90%	Provide spring inundation of fringing Lower Lake wetlands and fishway releases. Maintain Lower Lake levels above 0.7 mAHD from October to December and above 0.5 mAHD in autumn. Boost QSA in Nov, Dec and Feb to discharge equivalent to SA's normal Entitlement, and in Jan to 8,000 ML/day. Raise Lock 4 to 30 cm above FSL. Manage inflows via Pipeclay Creek and Slaney Creek weirs at Chowilla. Meet water for the environment demands for pumping to priority wetlands. (See Section 4.2 for details)	596.83
Moderate - 75%	During spring maintain Lower Lake levels above 0.8 mAHD and deliver up to 1 GL/day to the Coorong. Provide an additional 6 months of barrage releases for diadromous fish. Boost QSA in Nov, Dec and Feb to discharge equivalent to SA's normal Entitlement, and in Jan to 8,000 ML/day. Raise Lock 4 to 30 cm above FSL. Operate Pike regulator to 15 mAHD and Katarapko regulator to 11.5 mAHD. Manage inflows via Pipeclay Creek and Slaney Creek weirs at Chowilla. Meet water for the environment demands for pumping to priority wetlands. Deliver a 10,000 ML/day channel pulse in spring with a short (approximately 20 days) 15,000 ML/day peak. (See Section 4.2 for details)	810.13

Near average - 50%	Extend unregulated conditions in the CLLMM and provide an additional 6 months of barrage releases. Extend the QSA of 15,000 – 20,000 ML/d into late spring. Raise Lock 2 to 52 cm above FSL, and raise Lock 6 to 59 cm above FSL. Raise Lock 5 to 16.8 mAHD and Lock 4 to 13.5 mAHD. Operate Chowilla regulator to above 19.4 mAHD, Pike regulator to 15.25 mAHD and Katarapko regulator to 12.8 mAHD. Meet water for the environment demands for pumping to priority wetlands. (See Section 4.2 for details)	1213.9 – 1213.32 (two delivery options)
Wet - 25%	Extend unregulated conditions in the CLLMM and provide an additional 5 months of barrage releases. Enhance unregulated flow to inundate low elevation areas of the SA River Murray Floodplain Asset. Meet water for the environment demands for South Australian weir pool manipulations: • Raise Lock 2 to 52 cm above FSL (minimum discharge 5,700 ML/day); and • Raise Lock 5 to 50 cm above FSL and Lock 4 to 60 cm above FSL (minimum discharge 6,500 ML/day). Raise Lock 5 to 16.8 mAHD and Lock 4 to 13.5 mAHD. Operate Chowilla regulator to 19.75-19.85 mAHD, Pike regulator to 15.25 mAHD and Katarapko regulator to 12.8 mAHD. Meet water for the environment demands for pumping to priority wetlands. (See Section 4.2 for details)	1729.69

4.2 Priority actions for 2020-21

South Australia has developed discrete site-specific watering proposals for a number of locations throughout the South Australian River Murray system in 2020-21 as summarised in Table 1.

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 *2020-21 Annual Environmental Watering Priorities for the South Australian River Murray Water Resource Plan Area* (DEW, 2020).

A pied stilt and ruff at Tolderol Game Reserve Wetlands. Photo: Peter Koch, Tolderol Game Reserve Working Group

4.2.1 SA River Murray Channel and Floodplain

The proposed environmental watering actions for the main River Murray channel and floodplain seek to deliver environmental water 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 (EWRs) identified in the SA River Murray LTWP (Department of Environment, Water and Natural Resources, 2015). Based on the timing of the EWRs, environmental flows are generally sought in spring/summer with their magnitude and duration dependant on climatic conditions or scenarios.

In 2020-21, the focus is again on working with upstream states, the MDBA and the CEWH on a coordinated River Murray watering action that targets outcomes throughout the system. The aim is to coordinate releases from Hume Dam and the Goulburn River, providing outcomes in both these upstream areas and arriving at the South Australian border at the optimal time and magnitude to provide outcomes in the lower Murray.

The planning hydrographs (AOOs) under extreme dry to moderate scenarios indicated base flows to South Australia that were below Entitlement. Under these very dry conditions, where the availability of water for the environment is also low, it is not possible to use environmental water to increase the baseflows to a level where they meet the EWRs. Instead, the watering actions proposed for the extreme dry to moderate scenarios are focussed on increasing late spring/summer flows to address potential risks associated with low flows and hot, dry conditions such as thermal stratification, low dissolved oxygen and algal blooms, and this aligns well with delivery requirements for the CLLMM.

Under the near-average scenarios, the proposed watering action will generate a spring fresh (Figure 4) in the lower Murray which will support a range of outcomes in the main channel and near-bank areas. The duration of this pulse will be extended under the near-average scenario, with flows of 15,000 – 20,000 ML/day at the SA border into late spring. These outcomes include improved hydraulic conditions, increased food resources and habitat availability for native fish populations, and native vegetation growth and survival through improved soil water availability and groundwater freshening.

In the wet scenario, the planning hydrograph indicates flows of 40,000 – 45,000 ML/day which represents 'bankfull' conditions (Figure 4) and complete inundation of the SA River Murray channel. The proposed watering action for the wet scenario will see water for the environment delivered to increase the magnitude of the bankfull event to generate 'overbank' flows (Figure 4) and start to inundate areas of the SA River Murray floodplain. This inundation of low elevation

floodplain zones and temporary wetlands will provide outcomes for frog and bird breeding, recruitment of 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.

Some areas of the channel and floodplain will also benefit from weir pool manipulations, which are proposed at a range of sites subject to the prevailing conditions. The changes in water level will depend on the weir pool and flow conditions. The following potential weir manipulation scenarios were considered in early 2020, and reflect all potential actions corresponding from dry to wet water availability scenarios.

No weir manipulations are proposed under the extreme dry or very dry scenarios. In a dry to moderate scenario, it is proposed that weir pool 4 may be raised by 0.30 metres above normal pool level. Raising weir pool 4 by 0.30 metres above normal pool level will also occur under a moderate scenario, but only if the proposed Katarapko floodplain operations (which incorporate weir pool 4 raising) cannot occur (see Section 4.2.3 for details). Under near average conditions, potential weir raisings are planned for weir pool 2 along with potential weir raisings of Weirs 6, 5 and 4. If wet conditions occur then weir raisings are planned to occur at Weir 2 along with potential raises of Weirs 5 and 4 should the Pike and/or Katarapko floodplain operations (see Section 4.2.3 for details) not occur.

The durations of these raising actions range from 94-108 days (including the filling and drawdown phase) depending on the scenario and weir pool, and will take place between July and December 2020. Weir raisings are undertaken to provide for the mobilisation of carbon, nutrients and propagules from the floodplain to the river, support the growth and expansion of littoral vegetation, create diverse and productive biofilm and macroinvertebrate communities, promote groundwater freshening, and relieve soil salinity stress in the littoral zone (Lloyd *et al*, 2010).

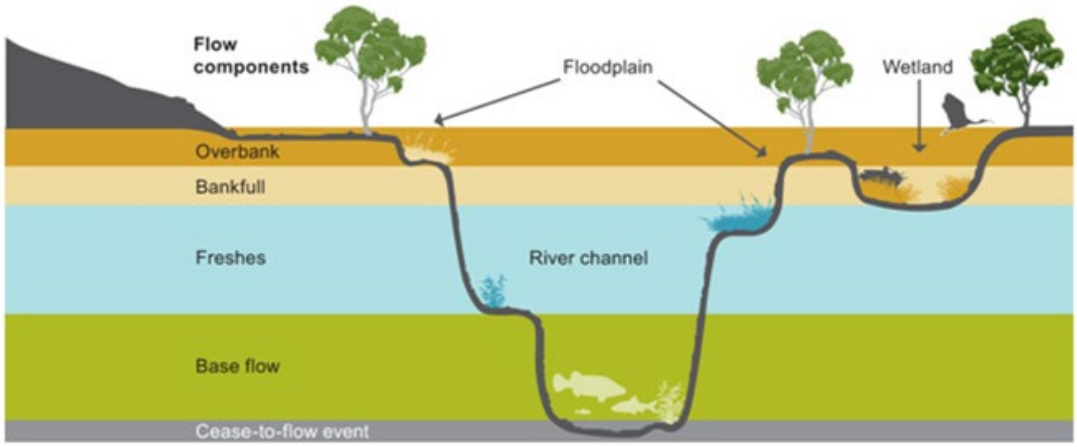


Figure 4. Conceptual illustration of flow components and their influence on different parts of the river channel and its floodplain (MDBA 2011).

4.2.2 Chowilla Floodplain

The proposed Chowilla Floodplain environmental watering actions only include the operation of the Chowilla Creek regulator if a near average or wet water resource availability scenario eventuates. Under extreme dry to moderate water availability scenarios, operation of the environmental regulator is deemed not to be required. Under these conditions the pumped delivery of water to a small number of priority wetlands and floodplain areas is planned. Additionally, under a moderate scenario, inflows via Pipeclay Creek and Slaney Creek weirs will be managed to optimise outcomes for native fish species through the anabranch.

If water availability improves within an appropriate timeframe to the near average or wet scenarios, operation of the floodplain regulator is planned to take place. Under a near average scenario the regulator will be operated to generate a medium to high floodplain inundation, while under a wet scenario operation of the regulator and the associated raising of Weir 6 could be undertaken to generate a high to maximum extent floodplain inundation of approximately 7000 to 8000 ha of floodplain and wetlands. Such an operation would 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 tree health benefits from watering and natural flooding in 2016.

Brandy Bottle Waterhole, Chowilla Floodplain. Photo: Alison Stokes, DEW

4.2.3 Pike and Katarapko Floodplains

With the completion of the Pike and Katarapko floodplain regulators in early 2020, it is proposed that these structures will be operated under moderate to wet water resource scenarios during 2020-21. Under the moderate to wet water resource scenarios, Pike and Katarapko regulators will be operated to generate low extent managed floodplain inundations, with the potential to increase the operation of the Katarapko regulator to a medium extent floodplain inundation under the near average or wet scenarios.

4.2.4 Wetlands

Forty one wetland sites have been identified as priorities for receiving water for the environment in 2020-21 as part of the Murraylands and Riverland Landscape Board watering program (Appendix D), with the watering of additional wetlands managed by Non-Government Organisations (NGOs) (e.g. Renmark Irrigation Trust and Nature Foundation SA) also listed as a priority. Sites are primarily located in the Riverland region of the River Murray in South Australia, but also include wetlands fringing the Lower Lakes. Under extreme dry to near average water resource scenarios, approximately 10.6 GL may be delivered to the priority sites managed by the Murraylands and Riverland Landscape Boards, with an additional 3.0 – 4.0 GL provided for wetlands managed by NGOs. Under a wet water resource scenario, the volume required for these priority sites will reduce to 4.25 - 5.99 GL as some wetlands will be inundated by the higher flow conditions and therefore will not require pumping.

River red gum recruitment at Wiela. Photo: Kate Mason, Murraylands and Riverland Landscape Board

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 greater than 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 known Murray hardyhead and regent parrot populations, and preventing the loss of long lived vegetation such as black box, river red gum and lignum floodplain communities. Watering at a number of wetlands will also provide habitats for waterbirds and provide breeding opportunities for six frog species, including 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.

4.2.5 Lower Lakes, Coorong and Murray Mouth Icon Site

Lakes Alexandrina and Albert

Water for the environment will be used to help seasonally alter water levels in the weir pool below Lock 1 within the range 0.55-0.90 m Australian Height Datum (AHD) during 2020-21. Maximum levels > 0.80 m AHD will be prioritised between September 2020 and January 2021 to promote small-bodied fish, frogs and invertebrates breeding in fringing wetlands of the Lower Lakes. Target species include the southern bell frog and Murray hardyhead, listed under the *Environment Protection and Biodiversity Conservation Act, 1999 (Commonwealth)*, and the southern pygmy perch, listed under state legislation. Minimum levels (~0.55-0.6 m AHD) will be prioritised in March and April 2021 to encourage aquatic plant germination, and to maintain barrage releases to the Coorong estuary. Environmental water delivery and barrage operations will aim to maintain lake levels above the Basin Plan target of 0.4 m AHD.

