Technical information supporting the South Australian Basin Plan Water Quality Outcome Evaluation

Matter 12: Progress towards the water quality targets in Chapter 9

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Acknowledgement of Country

We acknowledge and respect the Traditional Custodians whose ancestral lands we live and work upon and we pay our respects to their Elders past and present.

We acknowledge and respect their deep spiritual connection and the relationship that Aboriginal and Torres Strait Islanders people have to Country.

We also pay our respects to the cultural authority of Aboriginal and Torres Strait Islander people and their nations in South Australia, as well as those across Australia.

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Summary

This report represents South Australia's reporting on progress towards relevant water quality targets for South Australian Water Resource Plan areas: the South Australian River Murray, the Eastern Mount Lofty Ranges and South Australian Murray Region.

Specific water quality objectives are contained within Part 3 of Chapter 9 of the Basin Plan and water quality targets are specified in Part 4 of Chapter 9. Chapter 5 of the Basin Plan – 'Management objectives and outcomes to be achieved by the Basin Plan' also contains an objective and outcome relating to water quality and salinity. The objective in relation to water quality and salinity is to maintain appropriate water quality, including salinity levels, for environmental, social, cultural, and economic activity in the Murray–Darling Basin. The outcome in relation to water quality is that Basin water resources remain fit for purpose.

The approach adopted in this report was to undertake a comprehensive, quantitative assessment of the water quality targets contained within the Basin Plan. While the focus of this report is on the period since the 2020 Matter 12 reporting, data extending back to 2001 was assessed where available.

A summary of the assessments is shown below:

Managing water flows

Location	Variable	Data reliability	Key findings
Lower Murray – River Murray channel	Dissolved oxygen (DO)	Reliability Excellent	Exceedances are typically episodic and linked to poor water quality events upstream and/or high flow events, such as the 2022–23 River Murray flood event.
	Salinity		Since the Millennium Drought, salinity levels have generally remained below target thresholds at all sites, except for some exceedances at Milang during the low flow periods in 2019 and 2020.

Water-dependent ecosystems – Declared Ramsar wetlands

Location	Variable	Data reliability	Key findings
Coorong, and Lakes Alexandrina and	DO	Reliability Excellent	DO, pH, TN and TP exceedances are common in the Coorong, typically linked to higher salinity and evaporation. These typically increase with distance from the barrages and in low flow years when freshwater flushing is reduced. High water residence time (particularly in the South Lagoon) leads to hypersaline conditions and elevated nutrient concentrations in the water column and sediment.
Albert Wetland	рН	Continuous	
	Total Nitrogen (TN)		
	Total Phosphorus (TP)		
	Turbidity		Turbidity exceedances in the Coorong are sporadic and can be influenced by high flow events such as the 2022-23 flood. Wind and wave action can also resuspend sediments, increases turbidity.

Water Resource Plans - Water-dependent ecosystems

Location	Variable	Data reliability	Key findings			
Lower Murray – River Murray channel	Dissolved oxygen (DO)	Reliability Excellent	Dissolved oxygen has frequently exceeded the target ranges, particularly during the 2022-23 flood.			
	рН	Discrete & Continuous	pH levels have consistently remained within the target range at all sites.			
	Total phosphorus (TP)		Total phosphorus target exceedances are common, occurring during extreme low and high flow events. These originate upstream of SA and can result from the mobilisation of organic matter from the floodplain.			
Lower Murray – Pike, Katarapko and Chowilla floodplains	Dissolved oxygen (DO)	Reliability Excellent	Dissolved oxygen levels at Pike, Katarapko and Chowilla floodplain were within the target range from 2017-18 to 2022-23, except for one exceedance at Katarapko in 2022-23 due to an upstream blackwater event during the floods.			
Eastern Mount Lofty Ranges	Dissolved oxygen (DO)	★☆☆ Reliability ☆☆ Poor Discrete & Continuous	Low flows during the Millenium Drought led to DO saturation levels below targets at most sites from 2000–01 to 2000–10, with minimal data beyond that period.			
	рН		No pH exceedances were observed in the EMLR, though data availability is limited in many years.			
	Total nitrogen (TN)		Total nitrogen exceedances in the EMLR occur in years with data, though availability is limited.			
	Total phosphorus (TP)		Total phosphorus exceedances in the EMLR were infrequent, coinciding with the Millennium Drought and historically low flows across the Murray-Darling Basin.			

Water Resource Plans – Irrigation water

Location	Variable	Data reliability	Key findings
Lower Murray – River Murray channel	Salinity	Reliability Excellent Discrete & Continuous	Salinity has generally remained below the irrigation water target, with the last exceedances observed towards the end of the Millennium Drought below Lock 1.

Water Resource Plans – Recreational water

Location	Variable	Data reliability	Key findings
Lower Murray – River Murray channel	Cyanobacteria (blue-green algae)	Reliability Excellent Discrete & Continuous	Cyanobacteria levels are generally below target levels at all sites, except for exceedances at Lake Alexandrina and Goolwa, due to reduced mixing and flushing of the Lower Lakes and on occasions, influenced by inflows from upstream.

1 Purpose of document

1.1 Basin Plan

The Basin Plan 2012 (prepared under the Commonwealth *Water Act 2007*) provides a framework to deliver sustainable environmental, social, and economic outcomes for all Basin communities. In 2025, the Murray–Darling Basin Authority (MDBA) (the Authority) must evaluate the effectiveness of the Basin Plan against the objectives and outcomes set out in Chapters 5, 8 and 9, and by reference to the matters listed in Schedule 12. The 2025 evaluation will inform the review of the Basin Plan in 2026, which may then inform legislative amendments to the Commonwealth *Water Act 2007* and Basin Plan. The 2025 evaluation will draw on multiple sources of evidence, including the matters reported on under Schedule 12 (Basin Plan, Section 13.05).

1.2 South Australia's Matter 12 evaluation approach

Matter 12 of Schedule 12 is a 5-yearly reporting obligation held by Basin states and the Authority which is described in the Basin Plan as reporting on 'progress towards the water quality targets in Chapter 9'. This report represents South Australia's reporting on progress towards relevant water quality targets for South Australian Water Resource Plan areas: the South Australian River Murray, the Eastern Mount Lofty Ranges and South Australian Murray Region. All references to water quality in this report, including the Basin Plan targets, outcomes and objectives, are for surface water. There are no specific targets relating to groundwater contained within the Basin Plan, and the only objective that contains an explicit reference to groundwater relates to the maintenance of irrigation water (surface water or groundwater) that does not compromise crop yield or cause soil degradation.

Specific water quality objectives are contained within Part 3 of Chapter 9 of the Basin Plan and water quality targets are specified in Part 4 of Chapter 9. Chapter 5 of the Basin Plan – 'Management objectives and outcomes to be achieved by the Basin Plan' also contains an objective and outcome relating to water quality and salinity. The objective in relation to water quality and salinity is to maintain appropriate water quality, including salinity levels, for environmental, social, cultural, and economic activity in the Murray–Darling Basin. The outcome in relation to water quality and salinity is that Basin water resources remain fit for purpose. The water quality targets specified in Part 4 of Chapter 9 are detailed in Section 3 below and the water quality and salinity data assessment against targets is presented in Section 5.

The approach adopted in this report was to undertake a comprehensive, quantitative assessment of the water quality targets contained within the Basin Plan. While the focus of this report is on the period since the 2020 Matter 12 reporting, data extending back to 2001 was assessed where available. Assessing the data against the same targets prior to, and post-Basin Plan adoption in 2012 permits an evaluation of the contribution of the Basin Plan to the achievement of targets, and ultimately water quality outcomes. For the entire data period, achievement of Basin Plan water quality targets is taken to infer achievement of Basin Plan water quality objectives and progress towards Basin Plan water quality outcomes. For this reason, the evaluation presented in Section 6 of this report summarises the achievement of targets to demonstrate achievement of progress towards the objectives and outcomes, addressing the key questions relating to Basin Plan water quality outcomes.

1.3 South Australian Murray–Darling Basin

As required by the Basin Plan, the South Australian Department for Environment and Water has prepared three Water Resource Plans (WRPs) covering the Murray–Darling Basin within South Australia. These WRPs cover the South Australian River Murray (SARM), Eastern Mount Lofty Ranges (EMLR) and South Australian Murray Region, shown in Figure 1.1. Targets for Matter 12 reporting are defined at varying spatial scales across the SA Murray–Darling Basin.



Figure 1.1. South Australian Water Resource Plan Areas

1.3.1 South Australian River Murray

The South Australian River Murray (SARM) WRP area includes all the surface water in the River Murray and its floodplain from the South Australian border down to and including Lake Alexandrina and Lake Albert. It also includes portions of the Angas, Bremer and Finniss Rivers and Currency Creek, where they enter Lake Alexandrina.

The Priority Environmental Assets (PEAs) identified for the SARM WRP area are the South Australian River Murray Floodplain, the South Australian River Murray channel, and the Coorong, Lower Lakes, and Murray Mouth.

1.3.2 Eastern Mount Lofty Ranges

The Eastern Mount Lofty Ranges (EMLR) WRP area includes the lower end of the Murray–Darling Basin river system, extending from the Marne River catchment in the north to the Currency Creek catchment in the south.

The Bremer, Angas and Finniss rivers are some of the larger watercourses or water channels in the region. These are fed by water from runoff in the hills and then drain across the broad Murray Plains. The EMLR area includes the groundwater and surface waters of the Eastern Mount Lofty Ranges and the Marne Saunders Prescribed Water Resources Areas.

Given the nature of the EMLR WRP area and its limited flow contribution to the main River Murray, it is not expected that the outcome of this evaluation will be used to directly inform the adaptive management of the water resources of the River Murray itself. However, given the connection to the critical habitat of the Lower Lakes and Basin Plan resources used to achieve environmental outcomes, the evaluation will feed into the evaluation of the overall Basin Plan. There are several PEAs identified within the EMLR and for reporting purposes these will be consolidated into the Eastern Mount Lofty Ranges asset including the Marne Saunders.

1.3.3 South Australia Murray Region

The South Australian (SA) Murray Region WRP area covers most of the Murray–Darling Basin in South Australia from the state border in the east, to the edge of the plains of the Mount Lofty Ranges in the west, and southeast to the coast. The WRP covers groundwater and surface water for the area, including the Coorong and Murray Mouth (below the barrages). The WRP does not include the surface waters of the River Murray channel or Lower Lakes but includes the groundwater beneath these areas. The surface water resources in the WRP area are mainly ephemeral streams in semi-arid SA.

The SA Murray Region WRP area includes the Coorong and Murray Mouth, however, for the purposes of Basin Plan evaluation and reporting, the Coorong and Murray Mouth are reported along with the Lower Lakes as part of the Coorong, Lower Lakes and Murray Mouth PEA.

2 Water quality outcomes

In addition to water quality targets, the Basin Plan specifies high level objectives and outcomes relating to water quality in the Murray–Darling Basin.

Chapter 5 – Management objectives and outcomes to be achieved by the Basin Plan, includes objectives and outcomes relating to water quality and salinity, specifically stated in Section 5.04:

 The objective in relation to water quality and salinity is to maintain appropriate water quality, including salinity levels, for environmental, social, cultural and economic activity in the Murray– Darling Basin.

Note: See also the water quality objectives for Basin water resources in Part 3 of Chapter 9 of the Basin Plan.

• (2) The outcome in relation to water quality and salinity is that Basin water resources remain fit for purpose.

Chapter 9, Part 3 – 'Water quality objectives for Basin water resources' sets out objectives for declared Ramsar wetlands, other water-dependent ecosystems, water for human consumption, irrigation water, recreational water quality, the maintenance of good water quality, and the salt export objective.

3 Water quality targets

3.1 Water quality targets for managing water flows

All river operators and water for the environment managers must have regard to the targets relating to water flows when making decisions about the use of water for the environment (Section 9.14 of the Basin Plan). The following targets apply:

- Dissolved oxygen is to be maintained at a target value of at least 50% saturation (note, this equates to a dissolved oxygen concentration of 4.13 mg/L, at 25°C and 1 atmosphere of pressure (DEW 2021).
- The targets for recreational water quality are described in Section 9.18 of the Basin Plan.
- The levels of salinity at the reporting sites should not exceed the values set out in Table 2.1, 95% of the time. The Basin Plan requires that the MDBA assess whether these target values have been met 95% of the time over a 5-year period, based on water accounting years.

 Table 3.1.
 Reporting sites and targets for managing water flows

ltem	Reporting site	Target value (salinity μS/cm) (95% of time)
1	River Murray at Murray Bridge	830
2	River Murray at Morgan	800
3	River Murray at Lock 6	580
4#	Darling River downstream of Menindee Lakes at Burtundy	830
5	Lower Lakes at Milang	1000

*This report assesses sites within South Australia only (i.e. excludes the Burtundy reporting site).

3.2 Water quality targets for water resource plans

Targets for WRPs relate to fresh water-dependent ecosystems, irrigation water and recreational water, and inform measures outlined in the SARM, EMLR, and SA Murray Region WRPs.

3.2.1 Water quality targets for fresh water-dependent ecosystems

Although South Australian WRPs have not identified specific water quality targets for declared Ramsar wetlands¹ (instead using the targets in Schedule 11 of the Basin Plan), there are targets for the Coorong and Lakes Alexandrina and Albert in a dedicated Ramsar Management Plan (RaMP), which is currently under review. For completeness, both the current Basin Plan Schedule 11 targets for declared Ramsar wetlands and those defined in the 'draft for consultation' version of the RaMP have been applied in this report to fulfill Matter 12 requirements. To note, temperature has not been assessed under Schedule 11 and has therefore been excluded from Table 3.3 because there is no release of stored water from large water storages with a thermocline in South Australia (DEW 2019).

3.2.1.1 The Coorong, Lake Alexandrina and Albert declared Ramsar site

The Coorong is a declared Ramsar wetland and although dependent on freshwater flows from the River Murray, it is an estuary type ecosystem and therefore the targets applied in this assessment are technically not appropriate in this context. A significant body of scientific and monitoring work has been undertaken for the Coorong, which has informed more appropriate targets relating to the water quality parameters listed below and other nutrient parameters.

Salinity has been identified as critical to the management of critical components, processes, and services, as outlined in 'draft for consultation' version of the Ramsar Management Plan (DEW 2024a). The RaMP salinity targets set for Lake Alexandrina, and the Murray estuary, Coorong North and South Lagoons were assessed in this report, outlined in Table 3.2. There are no specific targets set for Lake Albert as the management of

¹ Ramsar wetlands are those of international importance under the Ramsar Convention. Ramsar wetlands are those that are representative, rare or unique wetlands, or are important for conserving biological diversity (<u>https://www.dcceew.gov.au/water/wetlands/australian-wetlands-database/australian-ramsar-wetlands</u>).

salinities in Lake Albert, independent of Lake Alexandrina, is considered impractical. Assessment of these targets followed the procedures outlined in Section 4.5 and Section 4.6. Since these targets are defined as average values across all the monitoring stations listed in Table 3.2, only data from periods when all stations had recorded data were included in the assessment.

Table 3.2.Salinity targets for the subcomponents of the Coorong and Lakes Alexandrina and Albert declared
Ramsar Wetland Ramsar site as outlined in the Ramsar Management Plan (RaMP). Note there are no
targets set for Lake Albert

RaMP subcomponent	Resource condition salinity target	Reporting sites	
Lake Alexandrina	Long-term annual average of 700 EC (μ S/cm).	Lake Alexandrina salinity is based on the average daily salinity at A4260574 (near Mulgundawa),	
	Below 1,000 EC (μS/cm) 95% of years.	A4260524 (Milang Jetty), A4260575 (Poltalloch Plains), A4261156 (3km west Point McLeay) and A4261133 (Beacon 90 – offshore Raukkan).	
	Below 1,500 EC (μ S/cm) all of the time.		
Murray estuary, Coorong North, and South Lagoons	Murray estuary average monthly salinities <35 ppt.	Murray estuary salinity is based on the average daily salinity at A4261036 (Beacon 12 Goolwa Channel), A4261039 (Barker Knoll), A4261128 (Mundoo Channel), and A4261043 (Beacon 1, Ewe Island Shacks).	
	North Lagoon average monthly salinities <45 ppt.	North Lagoon salinity is based on the average daily salinity at A4261134 (Beacon 19 Pelican Point), A4261135 (Long Point), and A4260572 (Robs Point).	
	South Lagoon average monthly salinities over winter <60 ppt.	South Lagoon salinity is based on the average daily salinity at A4260633 (Parnka Point), A4261209 (near Cattle Island), and A4261165 (NW Snipe Island).	
	South Lagoon daily salinities year- round <100 ppt 95% of the time.	South Lagoon salinity is based on the average daily salinity at A4260633 (Parnka Point), A4261209 (near Cattle Island), and A4261165 (NW Snipe Island).	

Target application zone (Target assessment)	Water- dependent ecosystem	Ecosystem type	Turbidity (NTU) (Annual median)	Total Phosphorus (μg/L) (Annual median)	Total Nitrogen (μg/L) (Annual median)	Dissolved oxygen (% saturation) (Annual median within the range)	pH (Annual median within the range)	Salinity
Lower Murray	Declared Ramsar wetlands	Streams and rivers	50	100	1000	85 to 110%	6.5 to 9.0	End-of- Valley targets in
		Lakes and wetlands	20	10	350	90 to 110%	6.5 to 8.0	Appendix 1 of Schedule B to the
	Other water- dependent ecosystems	Streams, rivers, lakes and wetlands	50	100	1000	85 to 110%	6.5 to 9.0	Agreement

Table 3.3. Basin Plan Schedule 11 targets for freshwater-dependent ecosystems

3.2.1.2 Eastern Mount Lofty Ranges

The EMLR presents a challenge in assessing water quality targets defined in Schedule 11. The nature of the catchments, as reflected in the flow data available, supports the separate effort underway to define both water for the environment requirements and water quality targets more appropriate for the system. The assessment presented in this report uses the comparatively limited water quality data that is available for the EMLR to assess against the water quality targets for freshwater-dependent ecosystems and irrigation water and highlights the need for regionally specific water quality targets.

3.2.2 Water quality targets for irrigation water

The water quality target for irrigation water in South Australia (Southern Basin Region, Murray River and tributaries) is as follows:

- salinity remains below 833 μ S/cm 95% of the time over each period of 10 years that ends at the end of a water accounting period.

This target value applies at sites identified in the South Australian River Murray WRP (DEW 2019, refer to Table 12) where water is extracted for irrigation purposes by an irrigation infrastructure operator between the South Australian border and Wellington.

3.2.3 Water quality targets for recreational water

The Basin Plan, Section 9.18, states that: 'The water quality targets for water used for recreational purposes are that the values for cyanobacteria cell counts or biovolume meet the guideline values set out in Chapter 6 of the Guidelines for Managing Risks in Recreational Water' (National Health and Medical Research Council (NHMRC 2008). The values from the NHMRC guidelines are presented in Table 3.4 and the assessment of recreational water has been completed against these targets.

It should be noted that since the 2008 NHMRC guidelines were published, the World Health Organisation (WHO) has published updated guidelines for recreational water quality (WHO 2021). As per advice received

from SA Water, these guidelines are considered to be more relevant than the NHMRC guidelines and are currently being used by SA Health in assessing recreational water quality.

Characteristic	Guideline	Supporting information
Cyanobacteria and algae in fresh waters	Fresh recreational water bodies should not contain: $\geq 10 \ \mu g/L \ total \ microcystins; >50,000$ cells/mL toxic <i>Microcystis aeruginosa</i> ; or biovolume equivalent of >4 mm ³ /L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume, or $\geq 10 \ mm^3/L$ for total biovolume of all cyanobacterial material where known toxins are not present, or cyanobacteria scums consistently present.	A single guideline value is not appropriate. Instead, 2 guideline values have been established, based on known risks associated with known toxins and probability of health effects caused by high levels of cyanobacterial material. A situation assessment and alert levels framework for the management of algae/cyanobacteria in recreational waters has been developed that allows for a staged response to the presence and development of blooms.

 Table 3.4.
 Excerpt from National Health and Medical Research Council Guidelines for Managing Risks in Recreational Water* (2008)

* Table A: 'Summary of the Guidelines'

3.3 Salinity targets for long-term salinity planning and management

Section 9.19 of the Basin Plan – 'Salinity targets for the purposes of long-term salinity planning and management', describes the surface water salinity targets for the Murray–Darling Basin, noting that Basin states are to apply the targets in performing long-term salinity planning and management functions. The salinity targets are End-of-Valley targets set out (as absolute values) in Appendix 1 of Schedule B to the Murray–Darling Basin Agreement (Schedule 1 of the Commonwealth *Water Act 2007*. Refer to Table 3.5 below. As defined in Schedule B, Part III – 'Salinity Targets', of the Murray–Darling Basin Agreement, achievement of the Basin salinity target at Morgan is to be assessed by the Authority using appropriately configured models, but for completeness has been assessed against available data in this report. However, the South Australian End-of-Valley targets have been assessed using the continuous flow and salinity monitoring undertaken by South Australia for relevant End-of-Valley target sites for which it is responsible, as required under Schedule B, Part VI – 'Monitoring'. The data from the Morgan site also informs the Authority's Basin Salinity Target modelling assessment.

Table 3.5.	End-of-Vallev	targets for salinit	v for South Australia*.
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Valley	End-of-Valley target (μS/cm)
Basin salinity target	800**
SA Border	412**
Berri	543**
Below Morgan	770**

* Appendix 1, Schedule B to the Murray–Darling Basin Agreement

** Daily salinity must be less than this target at least 95% of the time.

4 Methodology

The following is a description of the methods used to assess water quality data against the targets provided in Chapter 9 of the Basin Plan.

4.1 Primary data

Multiple sources of data were included in the assessment as summarised in Table 4.1.

