South Australia's River Murray Environmental Watering Report

2014-2015

Australian Government

MURRAY–DARLING BASIN AUTHORITY

Government of South Australia
Department of Environment, Water and Natural Resources

Acknowledgement of the Traditional Owners

The Department of Environment, Water and Natural Resources 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.

Other Acknowledgements

This is the seventh River Murray environmental watering report to be produced by the South Australian Government. It was prepared by staff in the Department of Environment, Water and Natural Resources (DEWNR). The following agencies and organisations are acknowledged for their important role in environmental water management:

- Commonwealth Environmental Water Office (CEWO);
- Commonwealth Department of Environment;
- Murray-Darling Basin Authority (MDBA) including The Living Murray (TLM) program;
- Natural Resources South Australian Murray-Darling Basin (NR SA MDB);
- Local Action Planning Committees (LAP); and
- Nature Foundation South Australia (NFSA).

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Murray hardyhead. Photo by Scotte Wedderburn

1. Introduction and purpose

This report is prepared as a summary document on environmental watering for the River Murray in South Australia during the 2014-15 year. It is not a comprehensive summary; rather, it is a brief synopsis of some selected observations based on the available data and documentation.

The Murray-Darling Basin Plan (Basin Plan), adopted in November 2012, introduced comprehensive requirements for Basin States with respect to environmental water planning and reporting. The requirements are set out in Chapter 8 (Environmental Watering Plan) and Schedule 12 of the Basin Plan. The reporting requirements set out in the Basin Plan are met through separate reporting processes; these processes are quite detailed and encapsulate reporting on all aspects of Basin Plan implementation and are not limited to environmental watering. For this reason, South Australia has elected to continue to prepare this annual report as a stand-alone general reference aimed at a wider audience.

Within this document, the following have been summarised:

- the types and sources of environmental water available to the River Murray in South Australia;
- the environmental water planning framework;
- the delivery of environmental water including volumes and approximate timing;
- a brief summary of some of the successful environmental outcomes achieved through that delivery;
- two case studies of successful environmental watering actions within the 2014-15 year;
- assessment of environmental water delivery against environmental water requirements for selected sites;
- an update on Multi-Site Environmental Watering Trials (MSEWTs); and
- consultation undertaken during planning and delivery of environmental water.

This report meets the South Australian Government's commitment to the Council of Australian Governments (COAG) to publish an annual report on River Murray environmental water use in South Australia that provides transparency and accountability for public information sharing (National Water Initiative Policy Guidelines for Water Planning and Management 2010).

2. Environmental water types and sources

The planning, management, delivery, reporting and evaluation of environmental water within the Murray-Darling Basin in South Australia is coordinated within the Department of Environment, Water and Natural Resources (DEWNR) and undertaken in partnership with other government agencies including the Murray-Darling Basin Authority (MDBA) and Commonwealth Environmental Water Holder/Office (CEWH/ CEWO), research organisations, non-government organisations and community groups.

Environmental water within South Australia falls into two broad categories: Held Environmental Water (HEW) and Planned Environmental Water (PEW). A description of each follows.

2.1 Held Environmental Water

HEW is water held on licence for the purpose of achieving environmental outcomes. There are two major environmental water holders that provide HEW to South Australia:

- the CEWH holds 1,759,039 ML of water entitlements in the Southern Connected Basin for use in the Southern Connected Basin (as of 30 June 2015); and
- The Living Murray (TLM) Program in the MDBA holds 479,975 ML of water entitlements for use at the six TLM icon sites in the Murray-Darling Basin.

Additional HEW for use in South Australia is available through:

- the South Australian Minister for Water and the River Murray's wetland licence and account, with 34,782 ML available for use at pool connected wetlands with flow regulators and also named on the site-use approval;
- the South Australian Minister for Water and the River Murray's desalination licence and account, with 7,100 ML available for use at any priority site during 2014-15;
- Banrock Station's licence and account, with 2,454 ML available for Banrock Station wetland;
- the South Australian Minister for Water and the River Murray's licence and account with 1,035 ML for Tolderol wetland;
- return flow from environmental watering events upstream from the Victorian Environmental Water Holder (VEWH); and
- private donations.

2.2 Planned Environmental Water

Planned Environmental Water (PEW) is water that is committed by the Basin Plan or a water resource plan for a water resource plan area; or a plan or other instrument under State water law; for achieving environmental outcomes or other environmental purposes that are specified in the plan or the instrument, and cannot be taken or used for any other purpose.

The precise identification of PEW has not yet been formally agreed by the MDBA. South Australia has therefore not identified any PEW for 2014-15.

3. Environmental water planning framework

The Basin Plan has established a comprehensive framework for environmental water planning and reporting, aimed at integrating planning and management of environmental water across the Basin at all levels.

Central to this has been the development of the MDBA Basin-Wide Environmental Watering Strategy, which sets out the MDBA's assessment of how four important components of the Basin's water-dependent ecosystems are expected to respond over the next decade, given current operating rules and procedures. This includes making the best use of all water to achieve these objectives (noting that other variables like climate, fire, complementary actions or certain rules may affect the outcomes in some places). The four components: river flows and connectivity; native vegetation; waterbirds; and native fish have all declined appreciably. They are also good indicators of the health of river systems, and respond to environmental watering.

The MDBA also develops Basin Annual Environmental Watering Priorities. The Basin annual environmental watering priorities guide the annual planning and prioritisation of environmental watering across the Basin. This is done in order to achieve the most effective use of environmental water, promote better Basin-scale outcomes and coordinate environmental watering between environmental water holders and managers. All watering undertaken in the Murray–Darling Basin for environmental benefit, including watering that uses environmental water, is to be done having regard to the priorities.

The Basin Annual Environmental Watering Priorities are not an exhaustive list of all important environmental assets and functions throughout the Basin; and do not preclude other watering priorities identified by environmental water holders and managers at the State and regional level. States have responsibilities to develop long-term watering plans and annual environmental watering priorities. These are described in further detail in the sections that follow.

3.1 Development of annual environmental watering priorities

Each year DEWNR develops annual environmental watering priorities (annual priorities) and an annual environmental watering plan to provide the major environmental water holders (CEWH, TLM) with information regarding the proposed environmental watering actions.

As required under the Basin Plan, DEWNR identified annual priorities for the River Murray in South Australia for the use of HEW, which are set out in Table 1. These priorities were provided to the MDBA by 31 May 2014 (for the 2014-15 water year) with the approval of the South Australian Minister for Water and the River Murray. The annual environmental watering plan provides additional detail underpinning the priorities. This was subsequently published on the DEWNR website. Scenario-based planning (in which the scenarios relate to likely water availability) is used in the development of the annual priorities and the annual environmental watering plan. For 2014-15, South Australia prepared for scenarios based on annual exceedance probabilities (see Appendix 3 for an explanation of this term) of 50% (median), 75% (median/dry) and 90% (dry). The actual conditions in 2014-15 were consistent with the 50% scenario through August 2014, then rapidly declined to the 90% scenario by early September 2014.

Figure 1: Flow outlook for South Australia: Annual Exceedance Probabilities from MDBA's 'all years' multi-history run, end January 2014