Fish sampling in Lake Alexandrina. Photo: 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 and early spring (July-September 2020) barrage flows prioritised from Goolwa, Mundoo and Tauwitchere barrages will facilitate upstream migration of pouched and short headed lamprey and downstream migration of adult congolli and common galaxias (diadromous fish). During spring and summer (October-January 2020) 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.

Different size classes of congolli. Photo: Dr Scotte Wedderburn, University of Adelaide

Coorong and Murray Mouth Estuary

A range of outcomes can be achieved in the Coorong and Murray Mouth Estuary depending on the magnitude of flow. In extreme dry and very dry conditions, a minimum of fishways-only flow can be maintained for the entire year, providing healthy mudflats directly downstream of fishways, which provide feeding habitat for waterbirds and adult estuarine fish. Under a dry water resources scenario, relatively small barrage flows in spring and early summer in addition to the fishways-only flows will support the Coorong food web in parts of the North Lagoon.

During a moderate to near average scenario, moderate barrage flows can provide a greater area of influence into the majority of the Coorong North Lagoon. Flows of this magnitude can also create suitable habitat throughout the entire North Lagoon to support adult estuarine fish, as well as suitable feeding habitat for waterbirds, particularly migratory waders. Depending on the timing, magnitude and duration of the coordinated spring pulse, conditions conducive to black bream recruitment will also be targeted in the area downstream of the Goolwa barrage. Careful management of barrage releases is needed to create suitable salinity stratification within the water column for estuarine fish recruitment.

High flow years (i.e. wet scenario) can provide an even greater area of influence, extending to the Coorong South Lagoon. If high barrage flows occur between October and January, extending the duration of an unregulated flow event is a priority so that 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.

Flows to the Coorong from Tauwitchere barrage. Photo: Adrienne Rumbelow, DEW

4.2.6 2019-20 South Australian River Murray Multi-Site Watering Proposal

As described above, South Australia has developed discrete watering proposals for a number of locations throughout the South Australian River Murray system. The site-based watering proposals identify the volumes of environmental water required to undertake actions to meet the site-based outcomes.

In addition, a multi-site watering proposal has been developed which describes a coordinated environmental water delivery pattern for the South Australian River Murray. This multi-site proposal demonstrates opportunities to align the timing of watering actions at multiple locations and re-use water as it moves through the South Australian River Murray system. The multi-site proposal 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 proposal is underpinned by the objectives, targets and EWRs in the SA River Murray LTWP and the expected outcomes in the *Basin-wide Environmental Watering Strategy* (MDBA 2014).

The South Australian River Murray multi-site watering action has the following aims:

- coordinate the delivery of environmental water to South Australia to maximise the potential outcomes throughout the South Australian River Murray system;
- provide pathways for the dispersal, migration and movement of native water-dependent biota[1];
- provide pathways for the dispersal and movement of organic and inorganic sediment to maximise the delivery of resources to downstream reaches and to the ocean;
- deliver environmental water to the CLLMM, while providing benefits to upstream environmental assets en route;
- increase the effectiveness of environmental watering and the extent of benefits by aligning the timing, magnitude and duration of discrete actions; and

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

- maximise outcomes from watering in South Australia by using return flows where possible

The estimated volume of water for the environment required to deliver the 2020-21 multi-site proposal ranges from approximately 475.37 GL in the extreme dry scenario to 1729.69 GL in the wet (Table 4). Multi-site volume represents the net volume of environmental water required to be delivered to the South Australian border to support all proposed watering actions in the South Australian River Murray for that scenario. It is additional to water for the environment on South Australian licences, which is delivered as part of South Australia's Entitlement and therefore included in the base flow represented in the AOOs. It factors in return flows from site-based watering actions (e.g. channel pulses or Chowilla regulator operation) and their contribution to meeting other downstream demands.

Information on the combination of actions under each scenario are shown in Table 4. The preferred monthly delivery pattern for the multi-site proposal is indicated in Figures 5-10, and has been designed to ensure that the required delivery patterns for site-based actions and outcomes are also met.

This multi-site proposal will continue to be used and revised during real-time management planning, and was provided to environmental water holders via SCBEWC to support delivery planning for the 2020-21 water year.

Dragonfly on the Chowilla floodplain. Photo: Helga Kieskamp

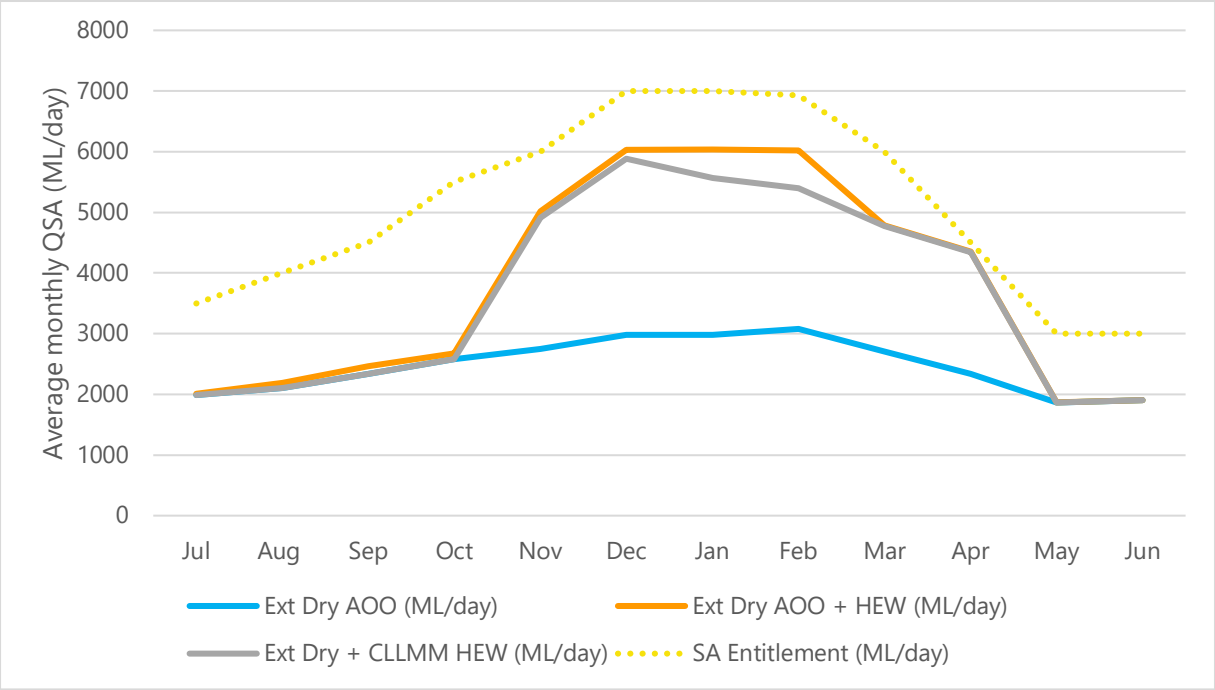


Figure 5. Preferred delivery pattern of South Australian multi-site environmental water under an extreme dry (100%) AOO scenario. Ext Dry AOO (blue line) represents flow conditions without additional environmental water; Ext Dry AOO + HEW (orange line) represents flow conditions that include the net monthly environmental water demands at the SA border to support all proposed watering actions in the SA River Murray; Ext Dry + CLLMM HEW (grey line) represents flow conditions that include the monthly environmental water demands at the SA border for the CLLMM only, it is presented as a reference point only and is incorporated into the 'Ext Dry AOO + HEW' demands'; SA Entitlement represents flow conditions if SA was to receive Entitlement only.

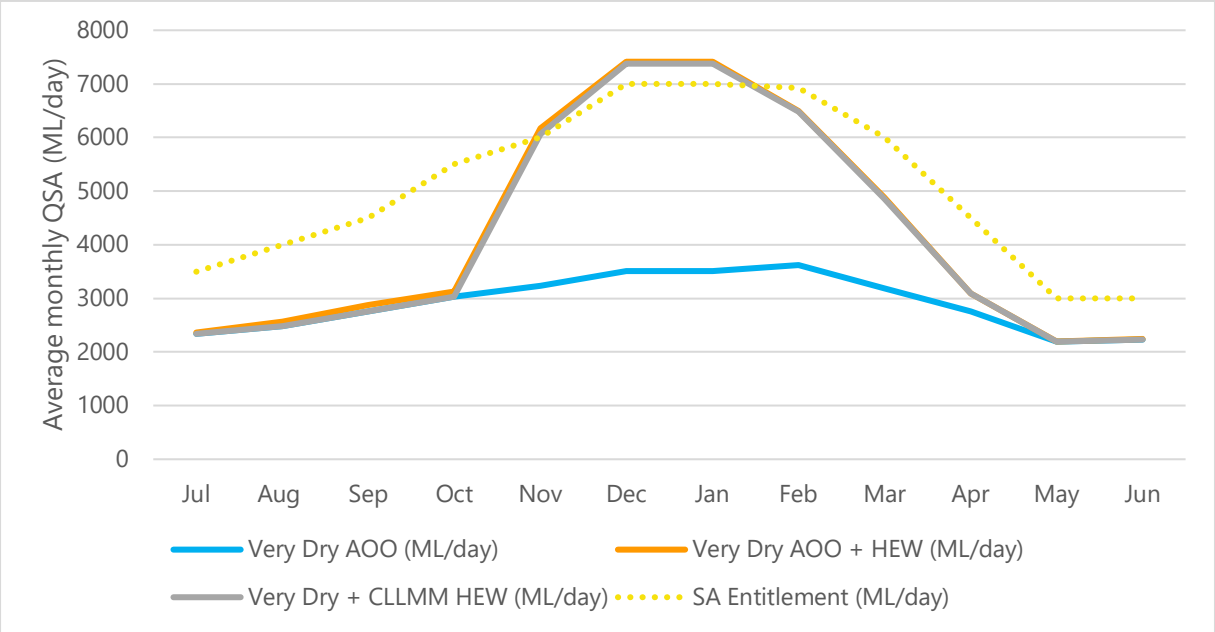


Figure 6. Preferred delivery pattern of South Australian multi-site environmental water under a very dry (95%) AOO scenario. Very Dry AOO (blue line) represents flow conditions without additional environmental water; Very Dry AOO + HEW (orange line) represents flow conditions that include the net monthly environmental water demands at the SA border to support all proposed watering actions in the SA River Murray; Very Dry + CLLMM HEW (grey line) represents flow conditions that include the monthly environmental water demands at the SA border to support watering actions at the CLLMM only, it is presented as a reference point only and is incorporated into the 'Very Dry AOO + HEW' demands'; SA Entitlement represents flow conditions if SA was to receive Entitlement only.