Table 4.1. Summary of data sources

Data Source	Description
SA Water	SA Water has provided water quality data from ongoing weekly discrete water quality sampling along the River Murray channel under the Joint Venture – River Murray Water Quality Monitoring Program. This dataset extends back to the early 2000s.
Environment Protection Authority (EPA)	For the 2020 assessment (DEW 2020), EMLR water quality sample data for multiple sites was sourced from the EPA. Since 2020, only one site has been sampled and this has been included in the 2024 evaluation.
Department for Environment and Water (DEW) – discrete	DEW has taken discrete water quality samples at Coorong sites under the <i>Healthy Coorong</i> , <i>Healthy Basin</i> program since 2019. This data collection has extended a dataset that commenced in the early 2000s, extracted from the Australian Water Quality Centre database for the same sites.
DEW – continuous (Water Data SA)	Data was obtained from continuous water monitoring sites administered by DEW and accessible via the public facing Water Data SA portal. Continuous monitoring in this context refers to sites that are recording data at a rate well below sub-daily, such as every 5 or 15 minutes. Data of this type was aggregated to daily average values for the analysis.

4.2 Description of parameters analysed

Table 4.2 provides a summary of the data available for reporting. Reporting has extended the datasets presented in the 2020 evaluation (DEW 2020). All datasets in this report were extended from 1 July 2019 to 30 June 2023, where data was available. Additional data collection which first commenced post 30 June 2019 are also presented in this report, as represented in the River Murray floodplain and Coorong assessments. As noted above, data was not available for some parameters included in the Schedule 11 targets, specifically: pesticides, heavy metals, and other toxic contaminants and have therefore not been assessed.

4.2.1 Dissolved oxygen

Dissolved oxygen represents the quantity of oxygen accessible to aquatic organisms within water bodies. Oxygen levels are influenced by the presence of organic matter, such as leaf litter and bacteria, as the decay of carbon consumes oxygen. Dissolved oxygen data, presented as a percentage of oxygen saturation, was primarily used in the exceedance analysis as this was available for the continuous data sites. However, the discrete data was dissolved oxygen concentration in mg/L and is presented as such. The target provides for both units, and in the case of mg/L, a target value of 4.13 mg/L was adopted as the equivalent value for the discrete data exceedance assessment as per DEW (2021).

4.2.2 Cyanobacteria

Cyanobacteria, also known as blue-green algae, are microscopic bacteria that produce toxins posing health risks to humans and livestock. The total blue-green algae measured in cells/mL is used in the exceedance analysis.

4.2.3 Nitrogen and phosphorus

Nitrogen and phosphorus are the primary nutrients present in waterbodies. Excess nutrients in streams and rivers can lead to an increase in primary productivity, that is, excessive plant and algal growth that degrades water quality. The analysis focused on quantifying the concentrations of these nutrients in water, measured in milligrams per litre (mg/L).

4.2.4 Salinity

Salinity refers to the quantity of dissolved salts in water. Extended periods of high salinity can harm the natural environment, crops, and livestock. Salinity, measured in electrical conductivity (EC) units (μ S/cm) and total dissolved solids (TDS g/L; or ppt), was used to indicate salinity levels in all the data analysed. As per Note 2 in Section 9.14(5)(c) of the Basin Plan – Targets for managing water flows, the target values can be expressed in milligrams per litre (mg/L) by multiplying the EC values by 0.6.

4.2.5 Turbidity

Turbidity has an important ecological effect in determining the depth to which light penetrates the water, affecting plant growth and changing the type of algae present, and is also relevant to both recreation and drinking water values. Turbidity data are typically expressed in Nephelometric Turbidity Units (NTU). Water with low NTU levels is clear, while higher NTU levels indicate some discoloration or opacity, with the worst being completely opaque.

4.2.6 pH

pH measures the acidity or alkalinity of a substance. A pH of 7 is neutral. Above 7 is alkaline, and below 7 is acidic. Extreme pH levels, either too high or too low, can be fatal to aquatic organisms. Most aquatic creatures thrive within a pH range of 6.5 to 9.0, although some can tolerate pH levels beyond this range.

4.3 River Murray floodplain watering events

Continuous monitoring data is available from Water Data SA for dissolved oxygen and salinity in multiple locations on the Chowilla, Pike and Katarapko floodplains in South Australia. Salinity data were not assessed, as floodplain-specific salinity targets are not included in the Basin Plan. However, an exceedance analysis for dissolved oxygen was undertaken using the available data by applying the water-dependent ecosystem target.

Table 4.2. Summary of available data for reporting

Location	Water-dependent ecosystem	Ecosystem type	Target purpose	Water quality parameter	Data type	Data source	No. sites
Lower Murray –	Other water-	Streams, rivers, lakes and wetlands	Managing flows	Dissolved oxygen	Discrete	SA Water	17
River Murray channel	dependent ecosystems				Continuous	DEW	11
				Salinity	Continuous	DEW	4
			WRPs – freshwater	Dissolved oxygen	Discrete	SA Water	17
			dependent ecosystems		Continuous	DEW	11
				рН	Discrete	SA Water	21
					Continuous	DEW	8
				Total phosphorus	Discrete	SA Water	11
			WRPs – irrigation water	Salinity	Continuous	DEW	15
			WRPs – recreational water	Cyanobacteria	Discrete	SA Water	19
			Long-term salinity planning and management	Salinity	Continuous	DEW	4
	Coorong and Lakes Ale declared Ramsar Wetla	exandrina and Albert and Ramsar site	RaMP – Lake Alexandrina	Salinity	Continuous	DEW	5
Lower Murray – Chowilla wetland	Declared Ramsar wetlands	Streams and rivers	WRPs – freshwater dependent ecosystems	Dissolved oxygen	Continuous	DEW	5
Lower Murray – Pike floodplain	Other-water- dependent ecosystems	Streams, rivers, lakes and wetlands	WRPs – freshwater dependent ecosystems	Dissolved oxygen	Continuous	DEW	6
Lower Murray – Katarapko floodplain	Other-water- dependent ecosystems	Streams, rivers, lakes and wetlands	WRPs – freshwater dependent ecosystems	Dissolved oxygen	Continuous	DEW	4
				Dissolved oxygen	Discrete	EPA	1

Location	Water-dependent ecosystem	Ecosystem type	Target purpose	Water quality parameter	Data type	Data source	No. sites
Eastern Mount	Other water-	Streams, rivers, lakes and wetlands	WRPs – freshwater		Continuous	DEW	1
Lofty Ranges	dependent ecosystems		dependent ecosystems	рН	Discrete	EPA	1
					Continuous	DEW	1
				Salinity (no exceedance analysis)	Continuous	DEW	17
				Total nitrogen	Discrete	EPA	1
				Total phosphorus	Discrete	EPA	1
Coorong	Declared Ramsar wetlands	Lakes and wetlands	WRPs – freshwater dependent ecosystems	Dissolved oxygen	Continuous	DEW	4
				рН	Discrete	HCHB*	10
					Continuous	DEW	4
				Salinity (no exceedance analysis)	Continuous	DEW	12
				Total nitrogen	Discrete	HCHB*	10
				Total phosphorus	Discrete	HCHB*	9
				Turbidity	Discrete	HCHB*	10
					Continuous	DEW	5
	Coorong and Lakes Alexandrina and Albert declared Ramsar Wetland Ramsar site		RaMP – Murray estuary	Salinity	Continuous	DEW	4
			RaMP – North Lagoon	Salinity	Continuous	DEW	3
			RaMP – South Lagoon	Salinity	Continuous	DEW	3

* Healthy Coorong, Healthy Basin program

4.4 Contextual data

In Section 5, a number of additional flow, water level and salinity data at various sites for the SA River Murray, Lower Lakes and Coorong are presented alongside the relevant water quality data to provide additional context to the water quality parameters presented. This additional information includes:

- flow to SA, including water for the environment and unregulated flow
- weir pool level at Locks 6, 5 and 4
- barrage releases
- Lake Alexandrina lake level
- water level and salinity in the Coorong, North and South Lagoons.

Flow to SA is a key explanatory contextual data source in explaining water quality results in the SA River Murray and the Coorong. Flow to SA is made up of several components:

- Entitlement flow to SA: This includes up to 1,850 GL/y for critical human water needs, irrigation and environmental land management. This flow includes South Australia's Additional Dilution and Loss Flow (ADF) entitlement of 696 GL/yr. This provides for losses from the South Australian border to Wellington and the dilution component ensures that water of suitable quality for human consumption can be extracted before it flows into Lake Alexandrina.
- Water for the environment: Held Water for the environment is available under a water access or delivery right, or an irrigation right and Planned Water for the environment (PEW). This is water committed by the Basin Plan or WRP and cannot be taken or used for any other purpose. All water for the environment is delivered for achieving environmental outcomes (DEW 2023) and in this report, all subsequent water for the environment flow references are to PEW.
- Unregulated flow: This is flow beyond regulated conditions, unallocated and for the environment.

The total flow to SA from 1 July 2012 to 30 June 2023 is shown in Figure 4.1. Notable high flow events occurred in 2012, 2016 to 2017 and a significant flood occurred in 2022 to 2023. Each of these periods, were characterised by large barrage releases at the end of the system and significant impacts on water quality in the SA River Murray. In years outside of these periods, water for the environment delivery made a critical contribution to the flow to SA, along the SA Murray River and out of the barrages to the Coorong and Murray Mouth. The flow to SA hydrograph is referenced throughout this report as water quality at locations throughout the SA River Murray and the Coorong is highly responsive to both low and high flows. The role of water for the environment in relation to water quality is expanded in the evaluation in Section 6.



Figure 4.1. Total flow to SA (QSA) between 2012 and 2023 showing components of the hydrograph, from DEW (2024a)

4.5 Data treatment

As noted in Table 4.2, the data analysed can be separated into discrete and continuous. All the discrete data analysed is the product of accredited laboratory analysis of samples collected by either SA Water or DEW, or in the case of one EMLR site, the EPA. No further data validation occurred, and this data was accepted as fit for purpose.

The continuous data collected by DEW is further divided into two categories for data validation: salinity and other water quality parameters. The DEW Water Resource Monitoring Unit (WRMU) maintains all the telemetered sites from which continuous data has been collated. The WRMU maintains the instrumentation and sensors and undertakes both sensor calibration and data validation for data appearing in Water Data SA.

Quality codes are assigned to the data, which reflect whether the data has been validated, and its relative quality, or whether it remains as unverified telemetry data. Outside of salinity, all water quality parameters remain as unverified telemetry (coded 1) as the WRMU does not possess the expertise to validate the data beyond removing spurious data, primarily attributable to instrument fouling or malfunction. In this context, the unverified telemetry data was treated as fit for purpose based on the WRMU expertise in sensor maintenance and is therefore incorporated in the exceedance analysis. After downloading daily data for the exceedance analyses, additional checks were conducted to remove any outliers, and the data was filtered by quality code. The analysis primarily incorporated data with grade codes of 30 (good), and 20 (fair), and 1 (unverified).

The tabulated exceedance data is presented for the full period of data availability whereas the plots of both discrete and continuous data are presented from water years ending 2016 and 2019, respectively (or from when records commenced) for ease of data visualisation.

4.6 Exceedance analysis

The water quality targets, presented in Section 2, are stated variously as median value (or 50% nonexceedance), 90%, 95% and 100% non-exceedance values. For example, the Schedule 11 targets for freshwater-dependent ecosystems (Table 3.3) are stated as target annual median values. Taking turbidity as an example, the annual target median value for a Ramsar wetland (lakes and wetlands) in the Lower River Murray is 20 NTU. Taken as written, this target only requires that for half of the time in a given water year, the turbidity should be at or below 20 NTU. There is no explicit statement as to the target turbidity for the remainder of the time. However, the objective in Section 9.08 of the Basin Plan requires that water quality characteristics with values better than a corresponding target, be maintained. This assessment therefore presents exceedance analysis results showing the percentage of days in a water year for which a given parameter exceeded its target (see Section 4.6.1 for targets with a temporal criteria).

Note that for some parameters it is desirable to maintain values higher than a specific target, for example pH and dissolved oxygen. The analysis is the same as for those where it is desirable to maintain values below a specific target, that is, an exceedance can be above or below target, depending on the target description². The evaluation of progress towards targets can then use these results to judge whether the objective of Section 9.08 has been achieved.

Exceedance is calculated as:

% exceedance = $\frac{\text{# of exceedances in water year}}{\text{total # available data points in water year}}$

4.6.1 Assessment for parameters with temporal targets

Various targets have a temporal component, where the water quality should not exceed the target more than a percentage of time over a given period. For example, the salinity targets for managing water flows dictate that water quality should not exceed the target more than 5% of the time over a 5-year period. This is assessed for each water year, and the analysis period includes the water year and 4 preceding water years.

Exceedance analysis is calculated in the same way as for the annual exceedances, although the whole period is considered. Where there is missing data, but exceedances within the 5-year analysis period would cause an overall exceedance regardless³, that year is considered to have exceeded.

4.6.2 Assessment for parameters with annual median targets

Some of the freshwater-dependent ecosystem targets are assessed against an annual median target. The assessment for the annual median also uses the percentage exceedance analysis, but exceedances are assessed against whether the annual median is more or less than the target. A percentage exceedance greater than 50% indicates that the annual median is greater than the target value.

4.7 Trend analysis

A trend analysis is not presented for any of the parameters due to the episodic and infrequent nature of water quality events (that is, exceedances) and the complexity of processes influencing water quality outcomes in all the WRP areas.

² For example, the WRPs target requires pH to be between 6.5 and 9.0. Thus, exceedances are calculated for pH values that lie below 6.5 (target >6.5), and for pH values that lie above 9.0 (target <9.0). Percentage exceedances for each site and water year pair can be combined to determine the total percentage of days/samples that the water quality parameter is outside of the target range.

³ For example, if assessing a water quality target of <10, and want to determine whether the target is exceeded more than 95% of the time over a 5-year period. If the 5-year water quality percentage exceedance is 'NA, NA, NA, NA and 78%', even if the missing years (NA) all had 0% exceedances, the fifth year would cause the whole period to exceed the target, so the final year is indicated as an exceedance.

4.8 Data reliability

The reliability of data used to assess the achievement of water quality targets was assessed using a method modified from Battisti et al. (2014). This approach scores datasets against questions relating to the method used for data collection, representativeness and repetition. A scoring system, as shown in Table 4.3, was used to assign a value from 0 to 2 for each question and set of data. The sum of the scores provides a final score for the dataset between 0 and 12. Final scores are then converted into a data reliability rating that ranges between poor and excellent using the matrix in Table 4.4.

R4-4h - d-	a <i>i</i> :	Scoring system			
Methods	Questions	Yes	Partially	Νο	
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2	1	0	
Standard methods	methods Has the same method been used over the sampling program?		1	0	
Representativeness					
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	2	1	0	
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	2	1	0	
Repetition					
Space	Has sampling been conducted at the same sites over the assessment period?	2	1	0	
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	2	1	0	

T I I I A A		* 1 · · · · · · · · · · · · · · · · · ·		4.0
l able 4.3.	Scoring system for the reliability	/ of data used to assess achieve	ement of targets for Matte	r 12 reporting

Table 4.4.Conversion of the final score (0 to 12) of data reliability to a rating category ranging between poor and
excellent for Matter 12 reporting

Final score	Rating category
12	Excellent
11	Very good
10	Good
9	Fair
≤8	Poor

Scores for reliability of data used in are presented in Table 4.5 to Table 4.11.

Table A. 1 and Table A. 2 (Appendix) provide the frequency (number) of data points available in the given year, to offer insights relating to data availability, for all discrete data used in this reporting. Water samples were consistently collected within a defined spatial extent at least twice monthly from mid-2010 up to recent years. Given the spatial and temporal extent of the data, it is considered both adequate and reliable for accurately reflecting changes over the assessment period. Continuous data availability is provided as charts in the results section of the report.

	· · · · · ·	Scores for reliability of the River Murray discrete data			
Methods	Questions	Cyanobacteria	Dissolved oxygen concentration	рН	Total phosphorus
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2	2	2	2
Standard methods	Has the same method been used over the sampling program?	2	2	2	2
Representativeness					
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	2	2	2	2
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	2	2	2	2
Repetition					
Space	Has sampling been conducted at the same sites over the assessment period?	2	2	2	2
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	2	2	2	2

Table 4.5. Scores for reliability of the River Murray channel discrete data used in the exceedance analysis

Table 4.0. Scores for reliability of the River Murray Channel Continuous data used in the exceedance analysis	Table 4.6.	Scores for reliabilit	y of the River Murra	y channel continuous data	a used in the exceedance analysis
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		Scores for reliability of the River Murray continuous data		
Methods	Questions	Dissolved oxygen saturation	Salinity	
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2	2	
Standard methods	Has the same method been used over the sampling program?	2	2	
Representativeness				
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	2	2	
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	2	2	
Repetition				
Space	Has sampling been conducted at the same sites over the assessment period?	2	2	
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	2	2	

Mashada	Questions	Sc	Scores for reliability of the Coorong discrete data used			
wethous		рН	Total nitrogen	Total phosphorus	Turbidity	
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2	2	2	2	
Standard methods	Has the same method been used over the sampling program?	2	2	2	2	
Representativeness						
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	2	2	2	2	
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	2	2	2	2	
Repetition						
Space	Has sampling been conducted at the same sites over the assessment period?	2	2	2	2	
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	2	2	2	2	

Table 4.7. Scores for reliability of the Coorong discrete data used in the exceedance analysis

Table 4.8.	Scores for reliability of the Coorong continuous data used in the exceedance analysis
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	Questions	Scores for reliability of the Coorong continuous data			
Methods		Dissolved oxygen saturation	рН	Turbidity	
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2	2	2	
Standard methods	Has the same method been used over the sampling program?	2	2	2	
Representativeness					
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	2	2	2	
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	1	1	1	
Repetition					
Space	Has sampling been conducted at the same sites over the assessment period?	1	1	1	
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	1	1	1	
			Scores for reliability o	f the EMLR discrete dat	a
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Methods	Questions	Dissolved oxygen saturation	рН	Total nitrogen	Total phosphorus
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2	2	2	2
Standard methods	Has the same method been used over the sampling program?	2	2	2	2
Representativeness					
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	0	0	0	0
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	0	0	0	0
Repetition			-		
Space	Has sampling been conducted at the same sites over the assessment period?	0	0	0	0
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	0	0	0	0

Table 4.9. Scores for reliability of the EMLR discrete data used in the exceedance analysis

Table 4.10. Scores for reliability of the EMLR continuous data used in the exceedance analysis

		Scores for reliability of the El	MLR continuous data
Methods	Questions	Dissolved oxygen saturation	рН
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2	2
Standard methods	Has the same method been used over the sampling program?	2	2
Representativeness			
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	0	0
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	0	0
Repetition			
Space	Has sampling been conducted at the same sites over the assessment period?	0	0
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	0	0

Methods	Questions	Scores for reliability of the floodplains data
Wethous		Dissolved oxygen saturation
Methods used	Are the methods used appropriate to gather the information required for evaluation?	2
Standard methods	Has the same method been used over the sampling program?	2
Representativeness		
Space	Has sampling been conducted across the spatial extent of the PEA with equal effort?	2
Time	Has the duration of sampling been sufficient to represent change over the assessment period?	2
Repetition	· · ·	
Space	Has sampling been conducted at the same sites over the assessment period?	2
Time	Has the frequency of sampling been sufficient to represent change over the assessment period?	2

Table 4.11. Scores for reliability of the River Murray floodplains continuous data used in the exceedance analysis

5 Results

Note that in all tables presented in this section, the "Year" column relates to the water year end, that is, data presented as 2001 is for the period 1 July 2000 to 30 June 2001.

5.1 River Murray in South Australia

Figure 5.1 and Figure 5.2 show maps of the monitoring sites (discrete and continuous respectively) used for analysis of the River Murray channel.



Figure 5.1. Data assessment site locations – River Murray channel discrete monitoring sites



Figure 5.2. Data assessment site locations – River Murray channel continuous monitoring sites

Flow to South Australia data is presented in Figure 5.3 to provide context when interpreting water quality results in the River Murray channel. In the period since the 2020 Matter 12 evaluation, flow to South Australia was notably higher from July 2021 onwards, with a significant flood in 2022–23 reaching a peak of 186,000 ML/day almost twice that of the two prior high flow events in the record presented (2010–11 and 2016–17). Conversely, flows were similar in 2019–20 and 2020–21 to those experienced in 2014–15 and 2015–16, remaining below 20,000 ML/day throughout.



Figure 5.3. Flow to SA (ML/day)

5.1.1 Managing water flows

Water quality exceedances observed in the SA River Murray are episodic and event-based; they are typically related to flow conditions and poorer water quality is observed during periods of low flow. The water quality of River Murray flow to South Australia is a product of upstream conditions and water quality in the upper River Murray or its tributaries. The MDBA manages the day-to-day operations and flows to SA in accordance with the Murray–Darling Basin Agreement. Influences on water quality both upstream and downstream of the South Australian border can be both anthropogenic and natural, with the 2022–23 River Murray flood an example of the latter where significant unregulated (near natural) flow volumes triggered notable water quality exceedances. Additionally, there are instances where river operations have resulted in water quality exceedances, such as when poor quality low dissolved oxygen (DO) water may need to be flushed through the Murray-Darling system following an algal bloom or bushfire. For example, in 2016 to 17, water with low dissolved oxygen due to flood conditions was shandied⁴ in Lake Victoria to release better quality water with higher oxygen levels into the Rufus River, although some low DO water entered SA towards the end of 2016. Also in 2017, salinity spikes and high pH were managed through Wentworth weir pool, using Lower Baaka (Darling) flows to flush higher salinity water out of the Darling and dilute it as it entered the Murray, resulting in below-target salinity and pH water entering SA. In 2020, the first flushing flows through the Darling (after several hot and dry years) caused a salinity spike (MDBA 2021). Fresher flows behind the initial flow front helped to dilute the water and reduce the salinity to within an acceptable range, and a relatively low salinity peak (\approx 240 μ S/cm) was observed upstream (Old Customs House (A4261022)) by the time the flow reached SA.

