Basin Salinity Management 2030

South Australia's 2019 Comprehensive Report

Government of South Australia
Department for Environment and Water

Acknowledgements

This report has been compiled by the Department for Environment and Water (DEW) with contributions from other organisations and branches within DEW.

The Water Security, Policy and Planning Branch would like to acknowledge and thank the following organisations and branches from DEW for their contribution to this report:

- SA Water
- Primary Industries and Regions SA
- Water Science and Monitoring Branch
- Natural Resources SA Murray-Darling Basin Region
- Water Infrastructure and Operations Branch

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Executive Summary

Murray-Darling Basin governments renewed their commitment to manage salinity in 2015 through the adoption of the Basin Salinity Management 2030 (BSM2030) strategy. The BSM2030 strategy builds on previous investments in salinity management as part of the Salinity and Drainage Strategy (1988-2000) and the Basin Salinity Management Strategy (2001-2015). The BSM2030 strategy maintains the existing accountability framework and management arrangements, while addressing contemporary issues such as the effects of environmental watering and exploring ways to optimise the operation of salt interception schemes (SIS).

This is South Australia's second comprehensive report which covers implementation of the BSM2030 strategy in 2017-18 and 2018-19. South Australia's key achievements and outcomes over the past two years are outlined below against each of the key elements of the BSM2030 strategy.

Salinity accountability framework

- South Australia remains compliant with Schedule B of the Murray-Darling Basin Agreement with a Salinity Register net credit balance of $7.621 million.
- Initial results from salinity assessments for actions undertaken as part of the South Australian Riverland Floodplain Integrated Infrastructure Program (SARFIIP) at Pike indicate that the combined impact of actions are likely to result in a net reduction in salt load to the River Murray averaged over 100 years.
- An audit of the Chowilla groundwater model was completed to compare modelled estimates of salinity impacts directly with observations collected during regulator operation. The audit confirmed that the Chowilla model is fit for purpose and can continue to be used for assessing potential salt load impacts from operation of the floodplain infrastructure.

Management of salt interception schemes

- SIS located in South Australia intercepted more than 467,768 tonnes of salt over the past two years.
- Tranche 1 of the Pike groundwater management scheme designed to enhance the ecological benefits of inundation of the Pike and Katarapko floodplains has been completed.

Flow management

- Salinity levels remained below the target levels in 2017-18 and 2018-19 at all South Australian End-of-Valley Target sites and Basin Plan reporting sites other than Milang which had a short exceedance above 1,000 EC.
- During 2017-18 and 2018-19 the Department for Environment and Water considered the salinity and water quality risks associated with 72 separate requests to undertake environmental watering and river operational actions as part of the approval process.
- Murray-Darling Basin Authority modelling estimates that salt export from the Murray-Darling Basin was 510,000 tonnes in 2017-18 and 360,000 tonnes in 2018-19.
- The Murray Mouth remained open 100 percent of the time due to dredging operations and delivery of environmental water.

Salinity management in catchments

- The South Australian Murray Region Water Resource Plan was submitted in 2018 and accredited by the Commonwealth Minister on 20 August 2019.

- The Eastern Mount Lofty Ranges and South Australian River Murray Water Resource Plans were submitted for accreditation in February 2019.

- The River Murray salinity zoning policy was revised and included in the Water Allocation Plan for the River Murray Prescribed Watercourse in February 2019 following a review of irrigation salinity management which was carried out in 2017.

- The South Australian River Murray Sustainability program and Commonwealth On-Farm Further Irrigation Efficiency program returned over 40 GL of water to the environment and reduced drainage and salt loads to the River Murray through improvements to irrigation efficiency.

- Construction of the South East Flows Restoration Project was completed in early 2019 to help manage salinity levels in the Coorong,.

Efficient governance

- The Department for Environment and Water completed the nomination of South Australian sites for inclusion in the Basin-wide core monitoring network to quantify salinity register entries, evaluate trends at End-of-Valley Target sites, improve knowledge and support salt interception scheme and river operations.

- The Waikerie to Morgan, Woolpunda and Pike-Murtho groundwater models were accredited by the Murray-Darling Basin Authority for use in estimating salinity register entries for 16 accountable actions.

- A review of the Loxton-Bookpurnong numerical groundwater model and accountable actions commenced and was substantially completed in 2018-19.

- A Run of River survey between Lock 1 and Lock 7 was carried out in May 2018 in accordance with a methodology updated and improved in 2017.

Strategic knowledge improvement

- South Australia supported the development of the transfer function as part of the second stage of the Mallee legacy of history knowledge project, including the trial of the transfer function in the Loxton to Bookpurnong groundwater model.

- The development of complex groundwater models for high value floodplains such as Pike and Katarapko continued to provide valuable learnings that will assist with understanding the salinity impacts of environmental watering.

Community engagement and communication.

- Extensive community engagement was undertaken in 2018 as part of the development of the Water Allocation Plan for the River Murray Prescribed Watercourse, which included revisions based on the outcomes from the South Australian review of irrigation salinity management.

- Significant community engagement has been carried out as part of the SARFIIP projects at Pike and Katarapko.

Introduction

The 2019 comprehensive report provides an update on South Australia's progress against the key elements of the Basin Salinity Management 2030 (BSM2030) strategy. The strategy reflects the contemporary understanding of salinity risk in the Murray-Darling Basin and includes efficient governance arrangements for status and comprehensive reporting completed in alternate years.

The report addresses the requirements of Schedule B of the Murray-Darling Basin Agreement (Schedule 1 of the *Water Act 2007*) and has been structured in accordance with the Basin Salinity Management reporting procedure that has been endorsed by the Basin Salinity Management Advisory Panel (BSMAP). The report has been considered by the Independent Audit Group (IAG) for Salinity as part of their audit of implementation of the BSM2030 strategy and the obligations set out in Schedule B to the MDB Agreement.

South Australia remains committed to the ongoing delivery of salinity management obligations under Schedule B and implementation of the BSM2030 strategy. The ongoing management of salinity in the Murray-Darling Basin is critical to continue to protect the environment, irrigated agriculture, industry and critical human water supplies from adverse effects of high salinities.

This report has been compiled by the Department for Environment and Water (DEW) and provides South Australia's key achievements and outcomes over the past two years against the following key elements of the BSM2030 strategy:

- **Salinity Accountability Framework** – the maintenance of the salinity registers and management of accountable actions.
- **Salinity accountability for environmental water management –** creating transparency through accounting for environmental watering salinity impacts and dilution flows.
- **Responsive management of salt interception schemes** – a new salt interception scheme management regime being trialed by the Murray-Darling Basin Authority (MDBA).
- **Flow management –** supporting the implementation of Basin Plan salinity targets for managing water flows through a coordinated management approach.
- **Salinity management in catchments** – reporting on End-of-Valley Targets and implementing cost-effective measures to improve salinity outcomes.
- **Efficient governance** – risk-based register management, maintaining monitoring networks, streamlining annual reporting and independent auditing.
- **Strategic knowledge improvement** – involvement in improving our understanding of the priority areas of Mallee legacy of history impacts, environmental water impacts, predictive salinity forecasting, and responsive SIS.
- **Community engagement and communication** – maintaining community engagement, relevant media releases and continuing consultation at community meetings.

1.Salinity Accountability Framework

1.1. South Australia's Salinity Register Balance

Under Schedule B of the Murray-Darling Basin Agreement, South Australia is accountable for actions that will change salinity in the River Murray. Actions such as irrigation development, which increase river salinity, result in a debit on the Salinity Register, whereas actions such as salt interception and improved irrigation efficiency, which decrease salinity impacts, result in credits on the Salinity Register. A comprehensive list of South Australia's 2019 salinity register entries is included in Table 1.

Based on the 2019 Salinity Register South Australia maintains a positive credit balance of $7.621 million (Table 1) and remains compliant with Schedule B. South Australia's Salinity Register balance is projected to go into debit prior to 2100 due to the estimated salinity impact of irrigation development. The decline into debit is partially due to the use of the accredited SIMRAT model as an interim assessment of irrigation salinity impacts (register entries 52 and 53).

Recent model reviews have demonstrated that it is likely that SIMRAT is overestimating the salinity impacts from irrigation as South Australia's overall register balance is projected to improve once SIMRAT interim assessments (register entries 52 and 53) are replaced by outputs from MODFLOW groundwater models as they are reviewed and accredited (register entry 51).

Due to the significant over-estimate of irrigated area and salinity impacts using the SIMRAT model, South Australia is no longer updating register entries 52 and 53. South Australia is investigating a cost effective repeatable methodology for mapping horticultural crops using remote sensing and machine learning that will be used to update numerical MODFLOW groundwater models and the SA Irrigation Development Based on Footprint Data register entry (register entry 51).