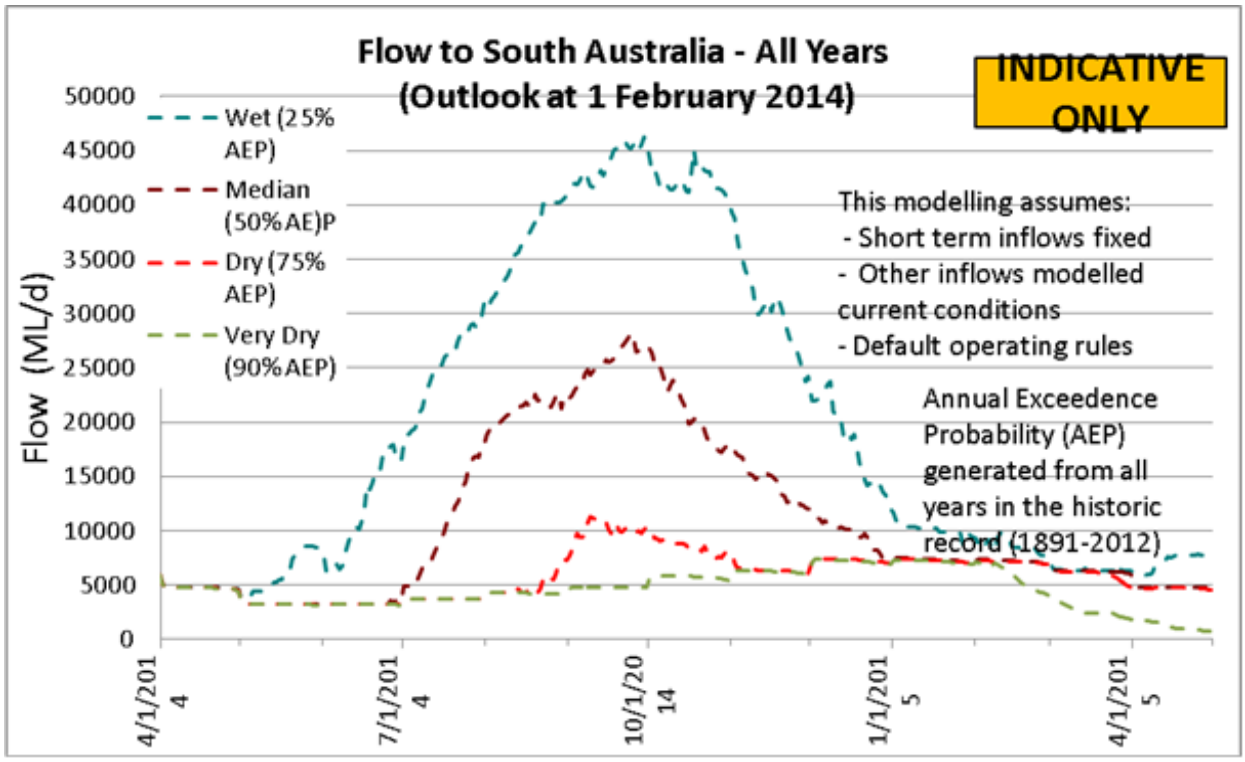


Table 1: 2014-15 Environmental watering priorities for the South Australian River Murray

Rank	Dry scenario (90 percent)	Median/Dry scenario 75 percent	Median scenario 50 percent
1	12 months of barrage releases Potential testing of Chowilla regulator	12 months of barrage releases Short flow pulse for CLLMM Long flow pulse for CLLMM Potential testing of Chowilla regulator	12 months of barrage releases Long flow pulse for CLLMM Create 25,000 ML/d QSA flow pulse for up to 90 days Potential testing of Chowilla regulator
2	Provision of water to threatened fish refuges	Provision of water to threatened fish refuges Create 15,000 ML/d QSA flow pulse for up to 90 days	Provision of water to managed gravity fed wetlands Pump water to priority temporary wetlands Create 25,000 ML/d QSA flow pulse for up to 60 days
3	Create 10,000 ML/d QSA flow pulse for up to 90 days	Create 15,000 ML/d QSA flow pulse for up to 60 days	Raise water levels in weir pools 1 and 2 by up to 50 cm
4	Provision of water to managed gravity fed wetlands Pump water to priority temporary wetlands	Provision of water to managed gravity fed wetlands Pump water to priority temporary wetlands	Variation of lake levels
5	Create 10,000 ML/d QSA flow pulse for 60 days	Raise water levels in weir pools 1 and 2 by up to 20 cm	

3.2 Long-term environmental watering plans

Under the Basin Plan, Basin States are required to prepare long-term environmental watering plans by November 2015, or an alternative date by negotiation. The purpose of these plans is set out in Chapter 8 of the Basin Plan (s8.19). It includes: the identification of priority environmental assets and ecosystem functions, and their associated ecological objectives, targets and environmental water requirements (EWRs); operational constraints; long-term risks to providing EWRs; and possible cooperative arrangements across the Basin for the planning and delivery of environmental water.

The long-term watering plans are important in setting out the long-term vision for environmental watering within different areas of the Basin, guiding the development of future annual environmental watering priorities at both the Basin and State levels, and the allocation of environmental water by environmental water holders to meet overall Basin Plan environmental objectives.

A long-term watering plan had not yet been finalised for the River Murray in South Australia for the 2014-15 year (but preparation was well underway by January 2015 and a plan was finalised, approved by the South Australian Minister for Water and the River Murray and submitted to the MDBA by November 2015). Although the plan has only recently been finalised, some of the EWRs, objectives and targets have been used to assess outcomes for within the 2014-15 year.

4. Environmental water delivery

4.1 Delivery summary

During 2014-15, a total of 809,941 ML of HEW (see Table 2) was delivered to priority sites identified in the South Australian River Murray annual environmental watering plan. The CEWH provided 597,900 ML; TLM provided 166,600 ML; water held on the Minister's wetland licence provided 34,782 ML and water held in South Australia on the other Minister's environmental water licences provided 8,200 ML; Banrock wetland licence provided 2,450 ML and private donations provided 9 ML. Appendices 1 and 2 provide details of sites that received environmental water.

Table 2: Environmental water used in South Australia 2014-15

Provider	**Volume in ML**
The Living Murray	166,600
Commonwealth Environmental Water Holder	597,900
Minister for Water and the River Murray	45,432
Private donation	9
Total	**809,941**

Figure 2 is a hydrograph showing the total flow to South Australia for the 2014-15 year. Flows above Entitlement Flow comprised unregulated flow from July to September 2014, peaking at 17,839 ML/day (11 August 2015) and held environmental water from September 2014 to June 2015[1].

The CEWH committed to the supply and delivery of environmental water to South Australia from July to December. In addition, there were return flows from environmental watering actions utilising water from the CEWH portfolio located upstream of the state border including from within the Goulburn, Broken, and Campaspe catchments and Hattah Lakes (approximately 134,000 ML).

From January to June 2015 the CEWH provided additional water for the Coorong. The delivery of water to the Coorong, Lower Lakes and Murray Mouth (CLLMM) was guided by a Short Term Barrage Operating Plan and a watering schedule between DEWNR and the CEWH. The intent of the watering schedule was to maintain the Lower Lakes within a healthy operating envelope of 0.5m AHD to 0.8m AHD lake level whilst maximising flow over the Lower Lakes barrages to meet environmental outcomes in the Coorong. It is a Basin Plan target to keep the Lower Lakes above 0.4m AHD. Longitudinal connectivity in the system was maintained with water from a Goulburn flow pulse action in January 2015 that bypassed Lake Victoria. This was the first time that the Lake was bypassed for an environmental outcome. Usually flows are passed to South Australia via Lake Victoria. The CEWH provided a total volume of 597,900 ML.

TLM provided environmental water for the raising of the water level in the Lock 6 weir pool (40cm above normal pool level), the testing of the Chowilla Regulator between September and December 2014 and for

[1] HEW that is held on a South Australian licence is delivered to South Australia as part of entitlement flow over the course of the year

the CLLMM. TLM return flows from upstream watering actions at Hattah Lakes and Gunbower Forest also made a significant contribution to flow to South Australia. This was a total volume of 166,600 ML.

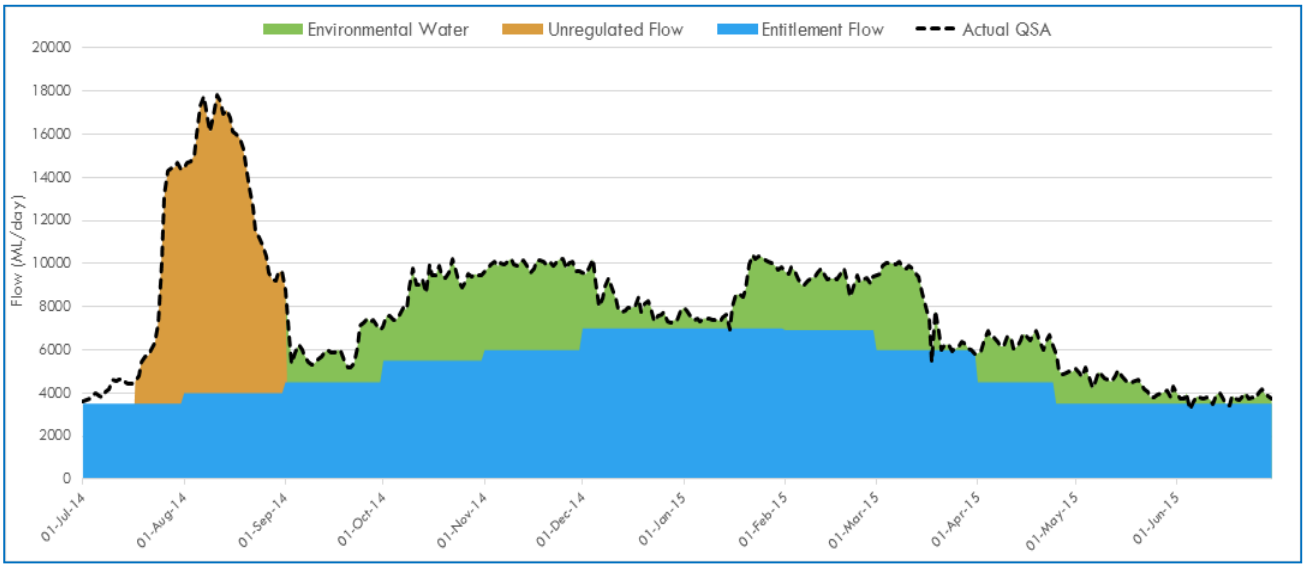
The South Australian Minister for Water and the River Murray provided some environmental water to add to an unregulated flow for the raising of the water levels within the weir pools of Locks 1 and 2 to 50cm above the normal operating range beginning in September 2014. This was a total volume of 8,200 ML.