For ease of interpretation across all parameters, the plots and exceedance tables are presented in spatial order from near the SA border to the end of the River Murray in SA to highlight the origins and persistence of water quality events that occur along the SA River Murray channel. Relevant water quality targets for managing

⁴ The addition of one water source to another, which modifies the quality of the water through dilution.

water flows are presented in Table 5.1 and the data availability for the analysis is shown in Figure 5.8 (DO) and Figure 5.10 (salinity).

Parameters	Targets	Notes
Dissolved oxygen (DO)	at least 50% saturation	For discrete data, DO concentration data is expressed in mg/L; an equivalent target value of 4.13 mg/L is adopted.
Salinity (EC)*	580 µS/cm	River Murray at Lock 6
	800 μS/cm	River Murray at Morgan
	830 μS/cm	River Murray at Murray Bridge
	1000 µS/cm	Lower Lakes at Milang

Table 5.1. Summary of water quality parameter targets for managing flows

* The Basin Plan requires that the MDBA assess whether these target values have been met 95% of the time over a 5-year period, based on water accounting years (that is, assessed for the water accounting period, and 4 previous water accounting periods). This assessment has also been included in the relevant exceedance tables below.

Additional to the Flow to SA graph (Figure 5.3), average daily lake levels in Lake Alexandrina (Figure 5.4) and total daily barrage releases (Figure 5.5) provide context for water quality.



Figure 5.4. Average daily lake level (m AHD⁵) using stations⁶on Lake Alexandrina.

⁵ Australian Height Datum

⁶ Milang Jetty (A4260524), Lake Alexandrina near Mulgundawa (A4260574), Lake Alexandrina at Poltalloch Plains (A4260575), Lake Alexandrina at Beacon 97 (offshore Raukkan) (A4261133) and Lake Alexandrina at Tauwitchere Barrage (A4260527).



Figure 5.5. Total barrage releases between 2010 and 2024

5.1.1.1 Dissolved oxygen

Figure 5.6 shows the discrete data for dissolved oxygen concentration at sites along the SA River Murray with the corresponding target value of 4.13 mg/L. The exceedance table (Table 5.2) confirms Morgan, Mannum, Mypolonga, Tailem Bend and Murray Bridge in the lower SA River Murray all had DO saturation exceedances in response to the 2010–11 high flows, whereas the 2016–17 high flow event saw DO exceedances along the length of the SA River Murray. The 2017 exceedances were due to a blackwater event as high flows across New South Wales and Victoria mobilised large amounts of organic matter from the floodplain into the River Murray. The large amount of organic matter was due to the high flow extending into areas of the floodplain that had not been inundated since the high flow in the early 1990s (DEW 2016). Similarly, the widespread exceedances calculated for 2023 were due to the flood event that peaked in the SA River Murray at the end of 2022, although no blackwater events were officially declared. The relatively higher percentage of exceedances at each site is commensurate with the significantly higher flows experienced throughout the SA River Murray that year. This flooding was a widespread phenomenon across the Murray–Darling Basin. Outside of the 2022– 23 flood event, the continuous DO data (percentage saturation), aggregated by River Murray channel reaches in South Australia (Figure 5.7 and Table 5.3) does not exceed the corresponding target value of 50% saturation. Note that local conditions, such as the very high-water levels experienced during the 2022-23 flood made routine discrete sampling locations inaccessible. During this period, sampling was undertaken at alternative locations and different sampling methods employed (T Frasca, SA Water 2024, personal communication. July). It is likely the differing data collection methods (both continuous compared to discrete, and differences in discrete data collection) influence the results presented below. However, all data is evaluated for quality and reliability and collectively offers comprehensive spatial and temporal coverage of the SA River Murray.



Figure 5.6. River Murray channel dissolved oxygen (discrete data) compared to the managing water flows target of maintaining dissolved oxygen concentration > 4.13 mg/L (equivalent to 50% saturation)



Figure 5.7. River Murray channel dissolved oxygen (continuous data) compared to the managing water flows target of maintaining dissolved oxygen saturation above 50% saturation

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray Renmark Sample Pump	NA	NA	NA	NA	NA	0	0	0	0	0	0	6	2	0	0	0	0	4
River Murray Berri Surface Pump	NA	NA	NA	NA	NA	0	0	0	0	0	0	8	0	0	0	0	0	8
River Murray Loxton Sample Pump	NA	NA	NA	NA	NA	0	0	0	0	0	0	6	2	0	0	0	0	4
River Murray Moorook Sample Pump	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	17
River Murray Cobdogla Sample Pump	NA	NA	NA	NA	0	0	0	0	0	0	0	4	0	0	0	0	0	18
River Murray Woolpunda Sample Pump	NA	NA	NA	NA	0	0	0	0	0	0	0	6	0	0	0	0	0	17
River Murray Waikerie Sample Pump	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	12
River Murray Cadell Sample Pump	NA	NA	NA	NA	0	0	0	0	0	2	0	4	4	0	0	0	0	8
River Murray Morgan Sample Pump	NA	NA	NA	NA	8	11	0	0	0	0	0	8	0	0	0	0	0	10
River Murray Blanchetown Sample Pump	NA	0	0	0	2	0	0	0	0	0	19							
River Murray Swan Reach Sample Pump	NA	NA	NA	NA	0	2	0	0	0	0	0	2	0	0	0	0	0	8
River Murray Swan Reach Town Sample Pur	NA	0	0	0	2	0	0	0	0	0	17							
River Murray Mannum Sample Pump	NA	NA	0	0	0	14	0	0	0	0	0	10	0	0	0	0	0	10
River Murray Cowirra Sample Pump	NA	NA	NA	NA	0	4	2	2	0	0	0	4	0	0	2	0	10	48
River Murray Mypolonga Sample Pump	NA	NA	NA	NA	NA	7	18	12	0	0	0	12	0	0	0	0	2	38
River Murray Murray Bridge Sample Pump	NA	NA	0	0	0	15	0	2	0	0	0	16	0	0	0	0	0	4
River Murray Tailem Bend Sample Pump	NA	NA	NA	NA	0	12	0	0	0	0	0	10	0	0	0	0	0	8

 Table 5.2.
 River Murray channel dissolved oxygen concentration annual (water year) percentage of samples exceedance analysis (discrete data) compared to the managing water flows target of maintaining dissolved oxygen above 4.13 mg/L (equivalent to 50% saturation)

Reach	Site number	Continuous monitoring sites	2017	2018	2019	2020	2021	2022	2023
Above Lock 6	A4261022	River Murray upstream Old Customs House (AMTD 637.1km)	NA	0	0	0	0	0	18
Lock 5 to Lock 6	A4261168	River Murray DS Chow Woolshed Adj Chow HS (AMTD 608.8)	NA	0	0	0	0	0	0
Lock 5 to Lock 6	A4260703	River Murray upstream Renmark (AMTD 570.6km)	4 9	0	0	0	0	0	5
Lock 4 to Lock 5	A4261023	River Murray upstream Pike River Outlet (AMTD 547Km)	NA	0	0	0	0	0	NA
Lock 4 to Lock 5	A4261278	River Murray downstream Lyrup (AMTD 531km)	NA	0	0	0	0	0	0
Lock 3 to Lock 4	A4261024	River Murray us Katarapko Ck Outlet (AMTD 482.4km)	82	0	0	0	0	0	1
Lock 3 to Lock 4	A4261263	River Murray 5km ds Katarapko Creek Outlet (AMTD 476km)	11	0	0	0	0	0	0
Lock 2 to Lock 3	A4260652	River Murray upstream Overland Corner (AMTD 426.5km)	NA	NA	NA	NA	0	0	0
Lock 2 to Lock 3	A4260594	River Murray upstream Sunlands PS (AMTD 373.6 Km)	0	0	0	0	0	0	0
Lock 1 to Lock 2	A4260702	River Murray downstream Hogwash Bend (AMTD 347.5km)	NA	NA	NA	NA	0	1	0
Lock 1 to Lock 2	A4260554	River Murray at Morgan No1 Pump Station (AMTD 321.7 Km)	NA	NA	NA	NA	NA	NA	15

 Table 5.3.
 River Murray channel dissolved oxygen annual (water year) percentage of days exceedance analysis (based on continuous) compared to the managing water flows target of maintaining dissolved oxygen saturation above 50% saturation



Figure 5.8. Data reliability analysis for River Murray channel continuous DO data, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.1.1.2 Salinity

Continuous salinity data at each of the SA End-of-Valley target locations is shown in Figure 5.9 and results of the exceedance analysis are presented in Table 5.4. Water quality at each site was also assessed to determine whether recorded values were below the target 95% of the time (as per criteria in Table 5.1), and these results are presented in Table 5.5.

All sites remain well below their respective targets, except for Milang, which had a 100% exceedance rate during the years of the Millennium Drought for which data was available (2004 to 2010), and subsequent exceedances in 2011 (50%), 2019 (24%), 2020 (9%) and 2021 (1%). The River Murray at Murray Bridge (daily read) also experienced an exceedance of 25% in 2007–08, which caused water quality to be greater than the 95% of time target for that year and the following 4 years. All the exceedances coincide with very low lake levels or low to no barrage flow (see Figure 5.4 and Figure 5.5), critical controlling factors for salinity in the Lower Lakes. This in turn is related to a reduction in flow to SA (Figure 5.3). The 2022 exceedances (3%) coincided with a reverse head event at the barrages whereby downstream water levels were higher than upstream and the barrages remained open throughout this event as an operational test. Conversely, higher barrage releases in spring 2020 and from winter 2021 onwards, supported by higher flows to SA, saw reductions in salinity and maintenance of salinity levels below the target for Milang.



Figure 5.9. River Murray channel and Lake Alexandrina salinity⁷ (from continuous data) since 2019 compared to site-specific targets for managing water flows.

⁷ The 5-site average at Milang comes from the sites Lake Alexandrina near Mulgundawa (Recorder) (A4260574), Lake Alexandrina at Milang Jetty Recorder) (A4260524), Lake Alexandrina at Poltalloch Plains (Recorder) (A4260575), Lake Alexandrina 3 km West Point McLeay (Star'Beacon 95) (A4261156) and Lake Alexandrina at Beacon 97 (Offshore Raukkan) (A4261133)

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Table 5.4. River Murray channel and Lake Alexandrina at Milang salinity annual (water year) percentage exceedance analysis (based on continuous data) compared to site-specific targets for managing water flows

Site number	Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4260510	River Murray at Lock 6	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
A4260554	River Murray at Morgan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A4261003	River Murray at Murray Bridge (daily read)	0	0	0	0	0	0	0	25	0	0	0	0	0	NA									
A4261162	River Murray at Murray Bridge (sensor)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
A4260524	Lower Lakes at Milang	NA	NA	NA	100	100	100	100	100	100	100	<mark>5</mark> 0	0	0	0	0	0	0	0	24	9	1	3	0

 Table 5.5.
 River Murray channel and Lake Alexandrina at Milang salinity (based on continuous data) compared to site-specific targets for managing water flows.

 Shading indicates whether water year salinity is below the target 95% of the time including that year and the four previous water years. Where five years of data are not available, but the year would exceed regardless, the year is also considered to have exceeded and the cell is shaded.

Site number	Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4260510	River Murray at Lock 6	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
A4260554	River Murray at Morgan		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A4261003	River Murray at Murray Bridge (daily read)	0	0	0	0	0	0	0	25	0	0	0	0	0	NA									
A4261162	River Murray at Murray Bridge (sensor)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
A4260524	Lower Lakes at Milang	NA	NA	NA	100	100	100	100	100	100	100	50	0	0	0	0	0	0	0	24	9	1	3	0



Figure 5.10. Data reliability analysis for continuous salinity data for the River Murray channel and Lake Alexandrina salinity (at Milang) since July 2000, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.1.2 Water resource plans

5.1.2.1 Freshwater-dependent ecosystems

Relevant water quality targets for freshwater-dependent ecosystems are presented in Table 5.6.

Table 5.6. Summary of water quality parameter targets for freshwater-dependent ecosystems in the River Murray channel

Parameters	Targets (Annual median)	Notes
Dissolved oxygen (DO)	85 to 110% saturation 7.0 – 9.0 mg/L	Lower Murray – other water-dependent ecosystems – streams, rivers, lakes, and wetlands
Total phosphorus	100 ug/L (0.1 mg/L)	
рН	6.5 to 9.0	

5.1.2.1.1 Dissolved oxygen

The discrete dissolved oxygen concentration data presented in Figure 5.11 is the same as that presented in Figure 5.6, albeit with the freshwater-dependent ecosystem targets applied, which have a lower tolerance for low dissolved oxygen than that for managing flows (50% saturation, or a concentration of 4.13 mg/L). For this reason, there are considerably more exceedances recorded under the analysis below. Table 5.9 shows the DO is often outside of the annual median target range, with significant exceedances at all sites in 2022–23, and for most sites with data prior to 2014.

The continuous DO saturation data presented in Figure 5.12, Table 5.10, Table 5.11, and Table 5.12 (annual median analysis) has been aggregated by reach and displays exceedances from above Lock 6 to the Morgan Pump Station. As the dissolved oxygen data is the same as for the 'Managing water flows' target, the availability of data in each reach and over time can be observed in Figure 5.8. The exceedances are a response to high flow events (Figure 5.3) with low DO originating upstream, crossing into SA, and persisting along the SA River Murray. Analysis of the discrete DO concentration data shows consistent exceedances in all years between 2014 and 2023 at all sites throughout the SA River Murray. However, there are only two sites with DO saturation values which are outside of the annual median target range, at Renmark (90%) and Katarapko Creek Outlet (71%), both in 2016–17. While the continuous DO data is collected by a sensor located 1 m below the water surface with corresponding temperature data also logged, the discrete data water samples are collected at pumping locations by SA Water and then subsequently analysed in a laboratory to produce DO concentrations. As noted above, local conditions, such as the very high water levels experienced during the 2022–23 flood can make routine sampling locations inaccessible. In these cases, discrete sampling is undertaken at alternative locations and different sampling methods are employed (Frasca, T. pers. comm., July 2024). It is likely the differing data collection methods (both continuous compared to discrete, and differences in discrete data collection) influence the results presented below. However, all data is evaluated for quality and reliability and collectively offers comprehensive spatial and temporal coverage of the SA River Murray.



Figure 5.11. River Murray channel dissolved oxygen (from discrete data) compared to freshwater ecosystem targets > 7.0 mg/L and < 9.0 mg/L

River Murray Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Renmark	NA	NA	NA	NA	NA	NA	10	8	16	9	12	25	17	10	15	2	25	42
Berri	NA	27	15	26	31	10	4	12	4	19	46							
Loxton	NA	14	11	8	29	13	12	11	6	33	46							
Moorook	NA	5	4	8	21	4	6	4	0	6	37							
Cobdogla	NA	14	6	10	27	10	6	10	0	12	33							
Woolpunda	NA	10	4	11	21	15	10	8	2	13	46							
Waikerie	NA	0	4	9	17	12	8	4	0	4	33							
Cadell	NA	9	6	13	19	17	13	8	2	15	37							
Morgan	NA	NA	NA	NA	NA	54	6	0	2	0	2	20	4	2	2	0	4	35
Blanchetown	NA	14	0	8	23	6	8	6	0	10	46							
Swan Reach	0	0	NA	NA	NA	44	4	0	2	0	0	17	6	17	4	2	11	40
Reach Town	NA	5	4	6	19	12	15	8	0	11	44							
Mannum	NA	NA	0	3	5	48	40	3 9	33	16	25	51	20	27	12	19	31	46
Cowirra	NA	55	8	33	38	25	25	14	22	44	60							
Mypolonga	NA	62	42	42	56	48	42	17	35	37	69							
Murray Bridge	NA	NA	21	12	16	61	51	61	48	48	37	61	5 0	28	25	32	40	<mark>5</mark> 2
Tailem Bend	NA	NA	NA	NA	NA	58	54	5 4	5 0	35	34	5 4	27	25	15	11	40	58

 Table 5.7.
 River Murray channel dissolved oxygen concentration annual (water year) percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem target > 7 mg/L

River Murray Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Renmark	NA	NA	NA	NA	NA	NA	38	27	20	45	31	35	37	35	45	35	31	25
Berri	NA	23	35	40	37	46	48	46	36	35	33							
Loxton	NA	14	38	29	29	31	33	34	31	25	29							
Moorook	NA	38	40	5 3	37	33	38	42	48	42	42							
Cobdogla	NA	32	40	56	37	33	40	37	34	40	49							
Woolpunda	NA	33	37	51	37	27	33	33	40	33	33							
Waikerie	NA	33	38	49	40	46	46	44	43	5 0	44							
Cadell	NA	18	37	45	31	29	35	33	38	43	42							
Morgan	NA	NA	NA	NA	NA	21	40	48	46	54	55	45	41	47	48	5 0	4 6	40
Blanchetown	NA	18	37	55	38	35	40	35	43	40	27							
Swan Reach	67	50	NA	NA	NA	24	46	44	44	52	55	46	38	33	39	48	43	37
Swan Reach Town	NA	43	42	45	38	33	35	43	54	42	31							
Mannum	NA	NA	67	36	31	26	29	27	15	24	32	18	22	15	33	26	21	27
Cowirra	NA	9	27	25	15	25	15	27	26	15	19							
Mypolonga	NA	0	17	15	17	10	12	15	17	17	13							
Murray Bridge	NA	NA	24	19	24	24	18	22	2	15	15	19	13	12	17	17	15	10
Tailem Bend	NA	NA	NA	NA	NA	16	17	19	2	19	21	21	21	27	27	19	23	12

 Table 5.8.
 River Murray channel dissolved oxygen concentration annual (water year) percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem targets < 9.0 mg/L</th>

 Table 5.9.
 River Murray channel dissolved oxygen concentration annual (water year) percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem target range of 7.0 to 9.0 mg/L. Shading indicates years with an annual median outside the target range (exceedances greater than 50%)

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Renmark	NA	NA	NA	NA	NA	NA	48	35	36	54	43	60	54	45	60	37	56	67
Berri	NA	NA	NA	NA	NA	NA	NA	NA	50	50	66	<mark>6</mark> 8	56	52	58	40	54	79
Loxton	NA	NA	NA	NA	NA	NA	NA	NA	28	49	37	58	44	45	45	37	58	75
Moorook	NA	NA	NA	NA	NA	NA	NA	NA	43	44	61	58	37	44	46	48	48	79
Cobdogla	NA	NA	NA	NA	NA	NA	NA	NA	46	46	6 6	64	43	46	47	34	52	82
Woolpunda	NA	NA	NA	NA	NA	NA	NA	NA	43	41	62	58	42	43	41	42	46	79
Waikerie	NA	NA	NA	NA	NA	NA	NA	NA	33	42	58	57	58	54	48	43	54	77
Cadell	NA	NA	NA	NA	NA	NA	NA	NA	27	43	58	50	46	48	41	40	58	79
Morgan	NA	NA	NA	NA	NA	75	46	48	48	54	57	<mark>6</mark> 5	45	49	50	50	50	75
Blanchetown	NA	NA	NA	NA	NA	NA	NA	NA	32	37	63	61	41	48	41	43	50	73
Swan Reach	67	50	NA	NA	NA	<mark>6</mark> 8	50	44	46	52	55	63	44	50	43	50	54	77
Swan Reach Town	NA	NA	NA	NA	NA	NA	NA	NA	48	46	51	57	45	50	51	54	53	75
Mannum	NA	NA	67	39	36	74	69	6 6	48	40	57	69	42	42	45	45	52	73
Cowirra	NA	NA	NA	NA	NA	NA	NA	NA	64	35	58	53	50	40	41	48	59	79
Mypolonga	NA	NA	NA	NA	NA	NA	NA	NA	62	59	57	73	58	54	32	52	54	82
Murray Bridge	NA	NA	45	31	40	85	69	83	50	63	52	80	63	40	42	49	55	62
Tailem Bend	NA	NA	NA	NA	NA	74	71	73	52	54	55	75	48	52	42	30	63	70



Figure 5.12. River Murray channel dissolved oxygen saturation (from continuous data) compared to freshwater ecosystem targets > 85% and < 110%

Table 5.10.	iver Murray channel dissolved oxygen saturation annual (water year) percentage of days exceedance analysis (from continuous data) compared t	D
	reshwater ecosystem targets > 85% saturation	

Reach	Site number	Continuous monitoring sites	2017	2018	2019	2020	2021	2022	2023
Above Lock 6	A4261022	River Murray upstream Old Customs House (AMTD 637.1km)	NA	2	1	8	0	4	23
Lock 5 to Lock 6	A4261168	River Murray DS Chow Woolshed Adj Chow HS (AMTD 608.8)	NA	3	0	0	2	1	0
Lock 5 to Lock 6	A4260703	River Murray upstream Renmark (AMTD 570.6km)	90	7	3	0	5	19	21
Lock 4 to Lock 5	A4261023	River Murray upstream Pike River Outlet (AMTD 547Km)	NA	0	1	0	0	0	NA
Lock 4 to Lock 5	A4261278	River Murray downstream Lyrup (AMTD 531km)	NA	6	9	1	0	2	0
Lock 3 to Lock 4	A4261024	River Murray us Katarapko Ck Outlet (AMTD 482.4km)	66	0	0	2	0	0	16
Lock 3 to Lock 4	A4261263	River Murray 5km ds Katarapko Creek Outlet (AMTD 476km)	47	0	1	1	0	3	20
Lock 2 to Lock 3	A4260652	River Murray upstream Overland Corner (AMTD 426.5km)	NA	NA	NA	NA	0	0	7
Lock 2 to Lock 3	A4260594	River Murray upstream Sunlands PS (AMTD 373.6 Km)	9	1	4	9	2	0	10
Lock 1 to Lock 2	A4260702	River Murray downstream Hogwash Bend (AMTD 347.5km)	NA	NA	NA	NA	1	11	12
Lock 1 to Lock 2	A4260554	River Murray at Morgan No1 Pump Station (AMTD 321.7 Km)	NA	NA	NA	NA	NA	NA	42

Table 5.11.	11. River Murray channel dissolved oxygen annual (water year) percentage of days excee	dance analysis (from continuous data) compared to freshwater
	ecosystem targets < 110% saturation	

Reach	Site number	Continuous monitoring sites	2017	2018	2019	2020	2021	2022	2023
Above Lock 6	A4261022	River Murray upstream Old Customs House (AMTD 637.1km)	NA	5	24	1	25	5	0
Lock 5 to Lock 6	A4261168	River Murray DS Chow Woolshed Adj Chow HS (AMTD 608.8)	NA	0	0	0	21	0	0
Lock 5 to Lock 6	A4260703	River Murray upstream Renmark (AMTD 570.6km)	0	2	5	0	16	0	0
Lock 4 to Lock 5	A4261023	River Murray upstream Pike River Outlet (AMTD 547Km)	NA	0	9	5	9	0	NA
Lock 4 to Lock 5	A4261278	River Murray downstream Lyrup (AMTD 531km)	NA	3	3	1	4	1	0
Lock 3 to Lock 4	A4261024	River Murray us Katarapko Ck Outlet (AMTD 482.4km)	5	23	0	0	1	0	8
Lock 3 to Lock 4	A4261263	River Murray 5km ds Katarapko Creek Outlet (AMTD 476km)	0	8	3	11	7	7	0
Lock 2 to Lock 3	A4260652	River Murray upstream Overland Corner (AMTD 426.5km)	NA	NA	NA	NA	13	1	31
Lock 2 to Lock 3	A4260594	River Murray upstream Sunlands PS (AMTD 373.6 Km)	0	11	0	0	1	4	15
Lock 1 to Lock 2	A4260702	River Murray downstream Hogwash Bend (AMTD 347.5km)	NA	NA	NA	NA	22	4	9
Lock 1 to Lock 2	A4260554	River Murray at Morgan No1 Pump Station (AMTD 321.7 Km)	NA	NA	NA	NA	NA	NA	2

 Table 5.12. River Murray channel dissolved oxygen annual (water year) percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target range 85 to 110%. Shading indicates years with an annual median outside the target range (exceedances greater than 50%).