Table 1. Summary of South Australia's Salinity Register entries

Register Number	Accountable Action	Estimated impact on Morgan 95%ile Salinity (EC)	Salinity Cost Effect ($M)
REGISTER A			
AUTHORISED WORKS OR MEASURES			
NA	SA Component of Salinity and Drainage Strategy Joint Works	-26	0[1]
NA	SA Component of Basin Salinity Management Strategy Joint Works	-31	1.142
	REGISTER A - JOINT WORKS TOTAL		**1.142[2]**
SOUTH AUSTRALIAN STATE ACTIONS			
51	SA Irrigation Development Based on Footprint Data	27	-1.881
52	SA Irrigation Development Due to Water Trade	0	-0.169
53	SA Irrigation Development based on Site Use Approvals	2	-0.207
54	SA Component of Bookpurnong SIS	-7	0.485
55	SA Component of Loxton SIS	-1	0.095
56	SA component of Waikerie Lock 2 SIS	-1	0.026
57	SA Improved Irrigation Efficiency and Scheme Rehabilitation Register A	-37	2.950
58	Qualco Sunlands Ground Water Control Scheme	-8	0.382
59	Pike Stage 1 SIS	-5	0.492
60	SA Component of Murtho SIS	0	0.029
	REGISTER A – WORKS AND MEASURES TOTAL		**2.202**
	REGISTER A TOTAL		**3.344**
REGISTER B			
79	SA Mallee Legacy of History	3	-0.251
80	SA Mallee Legacy of History – Irrigation	40	-2.739
81	SA Improved Irrigation Efficiency and Scheme Rehabilitation Register B	-74	5.273
NA	Transfers from Register A		1.994
	REGISTER B TOTAL		**4.277**
	TOTAL		**7.621**

[1] South Australia component of Salinity and Drainage Strategy works or measures were set aside to improve River Murray salinity and contribute to net salinity reduction.

[2] The total excludes transfers to Register B

1.2. New and Proposed Accountable Actions

South Australian Riverland Floodplain Integrated Infrastructure Program

On 24 April 2017 the South Australian government notified the MDBA of actions proposed to be undertaken as part of the South Australian Riverland Floodplain Integrated Infrastructure Program (SARFIIP), which are likely to have a Significant Effect in accordance with Schedule B of the Murray-Darling Basin Agreement. The salinity impacts associated with the SARFIIP program are being assessed using a series of groundwater models for the Pike floodplain, Pike highland and Katarapko floodplain which are discussed in the following section.

SARFIIP is a seven-year $155 million environmental works and measures program that has a focus on the Pike and Katarapko floodplains and optimising integrated management of environmental water delivery in the South Australian River Murray. The program is constructing environmental regulators and levee banks to achieve environmental watering of large areas of the floodplains. In addition, the program is constructing saline groundwater management projects at Pike River to improve ecological condition and offset salt loads that may be discharged to the river due to the altered watering regime of the floodplain. To assist effective program delivery, monitoring and management tools are also being delivered to support environmental watering in the future.

Pike Floodplain Salinity Register Impact Modelling

To assist with the design of infrastructure at the Pike floodplain and estimation of salinity impacts for register entries, DEW has utilised the accredited Pike-Murtho Numerical Groundwater Model (Woods, Li, Bushaway, & Yan, 2014/15) and has purpose built a floodplain numerical groundwater and solute transport model.

Climate-independent modelling is used to calculate the majority of South Australian salinity register entries which are assumed to change slowly, at a yearly or decadal level. It uses a model calibrated to steady climate conditions (i.e. no dynamic climate or surface water components) as a basis for estimating past and future salt loads to the River Murray under various scenarios. These actions are described as "climate-independent", implying that while some changes occur, they are assumed to occur at a yearly level, and short term fluctuations in rainfall or surface water levels have negligible influence.

SARFIIP management actions occurring at Pike, which are being assessed using the existing climate-independent Pike-Murtho Numerical Groundwater Model, are:

- Action 1 - Surface water infrastructure changes
- Action 2 - Tranche 1 highland well field
- Action 3 - Tranche 2 highland well field.

The more dynamic actions occurring at Pike as part of SARFIIP respond to a climate driven system at a sub-yearly level. For simplicity these actions are defined as "climate dependent". These actions have been modelled in the Pike Floodplain Numerical Groundwater Model. Actions assessed using this methodology are:

- Action 4 - Operation of surface water infrastructure
- Action 5 – Operation of floodplain groundwater management.

Draft results from the salinity assessments are detailed in Table 2. The results indicate that the combined impact of actions at Pike are likely to result in a net reduction in salt load to the River Murray averaged over 100 years.

The assessment of accountable actions and models for the Pike floodplain component of SARFIIP is being undertaken in accordance with the BSM Procedure - Conducting reviews and assessments. Once completed in 2020 the results will be presented to BSMAP for consideration and inclusion on the salinity registers.

Table 2 Draft 100 year average salt load impact summary for all scenarios (t/day)

Action 1: Surface water infrastructure changes	Action 2: Tranche 1 highland well field	Action 3: Tranche 2 highland well field	Action 4: Operation of surface water infrastructure	Action 5: Operation of floodplain groundwater management	Net Salt Load Impact (t/day)
-17	-51.8	-1.2	7.6	-9.8	-72.2

Katarapko Floodplain Salinity Register Impact Modelling

The Katarapko Floodplain Numerical Groundwater Model is being developed as a tool to estimate the long term salinity impacts of the operation of SARFIIP infrastructure on the Katarapko Floodplain. The assessment of accountable actions and models for the Katarapko floodplain component of SARFIIP is being undertaken in accordance with the BSM Procedure - Conducting reviews and assessments. The review has also incorporated learnings from the Pike Floodplain salinity impact register modelling project. It is anticipated that the Katarapko Floodplain Numerical Groundwater Model and Independent Peer Review will be completed in early 2020.

Chowilla Icon Site Groundwater Modelling of Salinity Impacts of Regulator Operations

The operation of the Chowilla flow management infrastructure (regulator) constructed in 2014 has the potential to raise the groundwater level adjacent to the river and increase the saline groundwater discharge to the River Murray.

In 2007, the (then) Department for Water Land and Biodiversity Conservation completed a groundwater impact assessment of the proposed Chowilla Regulator to assess the potential salinity impacts resulting from construction and operation (Howe, Yan, & Stadter, 2007). An Independent Peer Review (IPR) undertaken in 2008 to review the Chowilla model for its 'fitness for purpose' identified a number of issues in the model conceptualisation, calibration and validation. A series of refinements were recommended to upgrade the model to improve its suitability to inform register entries.

In 2011 a series of refinements were made to the model to address the issues raised. A second IPR was undertaken which recommended that the model is 'fit for purpose' for assessing salinity impacts resulting from operation of the Chowilla regulator. Entries were made to Salinity Register A in June 2014 to account for all projects included in The Living Murray program. Since 2014 further modelling of the salt load impacts of Chowilla operations was undertaken by Li, C et al. (2015) using the Chowilla 2012 Groundwater Model (RPS Aquaterra, 2012).

The Chowilla floodplain infrastructure has been operated successfully on four occasions since its construction. Model results can now be compared directly with observations collected during regulator operation. This comparison helps validate the salt load predictive capability of the model and better determine the optimal value for model parameters such as riverbed conductance. A review was carried out in 2018 to simulate two regulator operation trial events that were undertaken in 2014 and 2015. These were a low floodplain inundation event and an in-channel rise event (Li & Karbasi, 2018). The study found that:

- Given the model assumptions and the conservative approach, the overall match between the observed and modelled salt loads is considered very good for both the 2014 and 2015 events.
- The modelled salt loads are generally near the upper bound of the observations. This is intended and reflects the conservative nature of the model to ensure salt loads are not underestimated.
- The model cannot capture short-term fluctuations in salinity due to the simplified surface water inputs and the flow difference between the modelled in river conditions and the actual conditions.
- A riverbed conductance value of 10 m^2/d is the more optimal value to use and aligns with the upper bound of values estimated in the Chowilla 2012 Groundwater Model (RPS Aquaterra, 2012).

This study also demonstrated the benefit of model post-audit, which is a process of assessing a model by comparing its results with newly collected data. Model post-audits can be used to assess model performance, reduce model uncertainty and identify processes that are not captured in the model. This work has indicated that the Chowilla 2012 Groundwater Model remains fit for purpose and can continue to be used for assessing potential salt load impacts from operation of floodplain infrastructure.

2. Management of Salt Interception Schemes

2.1. Management and Operation of Existing Salt Interception Schemes in South Australia

There are seven salt interception schemes (SIS) in South Australia. The Bookpurnong, Loxton, Murtho and Waikerie Lock 2 SIS were constructed as part of the 61 EC joint works program for Basin Salinity Management Strategy (BSMS). These SIS complement the Woolpunda and remainder of Waikerie SIS constructed under the Salinity and Drainage Strategy and the Qualco-Sunland's and Pike SIS which are South Australian state actions.

A trial of Responsive Management of SIS was initiated in 2016 with the objective of informing a new operating regime for SIS assets. The responsive management trial incorporates monitoring activities such as groundwater monitoring, vegetation monitoring and unmanned aerial vehicle flights across targeted floodplains to identify any detrimental impacts on floodplain health from reduced pumping rates. Sites in South Australia include Clark's Floodplain, Thiele's Floodplain and Ramco Floodplain.