Environmental water was also allocated and delivered to approximately 68 priority wetlands and floodplain areas. Water for these actions was sourced from the CEWH (5,225 ML), from environmental water held by the South Australian Minister for Water and the River Murray (8,200 ML), from Class 9 wetland water (34,782 ML) and from a small donation from a private irrigator (9 ML). Water was delivered to these sites via pumping in spring and summer months or by gravity to achieve a range of vegetation and fauna breeding outcomes.

During 2014-15, it became evident that dredging of the Murray Mouth would be required to remove accumulated sand. Dredging commenced in January 2015. Prior to dredging commencing, a barrage flow of 2,000 ML per day was targeted to minimise sand ingress into the Murray Mouth region. After dredging commenced, a flow of 2,000 ML per day was also targeted.

Figure 2: Flow to South Australia 1 July 2014-30 June 2015 showing components of flow

(Note: South Australia received 7,500 ML less of its July Entitlement Flow. It was delivered in June 2014 due to construction works on the Lake Victoria outlet regulator.)



4.2 Summary of selected outcomes

South Australia was able to undertake environmental watering consistent with its annual priorities, with the outcomes as summarised briefly in Table 3.

Table 3: Environmental watering actions and preliminary outcomes for 2014-15

Site	Action	Additional details	Objectives	Approx. volume (ML)	Achieved?	Outcomes
CLLMM	Lake level manipulation	6 months, July – December	Wet/dry fringing wetlands – zooplankton emergence	380,000	No	Only one individual Southern bell frog recorded in Lake Alexandrina wetlands – it is assumed that this was because lake levels were not maintained through spring. As a result of these sub-optimal lake levels during spring and summer, the CLLMM annual watering priority 4 (Table 2) of *'Variation of Lake Level (for fringing wetlands)'* was not achieved.
	Barrage releases	12 months, releases from fishways only	Connectivity; fish passage	120,000	Yes	Continuous barrage outflows attracted fish and lead to an abundance of young-of-year diadromous fish (common galaxias and congolli) moving upstream through fishways between October and January; continuous trickle flows through Boundary Creek were achieved – however no Black bream larvae were detected meaning that the flow did not attract Black bream;

Site	Action	Additional details	Objectives	Approx. volume (ML)	Achieved?	Outcomes
						increased macroinvertebrate abundance at Murray Mouth.
	Pump water to fringing wetlands	4 sites (Milang, Tolderol, Point Sturt, Gollan's)	Habitat for EPBC Act (see Glossary) listed migratory birds and southern bell frog	400	Yes for Tolderol	Good bird response at Tolderol. Refer to case study for further details.
Channel	10,000 ML/d QSA flow pulse x 60 days	September – March	Vary water levels in tailwaters; increase water velocity (see Appendix 3 Table 1)	250,000 – 300,000*	Yes	Increased median velocity of approximately 0.05 m s^{-1}, with some cross sections in the weir pool increasing into the range representing moderate-flowing habitat. (CEWO Long Term Intervention Monitoring Project).
	10,000 ML/d QSA flow pulse x 90 days	Mid-September - mid-December	Perch larval dispersal/survival	300,000 – 450,000*	No	n/a
	Pump to temporary wetlands	30 sites, refer to Appendix 1	Various – depends on sites selected	10,300	Yes, see Appendix 1	Improved vegetation condition; frog breeding; Southern bell frogs detected calling at 3 sites.
	Gravity fed wetlands	Bookmark Creek, pool managed wetlands	Refer to wetland management plans	35,000	Yes, see Appendix 2	Improved vegetation; Southern bell frogs detected calling at 4 sites.
	Threatened fish refuges	2 sites (Disher Creek and Berri Evaporation Basin)	Support Murray hardyhead	1,500	Yes	Record abundances of Murray hardyhead with over 9,700 at Disher Creek and 4,600 at Berri Evaporation Basin.
	Weir pool raising	Raise Locks a and 2	Inundation of fringing wetlands	1,900	Yes	Both locks raised 50cm with inundation of fringing vegetation and wetlands.

Site	Action	Additional details	Objectives	Approx. volume (ML)	Achieved?	Outcomes
Chowilla	First testing of environmental regulator and ancillary structures	Low to mid-level environmental regulator operation	Works and measures testing; soil and groundwater freshening/ vegetation/fauna outcomes	Filling and water use total 33,200 with 17,165 used	Yes	Testing of the Chowilla regulator resulted in an additional 2,300 hectares of the Chowilla floodplain (9,000 hectares) being inundated with a significant vegetation and frog response.

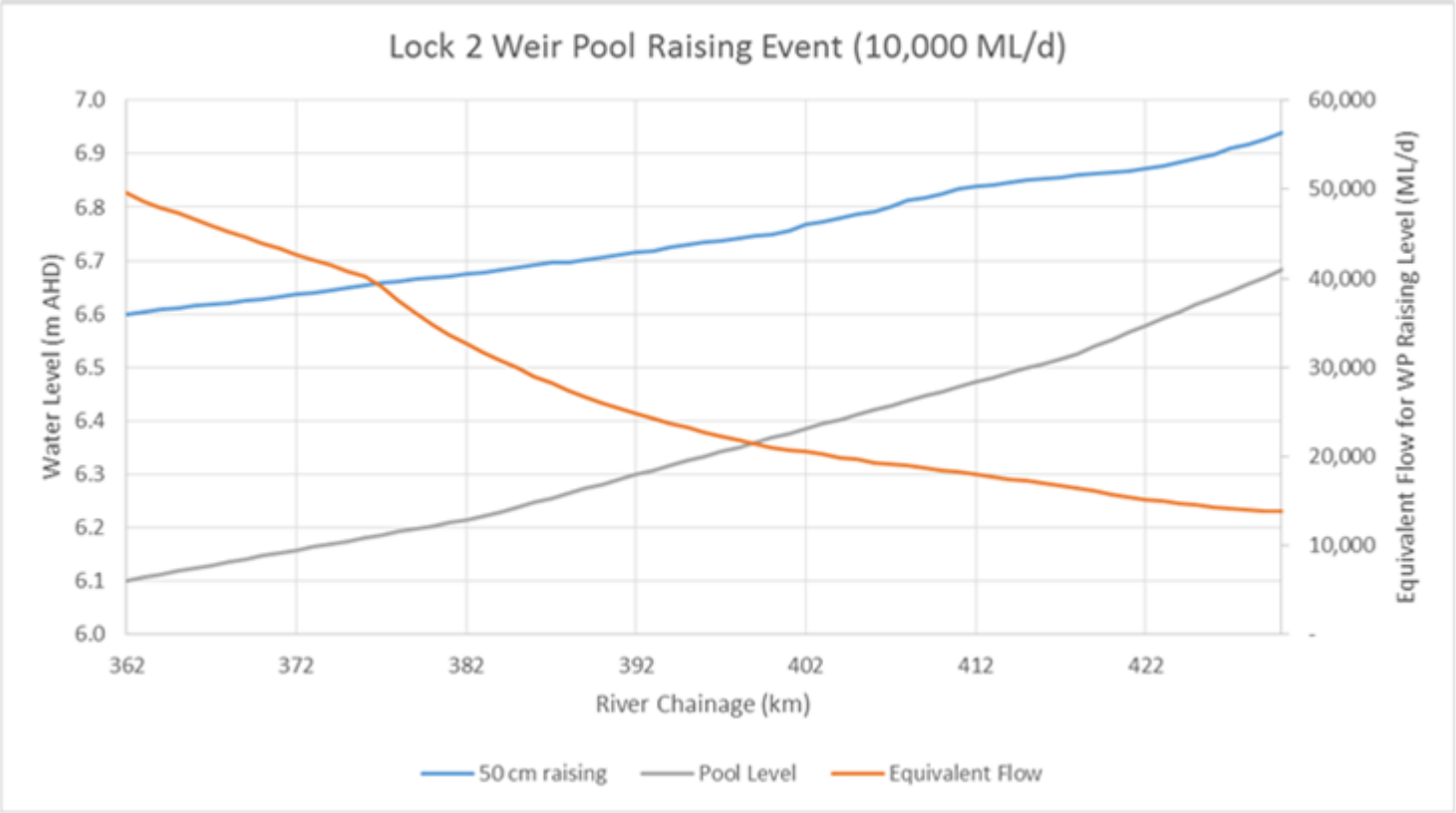


Figure 3: Inundation at Lock 2 - equivalence flow

4.3 Case Study - Tolderol Wetland

Background

The Tolderol Wetland is a large wetland complex (200 ha) situated within the Tolderol Game Reserve on the western fringe of Lake Alexandrina, approximately 13 km north-east of the township of Milang and approximately 80 km south-east of Adelaide. Tolderol wetland is part of the CLLMM Icon Site and the Coorong and Lakes Alexandrina and Albert Ramsar site, and is also subject to international migratory bird agreements.