Reach	Site number	Continuous monitoring sites	2017	2018	2019	2020	2021	2022	2023
Above Lock 6	A4261022	River Murray upstream Old Customs House (AMTD 637.1km)	NA	7	25	9	25	9	23
Lock 5 to Lock 6	A4261168	River Murray DS Chow Woolshed Adj Chow HS (AMTD 608.8)	NA	3	0	0	23	1	0
Lock 5 to Lock 6	A4260703	River Murray upstream Renmark (AMTD 570.6km)	90	9	8	0	21	19	21
Lock 4 to Lock 5	A4261023	River Murray upstream Pike River Outlet (AMTD 547Km)	NA	0	10	5	9	0	NA
Lock 4 to Lock 5	A4261278	River Murray downstream Lyrup (AMTD 531km)	NA	9	12	2	4	3	0
Lock 3 to Lock 4	A4261024	River Murray us Katarapko Ck Outlet (AMTD 482.4km)	71	23	0	2	1	0	24
Lock 3 to Lock 4	A4261263	River Murray 5km ds Katarapko Creek Outlet (AMTD 476km)	47	8	4	12	7	10	20
Lock 2 to Lock 3	A4260652	River Murray upstream Overland Corner (AMTD 426.5km)	NA	NA	NA	NA	13	1	38
Lock 2 to Lock 3	A4260594	River Murray upstream Sunlands PS (AMTD 373.6 Km)	9	12	4	9	3	4	25
Lock 1 to Lock 2	A4260702	River Murray downstream Hogwash Bend (AMTD 347.5km)	NA	NA	NA	NA	23	15	21
Lock 1 to Lock 2	A4260554	River Murray at Morgan No1 Pump Station (AMTD 321.7 Km)	NA	NA	NA	NA	NA	NA	44

5.1.2.1.2 Total phosphorus

Figure 5.13 shows total phosphorus discrete data at various locations along the River Murray in relation to the freshwater ecosystem target of <0.1 mg/L. Table 5.13 shows the percentage of days of exceedance of this target per year at each location and indicates whether the annual median total phosphorus at each site exceeds the target. The highest concentrations, and greatest numbers of days of exceedance coincide with the high flow events of 2010–11 and 2016–17, and the flood of 2022–23. As for the DO exceedances, which occur at the border and along the SA River Murray during these high flow events (Figure 5.3), the total phosphorus exceedances originate upstream of SA and can also be attributed to the mobilisation of large amounts of organic matter from upstream floodplains into the River Murray. The more localised exceedances for locations further downstream within SA in other years are likely a result of the local landscape including floodplains and irrigated land that contribute phosphorus when flows connect them to the River Murray.



Figure 5.13. River Murray channel total phosphorus (from discrete data) compared to freshwater ecosystem target <0.1 mg/L.

River Murray Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
8km downstream Lock 6	NA	90	84	84	94	29	0	6	NA														
11km downstream Lock 6	NA	74	8	35	4	0	76	96															
Renmark	NA	0	91	100	92	75	87	45	10	92	36	74	28	3	90	100							
Lock 5	84	60	28	8	8	4	2	8	23	53	94	81	83	75	15	0	75	25	44	13	8	78	96
Berri	NA	0	89	85	77	100	NA																
Loxton	NA	0	83	77	77	100	64	38	12	85	8	54	30	0	85	100							
Moorook	NA	0	92	92	77	100	64	31	0	81	31	35	8	7	85	96							
Cobdogla	NA	89	85	85	100	NA																	
Kingston on Murray	NA	40	NA																				
Lock 3	NA	NA	NA	NA	11	0	NA	NA	NA	80	NA												
Woolpunda	NA	0	23	76	100	77	100	NA															
Waikerie	NA	33	82	100	83	96	79	49	19	85	38	69	46	30	88	88							
Cadell	NA	0	65	85	85	100	NA																
Morgan	84	60	33	10	6	1	0	0	0	27	96	94	90	75	17	0	75	34	42	22	16	83	88
Lock 1	NA	0	87	92	85	100	NA																
Mannum	75	100	100	33	23	18	0	0	8	38	100	92	85	95	55	43	69	61	79	62	50	85	97
Cowirra	NA	100	77	86	NA																		
Mypolonga	NA	50	77	92	67	100	NA																
Swan Reach	NA	0	78	100	100	85	92	56	33	92	59	51	39	37	90	97							
Murray Bridge	86	100	67	46	29	19	6	0	4	29	98	98	84	94	49	37	65	52	72	62	54	87	81
Tailem Bend	90	100	60	56	46	32	8	2	6	27	100	100	85	88	46	62	71	44	73	48	43	79	92

 Table 5.13. River Murray channel total phosphorus annual (water year) percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem target < 0.1 mg/L. Shading indicates years with an annual median greater than the target</th>

5.1.2.1.3 pH

pH data is presented in Figure 5.14 and Figure 5.15 for discrete and continuous data, respectively. Exceedance analysis is presented in Table 5.14 to Table 5.19, which also includes assessment against the annual median target. Data reliability analysis is presented in Figure 5.16 for the continuous data. Continuous data for all sites presented here is not available after 2014, so continuous data from 2008 to 2014 only is presented in Figure 5.15. The results show pH largely remaining inside the freshwater ecosystem targets of >6.5 and < 9.0 at each site with some exceedances (values below pH 6.5) in the discrete data in 2011 at sites near the major SA floodplains, likely in response to the reconnection of these sites to the channel during the 2022–23 River Murray flood event. Conversely, the discrete data shows some exceedances above 9.0 in 2023, likely due to the dilution effect of the 2022–23 River Murray flood event as observed at the Lake Alexandrina and Goolwa sites.



Figure 5.14. River Murray channel pH (from discrete data) compared to freshwater ecosystem targets > 6.5 and < 9.0

Table 5.14.	River Murray channel pH annual (wa	ter year) percentage of samples excee	dance analysis (from discrete data)	compared to freshwater ecosystem targets
	> 6.5			

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray 8km downstream Lock 6	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	NA									
River Murray 11km Downstream Lock 6	NA	0	0	0	0	0	0	0	0														
River Murray Renmark	NA	NA	NA	NA	NA	0	0	0	0	0	7	0	0	0	2	0	0	0	0	0	0	0	0
River Murray Lock 5	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Berri	NA	NA	NA	NA	NA	0	0	0	NA	0	5	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Loxton	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Moorook	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Moorook Raw Water	NA	0	0	NA																			
River Murray Cobdogla	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Lock 3	0	0	0	0	0	0	0	0	0	0	4	0	0	NA									
River Murray Woolpunda	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Woolpunda Raw Water	NA	0	0	NA																			
River Murray Waikerie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Cadell	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Cadell Raw Water	NA	0	0	NA																			
River Murray Morgan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Lock 1	NA	0	0	0	0	0	0	NA															
River Murray Blanchetown	NA	0	0	0	0	0	0	0	0	0	0	0											
River Murray Swan Reach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Swan Reach Town	NA	0	0	0	0	0	0	0	0	0	0												
River Murray Mannum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Cowirra	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Mypolonga	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Murray Bridge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Tailem Bend	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Lake Alexandrina Milang	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake Alexandrina Goolwa Barrage US	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5.15.	River Murray channel pH annual (water year)	percentage of samples exceedance analysis (from dis	crete data) compared to freshwater ecosystem targets
	< 9.0		

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray 8km downstream Lock 6	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	NA									
River Murray 11km Downstream Lock 6	NA	0	0	0	0	0	0	0	0														
River Murray Renmark	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
River Murray Lock 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
River Murray Berri	NA	NA	NA	NA	NA	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Loxton	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Moorook	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Moorok Raw Water	NA	0	0	NA																			
River Murray Cobdogla	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Lock 3	0	0	0	0	0	0	0	0	0	2	0	0	0	NA									
River Murray Woolpunda	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murrat Woolpunda Raw Water	NA	0	0	NA																			
River Murray Waikerie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Cadell	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Cadell Raw Water	NA	0	0	NA																			
River Murray Morgan	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
River Murray Lock 1	NA	0	0	0	0	0	0	NA															
River Murray Blanchetown	NA	0	0	0	0	0	0	0	0	0	0	0											
River Murray Swan Reach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0
River Murray Swan Reach Town	NA	0	6	0	0	0	0	0	0	0	0												
River Murray Mannum	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Cowirra	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Mypolonga	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Murray Bridge	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Tailem Bend	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	2	0	0
Lake Alexandrina Milang	NA	NA	NA	NA	NA	0	0	0	0	2	0	2	0	2	0	0	2	0	0	0	0	0	17
Lake Alexandrina Goolwa Barrage US	NA	NA	NA	NA	NA	NA	0	0	0	0	2	0	14	0	0	0	0	0	0	0	0	0	8

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray 8km downstream Lock 6	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	NA									
River Murray 11km Downstream Lock 6	NA	0	0	0	0	0	0	0	0														
River Murray Renmark	NA	NA	NA	NA	NA	0	0	0	0	0	7	0	0	0	2	2	0	0	0	0	0	0	0
River Murray Lock 5	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0
River Murray Berri	NA	NA	NA	NA	NA	0	0	0	NA	0	5	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Loxton	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Moorook	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Moorok Raw Water	NA	0	0	NA																			
River Murray Cobdogla	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Lock 3	0	0	0	0	0	0	0	0	0	2	4	0	0	NA									
River Murray Woolpunda	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murrat Woolpunda Raw Water	NA	0	0	NA																			
River Murray Waikerie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Cadell	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Cadell Raw Water	NA	0	0	NA																			
River Murray Morgan	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
River Murray Lock 1	NA	0	0	0	0	0	0	NA															
River Murray Blanchetown	NA	0	0	0	0	0	0	0	0	0	0	0											
River Murray Swan Reach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0
River Murray Swan Reach Town	NA	0	6	0	0	0	0	0	0	0	0												
River Murray Mannum	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Cowirra	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Mypolonga	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
River Murray Murray Bridge	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Tailem Bend	0	0	0	2	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	2	2	0	0
Lake Alexandrina Milang	NA	NA	NA	NA	NA	0	0	0	0	2	0	2	0	2	0	0	2	0	0	0	0	0	17
Lake Alexandrina Goolwa Barrage US	NA	NA	NA	NA	NA	NA	0	0	0	0	2	0	14	0	0	0	0	0	0	0	0	0	8

 Table 5.16. River Murray channel pH annual (water year) percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem target range of 6.5 to 9.0. Shading indicates years with an annual median outside the target range (exceedances greater than 50%)



Figure 5.15. River Murray channel pH (from continuous data) compared to freshwater ecosystem targets > 6.5 and < 9.0, from 2008 to 2014

Table 5.17. River Murray channel pH annual (water year)	percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem targets
> 6.5		

Reach	Site number	Continuous monitoring sites	2008	2009	2010	2011	2012	2013	2014	2015
Below Lock 1	A4261161	River Murray adjacent Mannum Town Wharf	NA	0	0	0	0	NA	NA	NA
Below Lock 1	A4261162	River Murray at Murray Bridge (Long Island)	NA	0	0	0	11	100	NA	NA
Below Lock 1	A4261159	River Murray 2km downstream Wellington Ferry	NA	0	0	0	0	0	0	NA
Below Lock 1	A4261124	Goolwa Channel 2km West Clayton (Starboard Beacon 65)	NA	0	0	0	0	0	NA	NA
Below Lock 1	A4261133	Lake Alexandrina at Beacon 97 (Offshore Raukkan)	NA	0	0	0	0	0	NA	NA
Below Lock 1	A4261156	Lake Alexandrina 3km West Point McLeay (Star'Beacon 95)	NA	0	0	0	NA	NA	NA	NA
Below Lock 1	A4261153	Lake Albert Near Causeway at Waltowa Swamp	0	0	0	0	0	NA	0	0
Below Lock 1	A4261155	Lake Albert 2km North Warringee Point	NA	0	0	0	0	NA	0	0

Table 5.18. River Murray channel pH annual (water year) percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem targets < 9.0

Reach	Site number	Continuous monitoring sites	2008	2009	2010	2011	2012	2013	2014	2015
Below Lock 1	A4261161	River Murray adjacent Mannum Town Wharf	NA	0	0	0	0	NA	NA	NA
Below Lock 1	A4261162	River Murray at Murray Bridge (Long Island)	NA	0	0	0	0	0	NA	NA
Below Lock 1	A4261159	River Murray 2km downstream Wellington Ferry	NA	0	0	0	0	0	0	NA
Below Lock 1	A4261124	Goolwa Channel 2km West Clayton (Starboard Beacon 65)	NA	0	0	0	0	4	NA	NA
Below Lock 1	A4261133	Lake Alexandrina at Beacon 97 (Offshore Raukkan)	NA	6	10	0	0	0	NA	NA
Below Lock 1	A4261156	Lake Alexandrina 3km West Point McLeay (Star'Beacon 95)	NA	1	0	0	NA	NA	NA	NA
Below Lock 1	A4261153	Lake Albert Near Causeway at Waltowa Swamp	0	0	24	52	3	NA	1	0
Below Lock 1	A4261155	Lake Albert 2km North Warringee Point	NA	0	30	49	27	NA	0	20

 Table 5.19. River Murray channel pH annual (water year) percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target range 6.5 to 9.0. Shading indicates years with an annual median outside the target range (exceedances greater than 50%)

Reach	Site number	Continuous monitoring sites	2008	2009	2010	2011	2012	2013	2014	2015
Below Lock 1	A4261161	River Murray adjacent Mannum Town Wharf	NA	0	0	0	0	NA	NA	NA
Below Lock 1	A4261162	River Murray at Murray Bridge (Long Island)	NA	0	0	0	11	100	NA	NA
Below Lock 1	A4261159	River Murray 2km downstream Wellington Ferry	NA	0	0	0	0	0	0	NA
Below Lock 1	A4261124	Goolwa Channel 2km West Clayton (Starboard Beacon 65)	NA	0	0	0	0	4	NA	NA
Below Lock 1	A4261133	Lake Alexandrina at Beacon 97 (Offshore Raukkan)	NA	6	10	0	0	0	NA	NA
Below Lock 1	A4261156	Lake Alexandrina 3km West Point McLeay (Star'Beacon 95)	NA	1	0	0	NA	NA	NA	NA
Below Lock 1	A4261153	Lake Albert Near Causeway at Waltowa Swamp	0	0	24	52	3	NA	1	0
Below Lock 1	A4261155	Lake Albert 2km North Warringee Point	NA	0	30	49	27	NA	0	20



Figure 5.16. Data reliability analysis (continuous data) for River Murray channel pH since July 2007, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.
5.1.2.2 Irrigation water

Relevant water quality target for irrigation water is presented in Table 5.20.

Table 5.20. Summary of salinity target for irrigation water

Parameter	Target
Salinity	not exceed 833 uS/cm 95% of the time over each period of 10 years that ends at the water accounting period

Continuous salinity data for sites along the River Murray aggregated by reach is presented in Figure 5.17. The results of the exceedance analysis for the same sites are presented in Table 5.21. Whether sites remain below the target 95% of the time for each 10-year period is indicated in Table 5.22. The availability of data over time is shown in Figure 5.18. All sites remain well below the irrigation target of 833 μ S/cm, except for 2 sites below Lock 1 (Wood Point Pontoon and 2 km downstream from Wellington Ferry) between the 2008 and 2010 water years, during the Millenium Drought. These 2 sites are also the only sites which exceed the target 95% of the time, with the Wood Point Pontoon site exceeding between 2009–10 and 2016–17, and Wellington Ferry site exceeding between 2008–09 and 2018–19 (Table 5.22). Of these exceedances, the most significant was in 2009, with a 97% exceedance rate at 2 km downstream of Wellington Ferry, while other exceedances were below 50% exceedance. While still below the salinity threshold, increased salinity is observed along the entire length of the SA River Murray in Figure 5.17 at the start of 2023, following the high flow to SA (Figure 5.3) and the 2022–23 River Murray flood event, which likely mobilised salt from the surrounding floodplains including surface salt wash off and saline groundwater.



Figure 5.17. River Murray channel salinity (from continuous data) compared to water quality target for irrigation water of < 833 µS/cm

Reach	Site Number	Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Above Lock 6	A4261022	River Murray upstream Old Customs House (AMTD 637.1km)	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Above Lock 6	A4260510	River Murray at Lock 6 Upstream (AMTD 619.8km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Lock 5 to Lock 6	A4260705	River Murray upstream Chowilla Creek (AMTD 613.3km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 5 to Lock 6	A4260512	River Murray at Lock 5 Upstream (AMTD 562.4km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Lock 3 to Lock 4	A4260642	River Murray upstream Rilli Island (AMTD 500.5km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 3 to Lock 4	A4261025	River Murray upstream Moorook (AMTD 455.6km)	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 3	A4260652	River Murray upstream Overland Corner (AMTD 426.5km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 3	A4260573	River Murray at Woolpunda Pump Station (AMTD 411.5 Km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 3	A4260593	River Murray at Holder (AMTD 392.0 Km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 3	A4260594	River Murray upstream Sunlands PS (AMTD 373.6 Km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 3	A4260518	River Murray at Lock 2 Upstream (AMTD 362.1km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Lock 1 to Lock 2	A4260702	River Murray downstream Hogwash Bend (AMTD 347.5km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 1 to Lock 2	A4260554	River Murray at Morgan No1 Pump Station (AMTD 321.7 Km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 1 to Lock 2	A4260902	River Murray at Lock 1 Upstream (AMTD 274.3km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Below Lock 1	A4261163	River Murray at Walker Flat (AMTD 207km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0								
Below Lock 1	A4261126	River Murray at Wood Point Pontoon (AMTD 96km)	NA	NA	NA	NA	NA	NA	0	35	1	17	0	0	0	0	0	0	0	0	0	0	0	0	0
Below Lock 1	A4261159	River Murray 2km downstream Wellington Ferry	NA	97	4 5	0	0	0	0	0	0	0	0	0	0	0	0	0							

Table 5.21. River Murray channel salinity annual (water year) percentage of days exceedance analysis (from continuous data) compared to water quality target for irrigation water of < 833 μS/cm

Reach	Site Number	Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Above Lock 6	A4261022	River Murray upstream Old Customs House (AMTD 637.1km)	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Above Lock 6	A4260510	River Murray at Lock 6 Upstream (AMTD 619.8km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Lock 5 to Lock 6	A4260705	River Murray upstream Chowilla Creek (AMTD 613.3km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 5 to Lock 7	A4260512	River Murray at Lock 5 Upstream (AMTD 562.4km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Lock 3 to Lock 4	A4260642	River Murray upstream Rilli Island (AMTD 500.5km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 3 to Lock 4	A4261025	River Murray upstream Moorook (AMTD 455.6km)	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 3	A4260652	River Murray upstream Overland Corner (AMTD 426.5km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 4	A4260573	River Murray at Woolpunda Pump Station (AMTD 411.5 Km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 5	A4260593	River Murray at Holder (AMTD 392.0 Km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 6	A4260594	River Murray upstream Sunlands PS (AMTD 373.6 Km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 2 to Lock 7	A4260518	River Murray at Lock 2 Upstream (AMTD 362.1km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Lock 1 to Lock 2	A4260702	River Murray downstream Hogwash Bend (AMTD 347.5km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 1 to Lock 3	A4260554	River Murray at Morgan No1 Pump Station (AMTD 321.7 Km)) 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lock 1 to Lock 4	A4260902	River Murray at Lock 1 Upstream (AMTD 274.3km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Below Lock 1	A4261163	River Murray at Walker Flat (AMTD 207km)	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0								
Below Lock 1	A4261126	River Murray at Wood Point Pontoon (AMTD 96km)	NA	NA	NA	NA	NA	NA	0	35	1	17*	0	0	0	0	0	0	0	0	0	0	0	0	0
Below Lock 1	A4261159	River Murray 2km downstream Wellington Ferry	NA	97	45	0	0	0	0	0	0	0	0	0	0	0	0	0							

Table 5.22. River Murray channel salinity annual (water year) percentage of days exceedance analysis (from continuous data) compared to water quality target for irrigation water of < 833 µS/cm.