The SIS in South Australia diverted an estimated 245,291 tonnes of salt in 2017-18 and 222,477 tonnes in 2018-19. The SIS provide a significant contribution to the achievement of the Basin Salinity Target and the maintenance of acceptable salinity levels during low-flows. The annual performance of each scheme is presented in Table 3 below.

Table 3 Annual performance of salt interception schemes in South Australia

Salt Interception Scheme	2017–18			2018–19		
	Volume Pumped	Salt Load Diverted	Average Salinity	Volume Pumped	Salt Load Diverted	Average Salinity
	(ML)	(Tonnes)	(EC)	(ML)	(Tonnes)	(EC)
Pike	234	8,668	49,967	443	18,449	52,529
Murtho	1,802	42,621	38,723	1,498	36,069	38,214
Bookpurnong	896	23,238	39,087	701	17,490	39,302
Loxton	1,245	21,775	27,187	1,329	22,763	27,143
Woolpunda	4,701	91,859	30,557	3,903	73,829	30,088
Waikerie	3,235	57,130	29,886	3,140	53,877	29,175
Total	12,113	245,291	n/a	11,014	222,477	n/a

Operations 2017 – 18

With the exception of bores that have been mothballed, decommissioned or shut down due to typical operational and maintenance activities, all schemes have been operated in accordance with Operations and Maintenance manuals or any agreed responsive management directives provided by the MDBA.

Murtho SIS began 2017-18 with full operation of both floodplain and highland bores. In March 2018 the scheme was reduced to typical responsive management operations

In Loxton the majority of low yielding bores from Proud Avenue and Thiele's Homestead were mothballed in the 2016-17 and 2017-18 financial years. All floodplain bores and other highland bores operated at 100 percent during this time with the exception of bores included in the responsive management trials.

The Bookpurnong SIS began 2017-18 with the reinstatement of all floodplain and highland bores at full operations excluding some highland bores which were not operated due to the removal of pumps, or pumps being un-operable. Targets have been adjusted for these sites. Three floodplain bores were mothballed in February 2018 and pumps were removed as part of the responsive management trial.

The Waikerie SIS was operated at the full extent possible including floodplain bores until February 2018 when two Waikerie bores were mothballed and had pumps removed as part of the responsive management trial. This was followed by the staged shutdown of the entire Waikerie SIS and Woolpunda SIS for flow meter replacement until December 2018.

Operations 2018–19

In 2018-19 Murtho was returned to full operation after a period of responsive management.

The Loxton SIS floodplain bores continued full operation to the extent possible with the exception of responsive management trials for 2018-19.

Bookpurnong SIS began 2018-19 with full operation of floodplain bores with the exception of bores involved in the responsive management trial. Six highland bores were operated to the full extent possible between May and August 2018 after which time SA Water were instructed to continue full operation of all highland bores to the extent possible.

For the first part of 2018-19 the Waikerie SIS and Woolpunda SIS were shut down for planned maintenance including flow meter replacement. Both Waikerie SIS and Woolpunda SIS were reinstated in December 2018 and highland bores were operated to the full extent possible for the rest of the financial year, excluding the bores involved in responsive management trials.

Stockyard Plain Disposal Basin

Stockyard Plain Salinity Management Basin (SPSMB) receives groundwater pumped from the Woolpunda, Waikerie, Lock 2 and Qualco SIS. A 25 year review of SPSMB was undertaken in 2018-19 and found that the salt load returns to the River Murray after 100 years (2090) are within acceptable range. The study did however recommend that further work be carried out to investigate opportunities to maintain and/or extend the life of the asset and to improve understanding of legacy impacts when it is decommissioned.

2.2. Construction of New Salt Interception Schemes in South Australia

The Salinity Management Measures (SMM) project is one of four components of SARFIIP. SMM incorporates the construction of a groundwater management scheme (GMS) to enhance the ecological benefits of inundation of the Pike and Katarapko floodplains. Construction of the GMS has been undertaken in two steps - Tranche 1 and Tranche 2 (refer Figure 1) with a maximum capacity of 175L/s to accommodate future regional groundwater flux from irrigation.

The SMM Tranche 1 GMS is now complete and includes a bore field consisting of 13 bores connected by a 10.7 km buried pipeline to the existing Pike SIS Stage 1.

The SMM Tranche 2 construction works began in June 2019 and includes both a highland and floodplain bore field. The highland bore field incorporates six production bores and 7.1 km of buried pipeline from Coombs Bridge to Paringa. The floodplain bore field includes five production wells and 7.7 km of pipeline. All intercepted groundwater will be transferred to the Noora Disposal Basin. The GMS is supported by a groundwater monitoring network, which is being integrated into the Pike floodplain monitoring program to assess ecological response and adaptive management of both groundwater and surface water management actions.