Prior to 1970, the wetland was privately owned and grazed. In 1970, the South Australian Government purchased Tolderol as part of a state program to conserve water bird populations and habitat. It is now owned and managed by DEWNR. Before river regulation, it was a low lying littoral wetland that would have been temporarily inundated depending on water levels within Lake Alexandrina. River regulation changed the hydrology of Lake Alexandrina to a permanent freshwater lake.

The aim of the 1970s work was to increase the area of seasonally inundated brackish wetland habitat to supply the critical summer habitat for migratory water birds, including waders. A series of regulated

Tolderol Wetland. Photo: Chris Wright

artificial bays (refer to Figure 4) were constructed in 1976. A main channel runs parallel to the lake shore, with a series of interconnecting channels between the bays. Water was supplied to the bays by a pump that lifted water from Lake Alexandrina. The freshwater environment within bays created a refuge for water fowl feeding and protection, with flows controlled between bays and channels to mimic natural flooding and dry conditions with combinations of salt marsh, mudflats and shallow water. Active management of Tolderol Wetland ceased in 2008 and during the drought the wetland was disconnected from the lake due to falling water levels in Lake Alexandrina.

Site values

Vegetation

A wetland survey undertaken in 2004 identified a range of vegetation types and over 60 species, dominated by low growing swamp and marsh plants. The *Sarcocornia quinqueflora* shubland occurs at the wetland and is listed as rare in the region.

Birds

When wet, the marshes provide vital habitat for migratory waders over summer as well as over 50 waterbird species. Over 125 bird species have been recorded at Tolderol Wetland, of which twenty seven are Ramsar species, including the Australasian Bittern (*Botaurus poiciloptilus*) (endangered), the critically endangered Orange-bellied Parrot (*Neophema chrysogaster*) and the Australian Painted Snipe (*Rostratula australis*) (vulnerable). Other important species previously recorded at Tolderol include the Australian Bustard (*Ardeotis australis*), Australasian Darter (*Anhinga novaehollandiae*), Yellow Wagtail (*Motacilla tschutschensis*) and Golden-headed Cisticola (*Cisticola exilis*). Glossy Ibis (*Plegadis falcinellus*), Sacred Ibis (*Threskiornis aethiopica*), Straw-neck Ibis (*Threskiornis spinicollis*) and Royal Spoonbills (*Platalea regia*) are known to breed nearby.

Fish

In a 2004 baseline survey, eight species of native fish were recorded, including the Southern Pygmy Perch (*Nannoperca australis*) which is a protected species under the South Australian *Fisheries Management Act 2007*. The nationally threatened Murray Hardyhead (*Craterocephalus fluviatilis*) has been captured at nearby Boggy Lake and there is a strong likelihood that Tolderol could provide habitat for this species with appropriate management.

Frogs

Tolderol is one of the few wetlands in the CLLMM region that has supported the Southern bell frog (*Litoria raniformis*), considered vulnerable and protected under the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act* 1999 and South Australian *National Parks and Wildlife Act 1972*. Other frog species recorded in the 2004 survey are the Brown Tree Frog (L*itoria ewingii),* Spotted Grass Frog (*Limnodynastes tasmaniensis*) and Common Eastern Froglet (*Crinia signifera*).

Cultural and Social Values

The wetland is culturally very significant for the Ngarrindjeri people – the traditional owners of the region. The Ngarrindjeri have previously identified Tolderol as an important site for future management, which requires ongoing consultation with the Ngarrindjeri Regional Authority.

Due to its location, the wetland has significant social and recreational values for bird watching and game hunting in designated areas. In the past, Tolderol attracted many visitors, particularly during the migratory bird season. In the absence of water, bird numbers have declined as have the numbers of birdwatchers visiting the site. As a game reserve, hunting is permitted in designated areas during and if the hunting season opens, generally between February and June. Hunting is only permitted in small sections of the wetland with controls on take.

Recent history and the watering trial

Considerable work was completed by NR SA MDB during 2012-13 under the Commonwealth Water for the Future program to develop a proposal to restore Tolderol Wetland to its former condition by upgrading infrastructure to create a water regime within the wetland that supports migratory waterbirds as well as other bird, macrophytes, fish and amphibian species. The on-ground works proposed include upgrading culverts with water control infrastructure for individual bays, as well as upgrading existing connections between bays and maintaining connectivity between the main connector channel and Lake Alexandrina. Some work has progressed using funds from Natural Resources South Australia Murray-Darling Basin Board.

An environmental watering trial was successfully undertaken at Tolderol in 2014-15. The purpose of the trial was to attempt to reinstate natural habitats. Basins 5, 6 and 7 (a total of approximately 35 hectares) were watered. As a result of the project, thousands of waterbirds including nine international migratory species flocked to the wetlands to feed.

Unfortunately water-plant and reed growth in the main supply channel, coupled with low water levels in Lake Alexandrina, made it difficult to maintain flow to the pump that feeds the basins. The basins were then allowed to dry. Further watering is proposed to occur during 2015-16.

This project has reiterated the importance of Tolderol Wetland as suitable habitat for waders, particularly given such habitat is in short supply in the CLLMM region. The project was strongly supported by community groups and volunteers in the region. Over 60 volunteers attended monitoring days, undertook bird surveys or provided input into management over the course of the trial.

Priority works are needed at Tolderol Wetland to complete the upgrades to the infrastructure. This would enable future management of the wetland to occur with minimal operational support and maintenance compared with the more intensive pumping regimes formerly in place.

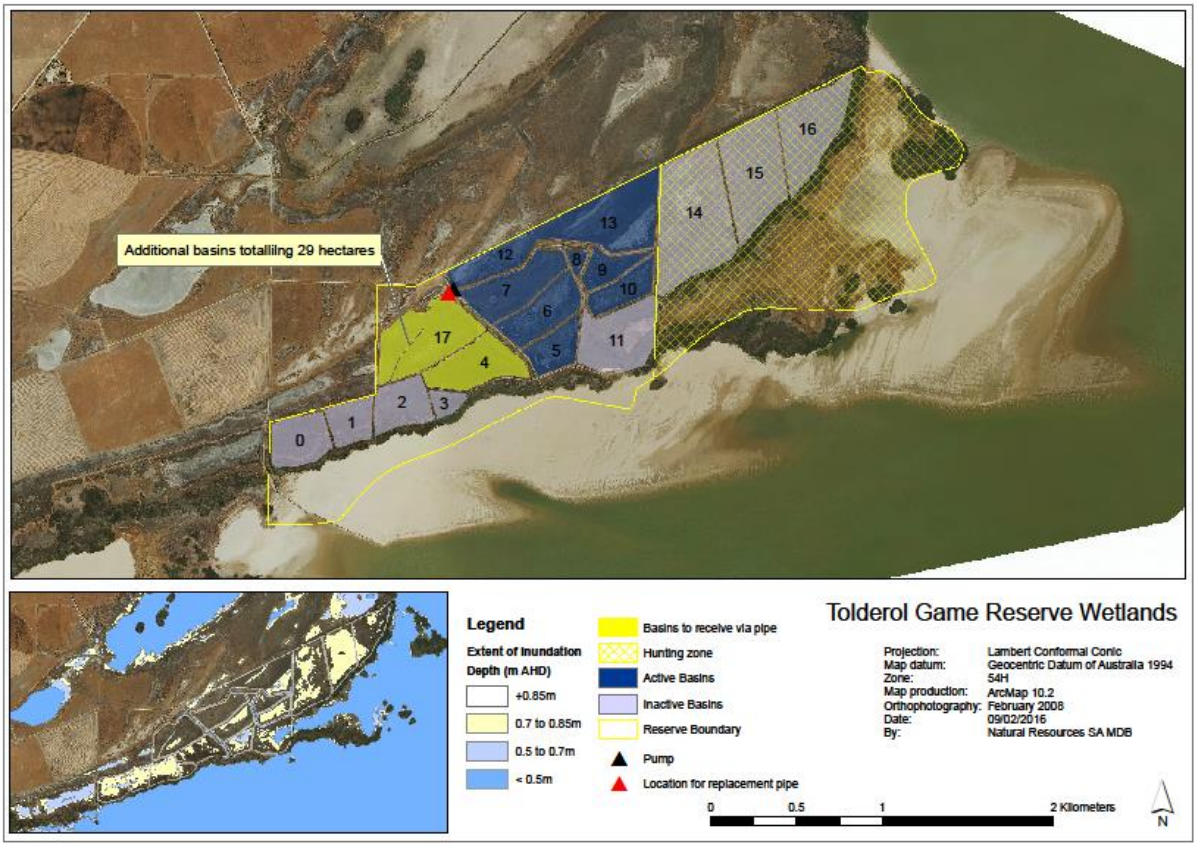


Figure 4: Tolderol Wetland

4.4 Case Study - Chowilla

TLM continues to play a major role in the return to health of the Murray-Darling Basin system by focusing effort on the efficient use of recovered environmental water at the six 'icon sites' along the river. The Chowilla Floodplain is one of the icon sites and is one of the last parts of the Lower Murray that retains much of its natural character. Located near Renmark in South Australia, Chowilla is:

- the largest floodplain complex in the Lower Murray;
- a part of the Riverland Ramsar wetland of international importance;
- a part of the Chowilla Game and Regional Reserve;
- the largest remaining area of natural river red gum forest in the Lower Murray; and
- home to many iconic and endangered native species, including the Murray cod, Regent parrot and the Southern bell frog.