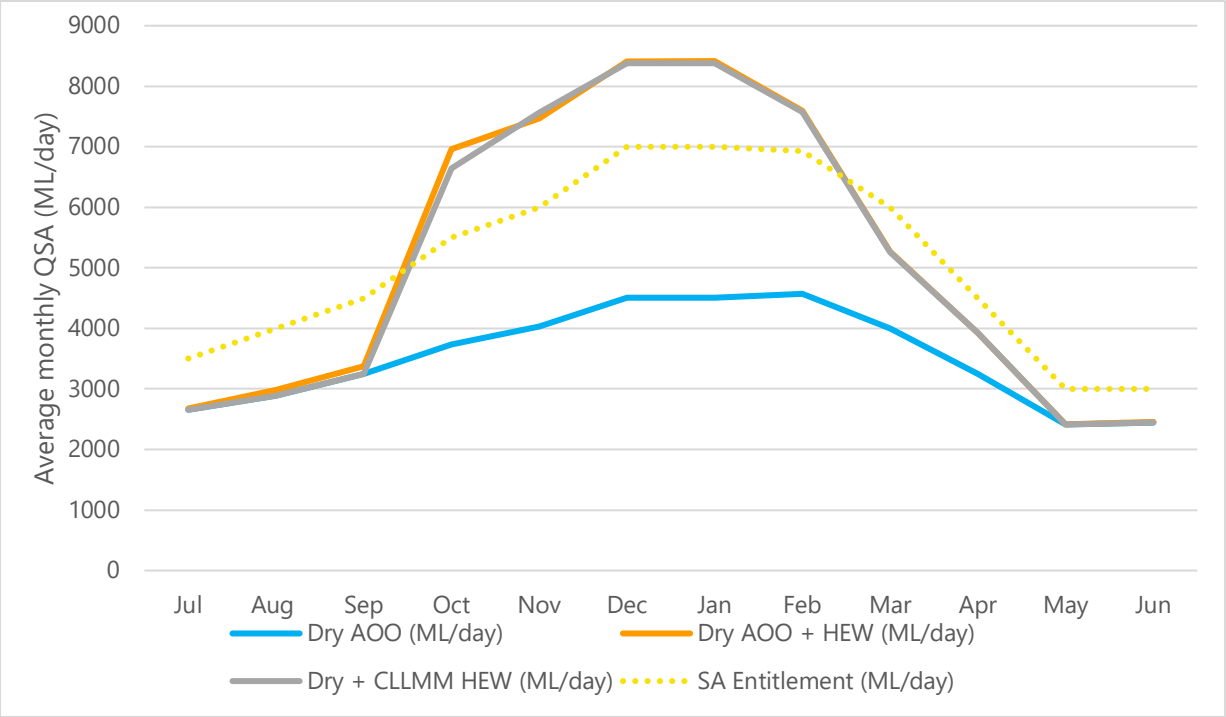


Figure 7. Preferred delivery pattern of SA multi-site environmental water under a dry (90%) AOO scenario. Dry AOO (blue line) represents flow conditions without additional environmental water; Dry AOO + HEW (orange line) represents flow conditions that include the net monthly environmental water demands at the SA border to support all proposed watering actions in the SA River Murray; Dry + CLLMM HEW (grey line) represents flow conditions that include the net monthly environmental water demands at the SA border to support watering actions at the CLLMM only. It is presented as a reference point only and is incorporated into the 'Dry AOO + HEW' demands. SA Entitlement represents flow conditions if SA was to receive Entitlement only.

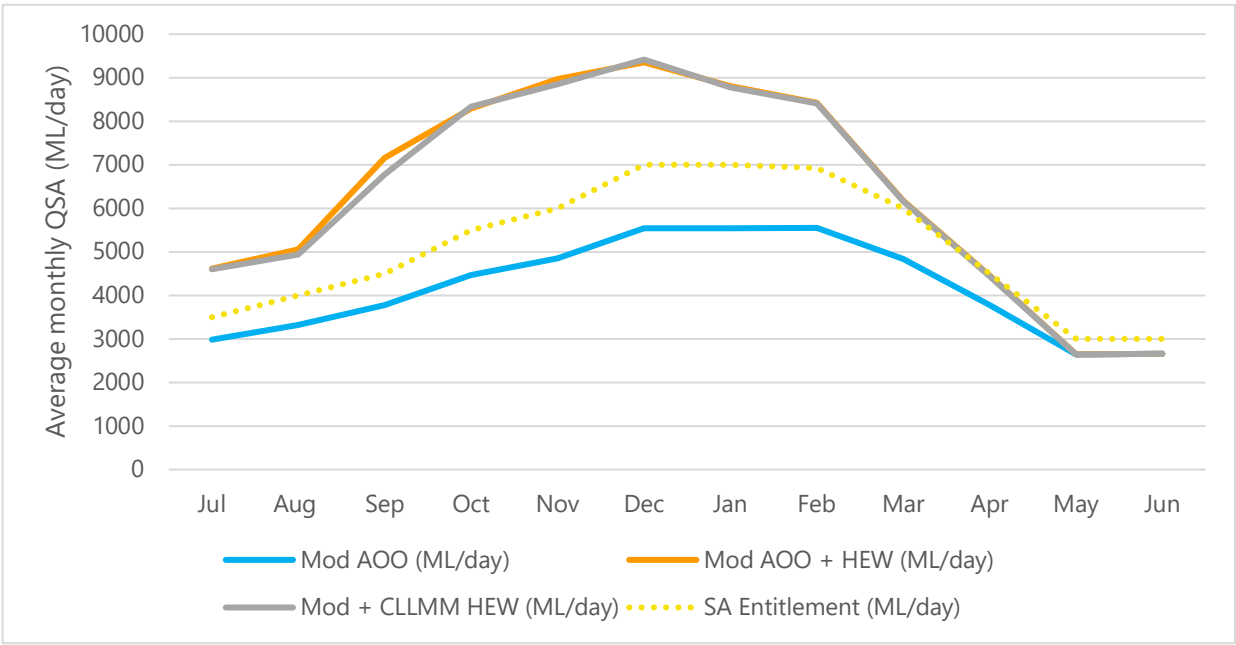


Figure 8. Preferred delivery pattern of South Australian multi-site environmental water under a moderate (75%) AOO scenario. Mod AOO (blue line) represents flow conditions without additional environmental water; Mod AOO + HEW (orange line) represents flow conditions that include the net monthly environmental water demands at the SA border to support all proposed watering actions in the SA River Murray; Mod + CLLMM HEW (grey line) represents flow conditions that include the net monthly environmental water demands at the SA border to support

watering actions at the CLLMM only, it is presented as a reference point only and is incorporated into the 'Mod AOO + HEW' demands'; SA Entitlement represents flow conditions if SA was to receive Entitlement only.

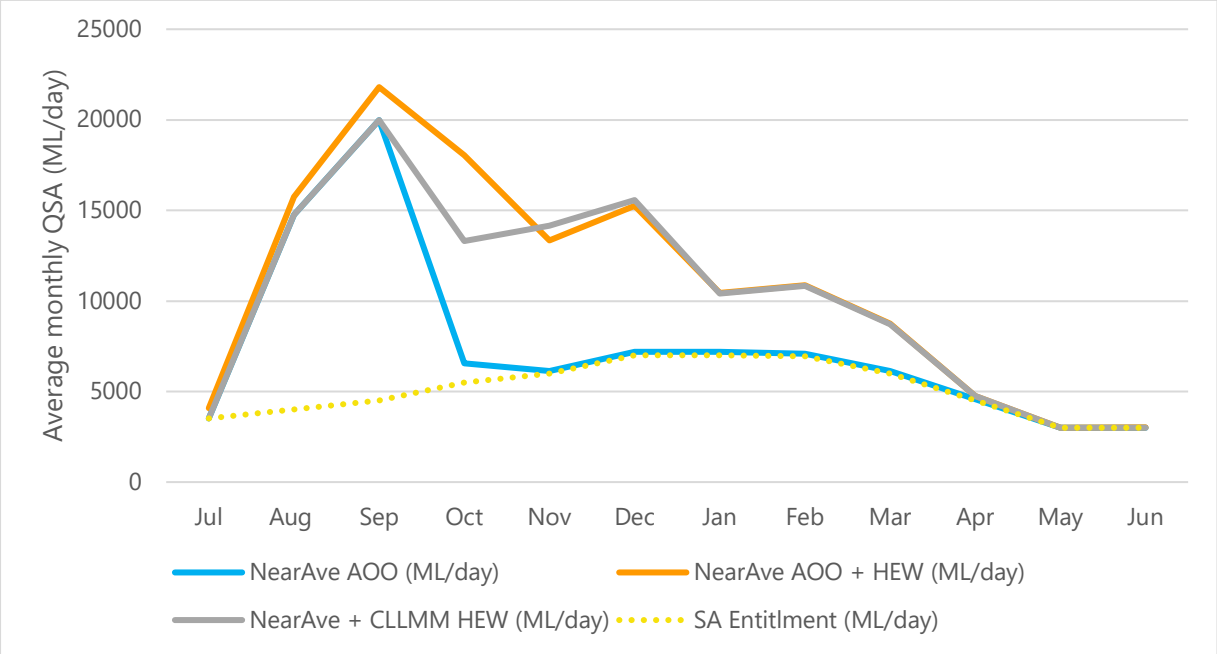
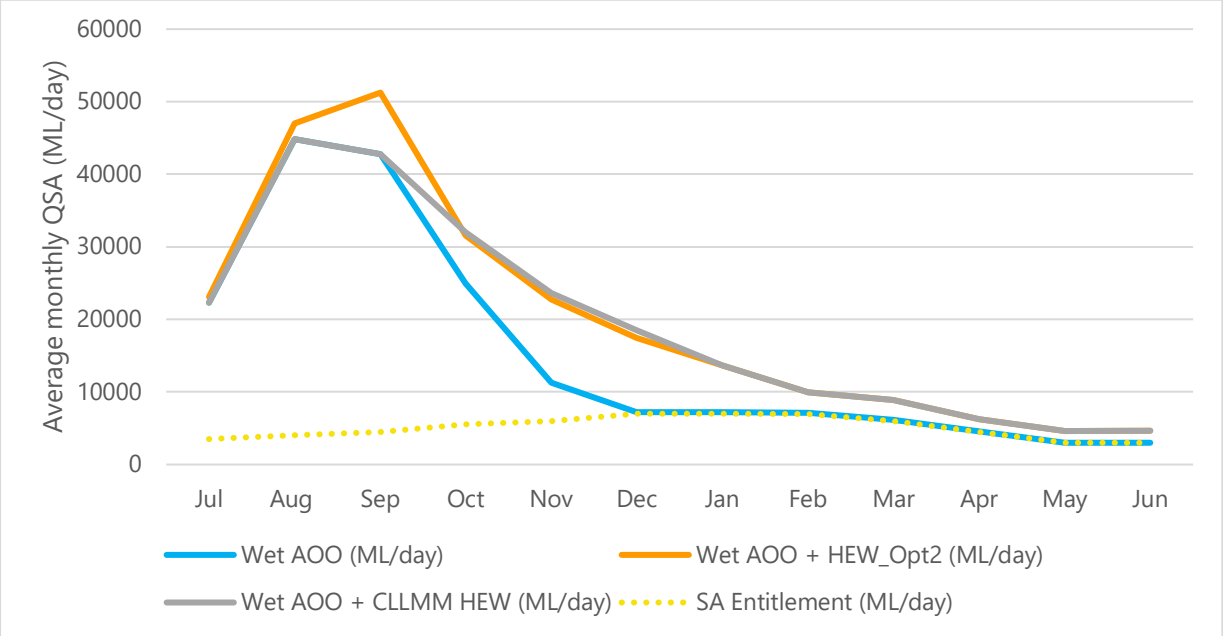


Figure 9. Preferred delivery pattern of South Australian multi-site environmental water under a near average (50%) AOO scenario. NearAve AOO (blue line) represents flow conditions without additional environmental water; NearAve AOO + HEW (orange line) represents flow conditions that include the net monthly environmental water demands at the SA border to support all proposed watering actions in the SA River Murray; NearAve + CLLMM HEW (grey line) represents flow conditions that include the net monthly environmental water demands at the SA border to support watering actions at the CLLMM only. It is presented as a reference point only and is incorporated into the 'NearAve AOO + HEW' demands'. SA Entitlement represents flow conditions if SA was to receive Entitlement only.

Figure 10. Preferred delivery pattern of South Australian multi-site environmental water under a wet



(25%) AOO scenario. Wet AOO (blue line) represents flow conditions without additional environmental water; Wet AOO + HEW (orange line) represents flow conditions that include the net monthly environmental water demands at the SA border to support all proposed watering actions in the SA River Murray; Wet + CLLMM HEW (grey line) represents flow conditions that include the net monthly environmental water demands at the SA border to support watering actions at the

CLLMM only. It is presented as a reference point only and is incorporated into the 'Wet AOO + HEW' demands'; SA Entitlement represents flow conditions if SA was to receive Entitlement only.