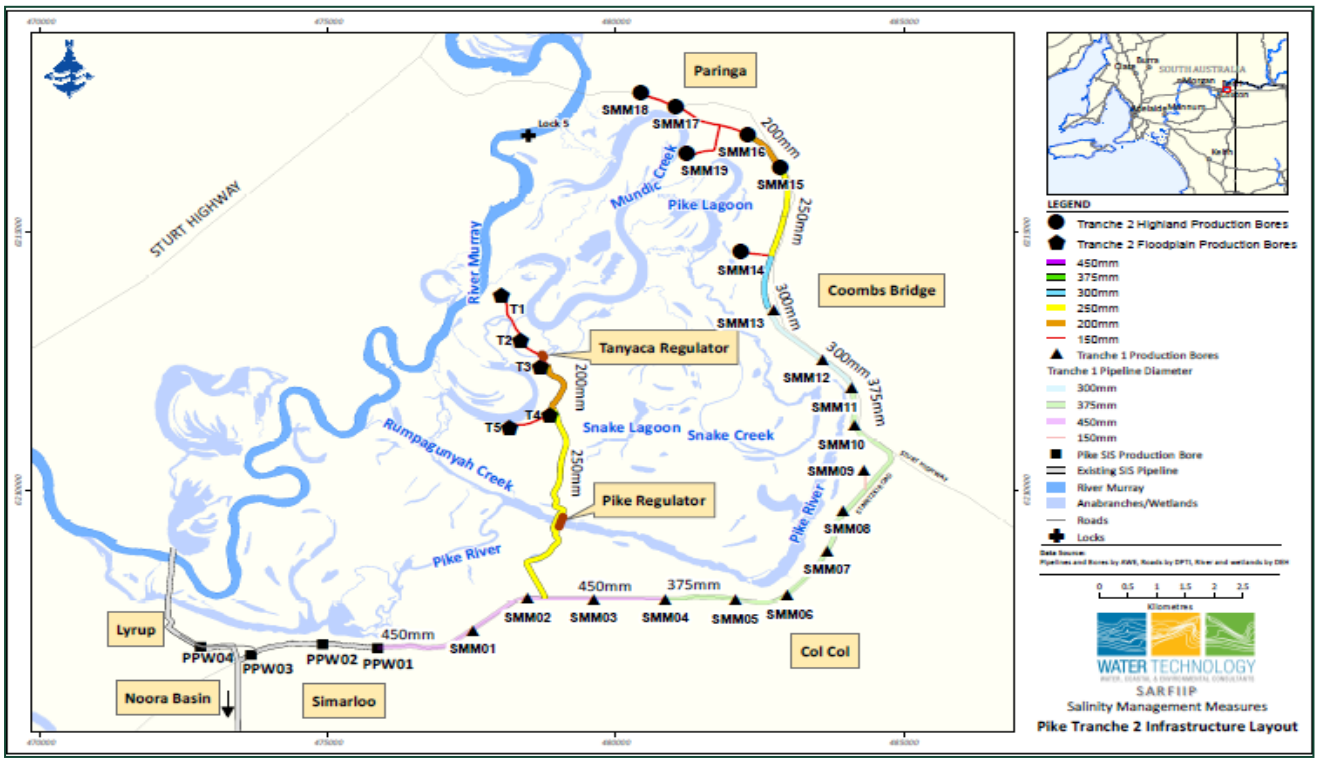


Figure 1 Pike SIS Tranche 1 and Tranche 2 Infrastructure Layout

3.Salinity Management

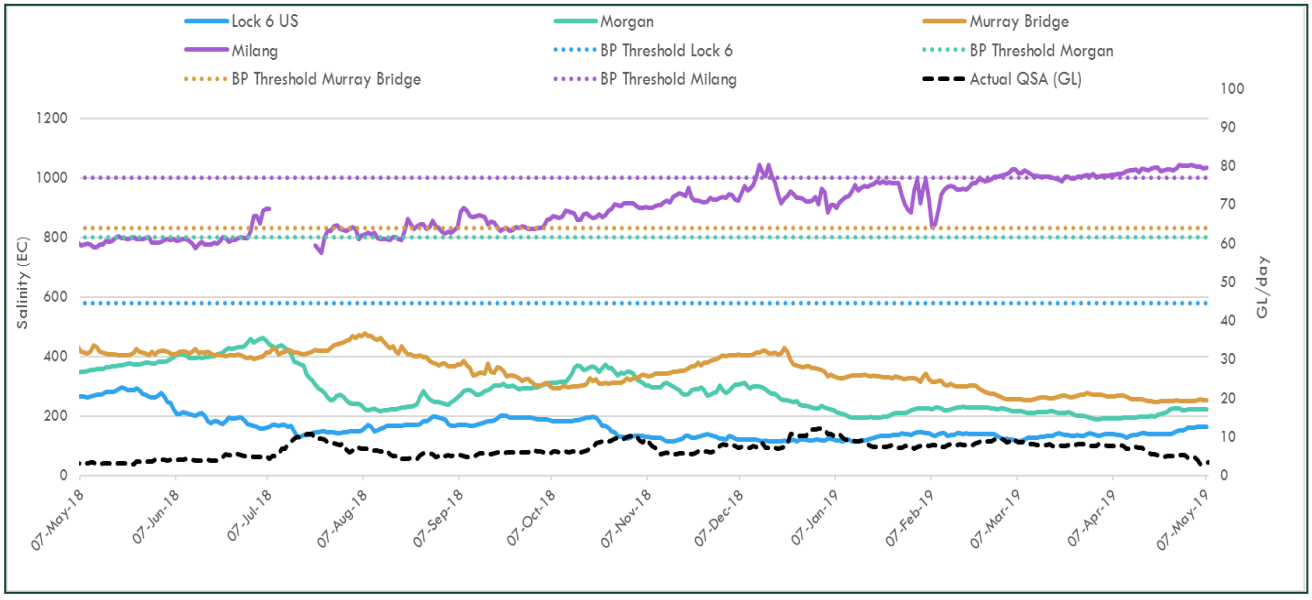
3.1. Flow-Based Management

The Basin Plan establishes the Water Quality and Salinity Management Plan (WQSMP), which sets out key causes of water quality degradation, water quality objectives for Basin water resources and water quality targets. The WQSMP includes provisions governing how certain entities must 'have regard to' water quality targets when making decisions about flow management and the use of environmental water.

The salinity targets for managing water flows (Basin Plan 9.14) that are relevant to South Australia are:

- River Murray at Lock 6 – 580 EC
- River Murray at Morgan – 800 EC
- River Murray at Murray Bridge – 830 EC
- Lower Lakes at Milang – 1,000 EC

In 2017-18 and 2018-19 salinity levels remained below the salinity targets for managing water flows for the majority of the period. However, an increasing salinity trend at Milang has been observed over the reporting period culminating in daily average salinity levels reaching and exceeding 1000 EC between March and May 2019 (Department for Environment and Water, 2019). All other sites remained well below target levels as illustrated in Figure 2.



Note: Missing Milang salinity readings periodically during July are due to biofouling at the EC sensor.

Figure 2 South Australian River Murray Daily Average Salinity

The South Australian River Murray Operating Plan and the Annual Environmental Watering Plan guide transparent and coordinated River Murray operational decisions in South Australia, in a manner consistent with, and which has regard for, Basin Plan objectives. These plans document the objectives and outcomes sought under a range of climate and inflow scenarios, describe how the desired outcomes are proposed to be delivered and identify how the River Murray in South Australia may be routinely operated under a number of potential water availability scenarios. During 2017-18 and 2018-19 flow management and environmental watering decisions were made on a daily basis by DEW, consistent with the objectives and outcomes of these plans.

A River Murray action request is required to be submitted by any person or organisation proposing to undertake an action that may have associated third party risks, or are outside of the River Murray Annual Operating Plan or the Annual Environmental Watering Plan. The purpose of the River Murray action request is to capture specific details of all actions being undertaken and enable the impacts of the action (or cumulative actions) to be considered, such as risks to water quality. River Murray action requests provide sufficient information to make a prompt decision to undertake, modify, or not undertake a proposed action, given the conditions in the river at the time the event is proposed.

During 2017-18 and 2018-19, a total of 72 River Murray action requests were submitted to DEW relating to wetland management, increasing flows through regulators, floodplain management, weir pool raising and lowering and testing injection bores. All requests were assessed for their individual and cumulative impacts on the River Murray and downstream users and all requests were deemed as low risk to water quality. Water quality monitoring is required, prior to and after actions, to ensure the action did not result in an unintended consequence.

Exporting Salt from the Murray-Darling Basin

There is approximately 100 billion tonnes of salt in groundwater in the Murray-Darling Basin and an additional 1.5 million tonnes of salt is deposited each year by rainfall (Herczeg, Dogramaci, & Leaney, 2001). Unless salt is exported from the basin it will accumulate, potentially leading to salinisation of wetlands and floodplains. In low flow years, like 2017-18 and 2018-19, environmental water plays a vital role in salt export from the Murray-Darling Basin to the Southern Ocean.

The MDBA has estimated that salt export from the Murray-Darling Basin was 1,940,000 tonnes in 2016-17, 510,000 tonnes in 2017-18 and 360,000 tonnes in 2018-19. The contribution that environmental water has on salt export has been modelled through the Commonwealth Environmental Water Office Long-Term Intervention Monitoring Project in the lower River Murray (Commonwealth of Australia 2019). Results indicate that in 2016-17 (a high flow year), approximately 8 percent of salt exported from the Basin was due to Commonwealth environmental water. In 2017-18, which was a much lower flow year, modelling indicates that approximately 69 percent of salt exported from the Basin was due to environmental water. This demonstrated that environmental water plays a much more significant role in salt export in drier years and ensuring conditions are suitable for estuarine species in the Coorong (Commonwealth of Australia, 2019).

Maintaining an open Murray Mouth is also vital to ensure adequate flushing of salt from the River Murray system into the Southern Ocean. When the flow to South Australia and barrage releases are low, sand deposits may occur inside the Murray Mouth causing restrictions and increasing the risk of closure. Barrage releases of greater than 2 gigalitres (GL) a day are required to minimise the risk of Murray Mouth closure. In 2018-19 the delivery of water for the environment enabled barrage releases of 2 GL/day or greater for 18 days (5 percent of the time).

To maintain connectivity (exchange of water) and to ensure salt export between the Coorong and the Southern Ocean it has been necessary for dredging operations to be undertaken at the Murray Mouth in the absence of adequate flow. In 2017-18 and 2018-19 two dredges operated in the Goolwa Channel and the Murray Mouth to remove over 2.5 million cubic meters of sand. These operations combined with the delivery of environmental water have enabled the Murray Mouth to remain open for 100 percent of the time over the reporting period.

Cumulative Impacts from Environmental Water Management

Technical investigations have been undertaken to inform salt load estimates for environmental water management operations in the South Australian section of the River Murray. This includes a review of salt load estimation methods and available historical estimates and development of numerical groundwater models to provide salt load estimates for environmental operations on the Pike, Katarapko and Chowilla Floodplains.

Salt load estimates for weir pool raising activities have been developed for individual lock reaches by fitting curves to historical observations from previous weir pool raising operations and high flow events. A surface water model for the South Australian section of the River Murray has also been developed using the Source modelling platform to calculate the river flow and salinity from the South Australian border down to the Lower Lakes. The model is currently being run to test its functionality to inform downstream impacts of environmental watering operations at Pike, Katarapko and Chowilla Floodplains and weir pool raising.

3.2. Land Based Management

Water Quality Management Plans

A key element of Basin Plan implementation in South Australia is the development and implementation of Basin Plan compliant water resource plans for each of the State's three water resource plan areas. Water resource plan requirements are set out in Chapter 10 of the Basin Plan, with specific water quality management plan provisions included in Part 7.

South Australia submitted its first water resource plan, the South Australian Murray Region Water Resource Plan (Department for Environment and Water, 2018), in 2018 and two remaining plans, Eastern Mount Lofty Ranges Water Resource Plan (Department for Environment and Water, 2019) and South Australian River Murray Water Resource Plan, in February 2019 (Department for Environment and Water, 2019).

The South Australian Murray Region Water Resource Plan was accredited by the Commonwealth Minister on 20 August 2019. The other two plans are currently being assessed by the MDBA. An extension for Eastern Mount Lofty Ranges and South Australian River Murray water resource plans was requested, as contingency planning, to allow for any changes that may be required during the MDBA's assessment. An extension until 31 December 2019 has been granted by the Commonwealth Minister for Water Resources.

Each of South Australia's water resource plans include a water quality management plan which have been developed with consideration of the impacts of wider natural resource management and land management on water quality. The water quality management plans identify causes of water quality degradation, risks to water quality, water quality and salinity targets and measures that will contribute to the achievement of the water quality objectives.

Salinity Provisions in the Water Allocation Plan for the River Murray Prescribed Watercourse

Salinity zoning regulates the amount of water that can be used for irrigation within salinity impact zones set out in the Water Allocation Plan for the River Murray Prescribed Watercourse (the WAP). A set of rules is in place within salinity zones for the granting and varying of site use approvals, which provide an authorisation to use water at a particular site.

A Review of Irrigation Salinity Management was carried out in 2017 which included the River Murray salinity zoning policy. In 2018, amendments were made to the policy to help facilitate new irrigation development and make it easier to change to higher water use crops within the salinity impacts from irrigation accounted for and offset on the Basin salinity register. The policy was subsequently incorporated into the WAP in February 2019 following community consultation in 2018.