The River Murray floodplain has experienced severe ecological decline, due to long periods without flooding. This decline was made significantly worse by the millennium drought. Floods that naturally occurred about 45 times in 100 years now occur only about 12 times in 100 years. This has resulted in:

- rising soil salinity;
- the death of trees particularly the majestic river red gum and the black box; and
- fewer breeding opportunities for floodplain wildlife.

The Chowilla Floodplain project aims to reverse this decline by enabling inundation of large areas of the floodplain at frequencies more like the natural conditions under which plants and animals have evolved.

Through TLM, an environmental regulator has been installed on Chowilla Creek. The Chowilla Creek environmental regulator (completed in 2014), and other structures are important in the management of the floodplain. The new structures divert water from the River Murray into Chowilla Creek, where the environmental regulator holds it. To protect the habitat of iconic native fish species such as Murray cod and golden perch, suitable flow rates are maintained through the river and anabranch creeks when the environmental regulator is in operation. This inundates large areas of the floodplain at more natural frequencies, resulting in simulated high flows and restored health while using less water than in a natural flood. These works allow up to about 7,500 ha of the floodplain to experience simulated high flows.

The activities underway are directed by the Chowilla environmental water management plan. The environmental water management plan documents the site's water requirements and outlines how the regulator and other measures will be used to meet those needs. The plan describes the preferred operation and the monitoring required to support the icon sites future management.

Three high level ecological objectives have been set for the Chowilla Floodplain by the Murray-Darling Basin Ministerial Council:

- maintain high-value wetlands;
- maintain the current area of river red gum forest; and
- maintain at least 20 per cent of the original area of black box vegetation.

The Chowilla environmental water management plan sets more detailed objectives and targets to achieve the restoration of the floodplain.

Initial testing of the Chowilla Creek environmental regulator and ancillary structures was undertaken between September and December 2014. The Chowilla regulator water level reached the target height for the start of testing of 19.1 m AHD, raising water levels by approximately 2.7m. The water level was maintained for two weeks, then gradually lowered again. The primary focus of the event was to

commence the testing of the new structures. TLM delivered 105,600 ML of environmental water which helped to enhance flows at the SA border to 10,000 ML/day to enable filling behind the Chowilla regulator and maintenance of River Murray flows. The Chowilla testing resulted in the inundation of approximately 2,300 hectares of wetlands and floodplains. By comparison, a river flow of approximately 55,000 ML/day is needed to achieve a similar extent of inundation without operation of the infrastructure.

The watering event produced many positive ecological responses. These included improvements in the health of trees in inundated areas (including the emergence of saplings and flushes of new foliage), an increase in floodplain understorey species richness and positive responses from aquatic and flood dependent species (including Spiny mud grass, also known as Moira grass) which had not been recorded at the site for some time. Twenty-five waterbird species were observed at the site during the watering, and six species of frogs were observed, including the nationally threatened Southern bell frog. Productivity boosts were recorded within the Chowilla anabranch and downstream in the River Murray.

This watering action was categorised as a 'low floodplain' inundation. Larger scale watering events will be possible in the future when larger river flows are available. The testing event contributed to learnings about both the benefits of managed watering actions and the risks. For example, significant carp breeding was recorded in some of the larger wetland sites on the Chowilla floodplain. This is a Basin wide problem and there are no easy solutions. No significant water quality issues were observed during the event.

Lake Limbra. Photo: Tony Herbert

4.5 Assessment of environmental water delivery against environmental water requirements for selected sites

Each year, an assessment is completed to determine whether environmental water requirements (EWRs) have been met for the floodplain, channel and CLLMM. These EWRs have been developed to inform environmental watering decisions and are based on the current understanding of the flow-ecology relationship for these assets. A hydrological assessment of whether EWRs have been met can be used to indicate potential environmental outcomes in the absence of ecological monitoring. The EWRs are described in South Australia's River Murray long-term environmental watering plan DEWNR (2015) and summarised in Appendix 3.

4.5.1 Floodplain and in-channel

Flow to South Australia (QSA) peaked at 17,839 ML/day (11 August 2014) and remained above 15,000 ML/day for 16 days in total (4 to 19 August 2014). The increase in flows was due to an unregulated flow event and no environmental water delivery occurred during this period. This peak in flows was outside the timing period specified for the channel EWRs, which is 90 days at 15,000-20,000 ML/day between September and March; therefore the channel EWRs were not met.

Between 1 September 2014 and 31 March 2015, maximum QSA was 10,434 ML/day (22 January 2015), indicating only the lowest channel EWR (IC1) was relevant to the 2014-15 water year. Analysis of the actual flow conditions in 2014-15 against the EWR metrics indicates that all metrics for the lowest channel EWR (IC1) were met except median discharge which was slightly below the value specified by the EWR (Table 3).

For the EWR to be achieved in any given water year, four metrics must be met concurrently – median discharge, discharge range, duration and timing. The closest that flow conditions in 2014-15 came to fulfilling this was between 9 October and 7 December 2014 (Table 3). During this period, South Australia received approximately 225 GL of environmental water, with the addition of environmental water used to boost QSA by up to approximately 4.5 GL on any one day.

Table 4. Comparison of actual flow to South Australia in 2014-15 to metrics for EWR-IC1
Green indicates that the actual flow conditions met the EWR metric.

	Median discharge	Discharge range	Duration	Timing
EWR-IC1 metrics	10,000 ML/day	7,000 – 12,000 ML/day	>60-days	Sep-Mar
Results for 2014-15	9,802 ML/day	7,992 – 10,226 ML/day	60-days	9-Oct to 7-Dec 2015

The channel ecological targets that EWR-IC1 is likely to have a large positive contribution towards have been identified as:

- thermal stratification does not persist for more than 5 days at any time;
- length-frequency distributions for foraging generalists (fish) include size classes showing annual recruitment; and
- relative abundance and biomass of common carp do not increase in the absence of increases in abundance and biomass of flow-dependent native fish.

4.5.2 Coorong, Lower Lakes and Murray Mouth (CLLMM)

Achieving continuous barrage fishway flow for five years is an important milestone that was achieved in 2014-15. However, substantial barrage flows are required every spring and summer to facilitate appropriate water quality and water level conditions in the Coorong.

A total volume of 986,000 ML was released out of the barrages in 2014-15. The second CLLMM EWR – EWR-CLLMM-2 (see Appendix 3 Table 3) has a minimum annual outflow volume of 3,150,000 ML so for 2014-15 this EWR was not met. This volume was not adequate to meet the EWRs for the site.

Despite exceeding the required volume for the first CLLMM EWR, EWR-CLLMM- 1, the actual pattern of delivery did not align with the preferred hypothetical monthly outflow pattern described by the EWR, with monthly outflows peaking in August 2014 then falling below 50,000 ML in January 2015, rather than the peak occurring in late spring/early summer as specified in the EWR (see Figure 5). This flow was not adequate to meet the EWRs for the site.

Lake levels ranged from 0.47m AHD to 0.86m AHD, with levels remaining above 0.75m AHD throughout July, August and part of September 2014, and minimum levels recorded in April 2015. The value and timing of minimum lake levels aligned well with the metrics for EWR-CLLMM1; however, maximum lake levels exceeded the EWR metric and occurred in August rather than between October and December. During this summer period the recorded average lake levels varied between 0.70m AHD and 0.49m AHD, as a result of reduced inflows and high rates of evaporation.

Peaks in barrage outflows (16 August 2014) and water levels in the Lower Lakes (10 August 2014) coincided with an unregulated flow event, with no addition of environmental water at that time. Environmental water delivery (apart from the 182,000 ML of environmental water held in South Australia and delivered as part of Entitlement Flow) to the South Australian border commenced on 2 September 2014 and continued through the remainder of the water year.