4.3 Environmental Water Availability

4.3.1 Held Environmental Water

The priorities were developed between February and April 2020, which is prior to water allocation announcements being made. For the purposes of planning and prioritisation, potential HEW availability was estimated under each resource availability scenario, based on environmental water delivery in recent years and advice from water holders (Table 3). Approximately 250 – 300 GL of carryover from 2019-20 will be available in 2020-21. This is from both the CEWO and TLM holdings across the southern-connected Basin and does not include South Australian HEW. These carryover volumes have been factored into the estimates provided in 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 the southern-connected Basin in 2020-21 under each resource availability scenario (September 2019)

Scenario	Estimate of HEW available
Extreme Dry (99%)	**486 GL**
Very Dry (95%	**622 GL**
Dry (90%)	**722 GL**
Moderate (75%)	**1,296 GL**
Near average (50%)	**1,643 GL**
Wet (25%)	**1,940 GL**

HEW is available from the following sources: the CEWH, TLM, 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 is presented below. Water that is HEW under the River Murray WRP is recorded on the *Register of Held Environmental Water* on the DEW website, as required under the Basin Plan.

Commonwealth Environmental Water

Total Commonwealth holdings of water for the environment within the southern-connected Basin are approximately 2,130 GL (at 29 February 2020), with varying levels of security and a long-term average annual yield of 1584 GL[2].

Of this volume, approximately 162 GL of registered entitlement (144 GL long-term average annual yield) is held in South Australia and forms part of South Australia's Entitlement flow. Most of this holding is Class 3 (High Security) and the availability of this water in 2020-21 will be in-line with the *River Murray Allocation Framework* (SAMDB NRM Board 2019).

The Living Murray Environmental Water

TLM holdings are approximately 480 GL long-term cap equivalent. The Minister for Environment and Water holds 45 GL of TLM water in South Australia which is part of South Australia's Entitlement flow (Class 3 High Security). The availability of this water in 2020-21 will be in-line with the *River Murray Allocation Framework* (SAMDB NRM Board 2019).

It is anticipated that approximately 9 GL of River Murray Increased Flows from the Snowy Agreement will be carried over in the River Murray into 2020-21. A further 319 GL exists within the Snowy storages, however this water cannot be called on for use in the River Murray until these storages reach the trigger level. It could be several years until the Snowy storages recover to the level where this can occur.

[2] http://www.environment.gov.au/water/cewo/about/water-holdings viewed 29 February 2020

Victorian Environmental Water Holder (VEWH)

The VEWH manages environmental water holdings in the Murray, Goulburn and Campaspe rivers. Under some circumstances, they may trade HEW to South Australia, generally as a result of return flows from upstream environmental watering actions. This water is protected within the River Murray and delivered through to the end of the system.

South Australian Minister for Environment and Water

In addition to TLM holdings, 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 flow.

Of this total volume, 37.6 GL is within the Wetlands Consumptive Pool (Class 9) described in the *Water Allocation Plan for the River Murray Prescribed Watercourse* (WAP) (SAMDB NRMB, 2020). This water is held on licence for managed pool-connected wetlands within the River Murray WRP area and is sourced from the 'Dilution and Loss' component of South Australia's Entitlement. This volume does not affect water available for consumptive use.

Approximately 6.6 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). This is primarily Class 3 (High Security) water and, as such, availability in 2020-21 will be in-line with the River Murray Allocation Framework (SAMDB NRM Board 2019).

Non-Government Organisations

Accolade Wines holds 1.38 GL of Wetlands Consumptive Pool water (Class 9) for the management of the pool-connected areas of Banrock Station Wetland Complex.

Salt Creek, Chowilla Creek system. Photo: Alison Stokes, DEW

4.3.2 Planned Environmental Water Availability

Planned environmental water (PEW) is defined under the South Australian River Murray WRP as any water that is committed or preserved for achieving environmental purposes or outcomes and that cannot be used for any other purpose unless required in emergency (in accordance with Section 6 of the Water Act). PEW is also identified in the 2020

River Murray WAP and includes the unallocated portion of annual South Australian Entitlement flow, unregulated flows to South Australia, and the dilution and loss component of South Australia's Entitlement flow.

4.4 Co-operative Watering Arrangements

4.4.1 Between Water Resource Planning Areas

Water holders and managers of water for the environment have worked together for several years to trial, plan and coordinate annual multi-site environmental watering events. This planning aims to maximise the use of unregulated flows, water for the environment and return flows at multiple sites as water moves through the southern-connected Basin. This builds on several years of trials which have led to the environmental delivery of water being incorporated into normal River Murray operations. Current water planning and delivery practices have benefited from these trials, analysing issues and making changes to operational and accounting practices where appropriate.

The SCBEWC and Water Liaison Working Group contribute to the development of the multi-site events each year. Real-time Operational Advisory Groups hold regular teleconferences to ensure coordination and communication during events and rapid responses to any issues that may arise. Membership of these groups includes holders of HEW and managers of PEW, managers of environmental assets and river operators. South Australia has representatives on these cross-jurisdictional committees and is participating in the planning and coordination of large scale environmental watering events for 2020-21.

4.4.2 Within the River Murray Water Resource Planning Area

Existing mechanisms to assist with coordinating environmental watering within the WRP area are described in the South Australian River Murray WRP (DEW 2019).

For 2020-21, DEW has developed a multi-site proposal for the coordinated delivery of water for the environment within the WRP area. The South Australian multi-site watering proposal seeks to align site-specific watering actions that have been identified in this document, maximise the effectiveness of environmental water delivery and enhance ecological outcomes throughout the system. This multi-site approach is supported by South Australian policy that prevents return flows from environmental watering actions, such as the operation and testing of the Chowilla regulator and weir raisings, from being re-allocated for consumptive use, ensuring this water will flow down the river and be delivered to the CLLMM for ecological benefit.

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-wide level, as illustrated in Figure 11. A range of policies and procedures supporting delivery of water for the environment in South Australia have been recently developed or modified to ensure consistency with Basin Plan requirements. These, along with existing policies and processes currently in place to guide environmental water management along the River Murray in South Australia, are described in *Prerequisite Policy Measures Implementation in South Australia. Overview of arrangements and mechanisms used to implement Prerequisite Policy Measures* (DEW, 2019).

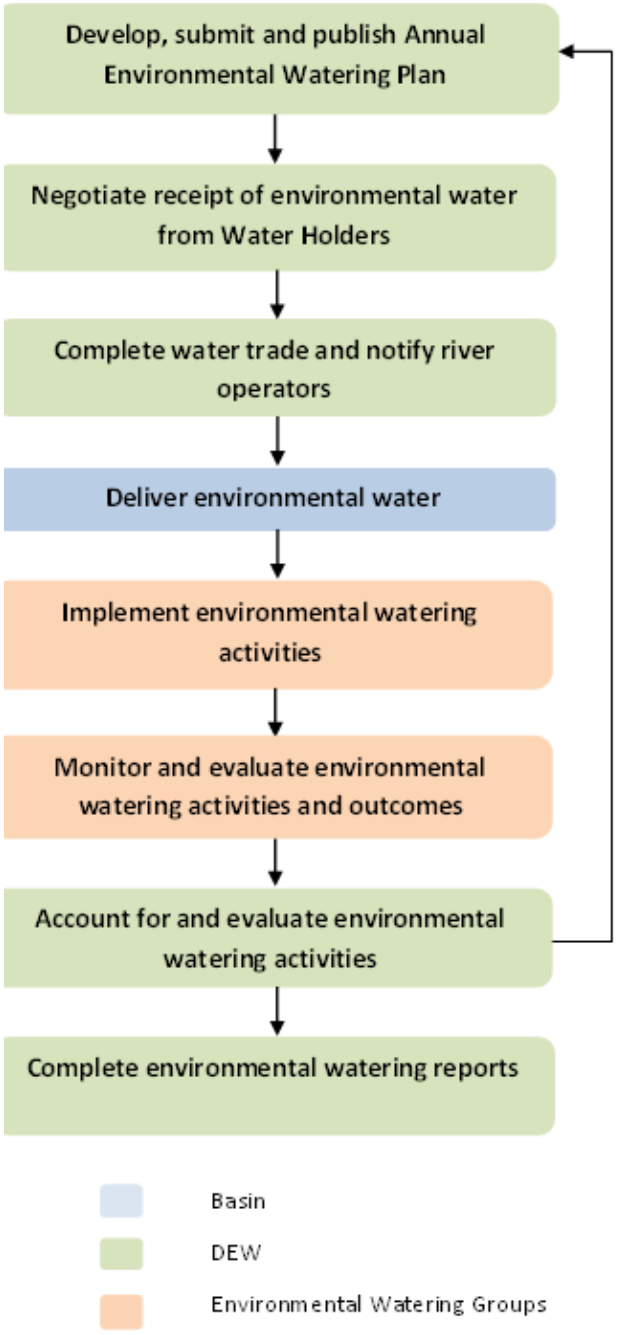


Figure 11. Implementation process for the Annual Environmental Watering Plan

5.2 Securing Water for the Environment

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 Murray Channel and the CLLMM. Icon site managers provide watering proposals that form part of the State's annual environmental watering priorities which are also submitted to SCBEWC to inform 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 South Australian River Murray region is included in the *River Murray Valley – Water Management Plan 2020-21*, which is available on the CEWO website. Watering schedules are developed that give effect to this portfolio management plan and outline the intended use of Commonwealth environmental water. These watering schedules are agreed by the CEWH and DEW.

The CEWH may also establish Partnership Agreements with non-government organisations for the delivery of Commonwealth environmental water along the River Murray in South Australia. Copies of these partnership agreements are available on the CEWH 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, 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 facilitated by the MDBA in consultation with water holders and river operators.

5.3 Delivering Water for the Environment

DEW, SA Water and the MDBA work co-operatively to manage arrangements for delivering water to South Australia for all purposes, including water for the environment. The annual environmental watering priorities and watering actions are incorporated into *South Australia's River Murray Annual Operating Plan 2020-21* (DEW, in prep). 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:

- adding environmental water upstream of the South Australian border for delivery to the River Murray Channel and CLLMM assets, and potentially to the floodplain if flows are sufficiently high;
- operating the barrages to influence water levels in the Lower Lakes, and water movement into the Coorong and out to sea through the Murray Mouth;
- operating Chowilla, Pike and Katarapko Regulators and raising the main channel weirs to increase the extent of inundation;
- operating 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;
- applying water to floodplain vegetation through drip irrigation or sprinklers; and
- operating flow control structures to implement wetting and drying regimes at pool-connected wetlands.

Proposed actions, delivery mechanism and costs 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, SA Floodplains Operations Advisory Group and the Environmental Flows Reference Group.

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 intervention monitoring at the Chowilla and CLLMM icon sites, with results used to inform water planning and delivery, environmental infrastructure operations and site, state and Basin Plan evaluation and reporting. This monitoring is coordinated by the icon site managers in DEW and will continue in 2020-21.

The CEWO identifies any specific monitoring and reporting requirements in their watering schedules for the use of Commonwealth environmental water. In addition, the CEWO Monitoring, Evaluation and Research (MER) Program (Flow-MER) (replacing the CEWO Long Term Intervention Monitoring Project which concluded in 2019) collects data in the River Murray Channel asset and has been designed to evaluate outcomes at the Basin-scale. It also demonstrates environmental outcomes from the delivery of Commonwealth environmental water at a regional level. South Australian Research and Development Institute (SARDI) have led the project in the lower Murray River. The current Flow-MER Project aims to extend selected activities that were established during the Long Term Intervention Monitoring and which form part of the Murray-Darling Basin Environmental Water Knowledge and Research Project.

Other key monitoring programs associated with managing water for the environment along the River Murray in South Australia are:

- ongoing monitoring of selected South Australian River Murray wetlands and floodplain areas, undertaken by the Murraylands and Riverland Landscape Board in partnership with wetland community groups;
- a productivity monitoring program undertaken in 2020-21 with combined resources from the state, TLM and the Australian government; and
- monitoring associated with the South Australian Riverland Floodplain Integrated Infrastructure Program on the Katarapko and Pike floodplains and in association with the Weir Pool Manipulation program.

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 site-specific management and monitoring plans such as DEWNR (2017) and MDBA (2012).

Nature Foundation SA 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.

Eastern long-neck turtle. Photo: Nathan Creeper, DEW

5.5 Accounting and reporting

In 2020-21, 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.