The new principles reduce the number of salinity impact zones from five zones to two zones – a High Salinity Impact Zone and a Low Salinity Impact Zone. By merging zones the total site use approval volume available in the High Salinity Impact Zone has increased. This allows for easier exchange of site use approval volumes between authorisation holders.

Irrigation development can also be expanded through 30-year site use approvals in the High Salinity Impact Zone, or 60-year site use approvals in the Low Salinity Impact Zone. The volumes approved will expire at the end of the 30 or 60-year terms and cannot be exchanged with other site use approval holders or applied in a different location to that on the site use approval. Volumes may also be increased for existing plantings, which do not have enough volume to cover the mature crop requirements or to support a change to a higher water use crop.

Salinity management provisions will be reviewed in 2027 or earlier if the following triggers are reached:

- If there is a high risk in the short term, that annual water use for irrigation will exceed 500 GL within salinity impact zones.
- If the total irrigated area approaches the area of irrigation offset on the Basin salinity registers (as at 20 February 2018).
- If South Australia's salinity register balance is projected to go into debit prior to 2050.

A monitoring and evaluation plan is currently in development to gauge the performance of the salinity zoning provisions in the WAP. This includes the overarching program logic and a monitoring and evaluation plan to:

- Collect, generate and analyse data so that salinity zoning may be monitored.
- Monitor administration of the policy against review triggers.
- Ensure accurate and robust evidence is available to support a policy review scheduled for 2027.

DEW officials are also in the preliminary stages of investigating a reliable, repeatable and cost effective method of mapping horticultural crop types along the River Murray in South Australia using remote sensing. This information will assist in tracking irrigation development after an approval has been granted.

South Australian Irrigation Efficiency Improvement Programs

Irrigation efficiency improvement programs apply the latest irrigation technology on farms to manage water consumption. Typically, projects aim to reduce the volume of water pumped to meet the crop requirements, which results in reduced root zone drainage. Reduced root zone drainage contributes to a reduction in discharge of saline groundwater to the River Murray. South Australia currently has one open irrigation efficiency improvement program (the Commonwealth On-Farm Further Irrigation Efficiency program), which is outlined below.

South Australian River Murray Sustainability program

The $265 million South Australian River Murray Sustainability (SARMS) Program grew from an industry-led initiative to achieve water returns and efficiency targets specified under the Murray-Darling Basin Plan. The SARMS Program has funded 257 projects throughout the River Murray regions, which will return 40 GL of water for the environment and assist in managing salinity impacts from irrigation.

Commonwealth On-Farm Further Irrigation Efficiency program

The South Australian Murray Darling Basin Natural Resources Management (SAMDBNRM) Board delivered a pilot of the Commonwealth On-Farm Further Irrigation Efficiency (COFFIE) Program between September 2016 and October 2018, which was funded through the Water for the Environment Special Account (WESA). A total of 66 projects were funded through the pilot COFFIE Program resulting in the recovery of 2.15 GL of water access entitlements for the environment, which will contribute to the 450 GL of efficiency measures recovery under the Murray-Darling Basin Plan.

A number of case studies promoting the outcomes of works funded through the pilot COFFIE Program have been developed and are available to view at the following link - http://www.agriculture.gov.au/water/mdb/programs/basin-wide/water-efficiency/case-studies

Water Efficiency Program

The Water Efficiency Program (WEP) superseded the pilot COFFIE Program and formally commenced in July 2019. The SAMDBNRM Board was approved by the Australian Government to continue acting as a Delivery Partner under the WEP, which will fund water efficiency projects across five key themes – urban, industrial, metering, off-farm and on-farm, subject to socio-economic criteria being met. The WEP will operate across the Murray-Darling Basin, in all surface water SDL units and contribute to the 450 GL of efficiency measures recovery under the Murray-Darling Basin Plan.

South East Flows Restoration Project

The South East Flows Restoration Project (SEFRP) is a $60 million investment made by the South Australian and Australian governments to assist salinity management in the Coorong South Lagoon, enhance flows to wetlands in the Upper South East and reduce drainage outflow at Kingston beach. To maintain a healthy ecosystem, the Coorong South Lagoon requires a target salinity range of no greater than 100g/L. Reduced inflows have raised salinity in the Coorong South Lagoon to a hypersaline range, i.e. a very high salt concentration, making it too salty to support important species.

Historically quantities of freshwater flowed into the Coorong South Lagoon from the South East however this source of freshwater has been reduced by drainage works in the South East over the past 150 years. By restoring inflows from the South East, the SEFRP seeks to assist maintaining salinity in the Coorong South Lagoon at suitable levels and prevent ecological degradation during low flows from the River Murray.

The infrastructure constructed between March 2017 and early 2019 through SEFRP includes a new flow path to connect existing elements of the South East Drainage Network, which provides capacity to deliver a median volume of up to 26.5 GL per year directly into the Coorong South Lagoon. Additional environmental benefits are gained by diverting water to local wetlands en-route of the flow path where landholder approval is granted. The project also includes storage within Tilly Swamp - this ensures water delivery into the Coorong is controlled.

SARFIIP – Floodplain Inundation Measures

One of the major threats to floodplains of high conservation value in the lower River Murray is increased soil and groundwater salinity. The groundwater underlying much of the lower Murray floodplain is typically saline, annual rainfall

in the semi-arid geographical locations of the lowland floodplain environments is low, and river regulation has stabilised water levels and reduced the frequency and duration of floods. This combination has contributed to elevated groundwater levels in Riverland floodplains and are attributed as being key drivers of soil salinisation resulting in saline groundwater levels increasing up to three metres higher than would have occurred under natural, pre-regulation conditions (AECOM Services Pty Ltd, 2016).

Pike Floodplain Inundation Measures

The Pike floodplain located adjacent to Lock 5 just south of Paringa in the Riverland is subject to a number of threatening processes that compromise the ecological integrity of the floodplain. The key threats to the site are reduced frequency and duration of floodplain inundation, loss of variability in water levels, obstructions to fish passage, pest plants and animals and increased soil and groundwater salinity.

SARFIIP aims to improve the ecological health of the floodplain through the construction of floodplain infrastructure, which will deliver critical environmental flows to the floodplain, simulate flooding regimes and freshen groundwater beneath the floodplain. The Salinity Management Measures program at Pike (see Section 2.2 for more detail) will also compliment these actions by reducing the regional saline groundwater flux and the achievement of salinity neutrality for the Pike and Katarapko Floodplain Inundation Measures Projects. Completion of construction of floodplain infrastructure is anticipated to occur in November 2019.

Katarapko Floodplain Inundation Measures

Katarapko floodplain is a major floodplain and anabranch system of the South Australian River Murray adjacent to Lock 4 on the River Murray. The key threats to the floodplain include shallow saline groundwater and soil salinisation.

The intent of the proposed surface water management infrastructure is to improve the condition of floodplain biotic communities, in particular improvement of native vegetation condition by increasing soil water availability. The expected benefits come as a result of leaching of salt from the soil profile, emplacing low salinity water into the soil profile, and reducing groundwater salinity at the top of the water table.

Floodplain inundation may however result in degradation of native vegetation where there is no reduction in salt content via surface wash-off or downward displacement of salt, and/or no increase in soil moisture content (Department for Environment and Water, 2017). To manage these risks infrastructure operators may alter the extent of inundation for each operation and ensure high flows that inundate areas outside of the influence of the environmental regulators are maintained (Department for Environment and Water, 2017).

Construction of surface water management infrastructure is likely to be completed in April 2020.

Healthy Coorong Healthy Basin

Healthy Coorong, Healthy Basin is a $70 million commitment to restore a healthy Coorong, announced by the Australian and South Australian governments in December 2018. The Healthy Coorong, Healthy Basin Action Plan outlines the on-ground works, management tools, research, trials and investigations, and other activities to get the Coorong back on track for a healthy future. The action plan includes six projects that work together to improve the ecology, knowledge and management of the Coorong, including two projects specific to salinity and water quality:

- Undertaking scientific trials and investigations to address critical knowledge gaps relating to water quality, aquatic plant health and nutrient and food web dynamics, so as to inform decisions around longer-term management options.
- Optimising and integrating water delivery and management systems that are based on better, real time monitoring data and information.

3.3. End of Valley Outcomes

The BSM2030 strategy retains the End-of-Valley Targets to preserve Basin-wide monitoring and to inform the assessment of salinity risk to the shared water resources and within-valley assets.

As part of the BSM2030 strategy, flow and salinity must be monitored at each End-of-Valley Target site and reported annually. The flow monitoring results for the Basin Salinity Target and the three South Australian End-of-Valley Target sites are presented in Table 4.

In 2017–18 and 2018–19 monitored daily salinity remained below the target levels at all sites. The program of salinity controls implemented to date, including SIS and improved irrigation system and on-farm practices, in addition to the delivery of environmental flows, have contributed to the maintenance of in-river salinity levels below target levels.