Table 5. Comparison of actual barrage outflows in 2014-15 to metrics for EWR-CLLMM1

Green indicates the actual barrage outflows met the EWR metric.

	Annual barrage outflow volume (ML)	**Barrage outflow timing**	**Lake water level range (mAHD)**		**Lake water level timing**	
			Min	**Max**	**Min**	**Max**
EWR-CLLMM1 metrics	>650,000 ML	Peak in Oct-Dec (Figure)	0.40	0.75	Mar-May	Oct - Dec
Actual results for 2014-15	986,000 ML	Peak in August (Figure)	0.47	0.86	April	August

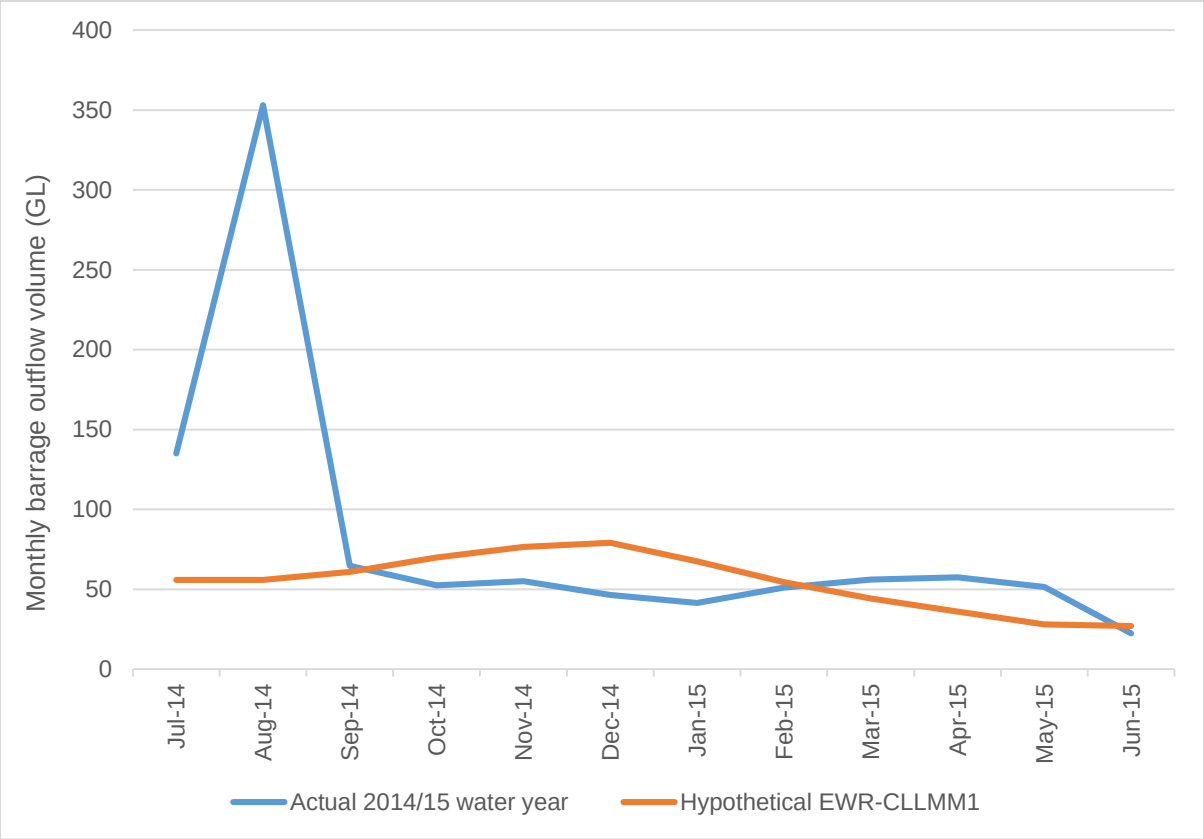


Figure 5. Comparison of actual barrage outflows in 2014-15 to preferred hypothetical delivery pattern for EWR 1

Coorong South Lagoon water levels ranged from a minimum of -0.23m AHD in March 2015 to 0.91m AHD in June 2015. The EWR-CLLMM1 specifies water level requirements between September and November, and between February and March. During these periods, minimum water levels remained within the specified range, however maximum water levels were exceeded (Table 6).

The ecological targets that EWR-CLLMM1 is likely to have a large positive contribution to have been identified as:

- Maintain or improve abundances of Murray hardyheads so that 'Relative Abundance Index' values of ≥1 are achieved on an annual basis;
- Detect recruitment success of Murray hardyheads and pygmy perch at least every second year;
- Sediment organic matter content between 1 and 3.5% dry weight in the Coorong and Murray Mouth; and
- Maintain or improve diversity of aquatic and littoral vegetation in the Lower Lakes as quantified using the CLLMM vegetation indices.

Table 6. Comparison of actual Coorong South Lagoon water levels in 2014-15 to metrics for EWR-CLLMM1

Green indicates the actual water levels met the EWR metric.

	Sep – Nov Coorong South Lagoon water level			Feb – Mar Coorong South Lagoon water level	
	Min (mAHD)	**Max (mAHD)**	**Duration (days)**	**Min (mAHD)**	**Max (mAHD)**
EWR-CLLMM1 metrics	0.00	0.20	≥ 90	-0.40	-0.20
Actual results for 2014-15	0.08	0.33	46	-0.23	0.11

4.6 Assessment against Basin Plan objectives and targets

4.6.1 Salinity

The Basin Plan specifies salinity targets for managing water flows at a number of sites along the River. These are set out in Table 6. The Basin Plan also identifies that *the levels of salinity at the reporting sites should not exceed the values set out in the table, 95% of the time.*

During 2014-15, the salinity was maintained below these targets for 100% of the time (Table 6).

Table 7: Basin Plan Targets for Reporting Sites and Salinity levels (EC) recorded in 2014-15

Location	Target	Maximum	Minimum	Average
Lock 6	580	410	110	180
Morgan	800	550	230	300
Murray Bridge	830	570	300	360
Milang	1 000	890	600	750

4.6.2 Murray Mouth and Coorong

The environmental objectives of section 8.06 (3)(c) and (d) of the Basin Plan are to ensure 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
- ensure that tidal exchanges maintain the Coorong's water quality (in particular salinity levels) within the tolerance of the Coorong ecosystem's resilience.

In 2014-15, the Murray Mouth remained open for 100% of the time due to dredging commencing on 9 January 2015. Barrage releases of greater than 2 GL/day are required to minimise the risk of the Murray Mouth closure (adapted from Walker 2002). In 2014-15, barrage releases were 2 GL/day or greater for 156 days (43% of year). Pulses were also trialled, as a means to move sand that had accumulated in the Mouth.

The South Australian River Murray Long Term Watering Plan has a target for salinity to be maintained below 100 parts per thousand (ppt) in the Coorong South Lagoon. In 2014-15, the average daily salinity in the Coorong South Lagoon remained below 100 ppt for 363 days. On the 2 days where this target was not achieved the average daily salinity in the Coorong South Lagoon was 102 ppt.

The salinity is calculated based on the average of three telemetered surface water monitoring stations in the Coorong South Lagoon; therefore it is likely that some of the southern regions of the South Lagoon would have exceeded this threshold during late summer.

4.6.3 Lower Lakes water levels

The objectives of section 8.06 (3)(e) of the Basin Plan are to manage water levels in the Lower Lakes to ensure sufficient discharge to the Coorong and Murray Mouth and help prevent riverbank collapse and acidification of wetlands below Lock 1, and to avoid acidification and allow connection between Lakes Alexandrina and Albert, by:

- maintaining levels above 0.4m AHD for 95% of the time, as far as practicable; and
- maintaining levels above 0.0m AHD all of the time.

In 2014-15, water levels in the Lower Lakes were maintained above 0.4m AHD for the entire year (Figure 6). The water levels enabled barrage releases on 352 days. There were 13 days when reverse head conditions were experienced and the barrages were closed to minimise the risk of seawater incursion. The fishways were kept open during this time. There were no incidents of riverbank collapse, no new reports of acidification of wetlands below Lock 1 and Lake Alexandrina and Lake Albert were connected for the entire year.

Figure 6: Lower Lakes average water levels in 2014-15

4.7 Multi-Site Environmental Watering Trials (MSEWTs)

The TLM Business Plan states that available environmental water should be managed to maximise environmental outcomes by re-using it at multiple sites. MSEWTs are an important element in the effort

to achieve system wide outcomes such as longitudinal connectivity and arrest of environmental decline across the Murray-Darling Basin. Planning for the environmental and hydraulic objectives of the 2014-15 trial was undertaken by the jurisdictions in conjunction with The Living Murray (TLM) Planning and Delivery section. The proposal for the 2014-15 event was to target Moira grass watering in both Barmah and Millewa forests. The required trigger for the event was intermittent natural flooding of Barmah-Millewa Forest for approximately two months at flow rates of between 15,000 and 20,000 ML/day. This trigger was not meet so there was no managed environmental watering event in Barmah-Millewa Forest in 2014-15. No release from Hume Reservoir for a specific overbank event was made and none of the relevant deviations agreed by Basin Officials Committee were utilised. The MDBA's River Murray Operations (RMO) section still delivered a significant volume of environmental water across the South Australian border throughout the year. The outcomes of this event for South Australia are reflected in the findings documented in section 4.2 of this report.