Non-government organisations generally operate through their own water licences and accounts, and 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.

DEW currently provides monthly reports and three-monthly forward plans to the CEWO on CLLMM environmental water delivery, and annual reports on water delivery in the South Australian River Murray Channel and weir pools.

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.

Hunter's Creek. Photo: Kirsty Wedge, DEW

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Glossary: Selected Terms and Acronyms

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

Name of unit	Symbol
day	d
gigalitre	GL
hectare	ha
megalitre	ML
metre	m
second	s

AHD – Australian Height Datum

AOO – Annual Operating Outlook

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

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

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

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 fish lifts (chambers, rather like lift-wells, that are flooded and emptied to enable fish to move across a barrier)

Floodplain — defined in the *Natural Resources Management Act 2004* as 'any area of land adjacent to a watercourse, lake or estuary that is periodically inundated with water and includes any other area designated as a floodplain: (a) by an NRM plan; or, (b) by a Development Plan under the Development Act 1993

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

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

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

PEA – priority environmental asset. Defined in the Basin Plan s8.49. The PEAs within the SA River Murray are described in the SA River Murray long-term environmental watering plan

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

Ramsar wetland — a wetland recognised under the 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

SAMDB 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 Section 11 means the maximum quantity of water that can be taken and used pursuant to the authorisation

WAP — Water Allocation Plan; a legal document that sets out the rules for managing the take and use of water resources that have been identified as significant, or 'prescribed', under the *Natural Resources Management Act 2004*.

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

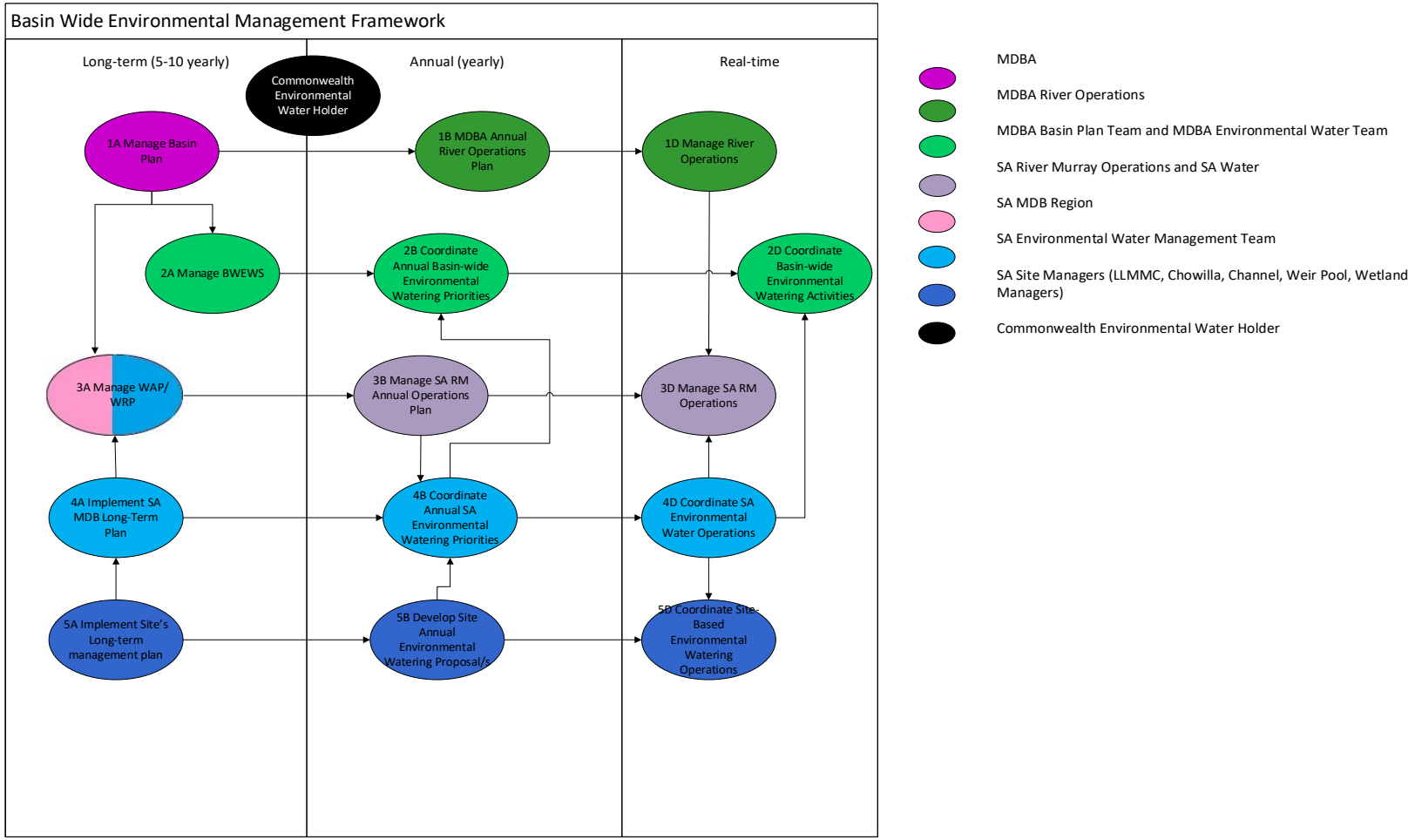
Water licence — a licence granted under state legislation entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area. This grants the licensee a right to take an allocation of water specified on the licence, which may also 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

WRP – Water Resource Plan; a legal document accredited by the MDBA that demonstrates how South Australia manages water to meet the standard set out in the Basin Plan, under the Commonwealth *Water Act 2007*, including sustainable diversion limits for urban, agricultural and industrial use.

Appendices

Appendix A. Basin-Wide Environmental Management Framework



Appendix B: Summary of environmental watering actions proposed for 2020-21 by environmental asset/site managers under five scenarios

Extreme Dry (99% AOO) and Very Dry (95% AOO) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	99% - Extreme Dry: Increase base flows between November 2020 and April 2021	○ Maintain Lake Alexandrina water levels >0.4 m AHD ○ Deliver fishway flows to the Coorong during December 2020 and January 2021	○ Upstream movement of young-of-year diadromous fish during peak upstream movement period - December and January (targeting congolli & common galaxias) ○ Avoid triggering Lower Lakes Drought Emergency Framework at +0.4 m AHD and acid sulfate soil risks at 0 m AHD ○ Maintain at least some refuge habitat in Lower Lakes wetlands year-round for threatened fish and frogs	424
	95% - Very Dry: Increase base flows between November 2020 and April 2021	○ Maintain lake levels above +0.4 m AHD for the entire year ○ Allow fishways to be operated for the entire year (~170 ML/d)	○ Upstream movement of young-of-year diadromous fish during entire upstream migration period - October to February (targeting congolli & common galaxias) ○ Avoid triggering Lower Lakes Drought Emergency Framework at +0.4 m AHD and acid sulfate soil risks at 0 m AHD ○ Maintain at least some refuge habitat in Lower Lakes wetlands year-round for threatened fish and frogs ○ Provide a continuous trickle flow year-round to Coorong mudflats directly downstream of barrage fishways to maintain habitable sediment conditions for invertebrates	467
Channel and Floodplain	99% - Extreme Dry: boost flow at the SA border to 6,000 ML/day in December, January and February	○ Prevent persistent thermal stratification and conditions conducive to harmful algal blooms from occurring	○ Maintain a diurnally-mixed water column to ensure diverse phytoplankton and avoid negative water quality outcomes. ○ Restore and maintain resilient populations of foraging generalists	269.02 Return flows 263.6
	95% - Very Dry: boost flow at the SA border to 7,000 ML/day in December and January, and 6,500 ML/day in February (i.e. discharge equivalent to SA's normal Entitlement)	○ Prevent persistent thermal stratification and conditions conducive to harmful algal blooms from occurring	○ Maintain a diurnally-mixed water column to ensure diverse phytoplankton and avoid negative water quality outcomes. ○ Restore and maintain resilient populations of foraging generalists	297.2 Return flows 291.3
Weir Manipulation	No weir pool manipulations proposed	N/A	N/A	N/A

Site	Action	Details	Objectives	Vol GL
Chowilla	Pump to priority wetlands. [3] Manage anabranch inflows via Pipeclay Creek and Slaney Creek weirs to optimise flow conditions for native fish through the anabranch.	Potential pumping to up to 8 priority wetland sites Adaptive management of inflows via weirs and associated fish passage to optimise fast flowing habitat for native fish.	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Improve the abundance and diversity of grass and herblands; flood dependant understorey vegetation; and submerged and emergent aquatic vegetation. ○ Maintain sustainable communities of the eight riparian frog species recorded at Chowilla and improve the distribution and abundance of the nationally listed Southern Bell Frog ○ Create conditions conducive to successful breeding of colonial waterbirds in a minimum of three temporary wetland sites at a frequency of not less than one in three years ○ Maintain or improve the diversity and abundance of key bird species ○ Re-establish habitat condition to sustain high value fauna communities ○ Establish groundwater and soil conditions conducive to improving vegetation condition *Extent of achievement of above objectives limited to watering sites receiving pumped delivery of water for the environment* ○ Maintain the extent and diversity of distribution of native fish	Up to 7 N/A
Pike	Manage base-flow conditions through anabranch		○ Maintain suitable flowing habitat for native fish	N/A
Katarapko	Maintain base-flow conditions through anabranch targeting optimal flow conditions for native fish		○ Maintain suitable flowing habitat for native fish	N/A
Wetlands	Delivery of water to up to 41 priority wetlands located along the River Murray from the border to the Lower Lakes		○ Support known populations of Murray hardyheads (nationally threatened), including providing conditions for breeding opportunities ○ Regent parrot (nationally threatened) populations supported ○ Providing breeding opportunities and refugia for Southern bell frogs (nationally threatened). ○ Prevent loss of long lived vegetation: black box, River red gums, lignum and River cooba ○ Provide refuge habitats for waterbirds	10.6

[3] Delivery dependant on resourcing for pumping and bank reinstatement.

Site	Action	Details	Objectives	Vol GL
	Additional delivery of water to wetland sites by Non-Government Organisations including Renmark Irrigation Trust, Accolade, Nature Foundation SA and the Australian Landscapes Trust.		○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of long lived vegetation including black box, River red gums, lignum and River cooba. ○ Support Regent parrot (nationally threatened) populations	3-4

Dry (90% AOO) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Increase base flows between October and December 2020	○ Raise Lower Lake water levels in spring to >0.7 m AHD (leading to inundation of some fringing wetlands) ○ Allow fishways to be operated for the entire year (~170 ML/d)	○ Upstream movement of young-of-year diadromous fish during entire upstream migration period - October to February (targeting congolli & common galaxias) ○ Provide a continuous trickle flow year-round to Coorong mudflats directly downstream of barrage fishways to maintain habitable sediment conditions for invertebrates ○ Growth and recruitment of emergent and submergent aquatic vegetation in Lower Lakes wetlands from inundation of fringing wetlands ○ Habitat for threatened fish (Murray hardyhead, Southern pygmy perch) and frogs (southern bell frog)	316
	Increase base flows between January and April 2021	○ Allow fishways to be operated for the entire year (~170 ML/d) ○ Maintain lake levels >0.5 m AHD in autumn 2021	○ Continuous connectivity between the river and estuary ○ Continuous fish passage for diadromous fish ○ Fishways functional year-round ○ At least some threatened fish habitat in Lower Lakes remains inundated year-round	263
Channel and Floodplain	Boost flow at the SA border in November, December and February to discharge equivalent to SA's normal Entitlement, and in January to 8,000 ML/day	○ Prevent persistent thermal stratification and conditions conducive to harmful algal blooms from occurring	○ Maintain a diurnally-mixed water column to ensure diverse phytoplankton and avoid negative water quality outcomes. ○ Restore and maintain resilient populations of foraging generalists	312.6 Return flows 306.3

Site	Action	Details	Objectives	Vol GL
Weir Pool Manipulation	Raise Weir Pool 4 to 13.5 mAHD (by up to 0.3 m above normal pool level).	○ Trigger flow will achieve a flow of ≥ 4,000ML/d downstream of the action for the duration of the action including during filling.	*Weir pool raising will contribute to achievement of the following objectives:* ○ Provide for the mobilisation of carbon, nutrients and propagules from the floodplain to the river ○ Establish and maintain groundwater and soil moisture conditions conducive to improving riparian vegetation. ○ Establish groundwater conditions conducive to maintaining diverse native vegetation ○ Promote bacterial rather than algal dominance of biofilms and improve food resource quality for consumers. ○ Maintain a viable, functioning River Red Gum, black box, river cooba, and lignum populations within the Floodplain ○ Establish and maintain diverse water dependent vegetation within aquatic zones ○ Establish and maintain diverse native vegetation comprising native flood dependent and amphibious species within the shedding floodplain zones ○ Restore resilient populations of [native fish] wetland/floodplain specialists within aquatic zones during floodplain flow events ○ Provide habitat conducive to supporting diverse communities of riparian frogs ○ Provide refuge for the maintenance of adult populations of waterbirds	Fill volume 6.30 Losses 0.48 **Total 6.78** Return Flow 6.30 *additional passing flow 79.08*
Chowilla	Pump to priority wetlands. [4]	Potential pumping to up to 8 priority wetland sites *(final number and precise volumes contingent on resourcing for bank instatement and pumping costs)*	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Improve the abundance and diversity of grass and herblands; flood dependant understorey vegetation; and submerged and emergent aquatic vegetation. ○ Maintain sustainable communities of the eight riparian frog species recorded at Chowilla and improve the distribution and abundance of the nationally listed Southern Bell Frog ○ Create conditions conducive to successful breeding of colonial waterbirds in a minimum of three temporary wetland sites at a frequency of not less than one in three years	Up to 7

[4] Delivery dependant on resourcing for pumping and bank reinstatement.