Table 4 End-of-Valley Target Monitoring Results

Valley	End-of-Valley Target (as % of baseline)	Valley Reporting Site	2017–18 monitoring (Daily Mean EC)		2018–19 monitoring (Daily Mean EC)	
Basin salinity target	800 EC (95%ile)	Murray at Morgan (A4260554)	EC (Max) EC (Avg) EC (95 %ile)	465 359 439	EC (Max) EC (Avg) EC (95 %ile)	459 262 367
SA Border	412 EC (80 %ile)	Murray at SA Border (A4261022)	EC (Max) EC (Avg) EC (80 %ile)	301 227 262	EC (Max) EC (Avg) EC (80 %ile)	200 146 175
Berri	543 EC (80 %ile)	Murray at Berri (A4260537)	EC (Max) EC (Avg) EC (80 %ile)	389 293 324	EC(Max) EC(Avg) EC (80 %ile)	265 187 226
Below Morgan	770 EC (80 %ile)	Murray at Murray Bridge (A4261162)	EC (Max) EC (Avg) EC (80 %ile)	589 410 466	EC (Max) EC (Avg) EC (80 %ile)	478 320 383

4. Efficient Governance

4.1. Basin Wide Core Salinity Monitoring Network

The BSM2030 strategy commits the MDBA and partner governments to nominate key salinity monitoring sites for inclusion in the Basin-wide core salinity monitoring network (the monitoring network). The monitoring network will be maintained for the life of the BSM2030 strategy and will be reviewed at least every five years to ensure the network continues to provide a sound basis for salinity assessment in response to an improved knowledge of risk and uncertainty. The sites included in the monitoring network are those that the MDBA and partner governments consider to be critical in providing information to support a range of activities under the BSM2030 strategy.

South Australia nominated 435 groundwater bores that are monitored by DEW in October 2017. A further 475 groundwater bores that are monitored to support the SIS program in South Australia have been nominated by the MDBA. The MDBA have also nominated 66 surface water sites in South Australia for inclusion in the monitoring network that are funded by joint program.

4.2. Review of Salinity Register Models and Entries

Reviews of accountable actions and delayed salinity impacts are undertaken on a regular basis to ensure that approved models or methods and corresponding register entries remain up to date and are based on the best available information. South Australia uses a series of accredited groundwater models that span the length of the River Murray in South Australia (see Figure 3). The models underpin the estimation of salt loads entering the River Murray from the South Australian border to Wellington and are the basis for authorised works and measures and South Australian state action entries on the salinity registers.

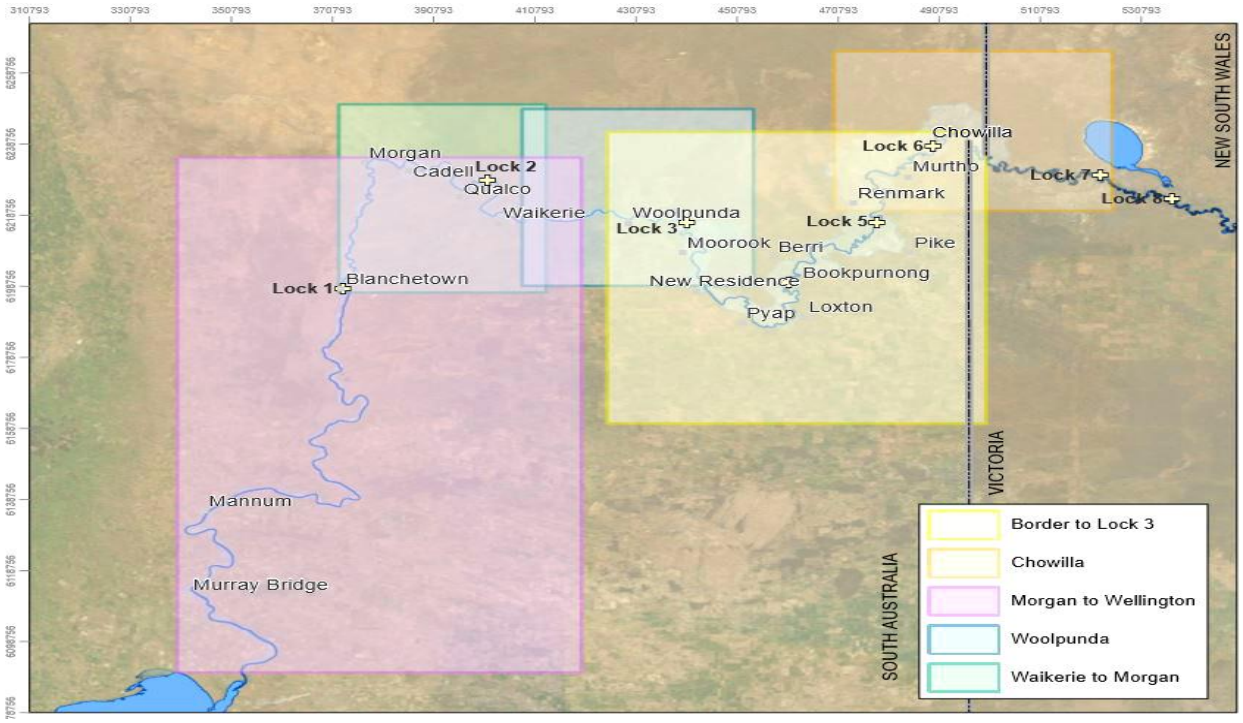


Figure 3 Coverage of South Australian Accredited Regional Numerical Groundwater Models

Waikerie to Morgan, Woolpunda and Pike-Murtho

The Waikerie to Morgan, Woolpunda and Pike-Murtho MODFLOW models were reviewed between 2012 and 2014 in accordance with BSMS Operational Protocols applicable at the time the reviews were undertaken. The Waikerie and Woolpunda SIS have also undergone technical review as required by Schedule B. The updated models and associated documentation were independently peer reviewed and found fit for purpose.

An addendum report was provided to the MDBA to finalise the model and salinity register entry reviews on 27 October 2017. This report was also independently peer reviewed and the reviewer recommended that the report be accepted as providing a comprehensive response to the issues raised by the MDBA and that the salt loads generated from the models be used by the MDBA to update salinity register entries.

In May 2018 BSMAP agreed that the credit/cost sharing ratio between the Joint Work and State Action components would be maintained in accordance with the Ministerial Council decisions for Waikerie Lock 2 and Murtho SIS (2007 for Waikerie Lock 2 and 2008 for Murtho) when the schemes were approved for construction and that the credit/cost sharing ratios for the Joint work and State Action components of all the shared BSMS SIS would be reviewed in 2026 as part of the BSM2030 strategy review. Members of BSMAP also noted that the outcomes of the reviews of accountable actions in Waikerie-Morgan, Woolpunda and Pike-Murtho would be used in preparing the 2018 salinity registers.

In August 2019 South Australia was notified in writing that the Waikerie to Morgan (2012), Woolpunda (2013) and Pike-Murtho (2014) groundwater models had been approved by the MDBA under Schedule B of the Murray-Darling Basin Agreement and were used for updating 16 salinity register entries.

Loxton to Bookpurnong Technical Review - SIS Review

The Loxton and Bookpurnong SIS were commissioned in 2007 and 2006, respectively. The purpose of the schemes was to reduce the discharge of saline groundwater to the River Murray above and below Lock 4 on the River Murray. The schemes are accountable actions under Schedule B of the Murray-Darling Basin Agreement, and they are required to be reviewed in accordance with the BSM2030 strategy review plan.

The Loxton and Bookpurnong SIS Review (RPS , 2018) and the hydrogeological review (Currie, 2018) investigated the environmental conditions which may have influenced the operation of the schemes, assessed the performance of the schemes in intercepting salt loads, informed the review of the hydrogeological conceptualisation of the scheme and reviewed representation of the scheme in the numerical groundwater model and how this may be improved.

Loxton-to-Bookpurnong Numerical Groundwater Model Review and Accountable Actions

A review of the Loxton to Bookpurnong numerical groundwater model and accountable actions was initiated in late 2018 in conjunction with an independent peer review of the model which is undertaken concurrently. Their salinity impact was last assessed in 2011 using the Border to Lock 3, 2rd generation numerical groundwater model. The aim of this review was to upgrade the existing Border to Lock 3 model in the Loxton to Bookpurnong area to incorporate new information and knowledge from hydrogeological investigations, a hydrostratigraphy review and mapping of irrigation development through time.

The review included evaluating salt loads resulting from accountable actions such as land clearance, irrigation area development, changes in irrigation practice and the construction of SISs.

The model was calibrated using long-term observed (historical) regional potentiometric heads from observation wells and a combination of manual and automated calibration. The calibration shows an acceptable match to observed level and trends in the majority of the wells. The salt load results show better match to run of river data and geophysical surveys, which increases the confidence in the model results. The model was used to estimate salt loads to the River Murray for different scenarios required for the Salinity Register.

Refinement of recharge estimates resulting from the MDBA Transfer Function Project did not occur due to the timing of the numerical groundwater model review. However learnings from the Transfer Function Project were considered by the DEW Groundwater Modelling Team responsible for the Loxton to Bookpurnong numerical groundwater model review.