Pelicans at the Coorong. Photo: Adrienne Rumbelow

5. Consultation

This section of the report describes how stakeholders were engaged during planning for environmental watering prior to the start of the 2014-15 water year as well as during the actual delivery of environmental water. The consultation was well received by the stakeholder groups and is being continuously improved. State and commonwealth agencies are continuing to work together at forums such as the Southern Connected Basin Environmental Watering Committee to help build a common understanding of local system needs and how these relate to local needs of other areas so we can improve coordination system wide.

5.1 Consultation during planning for environmental water

Early in 2014, a workshop was held to begin discussing annual priorities for 2014-15. Key government stakeholders, environmental water holders and local scientific experts were invited to attend. Prior to this workshop, regional departmental staff sought input from Local Action Planning (LAP) officers and LAP committees regarding likely priority sites.

Input and feedback were sought from traditional owners, community groups and peak bodies that had been consulted on environmental watering priorities in previous years. These included the SA MDB NRM Board, the River Murray Operations Working Group, the River Murray Advisory Committee, LLCMM Community Advisory Panel, the LLCMM Scientific Advisory Group, Chowilla Community Reference Committee; the Community Action for the Rural Environment (CARE) committee, Local Action Planning Committees, the First Peoples of Murray and Mallee Region and the Ngarrindjeri Regional Authority (through the Kungan Ngarrindjeri Yunnan Agreement (KNYA) Taskforce and Yarluwar Ruwe Committee).

Presentations detailing objectives, required volumes, preferred timing of delivery, modelled outputs and associated monitoring were delivered at the regular (and specially-organised) group meetings, and written feedback was sought on draft annual priorities. The LLCMM Community Advisory Panel and Scientific Advisory Group are regularly engaged throughout the year to inform real-time management and water delivery decisions. The engagement with these key groups is critical to fostering ongoing relationships and to gain feedback to inform modification and improvement of the process for the future.

Annual priorities for environmental watering are also developed in close collaboration with the key environmental water holders (CEWH and TLM) with regular meetings and teleconferences occurring throughout the year.

5.2 Consultation for delivery of environmental water

The actual delivery of watering actions is undertaken following ongoing conversations to determine optimum timing of delivery of environmental water. A range of stakeholders and local groups are engaged on an ongoing basis through their regular meetings. The community was informed regarding potential forthcoming flow events through these committees and the weekly DEWNR River Murray Flow Report bulletins. Good communication ensured that local communities were aware of pending environmental watering actions and the anticipated ecological benefits. SA Water staff and other agencies were regularly informed of the timing for environmental water delivery and there was regular flow advice information provided on the DEWNR website and via email.

Frequent meetings of the Environmental Flows Reference Group are convened by DEWNR throughout the water year to seek input from scientific experts and site managers into environmental delivery options, align timing of delivery and to share the outcomes of monitoring. The group comprises environmental water managers and scientific experts.

Inundation of riparian area at Hogwash Conservation Park. Photo: Tian Shi

6. Conclusion

This report has described the volumes and timing of environmental water delivered for environmental watering actions along the River Murray in South Australia during the 2014-15 water year and highlighted some of the successful environmental outcomes achieved through that delivery. These include the huge numbers of congollis migrating upstream through the barrage fishways and the increasing numbers of threatened Murray hardyhead fish breeding and recruiting in the managed evaporation basins.

Standard planning and reporting practices are occurring each year and stakeholders are prepared to provide input when it is sought. There is greater awareness of the importance of forecasting and assessment of possible weather outlooks for future water use planning. There is an increasing understanding of the trade-offs required to be made regarding the height, timing and length of environmental flow events when construction and testing of infrastructure is underway.

Continued recovery of the River Murray in South Australia is dependent on ongoing provision of environmental water at the right ecological time and duration. Achieving continuous barrage fishway flow for five years was an extremely important milestone that was achieved in 2014-15. However, substantial barrage flows are required every spring and summer to facilitate appropriate water quality and water level conditions in both the Lower Lakes and the Coorong. Freshwater flows allow for seasonal water level increases in the Lower Lakes, and inundation of fringing wetlands with subsequent potential biota breeding and recruitment.

Gum Flat Wetland and inundation across the Chowilla Floodplain. Photo: Callie Nickolai

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Appendix 1. Table of watering actions

Site	Volume ML	Delivery time	Water Source	Action
Akuna	125.4	Nov-Dec	CEWH (via NR SAMDB)	pumped
Berri Evaporation Basin	1241	Sept-Jun	CEWH (via NR SAMDB)	gravity
Bookmark Creek	420	Sept-Jun	Minister's licence	gravity
Chowilla Floodplain	17,000	Sept-Dec	TLM	gravity
Calperum Station	276.1	Nov-June	CEWH (via NFSA)	pumped
Clarks Floodplain	201.4	Oct-June	CEWH (via NFSA)	pumped
Cobdogla	2.1	March	CEWH (via NFSA)	pumped
Gerard Black Box	0.6	Jul-Jun	Ministers Licence	sprinkler
Johnsons Waterhole	161.5	Sept-June	CEWH (via NFSA)	pumped
Katarapko Creek	27.3	May-Jun	Ministers Licence	pumped
Katarapko Island Creeks	134.7	May-Jun	Ministers Licence	pumped
Little Duck	37	Nov	Ministers Licence	pumped
LLCMM	743,899	Sept-Jun	TLM, CEWH, SA, VEWH	gravity
Lock 1 weir pool raising	1,134	Sept-Nov	Ministers licence + RMUF	gravity
Lock 2 weir pool raising	764	Sept-Nov	Ministers Licence + RMUF	gravity
Loveday wetland	1233	Jul-Jun	Ministers Licence	gravity
Loxton Riverfront Reserve	38.7	Sept-June	CEWH (via NFSA)	pumped
Markaranka Blackbox	9	Nov-Apr	Southcorp Wines	pumped
Markaranka South	201.2	Nov	CEWH (via NR SAMDB)	pumped
Markaranka East wetland	800	Jan-Feb	CEWH (via NR SAMDB)	pumped
Molo Flat	748.4	Dec-Mar	CEWH (via NR SAMDB)	pumped

Site	Volume ML	Delivery time	Water Source	Action
Morgan Conservation Park South	128.3	Nov-Mar	Ministers Licence	pumped
Morgan East wetland	193.8	Nov-Feb	Ministers Licence	pumped
Nikalapko	800	Nov	CEWH (via NR SAMDB)	pumped
Old Loxton Rd wetland	22.3	Jun	Ministers Licence	pumped
Overland Corner lignum basin	101	Apr-May	CEWH (via NR SAMDB)	pumped
Piggy Creek	201.2	Nov	CEWH (via NR SAMDB)	pumped
Pike-Mundic	220.3	Nov-Dec	CEWH (via NFSA)	pumped
Ramco River Terrace	7.5	Nov-April	CEWH (via NFSA)	pumped
Rilli Reach	25.1	Nov-April	CEWH (via NFSA)	pumped
South Teringie	136	Nov-May	CEWH (via NFSA)	pumped
Sugar Shack temporary basin	41.9	Nov	Ministers licence	pumped
Templeton	134	Oct-Mar	Ministers Licence	pumped
Thieles Flat	32.6	Sept-April	CEWH (via NFSA)	pumped
Tolderol wetland	416	Nov-Feb	Ministers Licence	pumped
Weila wetland drippers	1	Jul-Feb	Ministers Licence	dripper
Weila wetland	255	Nov-Feb	CEWH (via NR SAMDB)	pumped
Whirlpool Corner wetland	90	Dec-Mar	CEWH (via NR SAMDB)	pumped
Wigley Reach	314	Nov-Jan	CEWH (via NR SAMDB)	pumped
Winding Creek	100	Nov	Ministers Licence	pumped
TOTAL	**771,494.4**			