Site	Action	Details	Objectives	Vol GL
	Manage anabranch inflows via Pipeclay Creek and Slaney Creek weirs to optimise flow conditions for native fish through the anabranch.	Adaptive management of inflows via weirs and associated fish passage to optimise fast flowing habitat for native fish – no additional water requirement.	○ Maintain or improve the diversity and abundance of key bird species ○ Re-establish habitat condition to sustain high value fauna communities ○ Establish groundwater and soil conditions conducive to improving vegetation condition *Extent of achievement of above objectives limited to watering sites receiving pumped delivery of water for the environment* ○ Maintain the extent and diversity of distribution of native fish	
Pike	Manage base-flow conditions through the anabranch		○ Maintain suitable flowing habitat for native fish	N/A
Katarapko	Maintain base-flow conditions through anabranch		○ Maintain suitable flowing habitat for native fish	N/A
Wetlands	Delivery of water to up to 41 priority wetlands located along the River Murray from the border to the Lower Lakes		○ Support known populations of Murray hardyheads (nationally threatened), including providing conditions for breeding opportunities. ○ Regent parrot (nationally threatened) populations supported ○ Providing breeding opportunities and refugia for Southern bell frogs (nationally threatened). ○ Prevent loss of long lived vegetation: black box, River red gums, lignum and River cooba ○ Provide refuge habitats for waterbirds	10.6
	Additional delivery of water to wetland sites by Non-Government Organisations including Renmark Irrigation Trust, Accolade, Nature Foundation SA and the Australian Landscapes Trust.		○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of long lived vegetation including black box, River red gums, lignum and River cooba. ○ Support Regent parrot (nationally threatened) populations	3-4

Moderate (75% AOO) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Increase base flows in July and August 2020	○ Winter flows of 1-2 GL/d prioritised through Goolwa and Mundoo barrages to the Murray estuary and ocean ○ Barrage bays opened adjacent to fishways to facilitate fish movement through fishways	○ Provide appropriate flow conditions to encourage winter upstream migration of adult lamprey (i.e. freshwater signal through Murray Mouth and to the ocean) to promote migration to upstream spawning sites ○ Allow winter downstream migration of adult female congolli, to promote recruitment in the Coorong	100
	Increase base flows September to December 2020	○ Raise Lower Lake water levels in spring to >0.8 m AHD (leading to inundation of most fringing wetlands) ○ Allow all fishways to be operated for the entire year (~170 ML/d) ○ Deliver up to 1000 ML/d in total to the Coorong (>70% of flows from Tauwitchere barrage) during this period	○ Upstream movement of YOY diadromous fish during entire upstream migration period (targeting congolli & common galaxias) ○ Provide a continuous trickle flow year-round to Coorong mudflats directly downstream of barrage fishways to maintain habitable sediment conditions for invertebrates ○ Provide freshwater flows during spring and early summer to the Coorong North Lagoon to support the Coorong food web (zooplankton, benthic invertebrates, small-bodied fish) ○ Growth and recruitment of emergent and submergent aquatic vegetation in Lower Lakes wetlands from inundation of fringing wetlands ○ Majority of breeding habitat inundated (i.e. higher elevation fringing Lower Lakes wetlands) for threatened fish (Murray hardyhead, Southern pygmy perch) and southern bell frog	450
	Increase base flows January to June 2021	○ Allow fishways to be operated for the entire year (~170 ML/d) ○ Allow 1-bay of attractant flow at Tauwitchere for the entire year ○ Maintain lake levels >0.5 m AHD in autumn 2021	○ Continuous connectivity between the river and estuary ○ Continuous fish passage for diadromous fish ○ Fishways functional year-round ○ At least some threatened fish habitat in Lower Lakes remains inundated year-round ○ Localized estuary (<50 g/L d/s of barrages and North Lagoon) for adult estuarine fish and macroinvertebrates	241
Channel and Floodplain	Boost flow at the SA border in November, December and February to discharge equivalent to SA's normal Entitlement, and in January to 8,000 ML/day	○ Prevent persistent thermal stratification and conditions conducive to harmful algal blooms from occurring	○ Maintain a diurnally-mixed water column to ensure diverse phytoplankton and avoid negative water quality outcomes. ○ Restore and maintain resilient populations of foraging generalists	312.6 Return flows 306.3

Site	Action	Details	Objectives	Vol GL
Weir Pool Manipulation	Raise Weir 4 to 13.5 mAHD (0.3 m above normal pool level) This action will only be undertaken if the proposed Katarapko floodplain operation (incorporating WP4 raising) cannot occur. *Weir 4 raising in conjunction with a Katarapko regulator operation is incorporated into the Katarapko floodplain watering action below.*	Weir raising between August to November (depending on duration) Flows at Weir 5 of ≥ 5,400 ML/d required during filling phase. Targeting flows of ≥ 4,000ML/d downstream of Weir 4 for the duration of the action including during filling.	*Weir pool raising will contribute to achievement of the following objectives:* ○ Provide for the mobilisation of carbon, nutrients and propagules from the floodplain to the river ○ Maintain habitats and provide for dispersal of organic and inorganic material and organisms between river and wetlands. ○ Maintain water quality to support aquatic biota and normal biogeochemical processes. ○ Establish and maintain groundwater and soil moisture conditions conducive to improving riparian vegetation. ○ Establish groundwater conditions conducive to maintaining diverse native vegetation ○ Establish soil conditions conducive to maintaining diverse native vegetation ○ Promote bacterial rather than algal dominance of biofilms and improve food resource quality for consumers. ○ Maintain a viable, functioning River Red Gum, black box, river cooba, and lignum populations within the Floodplain ○ Establish and maintain diverse water dependent vegetation within aquatic zones ○ Establish and maintain diverse native vegetation comprising native flood dependent and amphibious species within the shedding floodplain zones ○ Restore resilient populations of [native fish] wetland/floodplain specialists within aquatic zones during floodplain flow events ○ Provide habitat conducive to supporting diverse communities of riparian frogs ○ Provide refuge for the maintenance of adult populations of waterbirds	Fill volume 6.30 Losses 0.34 **Total 6.64** Return flows 6.30 *Plus Additional passing TBC*

Site	Action	Details	Objectives	Vol GL
Chowilla	Pump to priority wetlands. [5] Manage inflows via Pipeclay Creek and Slaney Creek weirs to optimise outcomes for native fish through the anabranch.	Potential pumping to up to 8 priority wetland sites Adaptive management of inflows via weirs and associated fish passage to optimise fast flowing habitat for native fish – *no additional water requirement*.	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Improve the abundance and diversity of grass and herblands; flood dependant understorey vegetation; and submerged and emergent aquatic vegetation. ○ Maintain sustainable communities of the eight riparian frog species recorded at Chowilla and improve the distribution and abundance of the nationally listed Southern Bell Frog ○ Create conditions conducive to successful breeding of colonial waterbirds in a minimum of three temporary wetland sites at a frequency of not less than one in three years ○ Maintain or improve the diversity and abundance of key bird species ○ Re-establish habitat condition to sustain high value fauna communities ○ Establish groundwater and soil conditions conducive to improving vegetation condition *Extent of achievement of above objectives limited to watering sites receiving pumped delivery of water for the environment* ○ Maintain the extent and diversity of distribution of native fish	Up to 7
Pike	Operation of the Pike floodplain infrastructure to 15.0 mAHD to generate a low extent managed floodplain inundation.	○ Pike floodplain infrastructure operated to 15.0 mAHD ○ Lock 5 remains at Normal Pool Level (16.3 mAHD) for this operation ○ Instate a temporary rise in water level of ca. 0.45 m within the Pike anabranch system	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Establish and maintain a diverse plant community comprised of native flood dependent and/or amphibious species ○ Create conditions conducive to successful, small scale breeding events for waterbirds ○ Provide habitat conducive to supporting communities of native reptiles and mammals and woodland birds ○ Provide habitat conducive to supporting communities of riparian frogs	Filling - 2.94 Losses (evap and seepage) - 0.9 **Total - 3.85**

[5] Delivery dependant on resourcing for pumping and bank reinstatement.

Site	Action	Details	Objectives	Vol GL
		during a low flow period (Q is <20,000 ML/day).	○ Provide diverse hydraulic conditions and complex habitat for flow dependent biota and processes ○ Implement a seasonal hydrograph that encompasses variation in discharge, velocity and water levels ○ Provide for the facilitation of carbon and nutrient movement from the floodplain to the creek and river to generate localised fluctuations in productivity. ○ Promote bacterial rather than algal dominance of biofilms ○ Establish groundwater and soil conditions conducive to maintaining a diverse native vegetation community ○ Restore and maintain resilient populations of foraging generalists (e.g. Australian smelt, bony herring, Murray rainbowfish, unspecked hardyhead	Return flows – 2.8 *Additional Passing Flow 28.4*
Katarapko	Operate floodplain infrastructure to generate a low extent managed floodplain inundation	Katarapko floodplain infrastructure operated to raise water levels to 11.5 mAHD with weir 4 raised to 0.3 m to 13.5 mAHD.	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Establish and maintain a diverse plant community comprised of native flood dependent and/or amphibious species ○ Provide habitat conducive to supporting communities of native reptiles and mammals and woodland birds ○ Provide habitat conducive to supporting communities of riparian frogs ○ Implement a seasonal hydrograph that encompasses variation in discharge, velocity and water levels ○ Provide for the facilitation of carbon and nutrient movement from the floodplain to the creek and river to generate localised fluctuations in productivity. ○ Promote bacterial rather than algal dominance of biofilms ○ Establish groundwater and soil conditions conducive to maintaining a diverse native vegetation community ○ Restore and maintain resilient populations of foraging generalists (e.g. Australian smelt, bony herring, Murray rainbowfish, unspecked hardyhead	Filling - 7.3 Losses (evap and seepage) - 0.768 **Total - 8.1** Return flows – 7.3 *Additional Passing Flow: 26.4*
Wetlands	Delivery of water to up to 41 priority wetlands located along the River Murray from the border to the Lower Lakes		○ Support known populations of Murray hardyheads (nationally threatened), including providing conditions for breeding opportunities. ○ Regent parrot (nationally threatened) populations supported ○ Providing breeding opportunities and refugia for Southern bell frogs (nationally threatened).	10.6