4.3. Run of River Salinity Survey

A run of river survey between Lock 1 and Lock 7 was carried out in May 2018 in accordance with the 2017 methodology. The survey measured salinity at each kilometre along a river reach on (nominally) five consecutive days. The difference in EC of a parcel of water on consecutive days is assumed to be due to saline inflow. Figure 4 below illustrates the increase in salt loads between Lock 6 and Lock 3; these reaches incorporate some of South Australia's largest floodplains and several SISs.

The data from the survey has been analysed by Water Technology (Water Technology, 2019) to assess salt loads and indicate SIS impact of in-river salinity. Salinity varied during the run of river from 330 EC to 380 EC and overall salt inflows were significantly lower (40% decrease) than the results obtained in 2017, but there were some reaches where the results were higher which is likely due to flooding in late 2016.

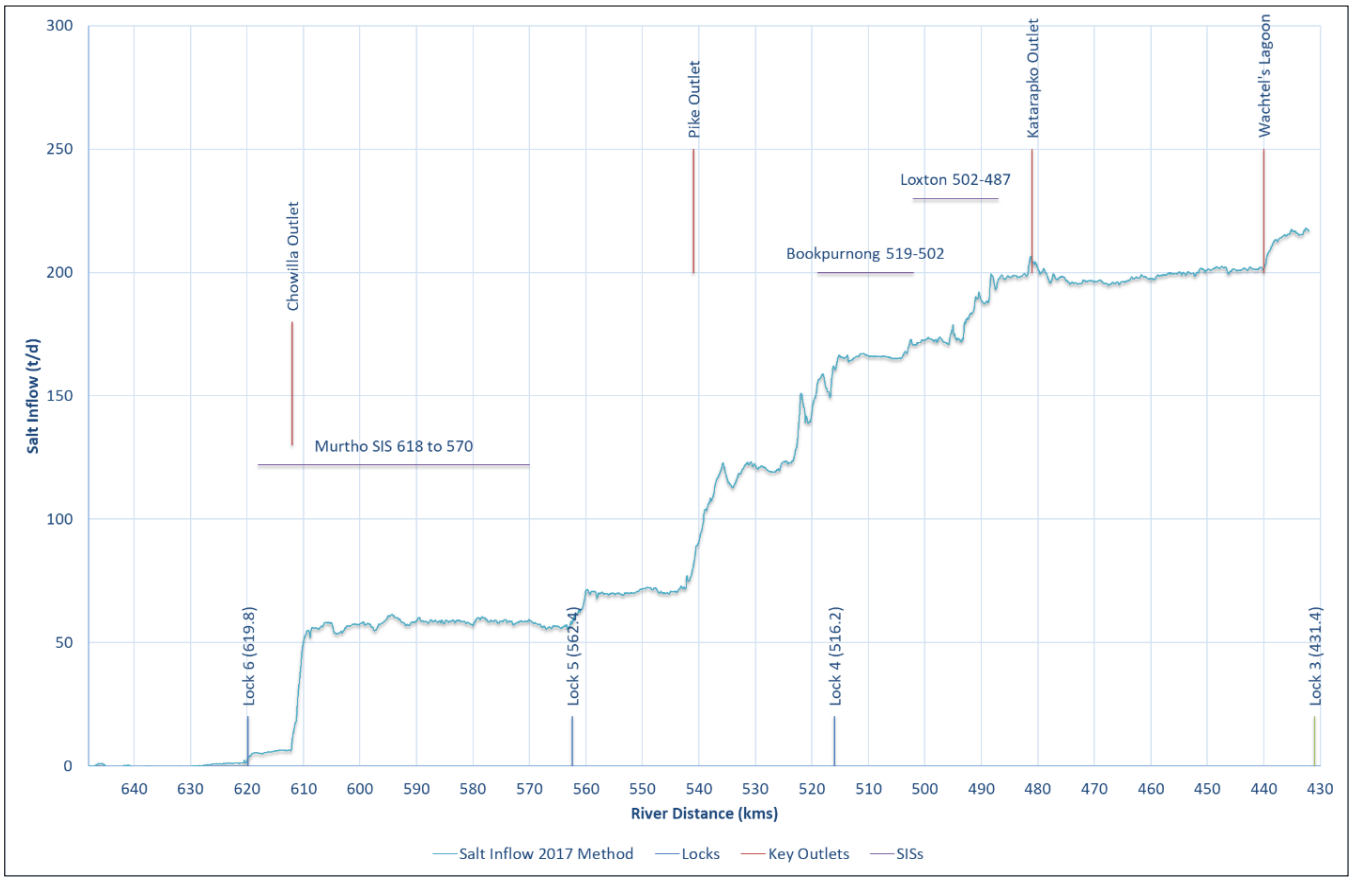


Figure 4 Run of River May 2018 Lock 7 to Lock 3 Cumulative Salt Inflow

4.4. Progress Towards 2017 IAG Salinity Recommendations

South Australian progress towards implementation of the 2017 IAG Salinity recommendations is discussed below.

Recommendation 1
That MDBA work closely with South Australia, NSW and Victoria to finalise the reviews of the South Australian register entries derived from the Waikerie to Morgan, Woolpunda and Pike-Murtho ground water models and ensure the registers are adjusted in a principled and timely manner.

The reviews of the South Australian register entries derived from the Waikerie to Morgan, Woolpunda and Pike-Murtho ground water models have been completed.

Recommendation 2
NSW as a matter of urgency should ensure it has the dedicated resourcing required to meet its obligations to conduct the reviews of salinity entries on the registers.

This recommendation was not directly relevant to South Australia.

Recommendation 3
BSMAP should work with the Commonwealth to determine how it can continue to be actively involved in BSMAP in an efficient and effective manner

South Australia continues to support the active involvement of the Commonwealth in BSMAP. The Commonwealth Government has a key role in the BSM2030 strategy as the entity responsible for holding and making available salinity credits associated with the dilution benefits from delivery of environmental water under the Basin Plan to offset salt mobilisation from environmental watering.

Recommendation 4
The MDBA and jurisdictions should learn from unexpected short term in-river salinity spikes from events such as occurred at Lake Bonney and the lower Darling, review where these may occur in the Basin in the future, and develop mitigation strategies to reduce the future risk of spikes occurring.

South Australia worked with the MDBA and Basin governments to review elevated salinity events in 2016–17 (Murray-Darling Basin Authority, 2017). The review identified the likely causes, duration and magnitude of the River Murray January 2017 event, including impacts on water users and the environment, effectiveness of mitigation and management responses, community engagement and outcomes and lessons learnt. A draft report was subsequently provided to BSMAP, Water Liaison Working Group, and Southern Connected Basin Environmental Watering Committee, with an evaluation of the process undertaken by BSMAP and the MDBA in 2018.

South Australia has also progressed work to estimate the cumulative impacts of environmental water management (see Cumulative Impacts from Environmental Water Management in Section 3.1 Flow-Based Management) to improve prediction and mitigation of short term in-river salinity spikes caused by environmental water management.

Recommendation 5
The MDBA, in conjunction with the jurisdictions, should develop a clear procedure setting out the roles and responsibilities of all parties for resolving the risks to river salinities associated with the cumulative impacts of environmental watering and other actions.

South Australia continues to support this recommendation and has worked with the MDBA and BSMAP to develop a *Guideline: 'having regard' to Water Quality Targets for Managing Water Flows* and a *Review of Elevated Salinity Events Procedure*. South Australia has also undertaken work to identify and manage the cumulative salinity risks from environmental watering as described in the Cumulative Impacts from Environmental Water Management section (Section 3.1).

Recommendation 6

The work required to set the framework for introducing the SOURCE Model for BSM2030 strategy purposes be progressed urgently so that the SOURCE Model can be introduced in 2018.

South Australia continues to support the transition to the SOURCE model to improve the resolution and accuracy of salinity routing and to improve salinity register transparency.

Recommendation 7

Given the range of modelling issues that need to be resolved quickly and efficiently under the BSM2030 strategy transition, there is a need for an expansion of the role of the Technical Working Group for Salinity Modelling or for similar committee(s) be set up to aid the facilitation of modelling issues in a planned way.

South Australia continues to support this recommendation and has ensured that relevant experts have provided input into the development of modelling procedures.

Recommendation 8

The MDBA and jurisdictions should consider the development of an approach to assessing the salinity impacts of irrigation that better represents actual water use; particularly in relation to the reduction in irrigation water use in some established irrigation areas in the southern basin.

South Australia continues to support this recommendation and is working with Basin governments to develop modelling procedures that provide a consistent methodology for representing irrigated area and water use when assessing the salinity impacts from irrigation. South Australia is also actively working to improve the methodology for tracking and monitoring irrigation development.

Recommendation 9

The economic impacts of the salinity management program in the MDB should be reviewed and updated before 2026 as an input to the strategic review of the BSM2030 strategy.

South Australia continues to support this recommendation and suggests that work to update the salinity cost functions should commence shortly to ensure that the review can be completed before 2026 to accurately represent costs and benefits of management actions on the salinity registers.