*This list excludes pool connected wetlands; these are listed in Appendix 2

Appendix 2. Managed wetlands that received class 9 water

Site	Delivery time
Banrock Station wetland	Jul-Oct
Bunyip Reach	Nov-Jan (+ refill)
Little Duck, Winding Creek	Nov
Devon Downs South	Jul-Jun
Hart Lagoon	Oct-Jun (+ refill)
Lake Merreti	Sept-Feb
Lake Woolpolool	Sept-Feb
Mussels, Loveday North, South, Sheepyard	Jul-Jun
Martins Bend	Jan-Jun (+ refill)
Morgan Lagoon CP	Jul-Mar
Morgans Lagoon LM	Jul-Nov
Murbpook Lagoon	Sep-Oct (+ refill)
Murkbo South	Oct-Jun
Narrung	Jan-Mar
Ngak Indau	Jul-Jun
Nigra Creek, Schillers,	Jul-Jun
Noonawirra	Jul-Jun
Pilby Creek, Pilby Lagoon, Lock 6 depression	Oct-Jun
Pipeclay Billabong	Oct
Ramco Lagoon	Oct-Jun (+ refill)
Reedy Creek	Jul-Jun
Riverglades	Jul-Jun
Slaney Billabong	Oct-Dec
Spectacle Lakes, Beldora Complex	Mar-Jun
Sugar Shack	Jul-Nov
Sweeneys Lagoon	Jul-Jun
Waltowa	Jul-Jun
Yatco North Lagoon	Apr-Jun

Appendix 3. Summary of environmental water requirements for the SA River Murray

Table 1: Environmental Water Requirements for the SA River Murray Channel Priority Environmental Asset (Table taken from (Wallace, et al., 2014a))

EWR #	Median discharge (ML/day QSA)	Discharge variability (ML/day QSA)	Duration (days)	Preferred timing	Average return frequency (years)	Maximum interval (years)
IC1	10,000	7,000 - 12,000	60	Sep-Mar	1.05	2
IC2	15,000	15,000 -20,000	90	Sep-Mar	1.33	2
IC3	20,000	15,000 - 25,000	90	Sep-Mar	1.8	2
IC4	25,000	20,000 - 30,000	60	Sep-Mar	1.7	2
IC5	30,000	25,000 - 35,000	60	Sep-Mar	1.8	2
IC6	35,000	30,000 - 40,000	60	Sep-Mar	1.8	2
IC7	40,000	35,000 - 45,000	90	Sep-Mar	2.1	3

Table 2: Environmental Water Requirements for the SA River Murray Floodplain Priority Environmental Asset (Taken from (Kilsby, et al., 2015))

EWR #	Median discharge (ML/day QSA)	Discharge variability (ML/day QSA)	Duration (days)	Preferred timing	Average return frequency (years)	Max interval (years)	Max rate of water level rise (m/day)	Max rate of water level fall (m/day)
FP1	50,000	45,000-55,000	30	Sep-Dec	1.6	5	0.05	0.025
FP2	60,000	55,000-65,000	30	Sep-Dec	2.0	5	0.05	0.025
FP3	70,000	65,000-75,000	30	Sep-Dec	2.6	5	0.05	0.025
FP4	80,000	75,000-85,000	30	Sep-Dec	3.6	5	0.05	0.025
FP5	80,000	75,000-85,000	60	Sep-Dec	7.6	8	0.05	0.025

Table 3: Environmental Water Requirements for the Coorong, Lower Lakes and Murray Mouth Priority Environmental Asset
Table taken from (O'Connor, et al., 2015). 'Timing' of barrage flows, lake levels and Coorong South Lagoon water levels include the entire duration of each month specified (i.e. from the beginning of the first month to the end of the final month).

EWR #	Average return interval (years)	Maximum interval (years)	Annual barrage flow (GL/yr)	Barrage flow timing	Lakes water level range (mAHD)	Lakes water level timing	Coorong south lagoon water level (mAHD)	Coorong south lagoon water level timing	Coorong south lagoon duration (days)
CLLMM1	1-in-1	N/A	>650[2]	Jul-Jun, with peak barrage outflows in Oct-Dec	0.4-0.75	Maximum lake levels Dec-Feb and minimum lake levels in Mar-May	0.0 to 0.2	Sept- Nov	≥90
							-0.2 to -0.4	Feb-Mar	-
CLLMM2	1-in-2	N/A	>3150[3]	Jul-Jun, with peak barrage outflows in Oct-Dec	0.4-0.83	Maximum lake levels Dec-Feb and minimum lake levels in Mar-May	0.35-0.45	Sept- Dec	≥120
							0 to -0.5	Mar-April	-
CLLMM3	1-in-3	5	>6,000	Jul-Jun, with peak barrage outflows in Oct-Dec	0.4-0.83	Maximum lake levels Dec-Feb and minimum lake levels in Mar-May	0.35-0.45	Sept- Jan	≥150
							0 to -0.5	Feb-April	-
CLLMM4	1-in-7	17	>10,000	Jul-Jun, with peak barrage outflows Oct-Dec	0.4-0.9	Maximum lake levels Dec-Feb and minimum lake levels in Mar-May	0.35-0.45	Sept-end Feb	≥180

[2] A total average barrage outflow of 2,000 GL/year over a three year rolling period (i.e. not less than 6,000 GL over three years) and not less than 650 GL/year in any one of the three years (Heneker 2010; Lester et al. 2011)

[3] A total average barrage outflow of 4,000 GL/year over a three year rolling period (i.e. not less than 12,000 GL over three years) and not less than 3150 GL/year in any one of the three years (Heneker 2010; Lester et al. 2011)

Appendix 4. Glossary

Term	Meaning
ADF – Additional Dilution Flow	Flow provided in addition to Entitlement Flow to help manage salinity in the River Murray
AHD - Australian Height Datum	Height above sea level
Annual exceedance probabilities (AEP)	A 90% AEP reflects that 90% of the historical records for annual river flow indicate that this flow rate was achieved; therefore there is a 90% chance of receiving at least this flow in any year
BWEWS	Basin Wide Environmental Watering Strategy
CEW	Commonwealth Environmental Water
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
CLLMM	Coorong Lower Lakes and Murray Mouth
DEWNR	SA Department of Environment, Water and Natural Resources
EC	A measure of water salinity
ECD	Ecological Character Description
EF – Entitlement Flow	The flow South Australia is entitled to receive under the Murray-Darling Basin Agreement
EPBC Act	Environmental Protection and Biodiversity Conservation Act (Commonwealth) 1999
EWR	Environmental water requirement - the water regime needed to sustain the ecological values of aquatic ecosystems and biological diversity at a low level of risk.
FPRMM	First Peoples of the River Murray and Mallee Region - native title holders in the Riverland, South Australia, including areas of the River Murray around Renmark, Berri, Barmera, Waikerie and Morgan.
GL	Gigalitres – a measure of volume, where a gigalitre equals 1,000 megalitres or 1,000,000,000 litres.
HEW	Held environmental water – defined within Section 4 of the *Water Act 2007*.
KNYA	Kungun Ngarrindjeri Yunnan Agreement.
Longitudinal connectivity	Water is allowed to travel the full length of the river and is not captured in storages – this allows distribution of seeds, fish and nutrients down the length of the river
LTIM	Long Term Intervention Monitoring
Lower Lakes	Lakes Alexandrina and Albert
LTWP	Long Term Watering Plan
MDBA	Murray Darling Basin Authority
ML/d	Megalitres per day

NRA	Ngarrindjeri Regional Authority - the peak regional organisation of the Ngarrindjeri people, descendants of the original indigenous inhabitants of the lands and waters of the Murray River, Lower Lakes and Coorong and adjacent areas.
PEW	Planned Environmental Water
Pool connected wetland	A wetland that can be connected to the main River channel when South Australia is receiving its Entitlement and normal operating pool levels are being maintained.
PPM	Pre-requisite policy measure - constraints that coincide with the unimplemented policy measures identified in s7.15 of the Basin Plan.
QSA	Flow at the South Australian border. Unless otherwise stated, flow rates (or discharges) are expressed with respect to flow at the South Australian border.
Ramsar Convention	An international convention that recognises important wetlands that meet defined criteria
SCBEWC	Southern Connected Basin Environmental Watering Committee - a multi-jurisdictional committee that provides advice on the coordinated delivery of environmental water.
SDL	Sustainable diversion limit – defined in the Basin Plan as the long-term average sustainable diversion limit.
Tailwater	Water located immediately downstream from a hydraulic structure, such as a dam (excluding minimum release such as for fish water), bridge or culvert.
Temporary wetland	A wetland basin that is not connected to the main River channel when South Australia is receiving its Entitlement flows and normal operating pool levels are being maintained.
TLM	The Living Murray Program – a long-running collaborative programme between the Murray-Darling Basin Authority and partner governments aimed at restoring the health of the River Murray system by recovering 500 gigalitres of water and constructing major water management structures at six environmental icon sites.
Unregulated flow	Water received in South Australia above legislative requirement and not traded
VEWH	Victorian Environmental Water Holder.
WRP Area	Water Resource Plan Area – water planning units identified for the purpose of implementing the Basin Plan. The water resource plan areas are listed in Chapter 3 of the Basin Plan.