Site	Action	Details	Objectives	Vol GL
			○ Prevent loss of long lived vegetation: black box, River red gums, lignum and River cooba ○ Provide refuge habitats for waterbirds	
	Additional delivery of water to wetland sites by Non-Government Organisations including Renmark Irrigation Trust, Accolade, Nature Foundation SA and the Australian Landscapes Trust.		○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of long lived vegetation including black box, River red gums, lignum and River cooba. ○ Support Regent parrot (nationally threatened) populations	3-4

Near Average (50% AOO) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Increase base flows directly following a small spring unregulated flow event between October and December 2020	○ Maintain water levels in the Lower Lakes between 0.8 – 0.85 m AHD for this period ○ Allow 5-10 GL/d barrage releases split between Goolwa, Tauwitchere and Mundoo barrages ○ Maintain suitable 'salt wedge' conditions (gradient of 5-20 ppt) from October to January downstream of Goolwa and Mundoo barrages, and downstream of part of Tauwitchere barrage	○ Create optimal salt wedge conditions downstream of Goolwa, Mundoo and Tauwitchere barrages for black bream spawning and recruitment ○ North Lagoon freshening to support increased benthic invertebrate diversity and abundance ○ North Lagoon freshening to support migratory wader feeding ○ North Lagoon freshening to support nursery grounds for juvenile estuarine fish and feeding habitat for adult estuarine fish ○ All breeding habitat inundated (i.e. higher elevation fringing Lower Lakes wetlands) for a sufficient period to allow threatened fish (Murray hardyhead, southern pygmy perch) and frogs (southern bell frog) recruitment	710
	Increase base flow between January and June 2021	○ Maintain lake levels in autumn >0.55 m AHD ○ Maintain fishway releases for the entire year ○ Allow at least 1-bay each of attractant flow at Tauwitchere and Goolwa barrage for the entire year	○ Continuous connectivity between the river and estuary ○ Continuous fish passage for diadromous fish ○ Fishways functional year-round ○ Threatened fish habitat in Lower Lakes remains inundated year-round and reasonable likelihood that most new recruits from spring will survive ○ Salt export to the Murray Mouth and Lake Alexandrina salinity <1000 EC year-round ○ North Lagoon <45 ppt year-round for adult estuarine fish and macroinvertebrates	290

Channel and Floodplain	Extend duration of flow at the SA border of 15,000 – 20,000 ML/day into late October/early November	Target delivery of EWR-IC2 described in the SA River Murray LTWP to contribute to the following targets: ○ Increase availability of moderate-fast (0.18 – 0.25 m/s) velocity habitat	○ In near-bank areas of upper weir pools, freshen groundwater and maintain/improve adult river red gum tree condition ○ Support spawning and recruitment of golden perch and silver perch by creating conditions conducive to reproductive activity when temperature thresholds (20 degrees) are exceeded	550 Return flows 539
Weir Pool Manipulation	Weir raisings at Weirs 2 and potentially also at one or more of Weirs 6, 5 and 4.	Raise Weir 2 by up to 52cm above normal pool level It is assumed that Weir 6, Weir 5 and Weir 4 will be raised in conjunction with a Chowilla, Pike, and Katarapko regulator operations, respectively. However if the floodplain regulator operations are NOT able to occur then the following weir raising actions may also be undertaken: - Raise Weir 6 by up to 59cm above normal pool to 19.84 mAHD - Raise Weir 5 by up to 50cm above normal pool level to 16.9 mAHD. - Raise Weir 4 by up to 60 cm above normal pool level to 13.8 mAHD Optimal timing August to November. *For August or later start if QSA > 15,000 ML/d in October weir pool water levels will be returned to full supply level earlier to avoid compromising River Murray Channel pulse outcomes.*	*Weir pool raising will contribute to achievement of the following objectives:* ○ Provide for the mobilisation of carbon, nutrients and propagules from the floodplain to the river ○ Maintain habitats and provide for dispersal of organic and inorganic material and organisms between river and wetlands. ○ Maintain water quality to support aquatic biota and normal biogeochemical processes. ○ Establish and maintain groundwater and soil moisture conditions conducive to improving riparian vegetation. ○ Establish groundwater conditions conducive to maintaining diverse native vegetation ○ Establish soil conditions conducive to maintaining diverse native vegetation ○ Promote bacterial rather than algal dominance of biofilms and improve food resource quality for consumers. ○ Maintain a viable, functioning River Red Gum, black box, river cooba, and lignum populations within the Floodplain ○ Establish and maintain diverse water dependent vegetation within aquatic zones ○ Establish and maintain diverse native vegetation comprising native flood dependent and amphibious species within the shedding floodplain zones ○ Restore resilient populations of [native fish] wetland/floodplain specialists within aquatic zones during floodplain flow events ○ Provide habitat conducive to supporting diverse communities of riparian frogs ○ Provide refuge for the maintenance of adult populations of waterbirds	Fill volume for just Weir 2 - 6.07 With total losses 0.19 **Total 6.26** Fill volume for Weirs 2, 4, 5 & 6 - 35.54 With total losses 1.25 **Total 36.79** Return Flows - 35.54 *(if all 4 weirs raised)* - 6.07 *(if only Weir 2 raised)*

Chowilla	Operate Chowilla regulator to generate a medium to high floodplain inundation.	Chowilla regulator operated to 19.4 mAHD (3 m increase above normal pool) or higher (if scale and duration of passing River Murray flows are sufficient) and Weir 6 – operated up to 19.85mAHD (0.6 m above normal pool level) to generate floodplain and wetland inundation over more than 5,000 hectares.	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Improve the abundance and diversity of grass and herblands; flood dependant understorey vegetation; and submerged and emergent aquatic vegetation**.** ○ Maintain sustainable communities of the eight riparian frog species recorded at Chowilla and improve the distribution and abundance of the nationally listed Southern Bell Frog ○ Create conditions conducive to successful breeding of colonial waterbirds in a minimum of three temporary wetland sites at a frequency of not less than one in three years ○ Maintain or improve the diversity and abundance of key bird species ○ Re-establish habitat condition to sustain high value fauna communities ○ Establish groundwater and soil conditions conducive to improving vegetation condition ○ Maintain the extent and diversity of distribution of native fish ○ Provide processes for the mobilisation of carbon and nutrients from the floodplain to the river	Filling – 45.8 Losses – 17.3 **Total 63.1** Return Flows 35.5 *Addl passing QSA-79.5GL*
Pike	Operation of floodplain infrastructure to generate a low extent managed floodplain inundation.	Operate floodplain regulators to 15.25 mAHD (raising water levels by 0.7m within the Pike anabranch) with Weir 5 also raised by 16.8 mAHD (increasing levels upstream of the weir by 0.5 m above normal pool level)	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Establish and maintain a diverse plant community comprised of native flood dependent and/or amphibious species ○ Create conditions conducive to successful, small scale breeding events for waterbirds ○ Provide habitat conducive to supporting communities of native reptiles and mammals and woodland birds ○ Provide habitat conducive to supporting communities of riparian frogs ○ Provide diverse hydraulic conditions and complex habitat for flow dependent biota and processes ○ Implement a seasonal hydrograph that encompasses variation in discharge, velocity and water levels ○ Provide for the facilitation of carbon and nutrient movement from the floodplain to the creek and river to generate localised fluctuations in productivity. ○ Promote bacterial rather than algal dominance of biofilms	Filling - 16.3 Losses (evap & seepage) - 4.5 ML **Total 20.74** Return Flows 16.1 *Nil addl Passing Flow*

			○ Establish groundwater and soil conditions conducive to maintaining a diverse native vegetation community ○ Restore and maintain resilient populations of foraging generalists (e.g. Australian smelt, bony herring, Murray rainbowfish, unspecked hardyhead	*required under this scenario*
Katarapko	Operation of floodplain infrastructure to generate a low medium extent managed floodplain inundation.	Floodplain infrastructure operated to increase water levels 12.8 – 12.9 mAHD (2.5-3.0 m above normal pool) within the Eckerts anabranch system and Weir 4 is raised +0.3 m above normal pool level (to a peak of 13.5 mAHD). Weir 4 raising <u>may</u> be increased a further 30 cm to 60 cm above normal pool level to a peak of 13.8 mAHD [6]	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Establish and maintain a diverse plant community comprised of native flood dependent and/or amphibious species ○ Create conditions conducive to successful, small scale breeding events for waterbirds ○ Provide habitat conducive to supporting communities of native reptiles and mammals and woodland birds ○ Provide habitat conducive to supporting communities of riparian frogs ○ Provide diverse hydraulic conditions and complex habitat for flow dependent biota and processes ○ Implement a seasonal hydrograph that encompasses variation in discharge, velocity and water levels ○ Provide for the facilitation of carbon and nutrient movement from the floodplain to the creek and river to generate localised fluctuations in productivity. ○ Promote bacterial rather than algal dominance of biofilms ○ Establish groundwater and soil conditions conducive to maintaining a diverse native vegetation community ○ Restore and maintain resilient populations of foraging generalists (e.g. Australian smelt, bony herring, Murray rainbowfish, unspecked hardyhead	Filling - 10 Losses (evap & seepage) - 1.7 **Total 11.76** Return flows –9.98 *Plus addl Passing Flow: 10.3* <u>OR with Weir 4 raising increased to 0.6 m:</u> Fill vol - 19.9 Losses (evap & seepage) - 2.35

[6] *This operation depends on capacity for increased raising of Lock 4 to 60 cm above normal pool level – depends on capacity to maintain appropriate head differential and confirmation by SA Water.*

				Total 22.25 Return flows – 19.9 *Plus addl Passing Flow: 5.6*
Wetlands	Delivery of water 37 priority wetlands located along the River Murray from the border to the Lower Lakes		The LTWP objectives of the channel asset, below 40,000 ML/day, that align with the wetland watering program include: ○ Establish and maintain a diverse native flood-dependent plant community in areas inundated by flows of 10,000–40,000 ML/day QSA ○ Establish and maintain a diverse macrophyte community in wetlands inundated by flows up to 40,000 ML/day QSA. ○ Establish and maintain groundwater and soil moisture conditions conducive to improving riparian vegetation. ○ Many of the priority wetlands within scope provide nature-based tourism experiences including camping, bird watching and recreation (Tolderol GR, Hogwash Bend CP, Katarapko NP, Morgan CP), contributing to local economies.	10.6
	Additional delivery of water to wetland sites by Non-Government Organisations including Renmark Irrigation Trust, Accolade, Nature Foundation SA and the Australian Landscapes Trust.		○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of long lived vegetation including black box, River red gums, lignum and River cooba. ○ Support Regent parrot (nationally threatened) populations	3-4

Wet (25% AOO) Scenario

Site	Action	Details	Objectives	Vol GL
CLLMM	Deliver e-water from October 2020 to January 2021 (immediately after a moderate unregulated flow event in spring)	○ Maintain water levels in the Lower Lakes between 0.8 – 0.85 m AHD (or higher) for this period ○ Allow 10-20 GL/d barrage releases, prioritised from	○ Maintain water levels in the Coorong South Lagoon >0.2 m AHD between October and December to support *Ruppia tuberosa* growth, flowering and seeding ○ Maintain salinity in the Coorong South Lagoon <60 ppt to promote *R. tuberosa* flowering and seeding	1140