*Shading indicates whether water year salinity is below the target 95% of the time including that year and the four previous water years. Where five years of data are not available, but the year would exceed regardless, the year is also considered to have exceeded and the cell is shaded.



Figure 5.18. Data reliability analysis (continuous data) for River Murray channel salinity since July 2000, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.1.2.3 Recreational water

Basin Plan water quality targets for recreational water are presented in Table 5.23.

Table 5.23.	Summary of	f blue-green	algae targ	get for recrea	ational water.
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Parameter	Target	Note
Cyanobacteria	Not exceed ≥ 50,000 cells/mL, or 10 μg/L	Assessed against Total blue- green algae parameter

Figure 5.19 shows the discrete data for total blue-green algae at sites along the SA River Murray with the target to not exceed 50,000 cells/mL. Percentage exceedance analysis for these sites is displayed in Table 5.24. Exceedances of 10% or less are present at most of the sites with long records. Morgan Sample Pump Station has slightly higher exceedances, with exceedances as large as 23% (2023). Both Lake Alexandrina sites have significant exceedances for all years with data, with exceedances over 98% for the 5 most recent water years (2019 to 2023) at Milang. The significantly higher number of exceedances observed in Lake Alexandrina and at Goolwa are reflective of reduced mixing and flushing of the lakes relative to the main channel.



Figure 5.19. River Murray channel blue-green algal cell count (from discrete data) compared to water quality target for recreational water of < 50,000 cells/mL

Site	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray 8km downstream Lock 6	NA	NA	NA	0	0	0	2	2	0	0	0	0	0	0	NA						
River Murray 11km Downstream Lock 6	NA	NA	NA	NA	NA	0	0	0	0	0	0	0									
River Murray Renmark Sample Pump	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
River Murray Lock 5	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
River Murray Lyrup Ferry	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
River Murray Berri Sample Pump	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Loxton Sample Pump	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Moorook Sample Pump	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
River Murray Cobdogla Sample Pump	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Kingston on Murray	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
River Murray Lock 3	NA	NA	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
River Murray Woolpunda Sample Pump	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
River Murray Waikerie Sample Pump	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
River Murray Cadell Sample Pump	NA	NA	NA	NA	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Morgan Sample Pump	0	0	0	0	0	18	0	4	0	2	2	0	13	4	0	12	0	0	4	0	23
River Murray Blanchetown Sample Pump	NA	NA	0	0	0	0	0	0	0	0	0	0									
River Murray Swan Reach Sample Pump	NA	0	0	4	0	3	0	2	0	0	0	0	2	0	2	2	0	0	0	0	0
River Murray Swan Reach Town Sample Pump	NA	NA	0	0	0	2	2	0	0	0	0	0									
River Murray Walkers Flat	NA	NA	NA	NA	0	0	4	0	0	0	0	NA									
River Murray Mannum Sample Pump	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
River Murray Cowirra Sample Pump	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
River Murray Wall Flat	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
River Murray Mypolonga Sample Pump	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Murray Bridge Sample Pump	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River Murray Jervois	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
River Murray Tailem Bend Sample Pump	NA	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	10
River Murray Tailem Bend Surface	0	0	NA	NA	NA	0	0	10	0	0	0	0	0	NA							
Lake Alexandrina Milang	NA	29	96	96	96	96	68	100	58	<mark>5</mark> 0	NA	NA	NA	NA	87	98	100	100	100	100	98
Lake Alexandrina Goolwa Barrage US	100	77	96	95	100	55	NA	NA	NA	NA	NA	100	96	92	NA						

Table 5.24. River Murray channel blue-green algal cell count percentage of samples exceedance analysis (from discrete data) compared to water quality target for recreational water of < 50,000 cells/mL

5.1.3 Long-term salinity management

Relevant water quality targets for long-term salinity management are presented in Table 5.25.

Parameter	Target	Notes
Salinity (absolute value;	not exceed 412 μS/cm (80%)	For SA Border, target site River Murray upstream Old Customs House (AMTD 637.1 km)
percentage of time target must	not exceed 543 μS/cm (80%)	For Berri, target site River Murray at Berri Irrigation PS (AMTD 525.7 km)
exceeded)	not exceed 800 μS/cm (95%)	For Basin salinity target, target site River Murray at Morgan No1 Pump Station (AMTD 321.7 km)
	not exceed 770 μS/cm (80%)	For Below Morgan, target site River Murray at Murray Bridge (Long Island)

 Table 5.25. Summary of salinity targets for long-term salinity management

Continuous salinity data at each of the SA End-of-Valley target locations is presented in Figure 5.20, along with the long-term salinity management targets (Table 5.25). Percentage exceedance analysis results are presented in Table 5.26 for these sites, as well as whether the sites exceed the relevant percentage of time target.

Figure 5.21 presents the data availability over the same period. Largely, all sites remain below their targets, although there are numerous minor exceedances (3% or less) at all sites except the Morgan No1 Pump Station. Importantly, no sites exceed the target more than 20% of the time (5% for Morgan). Exceedances of 22% and 21% respectively are seen at upstream Old Customs House (2023) and Murray Bridge Long Island (2009). The exceedance at upstream Old Customs House in 2023 coincides with the 2022–23 River Murray flood event and the significant flood flows entering the SA River Murray. Conversely, the exceedance at Murray Bridge Long Island in 2009 occurred during the Millenium Drought when flows were significantly lower in the SA River Murray (Figure 5.3) and the barrages, which are critical in exporting salt and maintaining salinity levels in the lower lakes and Murray River, were closed.



Figure 5.20. River Murray channel salinity (from continuous data) compared to site-specific End-of-Valley targets as per Table 5.25

 Table 5.26. River Murray channel salinity percentage of days exceedance analysis (continuous data) compared to site-specific End-of-Valley targets as per Table 5.25.

 The last column indicates whether the site is below the relevant target 95% of the time in the case of the Morgan station, and 80% of the time for all other stations.

Site number	SA Reporting Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Below % of time target?
A4261022	River Murray upstream Old Customs House (AMTD 637.1km)	NA	NA	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	22	Yes
A4260537	River Murray at Berri Irrigation PS (AMTD 525.7km)	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	Yes
A4260554	River Murray at Morgan No1 Pump Station (AMTD 321.7km)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes
A4261162	River Murray at Murray Bridge (Long Island)	NA	21	2	0	0	0	0	0	0	0	0	0	0	0	0	0	Yes							



Figure 5.21. Data reliability analysis (continuous data) for River Murray channel salinity (End-of-Valley targets) since July 2000, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.2 River Murray floodplains in South Australia

The Chowilla, Pike and Katarapko floodplains of the SA River Murray were assessed against the Basin Plan freshwater-dependent ecosystem targets for dissolved oxygen. Environmental regulators and other infrastructure such as blocking banks have been built on each of the floodplains, with site operations intended to maximise the environmental benefits derived from water for the environment delivery while minimising any water quality impacts. For example, adequate passing flows in the River Murray and through the floodplains, which ensure dilution, exchange and mixing, are accounted for during floodplain operations to mitigate potential water quality impacts from the inundation of the floodplains using water for the environment. The relevant target for each floodplain in the context of this report relates to dissolved oxygen as summarised in Table 5.27. A map of the floodplains, as well as relevant monitoring sites, is presented in Figure 5.22. For all 3 floodplains, there is missing or poor-quality data during and after the 2022–23 River Murray flood event. as many monitoring sites had to be removed due to high water. Data availability for each of the sites is also presented.

Table 5.27. Summary of dissolved oxygen target for freshwater-dependent ecosystems in SA River Murray floodplains.

Parameter	Target (Annual median)
Dissolved oxygen	within 85 to 110% saturation



Figure 5.22. Data assessment site locations – River Murray floodplain monitoring sites

5.2.1 Chowilla floodplain

The Lock 6 weir pool level changes displayed in Figure 5.23 highlight the timing of managed weir pool raising or lowering events, either for within-channel weir pool manipulation or for the purposes of Chowilla floodplain operations. Focusing on the period for which there is also continuous DO data available, medium weir pool raising events at Lock 6 to support operations at Chowilla floodplain occurred between July and November 2021 and again in 2022, immediately followed by the 2022–23 River Murray flood event.

Figure 5.24 shows the continuous data for DO saturation at sites within the Chowilla floodplain against the freshwater-dependent ecosystems target set out in Table 5.27 (85 to 110% saturation, or 7 to 9 mg/L). Exceedance analysis for these sites, are presented in Table 5.28 and Table 5.29. Table 5.30 shows whether the annual median DO falls outside the target range for each site. Data availability for these sites is presented in

Figure 5.25. The seasonal response of dissolved oxygen to temperature changes (warming in summer versus cooling in winter) is evident, whereby increasing water temperatures generally reduces dissolved oxygen levels and vice versa (although exceptions to this trend do occur, likely due to greater influences from other factors such as flow). Managed inundation events on the Chowilla floodplain in 2021 and 2022 did not result in DO exceedance events, with operations intended to maximise the environmental benefits derived from water for the environment delivery and to minimise any water quality impacts.

In all years, for all sites, DO was within in the target range (Table 5.30), though there were some exceedances within years which are worth noting. The exceedances due to the notable drop in DO saturation as low as 25% at the River Murray upstream of Old Custom House in late 2022 and into early 2023 originated above the SA border due to a blackwater event commencing because of high flows across New South Wales and Victoria. The event mobilised large amounts of organic matter from the floodplain into the River Murray as areas of the floodplain which had not been inundated since the high flow in the early 1990s (DEW 2016) were inundated. The same influence was observed at both the Chowilla Creek and Punkah Creek sites in 2022 and 2023 within the Chowilla floodplain, which was connected to the SA River Murray throughout the event.

Conversely, the exceedances due to DO saturation peaks above 110% observed at the River Murray upstream of Old Customs House in all years between 2018 and 2022 (Figure 5.24 and Table 5.29) coincide with relatively low flows in the River Murray (Figure 5.3). The same DO peaks were also observed at Chowilla Creek and Punkah Creek on the Chowilla floodplain and in the River Murray downstream of the floodplain in the same years, except for 2022 (Figure 5.24).



Figure 5.23. Weir pool level at Lock 6 (m AHD) from 2000 to 2024



Figure 5.24. Chowilla floodplain continuous dissolved oxygen saturation compared to freshwater ecosystem target >85% and <110%

Table 5.28.	Chowilla floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater
	ecosystem target > 85%

Site	2018	2019	2020	2021	2022	2023
A4261022 – River Murray upstream Old Customs House	2	1	7	0	4	23
A4261168 – River Murray DS Chowilla Woolshed Adj Chowilla HS	3	0	0	2	1	0
A4260580 – Punkah Creek at Sheeps Bridge	2	0	2	0	1	47
A4261107 – Chowilla Creek upstream Monoman Creek	0	0	1	0	1	39
A4261224 – Chowilla Creek 1.5km Upstream River Murray junction	1	0	1	1	9	42

 Table 5.29. Chowilla floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater

 ecosystem target < 110%</td>

Site	2018	2019	2020	2021	2022	2023
A4261022 – River Murray upstream Old Customs House	5	24	1	25	5	0
A4261168 – River Murray DS Chowilla Woolshed Adj Chowilla HS	0	0	0	21	0	0
A4260580 – Punkah Creek at Sheeps Bridge	18	1	11	3	0	0
A4261107 – Chowilla Creek upstream Monoman Creek	1	0	0	21	0	0
A4261224 – Chowilla Creek 1.5km Upstream River Murray junction	12	0	8	14	0	0

 Table 5.30. Chowilla floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater

 ecosystem target range of 85 to 110%. Shading* indicates years with an annual median outside the target range (exceedances greater than 50%).

Site	2018	2019	2020	2021	2022	2023
A4261022 – River Murray upstream Old Customs House	7	25	8	25	9	23
A4261168 – River Murray DS Chowilla Woolshed Adj Chowilla HS	3	0	0	23	1	0
A4260580 – Punkah Creek at Sheeps Bridge	20	1	13	3	1	47
A4261107 – Chowilla Creek upstream Monoman Creek	1	0	1	21	1	39
A4261224 – Chowilla Creek 1.5km Upstream River Murray junction	13	0	9	15	9	42

*No years exceed the 50% threshold for these sites, so no shading is present.



Figure 5.25. Data reliability analysis (continuous data) for Chowilla floodplain DO since July 2017, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.2.2 Pike floodplain

The Lock 5 weir pool level changes displayed in Figure 5.26 highlight the timing of managed weir pool raising or lowering events, either for within channel weir pool manipulation or for the purposes of Pike floodplain operations. Focusing on the period for which there is also continuous DO data available, weir pool raising events at Lock 5 to support operations at the Pike floodplain occurred in 2020, 2021 and 2022, with the latter immediately followed by the 2022–23 River Murray flood event.

Figure 5.27 displays the continuous data for dissolved oxygen saturation at sites within the Pike floodplain against the freshwater-dependent ecosystems target set out in Table 5.27. The exceedance analysis for these sites is presented in Table 5.31 and Table 5.32. Table 5.33 shows whether the annual median DO falls outside the target range for each site. Data availability for these sites is presented in Figure 5.28. The seasonal response of dissolved oxygen to temperature changes (warming in summer versus cooling in winter) is evident, whereby increasing water temperatures generally reduces dissolved oxygen levels and vice versa (although exceptions to this trend do occur, likely due to greater influences from other factors such as flow). Managed inundation events on the Pike floodplain in 2020, 2021 and 2022 did not result in DO exceedance events, with operations intended to maximise the environmental benefits derived from water for the environment delivery and minimise any water quality impacts.

No sites had an annual median outside the target range (Table 5.33), although Mundic Creek in 2021–22 and Pike River upstream of Col Col in 2022–23 were both above 45% exceedance. Dissolved oxygen saturation less than the 85% target was observed at all sites in 2022, associated with the 2022–23 flood (Figure 5.3) and the progression of a blackwater event originating upstream of South Australia. The low DO persisted in early 2023 in both the River Murray channel and the Pike floodplain before DO measurement at all sites was impacted by high flow and data records ceased across all sites. Conversely, DO saturations exceeding 110% were most significant in 2021 (with a maximum annual percentage exceedance of 36% at Pike River at Lettons downstream of Rumpagunyah Creek), when flow to SA was low (Figure 5.3) and supersaturated conditions likely persisted due to slower-moving water and seasonally lower water temperatures in the river and floodplain.



Figure 5.26. Weir pool level at Lock 5 (m AHD) from 2000 to 2024



Figure 5.27. Pike floodplain continuous dissolved oxygen saturation compared to freshwater ecosystem target >85% and <110%

Site	2018	2019	2020	2021	2022	2023
A4260703 – River Murray upstream Renmark	6	3	0	5	19	21
A4261278 – River Murray downstream Lyrup	6	8	1	0	2	0
A4261268 – Mundic Creek @ upstream Bank D	24	7	5	0	48	0
A4261539 – Tanyaca Creek upstream Tanyaca regulator	NA	NA	NA	7	26	0
A4261053 – Pike River upstream Col Col Bank	NA	NA	NA	0	26	46
A4260644 – Pike River at Lettons d/s Rumpagunyah Creek	12	1	1	8	2	NA

 Table 5.31. Pike floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater

 ecosystem target > 85%

 Table 5.32. Pike floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater

 ecosystem target < 110%</td>

Site	2018	2019	2020	2021	2022	2023
A4260703 – River Murray upstream Renmark	2	5	0	16	0	0
A4261278 – River Murray downstream Lyrup	3	3	1	4	1	0
A4261268 – Mundic Creek @ upstream Bank D	12	3	0	13	1	0
A4261539 – Tanyaca Creek upstream Tanyaca regulator	NA	NA	NA	6	1	0
A4261053 – Pike River upstream Col Col Bank	NA	NA	NA	5	0	0
A4260644 – Pike River at Lettons d/s Rumpagunyah Creek	2	0	4	36	0	NA

Table 5.33. Pike floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwate
ecosystem target range of 85 to 110%. Shading indicates years with an annual median outside the target range (exceedances greater than 50%)

Site	2018	2019	2020	2021	2022	2023
A4260703 – River Murray upstream Renmark	8	8	0	21	19	21
A4261278 – River Murray downstream Lyrup	9	11	2	4	3	0
A4261268 – Mundic Creek @ upstream Bank D	36	10	5	13	49	0
A4261539 – Tanyaca Creek upstream Tanyaca regulator	NA	NA	NA	13	27	0
A4261053 – Pike River upstream Col Col Bank	NA	NA	NA	5	26	46
A4260644 – Pike River at Lettons d/s Rumpagunyah Creek	14	1	5	44	2	NA



Figure 5.28. Data reliability analysis (continuous data) for Pike floodplain DO since July 2017, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.2.3 Katarapko floodplain

The Lock 4 weir pool level changes displayed in Figure 5.29 highlight the timing of managed weir pool raising or lowering events, either for within channel weir pool manipulation or for the purposes of Katarapko floodplain operations. Focusing on the period for which there is also continuous DO data available, weir pool raising events at Lock 4 to support operations at Katarapko floodplain occurred between July and November 2020 and again in 2021. No floodplain inundation operation was conducted in 2022 due to raised river flows preceding the significant flood event in the SA River Murray.

Figure 5.30 shows the continuous data for dissolved oxygen saturation at sites within the Katarapko floodplain against the freshwater-dependent ecosystems target set out in Table 5.27. Exceedance analysis for these sites, and additional sites within the floodplain, are presented in Table 5.34 and Table 5.35. Table 5.36 shows whether the annual median DO falls outside the target range for each site. Data availability for these sites is presented in Figure 5.31. The seasonal response of dissolved oxygen to temperature changes (warming in summer versus cooling in winter) is evident, whereby increasing water temperatures generally reduce dissolved oxygen levels and vice versa (although exceptions to this trend do occur, likely due to greater influences from other factors such as flow). Managed inundation events on the Katarapko floodplain in 2020 and 2021 did not result in DO exceedance events, with operations intended to maximise the environmental benefits derived from water for the environment delivery and minimise any water quality impacts.

Dissolved oxygen saturation less than the 85% target was seen at all sites in all years with data for the floodplain sites, albeit with fewer exceedances observed for the years in which floodplain operations occurred under comparatively higher flow conditions. The River Murray 5 km downstream of the Katarapko Creek Outlet site had the largest percentage of days less than the 85% target, with 54% in 2023, in line with high flows to SA in 2022–23 (Figure 5.3). This exceedance also indicates that the annual median for this site was outside the target range (Table 5.36), the only site and year for this to occur at the Katarapko sites. As noted above, the flood event originated upstream and initiated a blackwater event that progressed downstream to the SA River Murray. Dissolved oxygen saturation exceeding the 110% target was seen at all sites for all years with available data. The most significant exceedances were 21% in 2018 and 2021, both at Eckert Creek upstream of Log Crossing. Exceedances are most significant in years with low flow (2018 to 2021).



Figure 5.29. Weir pool level at Lock 4 (m AHD) from 2000 to 2024





Site	2018	2019	2020	2021	2022	2023
A4261278 – River Murray downstream Lyrup	6	8	1	0	2	0
A4261263 – River Murray 5km ds Katarapko Creek Outlet	0	1	1	0	3	54
A4261255 - Eckert Creek upstream Log Crossing	6	28	4	10	12	3
A4261108 – Katarapko Creek 2km upstream Katarapko	1	6	3	4	6	NA

 Table 5.34. Katarapko floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater

 ecosystem target > 85%

 Table 5.35. Katarapko floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater

 ecosystem target < 110%</td>

Site	2018	2019	2020	2021	2022	2023
A4261278 – River Murray downstream Lyrup	3	3	1	4	1	0
A4261263 – River Murray 5km ds Katarapko Creek Outlet	8	3	11	7	7	0
A4261255 - Eckert Creek upstream Log Crossing	21	6	8	21	1	0
A4261108 – Katarapko Creek 2km upstream Katarapko	9	3	11	1	4	NA

 Table 5.36. Katarapko floodplain continuous dissolved oxygen saturation percentage of days exceedance analysis (from continuous data) compared to freshwater

 ecosystem target range of 85 to 110%. Shading indicates years with an annual median outside the target range (exceedances greater than 50%).

Site	2018	2019	2020	2021	2022	2023
A4261278 – River Murray downstream Lyrup	9	11	2	4	3	0
A4261263 – River Murray 5km ds Katarapko Creek Outlet	8	4	12	7	10	54
A4261255 - Eckert Creek upstream Log Crossing	27	34	12	31	13	3
A4261108 – Katarapko Creek 2km upstream Katarapko	10	9	14	5	10	NA



Figure 5.31. Data reliability analysis (continuous data) for Katarapko floodplain DO since July 2017, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.3 Eastern Mount Lofty Ranges

As described in (DEW 2024c), the Eastern Mount Lofty Ranges (EMLR) WRP area covers an area of approximately 3,588 km² from the Marne River catchment in the north to the Currency Creek catchment, which flows into Lake Alexandrina, in the south (see Figure 5.32). The EMLR catchments are characterised by predominantly intermittent streams with sections of perennial flow supported by groundwater discharge. Of the 13 larger watercourses, 6 flow into Lake Alexandrina, while the remaining 7 flow into the SA River Murray upstream of Murray Bridge. Stream flow generally begins in Autumn and ceases to flow in mid-summer, predominantly influenced by rainfall and runoff, but also by groundwater discharge (South Australian Murray-Darling Basin Natural Resource Management Board 2019). Long-term rainfall data suggests that there have been declines in total annual rainfall in most localities in the EMLR WRP area contributing to a long-term decline in total streamflow in some areas (Savadamuthu et al. 2023). Decline in annual rainfall has been greatest since the onset of the Millenium Drought and has been driven mainly by changes to the seasonality of rainfall, largely due to decreased rainfall in spring and autumn (Savadamuthu and McCullough 2024). Collectively, the EMLR water courses contribute a relatively small, but variable annual average flow to the River Murray system. For example, the total modelled end of system flow from the 5 major catchments (Angas River, Bremer River, Currency Creek, Finniss River and Tookayerta Creek, all of which flow into Lake Alexandrina) totalled 29 GL in 2018–19 compared to 127 GL in 2022–23, highlighting the variability and influence of climate on runoff.