Recommendation 10

The jurisdictions and the MDBA should develop a strategic approach to management and oversight of the BSM2030 strategy implementation program, with a view to ensuring that all necessary actions can be delivered to support achievement of the strategy objectives, and to enable the 2026 review to be undertaken in an effective, timely manner.

South Australia continues to support this recommendation and has contributed to the development of the BSM2030 strategy implementation plan report and BSM2030 strategy review plan which are standing item on each BSMAP agenda to ensure that progress against strategy objectives is regularly reviewed.

5. Strategic Knowledge Improvement

The BSM2030 strategy has identified four priority areas for strategic knowledge improvement. These are:

- Mallee legacy of history – improving our understanding of dryland clearing impacts and the impacts of past irrigation practices pre-1988.
- Environmental water management – improving our understanding of the salinity impacts of environmental watering and cumulative system scale salinity impacts.
- Predictive forecasting for in-river salinity – to reduce risks associated with responsive SIS and to inform other management actions.
- Responsive SIS management – improving our understanding of the floodplain and in-river response to reduced SIS operations to reduce operating costs.

The Mallee legacy of history knowledge priority continued to be a focus for DEW in 2017-18 and 2018-19 with the transfer function pilot trial completed as part of the MDBA Transfer Function Project. The DEW Groundwater Modelling Team supported the consultants by providing irrigation data for the Loxton to Bookpurnong region, trialling the transfer function in the Loxton Bookpurnong 2011 accredited numerical groundwater model, providing feedback on the performance of the transfer function and collaborating on the report produced by the lead consultants on the project.

South Australia has also assisted in the development of an Australian Research Council linkage grant application for floodplain modelling. The aim of the project is to improve river and saline floodplain management by developing an evidence based modelling methodology. For management purposes, a modelling approach is needed that can evaluate options and predict outcomes for river salinity and floodplain tree health on regional and multi-decadal scales. It must include all key processes while having achievable data requirements and run times. Currently, no model meets these requirements. The project includes a number of partners including Flinders University, MDBA, CSIRO, Adelaide University and an International Advisor from the University of Denmark. This project aims to address these knowledge gaps to further improve our modelling approach for floodplains.

6. Community Engagement and Communication

Regular Reporting

DEW publishes a weekly River Murray Flow Report and also a monthly Water Resources Update. Both documents are emailed to approximately 1,000 recipients (the number has remained relatively stable over the previous five years) and published on the DEW website. The River Murray Flow Report provides information on the flow across the South Australian border, environmental watering activities, Murray Mouth dredging operations, and barrage and weir pool operations. The monthly Water Resources Update provides additional information on water entitlement, water held in storage and salinity at the Basin Plan Target sites.

Review of irrigation salinity management

Community consultation on the Review of Irrigation Salinity Management Policy in South Australia was planned in two phases. The first phase sought feedback on issues relating to salinity management policy in the South Australian Murray-Darling Basin (this occurred in April & May 2017) and the second phase undertaken during November 2017 sought feedback on options to improve the operation of the South Australian River Murray Salinity Zoning Policy.

Consultation and engagement of stakeholders was carried out by:

- Establishing a Salinity Review Panel who provided feedback and advice as the project proceeded.
- Promotion and provision of the consultation material on the South Australian government YourSAy website.
- Communication with stakeholders such as industry representative groups, government and non-government organisations.

Fifteen submissions on the final consultation paper were received from a range of stakeholders including individuals, Irrigation Trusts and industry bodies. The majority of submissions supported the proposed policy changes, which have since been implemented.

Consultation on the Water Allocation Plan for the River Murray Prescribed Watercourse

Following the Review of Irrigation Salinity Management Policy in South Australia (referred to above) the policy changes affecting the issuing and variation of Site Use Approvals were incorporated into Chapter 6 *Management of the Take and Use of Wate*r within the Water Allocation Plan for the River Murray Prescribed Watercourse. The WAP was developed by the SAMDBNRM Board and the community-based River Murray Advisory Committee (RMAC), in collaboration with key stakeholders and DEW. RMAC assists the SAMDBNRM Board with water policy development, and has representation from business, agriculture, viticulture, horticulture, tourism, environmental conservation and Aboriginal nations.

Public consultation on the draft WAP was undertaken between July and September 2018. A fact sheet which explains changes to salinity zoning was developed and is available on the SAMDBNRM Board website. Public consultation sessions were held in various locations along the River Murray in South Australia during the consultation period. Comments on the draft WAP were received from key stakeholders and the community helped to finalise the WAP which was adopted by the Minister for Environment and Water in February 2019.

SARFIIP - Katarapko and Pike Floodplain Ecological Restoration Projects

Extensive community consultation has occurred as part of SARFIIP, which has adopted a partnership approach in regards to project ideas, local knowledge and guidance. Local stakeholders engaged in the project include the Pike Community Reference Committee and the Katfish Reach Steering Group. The First Peoples of the River Murray and Mallee are also being engaged in SARFIIP to draw on their knowledge and protect their cultural heritage. Information and updates are regularly available on the DEW website and SAMDBNRM Board websites.

7. Priorities for Future Work

Pike and Katarapko Floodplain Salinity Register Impact Modelling

Pike and Katarapko Salinity Register Impact Modelling will be completed in 2019-20. The results will be presented to BSMAP for endorsement in 2020 with anticipation that register entries will be made for both Pike and Katarapko floodplain in 2020-21.

Loxton to Bookpurnong Numerical Groundwater Model Review and Accountable Action

The Review of the Loxton to Bookpurnong Numerical Groundwater Model Review and Accountable Action and the Independent Peer Review will be completed in 2019-20. The results will be presented to BSMAP in 2020 for endorsement and to seek approval to update the relevant salinity register entries.

Management of SIS

South Australia will continue to support the MDBA in the trial of responsive management and supports the extension of the responsive management of SIS trial until 2025. Knowledge gained from the trial will inform the BSM2030 strategy review in 2026.

Flow Management

South Australia will contribute to the review of Basin Plan water quality targets in 2020 and continue to monitor water quality against those targets. Work will also progress to refine the surface water model to improve prediction of cumulative impacts of environmental watering.

SARFIIP - Katarapko and Pike Floodplain Ecological Restoration Projects

Tranche 2 of the Pike GMS will be completed in mid-2020. Operation of the GMS and the floodplain infrastructure will be undertaken in accordance with an integrated operating plan due for completion in early 2020.

Monitoring and evaluating the salinity provisions in the Water Allocation Plan for the River Murray Prescribed Watercourse

The monitoring and evaluation framework and plan for monitoring irrigation development within salinity impact zones will be finalised and implemented. The development of a reliable, repeatable and cost effective method of mapping horticultural crop types along the River Murray in South Australia using remote sensing will be progressed.

Basin Salinity Management Procedures

DEW will continue working with the MDBA and other states to complete the new Basin Salinity Management Procedures which will replace the BSMS Operational Protocols. The BSM procedures will provide operational detail and consistency to guide the implementation of accountabilities under Schedule B.

Numerical Groundwater Model Updates

Groundwater model updates are scheduled in accordance with the Review Plan. The next models due for update are the Pyap to Kingston Model and the Berri-Renmark Model in 2019-20. These models are part of the larger Border to Lock 3 model and will build on the work already carried out as part of the Loxton to Bookpurnong model review in 2018-2019. DEW has commenced gathering and organising necessary information to support these reviews.

Progressing the ARC linkage project to further improve Floodplain Modelling.

South Australia will contribute time and expertise to the ARC linkage floodplain modelling project as discussed in Strategic Knowledge Improvement section (see Section 5).

8. Glossary

Units of measurement commonly used

Name of unit	Symbol	Definition in terms of other metric units	Quantity
Day	d	24 h	time interval
Electrical conductivity	EC	µS cm^{-1}	
gigalitre	GL	10^6 m^3	volume
hectare	ha	10^4 m^2	area
kilogram	kg	base unit	mass
kilometre	km	10^3 m	length
megalitre	ML	10^3 m^3	volume
Metre	m	base unit	length
second	s	base unit	time interval
Tonne	t	1000 kg	mass
Year	y	365 or 366 days	time interval
parts per thousand	ppt	10^{-3} kg (gram equivalent)	concentration

Shortened forms

mAHD – metres above the Australian Height Datum

BOC – Basin Officials Committee

BSM2030 – Basin Salinity Management 2030

BSMAP – Basin Salinity Management Advisory Panel

BSMS – Basin Salinity Management Strategy 2001–2015

DEW – Department for Environment and Water

MDB – Murray-Darling Basin

MDBA – Murray–Darling Basin Authority

SARFIIP – South Australian River Floodplain Integrated Infrastructure Program

SARMS – South Australian River Murray Sustainability program

SAMDBNRM –South Australian Murray–Darling Basin Natural Resource Management Board

SEFRP – South-East Flows Restoration Project

SIS – salt interception scheme

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Published by the Department for Environment and Water.
Government of South Australia
January 2020

Telephone +61 (8) 8595 2235
Facsimile +61 (8) 8463 6999

GPO Box 1047, Adelaide SA 5001

ABN 36702093234

Report prepared by:
Department for Environment and Water
Water and the River Murray Division
Water Security, Policy and Planning Branch

www.environment.sa.gov.au

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