		Tauwitchere barrage, between Oct-Dec	○ Maintain salinity in the Coorong South Lagoon <65 ppt to promote recruitment of other key Coorong food web biota (i.e. benthic invertebrates and small-mouthed hardyhead) ○ Surcharge water levels in the Lower Lakes to promote recruitment of high elevation emergent aquatic vegetation such as *Melaleuca halmaturorum*	
	Increase base flows between February and June 2021	○ Maintain lake levels in autumn >0.60 m AHD ○ Maintain fishway releases for the entire year ○ Allow at least 1-bay each of attractant flow at Tauwitchere and Goolwa barrage for the entire year	○ Continuous connectivity between the river and estuary ○ Continuous fish passage for diadromous fish ○ Fishways functional year-round ○ Threatened fish habitat in Lower Lakes remains inundated year-round and high likelihood that most new recruits from spring will survive ○ Salt export to the Murray Mouth and Lake Alexandrina salinity <1000 EC year-round ○ North Lagoon <45 ppt year-round for adult estuarine fish and macroinvertebrates ○ Higher flows through remainder of year maintain lower salinity in Coorong South Lagoon	315
Channel and Floodplain	Enhance unregulated flow to inundate low elevation areas of SA River Murray Floodplain Asset	Target EWR-FP1 described in the SA River Murray LTWP (Median discharge OSA 50,000 ML/d) to contribute to the following targets for the SA River Murray Floodplain PEA: ○ River red gum adult tree condition and population demographics in the target zone ○ Large Murray cod recruitment event ○ Support large-scale breeding by eight riparian frog species	○ River red gum adult tree condition and population demographics in the target zone ○ Large Murray cod recruitment event ○ Support large-scale breeding by eight riparian frog species	217.6 Return flows 213.2
	Extend duration of flow at the SA border of 20,000 – 30,000 ML/day into late October/early November	Target EWR-IC3 (Median discharge QSA 20,000 ML/day) to contribute to the following targets: ○ Abundant fast flowing habitat (>0.25 m/s) available	○ Abundant fast flowing habitat (>0.25 m/s) available ○ Improved soil water availability and reduced soil salinity ○ Growth of emergent aquatic plants in temporary wetlands inundated by high flows ○ Improved river red gum population demographics in inundated areas and areas adjacent due to lateral recharge of groundwater ○ Improved survival of Murray cod and catfish larvae	217.3 Return flows 213.0

		○ Improved soil water availability and reduced soil salinity ○ Growth of emergent aquatic plants in temporary wetlands inundated by high flows ○ Improved river red gum population demographics in inundated areas and areas adjacent due to lateral recharge of groundwater ○ Improved survival of Murray cod and catfish larvae		
Weir Pool Manipulation	Weir raisings at Weirs 2 and potentially also at one or both of Weirs 5 and 4 should the Pike and/or Katarapko floodplain operations not be able to proceed.	Raise Weir 2 by up to 52cm above normal pool level to 6.62 mAHD It is assumed that Weir 6, Weir 5 and Weir 4 will be raised in conjunction with a Chowilla, Pike, and Katarapko regulator operations, respectively. However if the new floodplain regulator operations at Pike and Katarapko are NOT able to occur then the following weir raising actions will also be undertaken: - Raise Weir 5 by up to 50cm above normal pool level to 16.9 mAHD. - Raise Weir 4 by up to 60 cm above normal pool level to 13.8 mAHD	*Weir pool raising will contribute to achievement of the following objectives:* ○ Provide for the mobilisation of carbon, nutrients and propagules from the floodplain to the river ○ Maintain habitats and provide for dispersal of organic and inorganic material and organisms between river and wetlands. ○ Maintain water quality to support aquatic biota and normal biogeochemical processes. ○ Establish and maintain groundwater and soil moisture conditions conducive to improving riparian vegetation. ○ Establish groundwater conditions conducive to maintaining diverse native vegetation ○ Establish soil conditions conducive to maintaining diverse native vegetation ○ Promote bacterial rather than algal dominance of biofilms and improve food resource quality for consumers. ○ Maintain a viable, functioning River Red Gum, black box, river cooba, and lignum populations within the Floodplain ○ Establish and maintain diverse water dependent vegetation within aquatic zones ○ Establish and maintain diverse native vegetation comprising native flood dependent and amphibious species within the shedding floodplain zones ○ Restore resilient populations of [native fish] wetland/floodplain specialists within aquatic zones during floodplain flow events	Fill volume for just Weir 2 - 5.59 With total losses 0.37 **Total 5.96** Fill volume for Weirs 2, 4 & 5 - 31.29 With total losses 2.46 **Total 33.75**

			○ Provide habitat conducive to supporting diverse communities of riparian frogs ○ Provide refuge for the maintenance of adult populations of waterbirds	
Chowilla	Operate Chowilla regulator and weir 6 to generate a high to maximum extent floodplain inundation.	Chowilla regulator operated up to 19.85 mAHD (3.45 m increase above normal pool) and Weir 6 – operated up to 19.85mAHD (0.6 m above normal pool level) to generate floodplain and wetland inundation over approximately 7,000 hectares.	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Improve the abundance and diversity of grass and herblands; flood dependant understorey vegetation; and submerged and emergent aquatic vegetation**.** ○ Maintain sustainable communities of the eight riparian frog species recorded at Chowilla and improve the distribution and abundance of the nationally listed Southern Bell Frog ○ Create conditions conducive to successful breeding of colonial waterbirds in a minimum of three temporary wetland sites at a frequency of not less than one in three years ○ Maintain or improve the diversity and abundance of key bird species ○ Re-establish habitat condition to sustain high value fauna communities ○ Establish groundwater and soil conditions conducive to improving vegetation condition ○ Maintain the extent and diversity of distribution of native fish ○ Instate connectivity to mid-elevation floodplain and all key wetlands ○ Provide processes for the mobilisation of carbon and nutrients from the floodplain to the river ○ Maintain the flow mosaic characteristic of the Chowilla Anabranch system ○ Establish a flow regime with distinct variability in components of the flood pulse	Filling – 74.4 Losses (evap & seepage) – 25.5 **Total - 99.9** Return Flow 61.3 *Additional passing flow 30.2 GL (in late Sept- Oct)*
Pike	Operation of Pike floodplain infrastructure to generate a low extent managed floodplain inundation.	Pike and Tanyaca regulators operated to 15.25 mAHD (0.7 m increase above normal pool) and Weir 5 – operated up to 16.8mAHD (0.5 m above normal pool level)	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Establish and maintain a diverse plant community comprised of native flood dependent and/or amphibious species ○ Create conditions conducive to successful, small scale breeding events for waterbirds ○ Provide habitat conducive to supporting communities of native reptiles and mammals and woodland birds ○ Provide habitat conducive to supporting communities of riparian frogs	Filling – 16.9 Losses (evap and seepage) - 4.4 **Total 21.3**

			○ Provide diverse hydraulic conditions and complex habitat for flow dependent biota and processes ○ Implement a seasonal hydrograph that encompasses variation in discharge, velocity and water levels ○ Provide for the facilitation of carbon and nutrient movement from the floodplain to the creek and river to generate localised fluctuations in productivity. ○ Promote bacterial rather than algal dominance of biofilms ○ Establish groundwater and soil conditions conducive to maintaining a diverse native vegetation community ○ Restore and maintain resilient populations of foraging generalists (e.g. Australian smelt, bony herring, Murray rainbowfish, unspecked hardyhead	Return Flow 16.7 *Nil additional passing flow under this scenario*
Katarapko	Operation of Katarapko floodplain infrastructure to generate a medium extent managed floodplain inundation.	Katarapko regulators operated to 12.9 mAHD (2.9 m increase in water levels within the Eckerts anabranch) and Weir 4 – raised up to 13.5 mAHD (0.3 m above normal pool level).	○ Maintain viable river red gum, black box, river cooba and lignum populations ○ Establish and maintain a diverse plant community comprised of native flood dependent and/or amphibious species ○ Create conditions conducive to successful, small scale breeding events for waterbirds ○ Provide habitat conducive to supporting communities of native reptiles and mammals and woodland birds ○ Provide habitat conducive to supporting communities of riparian frogs ○ Provide diverse hydraulic conditions and complex habitat for flow dependent biota and processes ○ Implement a seasonal hydrograph that encompasses variation in discharge, velocity and water levels ○ Provide for the facilitation of carbon and nutrient movement from the floodplain to the creek and river to generate localised fluctuations in productivity. ○ Promote bacterial rather than algal dominance of biofilms ○ Establish groundwater and soil conditions conducive to maintaining a diverse native vegetation community ○ Restore and maintain resilient populations of foraging generalists (e.g. Australian smelt, bony herring, Murray rainbowfish, unspecked hardyhead	Fill vol – 7.6 Losses (evap and seepage) - 1.5 **Total - 9.1** Return Flow 7.5 *Nil additional passing flow required under this scenario*

Wetlands	Delivery of water to 17-26 priority wetlands located along the River Murray from the border to the Lower Lakes		○ Establish groundwater conditions conducive to maintaining diverse native vegetation across the Floodplain PEA ○ Establish soil conditions conducive to maintaining diverse native vegetation across the Floodplain PEA ○ Maintain a viable, functioning River Red Gum population within the Floodplain PEA ○ Maintain a viable, functioning Black Box population within the Floodplain PEA ○ Maintain a viable, functioning River Cooba population within the Floodplain PEA ○ Maintain a viable, functioning Lignum population within the Floodplain PEA ○ Establish and maintain diverse native vegetation comprising native flood dependent and amphibious species within the shedding floodplain zones across the Floodplain PEA ○ Provide habitat conducive to supporting diverse communities of riparian frogs within the Floodplain PEA ○ Create conditions conducive to successful, small scale breeding events for waterbirds across the Floodplain PEA ○ Provide refuge for the maintenance of adult populations of waterbirds across the Floodplain PEA ○ Provide habitat conducive to supporting communities of native woodland birds, reptiles and mammals across the Floodplain PEA	4 to 6
	Additional delivery of water to wetland sites by Non-Government Organisations including Renmark Irrigation Trust, Accolade, Nature Foundation SA and the Australian Landscapes Trust.		○ Provide habitat for fish, turtles, frogs and water dependent birds ○ Support the maintenance of long lived vegetation including black box, River red gums, lignum and River cooba. ○ Support Regent parrot (nationally threatened) populations	3-4

Appendix C. 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: (a) declared Ramsar wetlands that depend on Basin water resources maintain their ecological character; and (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 (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: (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 (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: (a) the diversity and dynamics of geomorphic structures, habitats, species and genes are protected and restored; and (b) ecological processes dependent on hydrologic connectivity… (i) longitudinally along watercourses; and (ii) laterally between watercourses and their floodplains (and associated wetlands); and (iii)vertically between the surface and subsurface; are protected and restored; and (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 (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 (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: (i) maintaining levels above 0.4 metres Australian Height Datum for 95% of the time, as far as practicable; and (ii) maintaining levels above 0.0 metres Australian Height Datum all of the time; and (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: (a) flow sequences, and inundation and recession events, meet ecological requirements (e.g. cues for migration, germination and breeding); and (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.

Appendix D: Priority Temporary Wetlands for Pumping in 2020-21 as part of the Murraylands and Riverland Landscape Board's Watering Program

Complex	Wetland	Timing of watering
Berri Evaporation Basin	Berri Evaporation Basin	July 2020
Bookmark Creek	Bookmark Creek	Spring and for remainder of year
Disher	Disher Creek	
Katarapko Floodplain	Carpark Lagoons	
	Katarapko Creek Floodrunners	
	Katarapko Regent Parrot Floodrunner	
	Piggy Creek	
	Yabby Creek & Horseshoe Lagoons	
	Putjeda Creek	Between July 2020 and May 2021
Martins Bend	Martin Bend temporary 1 & 2	
	Martin Bend temporary 3	
Weila/Murtho	Murtho Park Flats	Between July 2020 and May 2021
	Murtho/Wiela Connector	Between July 2020 and May 2021
	Weila Regulator (Weila Shedding Basin)	Between July 2020 and May 2021
Woolenook	Squiggly Creek	
Akuna	Akuna	
Hogwash Bend	Hogwash Bend - Central Basin	
	Hogwash Bend - North Basin	
Maize Island	Maize Island	
Markaranka	Markaranka - Regent Parrot Strip	
Moorundie	Sweeney's Lagoon	
Morgan CP	Morgan CP South	
Morgan East	Morgan East	
Nigra/Schillers	Little Schillers Lagoon	
Nikalapko	Nikalapko	
Nilkra	Nilkra	
Old Parcoola	Old Parcoola	
Overland Corner	Overland Corner - Lignum Basins	August 2020
	Overland Corner - Main Basin	August 2020
Swan Reach Complex	Sugar Shack - Wetland 6	
Toolunka	Toolunka temporary	
Wigley Reach	Wigley Reach - Lignum Basin	
CLLMM	Tolderol Game Reserve	
	Investigator college	Between July 2020 and June 2021

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