The flow regime of the EMLR WRP catchments dictates the water quality results, which are presented below. As described in Section 3.2, the water quality targets specified in the Basin Plan are not appropriate for ephemeral, disconnected systems. However, the EMLR WRP area data available have been assessed to fulfil Matter 12 reporting requirements and to demonstrate the need for the system-appropriate targets currently under development. Note that there has been minimal water quality data collection in the EMLR beyond continuous salinity monitoring since the 2020 report but the data record commencing 2001 has been analysed and presented below for completeness. The water quality parameter targets for freshwater-dependent ecosystems and irrigation water used for the EMLR are summarised in Table 5.37.

Parameters	Target (Annual median)
Dissolved oxygen	within 85 to 110% saturation
Total phosphorus	not exceed 100 µg/L
Total nitrogen	not exceed 1000 µg/L
рН	within 6.5 to 9

 Table 5.37. Summary of water quality parameter targets for freshwater-dependent ecosystems and irrigation water in the EMLR



Figure 5.32. Data assessment site locations – EMLR monitoring sites

5.3.1 Dissolved oxygen

Discrete DO saturation exceedance analysis is shown in Table 5.38, Table 5.39 and Table 5.40 shows whether the annual median DO saturation falls within the 85 to 110% target for these years. Equivalent continuous data analysis is shown in Table 5.41 to Table 5.43, with data reliability shown in Figure 5.33. Response to very low flows during the Millenium Drought are observed in the annual median DO saturation (discrete data) outside of the target at most of the sites between 2000–01 and 2000–10 (Table 5.40). Exceedances are also present in 2015, however do not occur often.

The only continuous dissolved oxygen data available for the EMLR is from the site at Rodwell Creek off Scrubby Hill Road, Highland Valley and the data availability is displayed in Figure 5.33. This Rodwell Creek continuous data shows all annual median DO saturation values were outside of the target range (Table 5.43), with the majority of exceedances due to DO saturation less than 85% (Table 5.41).

Site	2001	2002	2003	2004	2005	2006	2007	2010	2015	2021
Angas River – downstream Strathalbyn GS426564	NA	NA	B 3	67	50	82	67	NA	NA	NA
Bremer River – Wandstead Road (7506)	NA	NA	0	<mark>5</mark> 5	42	45	75	NA	NA	NA
Bremer River – near Hartley GS426533	20	29	44	<mark>5</mark> 5	45	45	100	NA	NA	NA
Bremer River – at Jaensch Rd ford (1824)	NA	NA	NA	NA	5 0	0	B 3	100	<mark>5</mark> 0	NA
Finniss River – 4km east of Yundi GS426504	45	5 0	<mark>5</mark> 5	46	5 0	45	75	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	NA	NA	29	67	<mark>5</mark> 0	5 0	B 3	0	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	NA	NA	NA	5 0	50	0	0	5 0	0
Marne River – Mannum Rd (3844) (c0147)	NA	NA	5 0	100	100	80	NA	100	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	NA	NA	NA	5 0	0	0	0	100	NA

 Table 5.38. EMLR dissolved oxygen saturation percentage of samples exceedance analysis (from discrete data) compared to freshwater dependent ecosystem

 target > 85%

 Table 5.39. EMLR dissolved oxygen saturation percentage of samples exceedance analysis (from discrete data) compared to freshwater dependent ecosystem

 target < 110%</td>

Site	2001	2002	2003	2004	2005	2006	2007	2010	2015	2021
Angas River – downstream Strathalbyn GS426564	NA	NA	33	8	0	9	0	NA	NA	NA
Bremer River – Wandstead Road (7506)	NA	NA	60	27	33	36	0	NA	NA	NA
Bremer River – near Hartley GS426533	40	29	11	18	36	36	0	NA	NA	NA
Bremer River – at Jaensch Rd ford (1824)	NA	NA	NA	NA	50	100	0	0	0	NA
Finniss River – 4km east of Yundi GS426504	36	80	36	38	42	27	25	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	NA	NA	43	8	33	17	0	0	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	NA	NA	NA	0	<mark>5</mark> 0	50	<mark>5</mark> 0	0	0
Marne River – Mannum Rd (3844) (c0147)	NA	NA	0	0	0	0	NA	0	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	NA	NA	NA	0	0	0	100	0	NA

Table 5.40.	EMLR dissolved oxygen saturation percentage of samples exceedance analysis (from discrete data) compared to freshwater dependent ecosystem target
	range of 85 to 110%. Shading indicates years with an annual median outside the target range.

Site	2001	2002	2003	2004	2005	2006	2007	2010	2015	2021
Angas River – downstream Strathalbyn GS426564	NA	NA	66	75	50	91	67	NA	NA	NA
Bremer River – Wandstead Road (7506)	NA	NA	60	82	75	81	75	NA	NA	NA
Bremer River – near Hartley GS426533	60	58	55	73	81	81	100	NA	NA	NA
Bremer River – at Jaensch Rd ford (1824)	NA	NA	NA	NA	100	100	33	100	50	NA
Finniss River – 4km east of Yundi GS426504	81	80	91	84	92	72	100	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	NA	NA	72	75	83	67	33	0	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	NA	NA	NA	50	100	50	50	50	0
Marne River – Mannum Rd (3844) (c0147)	NA	NA	50	100	100	80	NA	100	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	NA	NA	NA	50	0	0	100	100	NA

Table 5.41. EMLR DO percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target > 85% saturation

Site number	Continuous monitoring sites	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4261139	Rodwell Creek Off Scrubby Hill Road Highland Valley	100	100	81	91	90	99	99	85	96

Table 5.42. EMLR DO percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target < 110% saturation</th>

Site number	Continuous monitoring sites	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4261139	Rodwell Creek Off Scrubby Hill Road Highland Valley	0	0	0	1	1	0	0	0	0

Table 5.43. EMLR DO percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target range of 85 to 110%. Shading indicates years with an annual median outside the target range.

Site number	Continuous monitoring sites	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4261139	Rodwell Creek Off Scrubby Hill Road Highland Valley	100	100	81	92	91	99	99	85	96



Figure 5.33. Data reliability analysis (continuous data) for Rodwell Creek DO since July 2014, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.3.2 Total phosphorus and total nitrogen

The discrete data for total phosphorus and total nitrogen is displayed as exceedances in Table 5.44 and Table 5.45 respectively. The Angas, Finniss and Marne Rivers all display annual median total phosphorus of less than 100 µg/L for fresh water-dependent ecosystems for all years with data. The Bremer River at Wandstead Road and near Hartley both show exceedances in 2006–07, and at Wandstead Road exceedances were also observed in 2003. These exceedances coincide with the Millennium Drought and historically low flows across the Murray–Darling Basin. The Bremer and Marne Rivers displayed exceedances between 50% and 100% (greater than the annual median target) against the equivalent total nitrogen target for the years in which data was available, except for the Bremer River in 2010.

Table 5.44.	. EMLR total phosphorus percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem target < 1	100 µg/L. Shading
	indicates years with an annual median greater than the target.	

Site	2001	2002	2003	2004	2005	2006	2007	2010	2015	2021
Angas River – downstream Strathalbyn GS426564	NA	NA	17	25	0	17	33	NA	NA	NA
Bremer River – Wandstead Road (7506)	NA	NA	67	27	15	23	60	NA	NA	NA
Bremer River – near Hartley GS426533	0	25	33	8	42	33	100	NA	NA	NA
Bremer River – at Jaensch Rd ford (1824)	NA	NA	NA	NA	0	0	17	0	0	NA
Finniss River – 4km east of Yundi GS426504	45	8	27	38	25	8	12	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	NA	NA	12	0	25	15	22	0	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	NA	NA	NA	0	0	0	0	0	0
Marne River – Mannum Rd (3844) (c0147)	NA	NA	0	0	0	0	NA	0	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	NA	NA	NA	0	0	0	0	0	NA

Table 5.45. EMLR total nitrogen percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem target < 1000 µg/L. Shading indicates years with an annual median greater than the target.

Site	2007	2010	2015	2021
Bremer River – at Jaensch Rd ford (1824) (c0140)	100	0	50	NA
Finniss River – 4km east of Yundi GS426504	0	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	0	0	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	0	0	0
Marne River – Mannum Rd (3844) (c0147)	NA	100	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	100	100	NA

5.3.3 pH

The discrete pH data (Table 5.46 and Table 5.47) displays no exceedances of the pH target for fresh waterdependent ecosystems, and hence the annual median pH is well within the target range (Table 5.48).

The only continuous pH data available for the EMLR is collected at the Rodwell Creek off Scrubby Hill Road, Highland Valley site (Figure 5.34) and the data availability is displayed in Figure 5.35. Only 2 minor exceedances were observed, in 2016 (Table 5.49) and in 2022 (Table 5.50), and overall no years exceeded the annual median target (Table 5.51).

Table 5.46.	EMLR pH percentage of samples exceedance analysis (from discrete data) compared to freshwater
	ecosystem target > 6.5

Site	2001	2002	2003	2004	2005	2006	2007	2010	2015	2021
Angas River – downstream Strathalbyn GS426564	NA	NA	0	0	0	0	0	NA	NA	NA
Bremer River – Wandstead Road (7506)	NA	NA	0	0	0	0	0	NA	NA	NA
Bremer River – near Hartley GS426533	0	0	0	0	0	0	0	NA	NA	NA
Bremer River – at Jaensch Rd ford (1824)	NA	NA	NA	NA	0	0	0	0	0	NA
Finniss River – 4km east of Yundi GS426504	0	0	0	0	0	0	0	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	NA	NA	0	0	0	0	0	NA	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	NA	NA	NA	0	0	0	0	0	0
Marne River – Mannum Rd (3844) (c0147)	NA	NA	0	0	0	0	NA	0	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	NA	NA	NA	0	0	0	0	0	NA

Table 5.47. EMLR pH percentage of samples exceedance analysis (from discrete data) compared to freshwater ecosystem target < 9.0</td>

Site	2001	2002	2003	2004	2005	2006	2007	2010	2015	2021
Angas River – downstream Strathalbyn GS426564	NA	NA	0	0	0	0	0	NA	NA	NA
Bremer River – Wandstead Road (7506)	NA	NA	0	0	0	0	0	NA	NA	NA
Bremer River – near Hartley GS426533	0	0	0	0	0	0	0	NA	NA	NA
Bremer River – at Jaensch Rd ford (1824)	NA	NA	NA	NA	0	0	0	0	0	NA
Finniss River – 4km east of Yundi GS426504	0	0	0	0	0	0	0	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	NA	NA	0	0	0	0	0	NA	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	NA	NA	NA	0	0	0	0	0	0
Marne River – Mannum Rd (3844) (c0147)	NA	NA	0	0	0	0	NA	0	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	NA	NA	NA	0	0	0	0	0	NA

Table 5.48. EMLR pH percentage of samples exceedance analysis (from discrete data) compared to freshwaterecosystem target range 6.5 to 9.0. Shading indicates years with an annual median greater than thetarget.

Site	2001	2002	2003	2004	2005	2006	2007	2010	2015	2021
Angas River – downstream Strathalbyn GS426564	NA	NA	0	0	0	0	0	NA	NA	NA
Bremer River – Wandstead Road (7506)	NA	NA	0	0	0	0	0	NA	NA	NA
Bremer River – near Hartley GS426533	0	0	0	0	0	0	0	NA	NA	NA
Bremer River – at Jaensch Rd ford (1824)	NA	NA	NA	NA	0	0	0	0	0	NA
Finniss River – 4km east of Yundi GS426504	0	0	0	0	0	0	0	NA	NA	NA
Finniss River – Winery Road (7511) (c0163)	NA	NA	0	0	0	0	0	NA	NA	NA
Finniss River – east of Yundi at ford (3188) (c0145)	NA	NA	NA	NA	0	0	0	0	0	0
Marne River – Mannum Rd (3844) (c0147)	NA	NA	0	0	0	0	NA	0	NA	NA
Marne River – south of Cambrai (3843) (c0146)	NA	NA	NA	NA	0	0	0	0	0	NA



Figure 5.34. EMLR pH (from continuous data) compared to freshwater ecosystem target > 6.5 and < 9.0

Table 5.49. EMLR pH percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target > 6.5

Site number	Continuous monitoring sites	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4261139	Rodwell Creek Off Scrubby Hill Road Highland Valley	0	2	0	0	0	0	0	0	0

Table 5.50. EMLR pH percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target < 9.0

Site number	Continuous monitoring sites	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4261139	Rodwell Creek Off Scrubby Hill Road Highland Valley	0	0	0	0	0	0	0	1	0

Table 5.51. EMLR pH percentage of days exceedance analysis (from continuous data) compared to freshwater ecosystem target range of 6.5 to 9.0. Shading* indicates annual median values outside of the target range.

Site number	Continuous monitoring sites	2015	2016	2017	2018	2019	2020	2021	2022	2023
A4261139	Rodwell Creek Off Scrubby Hill Road Highland Valley	0	0	0	0	0	0	0	1	0
*No years avegad the 50% threshold for those sites, so no shading is present										

No years exceed the 50% threshold for these sites, so no shading is present.

A4261139									
07/2014	07/2015	07/2016	07/2017	07/2018	07/2019	07/2020	07/2021	07/2022	07/2023

Figure 5.35. Data reliability analysis (continuous data) for Rodwell Creek pH since July 2014, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.
5.4 Coorong

As described in DEW (2024b), the Coorong is a shallow, estuarine lagoon forming the connection between the River Murray and the Southern Ocean. Hydrology in the Coorong is influenced by barrage flow, tidal influx through the Murray Mouth, evapotranspiration, and wind conditions (Gibbs et al. 2018; Higham 2012; Webster 2005). The environment of the River Murray estuary is directly influenced by freshwater flows through the barrages and the tidal influence at the Murray Mouth. There is a salinity gradient that increases with distance from the Murray Mouth, with salinities in the Coorong North Lagoon (CNL) varying between estuarine and hypersaline, and those in the Coorong South Lagoon (CSL) saline to extremely hypersaline (Brookes et al. 2022). Flows from the Upper South-East via Salt Creek only have localised effects in the South Lagoon (Mosley et al. 2020).

Dredging at the Murray Mouth has been required on several occasions both prior to and since the adoption of the Basin Plan, often for a sustained period of successive years. One such period was during the Millennium Drought (2001 to 2010) when the large reduction in barrage flows (Figure 5.5) necessitated dredging to maintain an open Murray Mouth (Higham 2012). CSL water levels dropped to below sea level (Figure 5.39) and salinity peaked at 150 g/L (Figure 5.40) (Brookes et al. 2009; Gibbs et al. 2018). During periods of low barrage flow, the tidal influence becomes greater, contributing to salt accumulation and reducing the natural flushing that occurs with freshwater inflow (Mosley et al. 2020). Conversely, periods of high barrage flow, such as those experienced during the 2022–23 River Murray flood event, result in higher water levels, reduced salinity in the Coorong, and improvements to the condition of the Murray Mouth.

Water levels and the degree of connectivity (that is exchange and flushing), through the Murray Mouth and between the lagoons, influence water quality conditions in the Coorong. Particle resuspension and turbidity generated by wind and wave action in the shallow lagoons is influenced by water level, and the high residence times (in the South Lagoon in particular) result in hypersaline conditions and elevated nutrient concentrations in the water column and the sediment (Brooks et al. 2022).

The Coorong has been assessed against the declared Ramsar wetland freshwater-dependent ecosystem targets as the Coorong is included in the SARM WRP as a Priority Environmental Asset. These targets are summarised in Table 5.52. However, as documented in the SA Murray Region WRP, the default targets (ANZECC⁸ guidelines for rivers (that is freshwater quality targets) adopted in the Basin Plan and applied throughout this assessment have been demonstrated as inappropriate for the estuarine conditions of the Coorong (Oliver et al. 2015). The Coorong is unique in this respect in the Murray–Darling Basin and the ANZECC guidelines for estuaries would have been more appropriate. A further considerable body of science developed under the *Healthy Coorong, Healthy Basin* (HCHB) Program resulted in the development of more appropriate Coorong water quality targets that are currently being considered. The exceedance analysis presented below for both the continuous and discrete water quality data highlights that the Coorong consistently exceeds the freshwater quality targets for all parameters and that the adoption of more appropriate targets is warranted.

Parameters	Target (for annual median)
DO	within 90 to 110% saturation
Total phosphorus	not exceed 10 µg/L
Total nitrogen	not exceed 350 µg/L
рН	within 6.5 to 8.0
Turbidity	not exceed 20 NTU

Table 5.52. Summary of water quality parameter targets for freshwater-dependent ecosystems in the Coorong

⁸ Australian and New Zealand Environment and Conservation Council

A map of the discrete and continuous monitoring sites for the Coorong is shown in Figure 5.36. Additional context is provided through water level and salinity for the CSL and CNL, which is presented in Figure 5.37 to Figure 5.40.



Figure 5.36. Data assessment site locations - Coorong monitoring sites



Figure 5.37. Average daily Coorong North Lagoon water level (m AHD), calculated from stations at Beacon 1 (A4261043), Pelican Point (A4261134), Long Point (A4261135) and Robs Point (A4260572) from 2000 to 2024



Figure 5.38. Average daily Coorong North Lagoon salinity (g/L), calculated from stations at Beacon 1 (A4261043), Pelican Point (A4261134), Long Point (A4261135) and Robs Point (A4260572) from 2000 to 2024



Figure 5.39. Average daily Coorong South Lagoon water level (m AHD), calculated from stations at Parnka Point (A4260633), Woods Well (A4261209) and Snipe Island (A4261165) from 2000 to 2024



Figure 5.40. Average daily Coorong South Lagoon salinity (g/L), calculated from stations at Parnka Point (A4260633), Woods Well (A4261209) and Snipe Island (A4261165) from 2000 to 2024

5.4.1 Dissolved oxygen

As shown in Figure 5.41, continuous DO monitoring commenced at 4 sites in the Coorong under the HCHB Program, 2 in the Coorong North Lagoon (CNL) at Pelican Point and Long Point and 2 in the Coorong South Lagoon (CSL) at Parnka Point and Snipe Island.

Table 5.55 shows whether the annual median DO saturation was within the target range. Long Point experienced annual median values outside of the target range in 2021–22 and 2022–23, while Parnka Point also fell outside of this range in 2022–23. Data reliability for the continuous data is shown in Figure 5.42.

DO at both the CNL sites frequently fell below the 90% DO saturation target (Table 5.53) with DO values often between 70% and 15% at Pelican Point, coinciding with the higher barrage releases passing the River Murray flood waters in 2022–23. The influence persists along the CNL to Long Point and to Parnka Point between the two lagoons. The DO saturation values above 110% (Table 5.54) at all sites are typically short-lived spikes as the barrage flows from 2021 onwards were comparatively higher, whereas higher DO saturation values are typically associated with lower flow conditions. However, exceedances of this target occur in all 3 years at all sites with the exception of 2022. Conversely, the DO saturation values at Snipe Island, towards the southern end of the CSL remain within the targets the most, with the exception of one period of very low values (50% to 25%), recording fewer exceedances than the other sites.



Figure 5.41. Coorong dissolved oxygen (from continuous data) compared to fresh water-dependent ecosystem target > 90% and < 110%

 Table 5.53. Coorong dissolved oxygen percentage of samples exceedance analysis (from continuous data) compared to fresh water-dependent ecosystem target of

 > 90%

Site number	Continuous monitoring sites	2021	2022	2023
A4261134	The Coorong at Pelican Point	19	78	70
A4261135	The Coorong at Long Point	8	21	28
A4260633	Coorong at Parnka Point	4	22	<mark>48</mark>
A4261165	The Coorong NW Snipe Island	16	26	10

 Table 5.54. Coorong dissolved oxygen percentage of samples exceedance analysis (from continuous data) compared to fresh water-dependent ecosystem target of

 < 110%</td>

Site number	Continuous monitoring sites	2021	2022	2023
A4261134	The Coorong at Pelican Point	5	0	5
A4261135	The Coorong at Long Point	27	6	7
A4260633	Coorong at Parnka Point	31	10	5
A4261165	The Coorong NW Snipe Island	8	4	3

 Table 5.55. Coorong dissolved oxygen percentage of samples exceedance analysis (from continuous data)

 compared to fresh water-dependent ecosystem target range of 90 to 110%. Shading indicates years

 with an annual median outside the target range.

Site number	Continuous monitoring sites	2021	2022	2023
A4261134	The Coorong at Pelican Point	24	78	75
A4261135	The Coorong at Long Point	35	27	35
A4260633	Coorong at Parnka Point	35	32	53
A4261165	The Coorong NW Snipe Island	24	30	13



Figure 5.42. Data reliability analysis (continuous data) for Coorong DO saturation, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.4.2 Total phosphorus and total nitrogen

Both the discrete total phosphorus and total nitrogen data along the length of the Coorong show values significantly above their respective targets of < 10 μ g/L and < 350 μ g/L (Figure 5.43 and Figure 5.44), which is reflected in the exceedance tables for the full period (Table 5.56 and Table 5.57). These also show annual median total phosphorus and nitrogen larger than the respective targets in the majority of years with data. The influence of the 2022–23 River Murray flood event in is evident in the CNL due to high barrage releases delivering higher concentrations of phosphorus and nitrogen, likely due to increased loadings from flood waters inundating floodplains and agricultural land throughout the Basin. Conversely, total phosphorus decreased substantially in the CSL during this time, albeit remaining significantly above the freshwater-dependent ecosystem targets for Ramsar declared wetlands. Total nitrogen also decreased in the CSL in response to the 2022–23 River Murray flood event due to increased flushing and dilution exporting nutrients from the CSL.



Figure 5.43. Coorong total phosphorus (discrete data) compared to fresh water-dependent ecosystem target of < 0.01 mg/L (10 µg/L)

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Murray Mouth	NA	100	NA	NA	100	NA	NA	NA	NA	94	92	92											
Tauwitchere	100	100	100	100	100	100	100	100	100	100	100	NA	NA	100	100	100	NA	100	100	NA	NA	NA	NA
Mark Point	100	100	100	100	100	NA	100	100	100	100	NA												
Long Point	100	100	100	100	100	100	75	100	100	100	100	NA	NA	100	92	100	NA	100	100	100	94	86	82
Nonnameena	100	100	100	100	100	NA	88	93	91														
Bonneys	100	100	100	100	100	100	100	100	100	100	100	NA	100	92	91								
McGrath Flat North	100	100	100	100	100	NA	100	100	NA	100	100	100	NA	NA	NA								
Parnka Point	100	100	100	100	100	100	100	100	100	100	100	NA	NA	NA	100	100	NA	100	100	100	NA	NA	NA
Villa de Yumpa	100	100	100	100	100	NA	100	100	100	100	NA	100	100	100	100	92	82						
Stony Well	100	100	100	100	100	NA	100	100	NA	100	100	100	100	100	100								
North Jacks Point	NA																						
South Policemans Point	100	100	100	100	100	NA	100	NA	NA	100	100	100	NA	NA	NA								
Snipe Point	NA	100	100	NA	100	100	100	100	100	91													
South Salt Creek	100	100	100	100	100	100	100	100	100	100	100	NA	NA	NA	100	100	NA	100	100	100	100	100	91
1.8km west of Salt Creek	NA	100	100	NA	100	100	100	100	100	92													
3.2 km south of Salt Creek	NA	100	100	NA	100	100	88	NA	NA	NA													

Table 5.56. Coorong total phosphorus percentage of samples exceedance analysis (from discrete data) compared to fresh water-dependent ecosystem target of < 10 μg/L. Shading indicates years with an annual median greater than the target.



Figure 5.44. Coorong total nitrogen (discrete data) compared to fresh water-dependent ecosystem target of < 0.35 mg/L (350 µg/L)

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Murray Mouth	NA	75	NA	NA	67	NA	NA	NA	NA	73	92	100											
Tauwitchere	100	100	60	92	100	100	75	67	100	75	100	NA	NA	100	100	100	NA	100	100	NA	NA	NA	NA
Mark Point	67	100	83	100	100	NA	100	100	100	100	NA												
Long Point	100	100	83	100	100	100	75	100	100	100	100	NA	NA	100	100	100	NA	100	100	100	67	71	92
Nonnameena	100	100	100	100	100	NA	93	86	100														
Bonneys	100	100	100	100	100	100	100	100	100	100	100	NA	93	92	100								
McGrath Flat North	100	100	100	100	100	NA	100	100	NA	100	100	100	NA	NA	NA								
Parnka Point	100	100	100	100	100	100	100	100	100	100	100	NA	NA	NA	100	100	NA	0	100	100	NA	NA	NA
Villa de Yumpa	100	100	100	100	100	NA	100	100	100	100	NA	100	100	100	100	100	100						
Stony Well	100	100	100	100	100	NA	100	100	NA	100	100	100	100	100	100								
North Jacks Point	NA																						
South Policemans Point	100	100	100	100	100	NA	100	NA	NA	100	100	100	NA	NA	100								
Snipe Point	NA	100	100	NA	100	100	100	100	100	83													
South Salt Creek	100	100	100	100	100	100	100	100	100	100	100	NA	NA	NA	100	100	NA	NA	NA	100	100	100	92
1.8km west of Salt Creek	NA	100	100	NA	100	100	100	100	100	100													
3.2 km south of Salt Creek	NA	100	100	NA	100	100	88	NA	NA	NA													

Table 5.57. Coorong total nitrogen percentage of samples exceedance analysis (from discrete data) compared to fresh water-dependent ecosystem target of < 350 µg/L. Shading indicates years with an annual median greater than the target

5.4.3 pH

Discrete data is shown for pH in Figure 5.45, with annual percentage exceedances shown in Table 5.58 and Table 5.59, with Table 5.60 showing whether the annual median pH value is within the target range for each site. Similarly, continuous data is shown in Figure 5.46, with data reliability shown in Figure 5.47. Annual percentage exceedances are shown in Table 5.61 and Table 5.62, with Table 5.63 showing whether the annual median pH value is within the target range for each annual percentage exceedances are shown in Table 5.61 and Table 5.62, with Table 5.63 showing whether the annual median pH value is within the target range for each site.

Continuous pH is recorded at the same sites as DO saturation and exceeds the upper target of 8.0 at all sites, consistently (Figure 5.46). As shown in Figure 5.38 (CNL salinity) and Figure 5.40 (CSL salinity), between the River Murray high flows in 2016 and the flood in 2022–23 (which were reflected in higher barrage releases), CNL salinities peaked seasonally between 35 to 45 g/L and in the CSL between 90 and nearly 120 Gg/L. Higher pH values are typically associated with higher salinity values and the dominance of evaporation in the water balance, both of which occur with comparatively reduced freshwater contributions from the barrages. Pelican Point is the exception for most of the record, likely due to the proximity of this site to the barrages and thus the influence of River Murray flows, which act to dilute salinity and thus pH. The pH data at this site remained below 8.0 and above 6.5 for some of the record, and the annual median was within the target range during 2021–22.

The discrete pH data displays a similar pattern along the length of the Coorong with values typically remaining above 8.0 particularly in the CNL as far as Parnka Point (Figure 5.45). The exceedances recorded in the latter years of the record between 2021 and 2023 at these sites are comparable to those observed in the Millenium Drought period between 2001 and 2010 (Table 5.59). Conversely, both the continuous and discrete pH data at all sites do not drop below the 6.5 target with the exception of South Salt Creek in 2014–15 and Long Point in 2020–21 and 2021–22 (Table 5.58 and Table 5.61). Due to the large number of exceedances above pH of 8, the annual median is exceeded at the majority of sites, in a majority of years where there is data (Table 5.60).



Figure 5.45. Coorong pH (discrete data) compared to fresh water-dependent ecosystem target of > 6.5 and < 8.0

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Murray Mouth	NA	0	0	0																			
Tauwitchere	0	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	NA	NA	0	0	NA	NA	NA	NA
Mark Point	0	0	0	0	0	NA	0	0	NA														
Long Point	0	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	NA	NA	0	0	0	0	7	0
Nonnameena	0	0	0	0	0	NA	0	0	0														
Bonneys	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0								
McGrath Flat North	0	0	0	0	0	NA	0	0	0	NA	NA	NA											
Parnka Point	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	0	0	NA	NA	NA
Villa de Yumpa	0	0	0	0	0	NA	0	0	NA	NA	0	0	0	0	0	0							
Stony Well	0	0	0	0	0	NA	0	0	0	0	0	0											
North Jacks Point	NA																						
South Policemans Point	0	0	0	0	0	NA	0	0	0	NA	NA	0											
Snipe Point	NA	0	0	0	0	0	0																
South Salt Creek	0	0	0	0	0	0	0	0	0	0	0	NA	NA	0	25	NA	NA	NA	NA	0	0	0	0
1.8km west of Salt Creek	NA	0	0	0	0	0	0																
3.2 km south of Salt Creek	NA	0	0	0	NA	NA	NA																

Table 5.58. Coorong pH percentage of samples exceedance analysis (from discrete data) compared to fresh water-dependent ecosystem target of > 6.5

Site	2001	2002	2003	2004	2005	2006	2007	2008	6003	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Murray Mouth	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	81	50	44
Tauwitchere	67	75	67	67	75	100	100	100	50	75	100	NA	NA	60	100	NA	NA	0	93	NA	NA	NA	NA
Mark Point	100	75	71	50	88	NA	60	100	NA	NA	NA	NA	NA	NA	NA	NA							
Long Point	100	100	100	92	88	75	50	100	100	75	50	NA	NA	<mark>4</mark> 0	75	NA	NA	0	<mark>4</mark> 3	67	75	43	78
Nonnameena	100	100	57	<mark>42</mark>	75	NA	NA	NA	NA	NA	NA	NA	100	43	67								
Bonneys	100	100	29	<mark>3</mark> 3	88	75	75	75	50	50	75	NA	NA	NA	NA	NA	NA	NA	NA	NA	94	15	44
McGrath Flat North	67	100	29	<mark>3</mark> 3	50	NA	NA	NA	NA	0	64	100	NA	NA	NA								
Parnka Point	100	100	29	42	63	25	50	50	25	25	50	NA	NA	NA	NA	NA	NA	0	64	75	NA	NA	NA
Villa de Yumpa	67	75	29	25	<mark>3</mark> 8	NA	80	50	NA	NA	0	57	53	75	<mark>3</mark> 6	44							
Stony Well	67	25	14	25	50	NA	NA	NA	NA	0	50	47	81	<mark>3</mark> 6	56								
North Jacks Point	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Policemans Point	<mark>3</mark> 3	75	17	<mark>2</mark> 3	75	NA	NA	NA	NA	0	<mark>3</mark> 6	50	NA	NA	56								
Snipe Point	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	29	27	81	50	56
South Salt Creek	67	75	17	31	63	50	50	25	75	75	50	NA	NA	80	50	NA	NA	NA	NA	14	69	57	89
1.8km west of Salt Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	21	20	81	50	78
3.2 km south of Salt Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	21	13	NA	NA	NA

Table 5.59. Coorong pH percentage of samples exceedance analysis (from discrete data) compared to fresh water-dependent ecosystem target of < 8

Site	2001	2002	2003	2004	2005	2006	2007	2008	6003	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Murray Mouth	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	81	50	44
Tauwitchere	<mark>6</mark> 7	75	67	67	75	100	100	100	50	75	100	NA	NA	60	100	NA	NA	0	93	NA	NA	NA	NA
Mark Point	100	75	71	50	88	NA	60	100	NA														
Long Point	100	100	100	92	88	75	50	100	100	75	50	NA	NA	40	75	NA	NA	0	43	67	75	50	78
Nonnameena	100	100	57	42	75	NA	100	43	67														
Bonneys	100	100	29	33	88	75	75	75	50	50	75	NA	94	15	44								
McGrath Flat North	<mark>6</mark> 7	100	29	33	50	NA	0	64	100	NA	NA	NA											
Parnka Point	100	100	29	42	<mark>6</mark> 3	25	50	50	25	25	50	NA	NA	NA	NA	NA	NA	0	64	75	NA	NA	NA
Villa de Yumpa	<mark>6</mark> 7	75	29	25	38	NA	80	50	NA	NA	0	57	53	75	36	44							
Stony Well	<mark>6</mark> 7	25	14	25	50	NA	0	50	47	81	36	56											
North Jacks Point	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Policemans Point	33	75	17	23	75	NA	0	36	50	NA	NA	56											
Snipe Point	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	29	27	81	50	56
South Salt Creek	<mark>6</mark> 7	75	17	31	6 3	50	50	25	75	75	50	NA	NA	80	75	NA	NA	NA	NA	14	69	57	89
1.8km west of Salt Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	21	20	81	50	78
3.2 km south of Salt Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	21	13	NA	NA	NA

 Table 5.60. Coorong pH percentage of samples exceedance analysis (from discrete data) compared to fresh water-dependent ecosystem target range 6.5 to 8.0.

 Shading indicates years with an annual median outside the target range.



Figure 5.46. Coorong pH (continuous data) compared to fresh water-dependent ecosystem target of > 6.5 and < 8

Table 5.61. Coorong pH percentage of days exceedance analysis (from continuous data) compared to fresh water-dependent ecosystem target of > 6.5

Site number	Continuous monitoring sites	2021	2022	2023
A4261134	The Coorong at Pelican Point	0	0	0
A4261135	The Coorong at Long Point	5	0	0
A4260633	Coorong at Parnka Point	0	0	0
A4261165	The Coorong NW Snipe Island	0	0	0

Table 5.62. Coorong pH percentage of days exceedance analysis (from continuous data) compared to fresh water-dependent ecosystem target of > 8.0

Site number	Continuous monitoring sites	2021	2022	2023
A4261134	The Coorong at Pelican Point	96	35	57
A4261135	The Coorong at Long Point	86	85	97
A4260633	Coorong at Parnka Point	100	90	84
A4261165	The Coorong NW Snipe Island	62	98	100

 Table 5.63. Coorong pH percentage of days exceedance analysis (from continuous data) compared to fresh water-dependent ecosystem target range 6.5 to 8.0.

 Shading indicates years with an annual median outside the target range.

Site number	Continuous monitoring sites	2021	2022	2023
A4261134	The Coorong at Pelican Point	96	35	57
A4261135	The Coorong at Long Point	91	85	97
A4260633	Coorong at Parnka Point	100	90	84
A4261165	The Coorong NW Snipe Island	62	98	100



Figure 5.47. Data reliability analysis (continuous data) for Coorong pH, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.4.4 Turbidity

Figure 5.49 (data reliability is shown in Figure 5.50) and Table 5.65 show a notable increase in the turbidity observed at the continuous CNL sites in late 2022 and early 2023. The 2022–23 River Murray flood event increased turbidity in the Coorong, likely due to discharge of the turbid River Murray flood water out of the barrages. The discrete data (Figure 5.48 and Table 5.64) reflects this influence of the barrage releases at the Murray Mouth and Tauwitchere sites in particular (Figure 5.5).

The relatively higher turbidity throughout the continuous record at Parnka Point, resulting in consistent exceedances of the 20 NTU target, is likely due to the hydraulic action of water moving through a relatively constricted part of the Coorong and the influence on mobilising sediment. Conversely, annual median turbidity primarily remains below the target for the majority of the time at both Woods Well and Snipe Island in the CSL and at all discrete sites in the CSL (Table 5.64 and Table 5.65). Site visits post-flood noted that a relative improvement in water clarity was observed in the CSL during the high water levels. The deeper water likely reduced the impact of wind and wave effects that might mobilise sediment in shallower conditions typically seen in the CSL, and thus increase turbidity.



Figure 5.48. Coorong turbidity (from discrete data) compared to fresh water-dependent ecosystem target of < 20 NTU.

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Murray Mouth	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	25	NA	NA	0	NA	NA	NA	NA	6	<mark>6</mark> 9	75
Tauwitchere	67	75	0	17	25	NA	25	0	0	25	75	NA	NA	80	31	44	NA	0	50	NA	NA	NA	NA
Mark Point	33	75	0	17	25	NA	0	40	0	0	NA	NA	NA	NA	NA	NA	NA						
Long Point	0	50	0	8	25	NA	0	0	0	25	25	NA	0	20	8	0	NA	0	0	7	6	15	50
Nonnameena	0	0	0	0	25	NA	6	14	17														
Bonneys	33	25	0	0	0	NA	25	0	0	0	0	NA	13	15	17								
McGrath Flat North	33	50	17	33	25	NA	10	40	NA	0	21	38	NA	NA	NA								
Parnka Point	0	25	33	50	50	NA	50	75	25	0	50	NA	NA	NA	0	50	NA	100	50	50	NA	NA	NA
Villa de Yumpa	0	100	33	50	<mark>6</mark> 3	NA	25	60	21	57	NA	0	43	27	31	14	8						
Stony Well	<mark>6</mark> 7	75	33	50	25	NA	0	38	NA	0	36	40	19	36	8								
North Jacks Point	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Policemans Point	0	0	0	0	0	NA	0	NA	NA	0	0	0	NA	NA	0								
Snipe Point	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	NA	0	0	0	0	29	0
South Salt Creek	0	0	0	0	13	NA	25	0	0	0	0	NA	0	0	0	33	NA	NA	NA	0	0	43	0
1.8km west of Salt Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	NA	0	7	0	0	36	0
3.2 km south of Salt Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	NA	100	29	13	NA	NA	NA

 Table 5.64. Coorong turbidity percentage of samples exceedance analysis (from discrete data) compared to fresh water-dependent ecosystem target of < 20 NTU.</th>

 Shading indicates years with an annual median greater than the target.



Figure 5.49. Coorong turbidity (from continuous data) compared to fresh water-dependent ecosystem target of < 20 NTU

 Table 5.65. Coorong turbidity percentage of days exceedance analysis (from continuous data) compared to fresh water-dependent ecosystem target of < 20 NTU.</th>

 Shading indicates years with an annual median greater than the target.

Site number	Continuous monitoring sites	2020	2021	2022	2023
A4261134	The Coorong at Pelican Point	NA	0	67	<mark>6</mark> 8
A4261135	The Coorong at Long Point	NA	0	9	37
A4260633	Coorong at Parnka Point	NA	3	13	13
A4261209	Coorong near Woods Well	9	11	NA	NA
A4261165	The Coorong NW Snipe Island	NA	0	0	0



Figure 5.50. Data reliability analysis (continuous data) for Coorong turbidity, where the presence of a bar indicates availability of good quality data (as defined in Section 4.5) at a particular monitoring site.

5.5 Coorong and Lakes Alexandrina and Albert declared Ramsar Wetland Ramsar site

The Coorong Lakes Alexandrina and Albert Wetland located at the end of the River Murray is considered nationally and internationally significant. The site incorporates 23 different wetland types which range from freshwater to hypersaline, dense vegetation to open water, and temporary to permanently inundated. This unique wetland supports nationally and internationally threatened species, over one hundred wetland dependent waterbird species, including migratory waterbird species, and over 40 species of fish. As noted above, the current Ramsar Management Plan (RaMP) for the Coorong, and Lakes Alexandrina and Albert Wetland is currently being revised but the targets contained in the draft are presented in Table 5.66 and assessed below.

RaMP subcomponent	Resource condition salinity target	Notes				
Lake Alexandrina	Long-term annual average of 700 EC (µS/cm).	Lake Alexandrina salinity is based on the average daily salinity at A4260574 (near Mulgundawa), A4260524 (Milang Jetty), A4260575 (Poltalloch Plains), A4261156 (3km west Point McLeay) and A4261133				
	Below 1,000 EC (µS/cm) 95% of years.	(Beacon 90 – offshore Raukkan).				
	Below 1,500 EC (μ S/cm) all of the time.					
Murray estuary, Coorong North, and South Lagoons	Murray estuary average monthly salinities <35 ppt.	Murray estuary salinity is based on the average daily salinity at A4261036 (Beaco 12 Goolwa Channel), A4261039 (Barker Knoll), A4261128 (Mundoo Channel), and A4261043 (Beacon 1, Ewe Island Shacks).				
	North Lagoon average monthly salinities <45 ppt.	North Lagoon salinity is based on the average daily salinity at A4261134 (Beacon 19 Pelican Point), A4261135 (Long Point), and A4260572 (Robs Point).				
	South Lagoon average monthly salinities over winter <60 ppt.	South Lagoon salinity is based on the average daily salinity at A4260633 (Parnka				
	South Lagoon daily salinities year-round <100 ppt 95% of the time.	Point), A4261209 (near Cattle Island), and A4261165 (NW Snipe Island).				

Table 5.66.	Summary of salin	ity targets from	the RaMP.

Continuous salinity data demonstrate that salinity in Lake Alexandrina has largely remained below 1,500 μ S/cm, following the return of freshwater flows in the Lakes after the Millennium Drought (1996-2010; Figure 5.51). Salinities greater than this level occurred only at the end of the Drought, as flows entered the Lake from the SA River Murray. Indeed, salinity has not exceeded this level since November 2010. Exceedance analysis (Table 5.67) indicates that salinity in Lake Alexandrina has surpassed 1,000 μ S/cm for more than 95% of the year in only two water years (since March 2010). However, the long-term average (801 μ S/cm) has remained slightly above the long-term annual average target value of 700 μ S/cm, likely due to high salinity in 2010.

Salinity data from monitoring stations in the Murray estuary (Figure 5.52), North Lagoon (Figure 5.53), and South Lagoon (Figure 5.54) illustrate the Coorong's unique salinity gradient. There has been considerable achievement of RaMP salinity targets in the Murray estuary, having surpassed the target only at the end of the Millennium Drought (Table 5.67). Moreover, the average monthly salinities in the North Lagoon have exceeded 35 ppt in one month in 2014 and 2020 (Table 5.67; Figure 5.53). By contrast, the South Lagoon has had limited

achievement regarding the winter-months (June, July and August) salinity target (Figure 5.54), and daily salinities have exceeded 100 ppt more than 95% of the time in six water years since 2010 (Table 5.67).



Figure 5.51. Average daily salinity (from continuous data) in Lake Alexandrina compared to the RaMP ceiling target of < 1,500 µS/cm (red dashed line) and the long-term annual average target of 700 µS/cm (blue dashed line).







Figure 5.53. Average monthly salinity (from continuous data) in the Coorong North Lagoon compared to RaMP ceiling target of <45 ppt (red dashed line).



Figure 5.54. Average daily salinity (from continuous data) in the Coorong South Lagoon compared to the RaMP ceiling target of <100 ppt (red dashed line) and the average winter month target <60 ppt (blue dashed line).

Table 5.67.The percentage of days or months exceedance analysis (from continuous data) compared to the RaMP salinity targets outlined in Table 5.66. The time
step (percentage of days or months) considered in relation to the target is shown. Shading indicates water years where salinity exceeded the target.
NA means that data from all monitoring stations specified in the RaMP were not available to be averaged.

RaMP subcomponent	Target	Time step	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Lake Alexandrina	Below 1,000 EC (μS/cm) 95% of years	Daily	NA	100	89	0	1	1	0	0	0	0	3	0	0	2	0
Murray Estuary	Average monthly salinities <35 ppt	Monthly	100	73	0	0	0	0	0	0	0	0	0	0	0	0	0
North Lagoon	Average monthly salinities <45 ppt	Monthly	NA	NA	NA	NA	NA	10	0	0	0	0	0	8	0	0	0
South Lagoon	Daily salinities year-round <100 ppt 95% of the time	Daily	NA	100	40	0	0	0	0	30	0	0	1	25	40	18	0

5.6 Overall evaluation of water quality parameters

5.6.1 Methodology

For the water quality parameters presented in previous sections, data is available from 2000–01 to 2022–23, depending on availability at each site. For this analysis, 3 time periods are considered. These are:

- 2000–01 to 2010–11 (pre-Basin Plan)
- 2011–12 to 2018–19 (post-Basin Plan)
- 2019–20 to 2022–23 (period since the last Matter 12 reporting).

To evaluate the water quality parameters over these 3 periods, the following methodology was followed for each location, target purpose, discrete or continuous data and water quality parameter:

- 1. Calculate the average water quality exceedance at each site over the 3 time periods, not including missing data (NAs). For temporal-based targets, the percentage of years which exceeds the temporal target are calculated, not including missing years.
- 2. The average over all sites for each period is calculated, not including sites with no data for the whole time period being considered. The average is calculated over all sites discounting sites with no values.
- 3. The result for each period is assigned a water quality impact value of; No data, NIL, Minor, Low, Moderate or High based on the values in Table 5.68, which differ slightly based on the type of analysis (percentage exceedance, annual median or temporal analysis).

Water quality impact	Percentage exceedance (%)	Annual Median (% exceedance)	Temporal Analysis (% of years exceedance)
No data	No data	No data	No data
NIL	0	<50.0	0
Minor	<10.0	50.0 to 55.0%	<10.0
Low	10.0 to 25.0	55.0 to 62.5%	10.0 to 25.0
Moderate	25.0 to 50.0	62.5 to 75.0%	25.0 to 50.0
High	50.0+	75.0%+	50.0+

Table 5.68. Key for overall evaluation

5.6.2 Results

Results of the analysis are presented in Table 5.69. It should be noted that none of the water quality impacts assigned in this table should be considered without referencing the expanded tables, figures and descriptions in the relevant sections of this report. This is because of the large number of missing data values, as well as the significant impact of specific water quality events (for example, the 2022–23 River Murray flood event), which make it difficult to assess how water quality impacts may be changing over time or in response to Basin Plan measures, when considered in this condensed and simplified format.

Table 5.69. Overall evaluation of water quality

Location	Target purpose	Water quality parameter	Data type ⁹	Analysis type ¹⁰	Pre-2012 Water quality impact	2012 to 2019 Water quality impact	2020 to 2023 Water quality impact	Notes
Lower Murray –	Managing	Dissolved	D	PE	Minor	Minor	Minor	Most significant exceedances in 2016–17.
River Murray channel	flows	oxygen	С	PE	No data	No data Minor Minor Data		Data starts in 2016–17.
		Salinity	С	ТА	Moderate	Low Low Most exce		Most exceedances at Milang.
	WRPs –	Dissolved	D	AM	Moderate	Minor	Low	Majority of exceedances in 2023.
	freshwater- dependent ecosystems	oxygen	С	AM	No data	NIL	NIL	Data starts in 2016–17.
		рН	D	AM	NIL	NIL	NIL	No annual median exceedances.
			С	AM	NIL	NIL	No data	Data only from 2007–08 to 2014–15. 100% exceedance at Murray Bridge in 2012–13
		Total phosphorus	D	AM	Low	Moderate	Low	Significant exceedances between 2009–10 to 2012–13, and between 2021–22 and 2022–23.
	WRPs – irrigation water	Salinity	С	TA	Minor	Low	NIL	No years exceeded for all sites except River Murray at Wood Point Pontoon and 2 km downstream Wellington Ferry, with exceedances occurring between 2007–08 and 2009–10 and affecting subsequent year's exceedance as per 10-year rule.
	WRPs – recreational water	Cyanobacteria	D	PE	Minor	Minor	Minor	All sites low exceedance except Lake Alexandrina sites, which have high exceedance for whole record.
	Long term salinity	Salinity	С	ТА	NIL	NIL	NIL	Requires all sites to below target 80%/95% of the time over whole record, which is achieved for all sites.

⁹ Data types are discrete (D) and continuous (C) ¹⁰ Analysis types are percentage exceedance (PE), annual median (AM) and temporal analysis (TA), assessed against the values in Table 5.68.

Location	Target purpose	Water quality parameter	Data type ⁹	Analysis type ¹⁰	Pre-2012 Water quality impact	2012 to 2019 Water quality impact	2020 to 2023 Water quality impact	Notes
	planning and management							
	RaMP – Lake Alexandrina	Salinity	С	PE	High	Minor	Minor	Only two water years (2009-10 and 2010- 11) included in pre-2012.
Lower Murray – Chowilla wetland	WRPs – freshwater- dependent ecosystems	Dissolved oxygen	С	АМ	No data	NIL	NIL	Data begins in 2017–18. No exceedances in record.
Lower Murray – Pike floodplain	WRPs – freshwater- dependent ecosystems	Dissolved oxygen	С	АМ	No data	NIL	NIL	Data begins in 2017–18. No exceedances in record.
Lower Murray – Katarapko floodplain	WRPs – freshwater- dependent ecosystems	Dissolved oxygen	С	АМ	No data	NIL	NIL	Data begins in 2017-–8. Only one exceedance in record (River Murray 5 km ds Katarapko Creek Outlet of 54% in 2022–23).
Eastern Mount Lofty Ranges	WRPs – freshwater- dependent	Dissolved oxygen	D	AM	Moderate	Moderate	NIL	Data only available from 2000–01 to 2006– 07, 2009–10, 2014–15 (data at 3 sites) and 2020–21 (data at only one site).
	ecosystems		С	AM	No data	High	High	One site only, 2014–15 to 2022–23.
		рН	D	AM	NIL	NIL	NIL	Data only available from 2000–01 to 2006– 07, 2009–10, 2014–15 (data at 3 sites) and 2020–21 (data at only one site).
			С	AM	No data	NIL	NIL	One site only, 2014–15 to 2022–23.
		Total nitrogen	D	AM	NIL	Minor	NIL	Data only available in 2006–07, 2009–10, 2014–15 and 2020–21, and not all sites have data in every year.
		Total phosphorus	D	AM	NIL	NIL	NIL	Data only available from 2000–01 to 2009– 10, 2014–15 and 2020–21.

Location	Target purpose	Water quality parameter	Data type ⁹	Analysis type ¹⁰	Pre-2012 Water quality impact	2012 to 2019 Water quality impact	2020 to 2023 Water quality impact	Notes
Coorong	WRPs – freshwater-	Dissolved oxygen	С	AM	No data	No data	NIL	Data starts in 2020–21.
	dependent ecosystems	рН	D	АМ	Low	NIL	Low	Significant exceedances at some sites, especially between 2000–01 and 2001–02. A lot of missing data.
			С	AM	No data	No data	High	Data starts in 2020–21.
		Total nitrogen	D	AM	High	High	High	Very high exceedances across all sites in all years.
		Total phosphorus	D	AM	High	High	High	Very high exceedances across all sites in all years.
		Turbidity	D	AM	NIL	NIL	NIL	A lot of missing data. Some significant exceedances at sites in certain years.
			С	AM	No data	No data	NIL	Exceedances at Pelican Point in 2021–22 and 2022–23
	RaMP – Murray estuary	Salinity	С	PE	High	NIL	NIL	
	RaMP – North Lagoon	Salinity	С	PE	No data	Minor	Minor	Data starts 2013-14.
	RaMP – South Lagoon	Salinity	С	PE	High	Minor	Low	Only two water years (2009-10 and 2010- 11) included in pre-2012.
6 Evaluation questions

6.1 The importance of water for the environment flow to SA in evaluating Matter 12 water quality targets

Delivery of water for the environment under the Basin Plan is a critical component of the total flow to SA (QSA), intended to improve the health of the system. The total water availability within the southern connected Basin in any given year influences the volume of water for the environment delivered to SA, but between 2012–13 and 2022–23, water for the environment accounted for on average 20% of total QSA. In years with lower total water availability, available water for the environment volumes are proportionally reduced. However, water for the environment volumes are critical in providing for outcomes along the length of the SA River Murray and influencing the end of system conditions at the Coorong, Lower Lakes, and Murray Mouth (CLLMM), including those related to water quality. Water for the environment becomes even more important in years when the unallocated portion of SA's entitlement is reduced and there is no unregulated flows to SA, for example in 2015-16 (32% of a total 2,486 GL of total QSA) and 2017-18 (36% of a total 2,699 GL of total QSA). The timing of delivery of water for the environment is also critical. Spring and summer water for the environment delivery is particularly important along the SA River Murray and at the end of the system, providing for connectivity and barrage releases to the Coorong and Murray Mouth. In years with higher total water availability, when flows exceed the amount of water required to meet delivery and storage capacity, unregulated flows are declared and this water flows to SA where it is protected as Planned Water for the environment. While water for the environment recovered under the Basin Plan can be delivered during unregulated flow conditions, when flows reach a magnitude such as that seen during the 2022–23 River Murray flood event, there is limited scope to manage the river. In such conditions, the relative contribution and thus influence on water quality attributable to water for the environment (as defined in Section 3.4 of the Basin Plan) is reduced. For example in 2022–23 when water for the environment accounted for only 4% of a total 23,085 GL QSA.

6.2 To what extent have water quality outcomes been achieved?

Prior to the adoption of the Basin Plan in 2012, there was comparatively less water quality monitoring than in recent years, meaning there are a number of parameters for which there is no data available to assess against water quality targets for the period before 2012. In general, parameters that had sufficient data to permit assessment were those related to managing flows and water-dependent ecosystems in the River Murray channel. Dissolved oxygen impacts were classified as minor (as defined in Section 5.6) and remained so for the assessed period post-Basin Plan adoption. Conversely, salinity impacts from managing flows were classified as moderate pre-Basin Plan and reduced to minor for the 2 subsequent periods, likely due to the enhanced salinity management measures introduced with the Basin Salinity Management Strategy in 2015. The maintenance of salinity below long-term salinity planning, and management targets is reflected in the nil impact classification for the entire period, 2000 to 2023. Although the impact classification of irrigation water against the salinity target declined from pre-Basin Plan to immediately post, this was attributed to notable exceedances occurring during the Millennium Drought at Wood Point and Wellington which did not persist beyond 2010. Salinity targets related to the RaMP were generally achieved post-Basin Plan apart from two years (2013-14 and 2019-20) in the Coorong's North Lagoon and four years (2015-16, 2019-20, 2020-21, and 2021-22) in the Coorong's South Lagoon (Section 5.5). Overall exceedances for the RaMP targets have been largely minor since 2012 (Section 5.6).

The variable water quality impact classifications of DO and total phosphorus data for freshwater-dependent ecosystems, from moderate to minor is reflective of the response of the system to high flow events post-Millennium Drought and the 2022–23 River Murray flood event. The minor classification of the cyanobacteria data for recreational water across all 3 periods is primarily attributable to the high exceedances observed in Lake Alexandrina throughout the record.

No data was available for the 3 SA River Murray floodplains prior to adoption of the Basin Plan, but the nil impact classification for DO for both assessed periods post-Basin Plan adoption reflects the targeted and effective management of water for the environment delivery to operate those sites to ensure there are no water quality impacts. Delivery of water for the environment to support managed inundation events on the SA River Murray floodplains is preceded by considerable planning and modelling. The water for the environment planning process, combined with monitoring throughout the event, ensures that actions do not result in water quality conditions that exceed targets either on the floodplains or in the main channel. The analysis presented above confirms that all managed inundation events on the Chowilla, Pike, and Katarapko floodplains between 2020 and 2022, facilitated by water for the environment delivery, did not result in any exceedance of the DO target for freshwater-dependent ecosystems. Operations were intended to maximise the environmental benefits derived from water for the environment delivery and minimise any water quality impacts.

Conversely, the notable water quality impacts assigned to the EMLR for DO (freshwater-dependent ecosystems) ranging from moderate (pre-Basin Plan) to high (post-Basin Plan) reflects both data availability and the nature of the system as discussed in Section 5.3. Similarly, the high pH, Total nitrogen and Total phosphorus water quality impacts that persist across all periods in the Coorong are a feature of the assessment against freshwater targets in an estuarine system characterised by very high nutrient loads and inadequate flushing by freshwater flows.

6.3 If water quality outcomes were not achieved, why not?

The adoption of the Basin Plan in 2012 has resulted in considerably higher volumes of water for the environment and the introduction of water quality targets for managing flows, water-dependent ecosystems, irrigation, and recreation. However, water quality exceedances observed in the SA River Murray are primarily episodic and event-based, and therefore short-lived. For this reason, many of the water quality impact classifications summarised in Table 5.69 remain unchanged between the pre and post-Basin Plan periods. Where there was a decline in water quality impact classification, such as for total phosphorus (waterdependent ecosystems target) or salinity (irrigation) this was attributed to notable exceedances in select years, rather than a persistent target exceedance. Flow conditions (volume, timing and origin) at the South Australian (SA) border and throughout the SA River Murray are key drivers of water quality. The water quality of River Murray flow to South Australia is a product of upstream conditions and water quality in the upper River Murray or its tributaries. The MDBA manages the day-to-day operations and flows to SA in accordance with the Murray–Darling Basin Agreement. The 2022–23 River Murray flood event, was Basin-wide, characterised by significant near natural flow volumes, triggered notable water quality exceedances both upstream and downstream of the SA border. Similarly, historically low-flow conditions experienced throughout the Basin during the Millennium Drought resulted in persistent exceedances of many water quality targets within the Basin and the SA River Murray.

For example, DO saturation and total phosphorus exceedances in the lower SA River Murray were in response to the 2010–11 high flows, whereas the 2016–17 high flow event saw DO exceedances along the length of the SA River Murray. The 2017 exceedances were due to a blackwater event as high flows across New South Wales and Victoria mobilised large amounts of organic matter from the floodplain into the River Murray. The large amount of organic matter was due to the high flow extending into areas of the floodplain that had not been inundated since the high flow in the early 1990s (DEW 2016). Similarly, the widespread exceedances calculated for 2023 were due to the 2022–23 River Murray flood event that peaked in the SA River Murray at the border by the end of 2022, with the relatively higher percentage of exceedances at each site commensurate with the significantly higher flows experienced throughout the SA River Murray that year. This was a widespread phenomenon during the flooding across the Murray–Darling Basin. The more localised exceedances of both DO and total phosphorus targets for locations further downstream within SA in other years are likely a result of the local landscape including floodplains and irrigated land that contribute phosphorus when flows connect them to the River Murray.

Conversely, flow salinity target exceedances at Milang throughout the Millennium Drought were due to very low-flow conditions and corresponding low lake levels, as well as low to no barrage flow, a critical controlling

factor for salinity in the Lower Lakes. Similarly, the irrigation salinity target was exceeded below Lock 1 and at Wellington on occasions during the Millennium Drought. However, since the adoption of the Basin Plan in 2012 following the Millennium Drought, salinity has remained below all targets for managing flows, irrigation, and for long-term salinity management with only the sparse exceedances due to flooding and challenging local conditions at the Lower Lakes. The significantly higher number of exceedances of the recreational water target for blue-green algae observed in Lake Alexandrina and at Goolwa are likely reflective of the accumulation of blue-green algae at the end of the system, when low water quality events occur, and the reduced mixing and flushing of the lakes relative to the main channel. While the Basin Plan has facilitated the delivery of water for the environment to the end of the system, the volume and timing of water delivery varies and cannot always respond to natural events such as blooms or blue-green algae.

As described in EMLR results section, the water quality targets specified in the Basin Plan are not appropriate for ephemeral, disconnected systems that characterise the EMLR. Similarly, the shallow, estuarine Coorong lagoons would be more appropriately assessed against the targets defined in the ANZECC guidelines for estuaries, rather than the declared Ramsar wetland freshwater dependent ecosystem targets in the Basin Plan, which are based on the ANZECC guidelines for rivers (freshwater quality targets). In both cases, this resulted in generally consistent exceedances across all Basin Plan targets applicable in these SA Murray–Darling Basin regions.

6.4 To what extent did the Basin Plan contribute to achieving water quality outcomes?

As shown in Figure 4.1 (in Section 4.4), water for the environment has been consistently delivered to SA since the adoption of the Basin Plan in 2012. The relative influence of water for the environment is magnified in low-flow years along the entire length of the SA River Murray, and particularly in maintaining lake levels and barrage releases. While most of SA River Murray target exceedances observed between 2000 and 2023 are attributable to blackwater events or blue-green algae that originate upstream, salinity impacts in the Lower Murray have the potential to migrate upstream if not managed. The delivery of water for the environment to the Lower Murray, typically in the order of 1,000 GL/y is critical for the ability to maintain Lower Lakes levels within the target envelope each year, while facilitating barrage releases to maintain Coorong water levels and salinity, and releases through the Murray Mouth. The planning and delivery of water for the environment and adequate flows to the end of the system maintain critical connectivity and support ecological outcomes across the entire CLLMM site, while preventing the ingress and migration of salinity upstream. Additionally, the SA River Murray channel and connected wetlands benefit from the flows enroute and likewise, the targeted delivery of water for the environment to SA River Murray floodplains has delivered inundation of floodplains while maintaining adequate passing flows in channel and water quality targets throughout the system.

As noted above, most of the water quality impacts observed in the SA River Murray are episodic, event-based and short-lived. For this reason, interventions, which might address events such as low DO, blackwater events, or blue-green algae, are not easily deployed on the scale at which these events occur. Although there are examples of operational actions taken to mitigate water quality impacts in some locations, in many cases these actions have shifted the impact to further downstream. While water quality impacts may be partially reduced due to dilution, it typically still results in a short-term water quality target exceedance. While there is no clear trend or trajectory of improving water quality across these parameters due to their episodic and occasional exceedances, there is also no evidence that water delivered under the Basin Plan has resulted in any exceedances. Instead, the delivery of water for the environment under the Basin Plan has likely maintained baseline water quality within the SA River Murray outside of notable high flow or flood events, as evidenced in the relatively stable water quality impact classifications for most of the parameters, pre and post-Basin Plan.

Although the Coorong has benefited from water for the environment delivery, which has supported water levels and salinity to periodically remain within preferred ranges, this has not been achieved consistently since the adoption of the Basin Plan. Furthermore, the progressive accumulation of nutrients in the system and the associated processes which have compromised the condition of the Coorong have occurred over decades. This

cannot be reversed with the current volume of water for the environment recovered and delivered to SA in any given year.

Salinity is the exception when aligning the achievement of water quality targets with the Basin Plan. Salinity is actively managed within the Basin, as guided by the Basin Salinity Management Strategy (BSMS) adopted in 2015. The BSMS supports Basin Plan flow management obligations to have regard to the salinity targets for managing water flows, informs the responsive management of salt interception schemes, and seeks to bring water for the environment fully into the accountability framework (MDBA 2024). The continuing active management of salinity throughout the Basin, and particularly within SA is evident in the maintenance of salinity below long-term salinity planning and management targets and the corresponding nil impact classification for the entire period, 2000 to 2023.

6.5 Have there been any unanticipated water quality outcomes?

There have not been any unanticipated water quality outcomes identified in this analysis. While the influence of the Basin Plan in making progress towards water quality outcomes for salinity is clear, it is not as evident for other water quality parameters. Despite this, the water quality exceedances observed in the data presented in this report for all periods can be explained by the available data. The origin, volume, timing, and frequency of flow into the SA River Murray from upstream and its interaction with other environmental parameters including climate, antecedent, and floodplain conditions are all explanatory variables for the exceedances observed. The most recent example of this is the 2022–23 River Murray flood event, which reached a peak not experienced in decades and followed a year of unregulated flow conditions. Although the magnitude and duration of the flow event was unanticipated, the water quality response was in line with that of previous events in the preceding decades that inundated significant areas of floodplain not connected to the main channel.

7 References

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8 Appendix

Table A. 1. River Murray discrete data frequency – number of samples available in the year

Locations	Parameters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray	рН																	41	11	12	13	11	11	27
11 km Downstream	Phosphorus																20	52	52	53	51	52	52	52
Lock 6	Cyanobacteria																	20	52	52	53	51	52	52
River Murray	рН	50	50	49	52	51	52	53	52	53	57	52	52	52	51	53	52	52	52	52	53	52	52	52
River Murray Lock 5	Phosphorus	50	50	49	52	52	52	53	52	53	57	52	52	52	51	53	52	52	52	52	53	52	51	52
	Cyanobacteria	25	50	49	50	52	50	26																
River Murray	Dissolved oxygen											1	52	48	49	53	52	52	52	52	53	52	52	52
Renmark	рН										16	15	26	24	49	53	52	52	52	52	53	52	52	52
Pump	Phosphorus										22	13	12	12	38	40	39	39	39	39	40	39	39	39
	Cyanobacteria									4	52	52	52	46	52	52	52	52	52	53	52	52	52	52
River Murray	Dissolved oxygen														22	52	53	52	52	52	52	53	52	52
Berri Sample Pump	рН														27	65	53	52	52	52	52	53	52	52
·	Cyanobacteria														49	52	52	52	52	53	52	52	52	52
River Murray Loxton Sample Pump	Dissolved oxygen														21	53	52	52	52	52	53	52	52	52
	рН														21	53	52	52	52	52	53	52	52	52
	Phosphorus														14	40	26	26	26	26	27	26	26	26
	Cyanobacteria														47	52	52	52	52	53	52	52	52	52

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Locations	Parameters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray	Dissolved oxygen														21	52	53	52	52	52	52	53	52	52
Moorook	рН														26	65	53	52	52	52	52	53	52	52
Pump	Phosphorus														14	39	27	26	26	26	26	27	26	26
	Cyanobacteria														47	52	52	52	52	53	52	52	52	52
River Murray	Dissolved oxygen														22	52	52	52	52	52	51	53	52	51
Sample	рН														22	52	52	52	52	52	51	53	52	52
Pump	Cyanobacteria														47	52	51	52	52	53	51	52	52	52
River Murray Woolpunda	Dissolved oxygen														21	52	53	52	52	52	52	53	52	52
Sample	рН														26	65	53	52	52	52	52	53	52	52
Pump	Cyanobacteria														47	52	52	52	52	53	52	52	52	52
River Murray	Dissolved oxygen														21	52	53	52	52	52	52	53	52	52
Waikerie	рН														21	52	53	52	52	52	52	53	52	52
Sample Pump	Phosphorus														14	39	27	26	26	26	26	27	26	26
	Cyanobacteria														47	52	52	52	52	53	52	52	52	52
River Murray	Dissolved oxygen														22	52	53	52	52	52	52	52	53	52
Sample	рН														10	27	53	52	52	52	52	52	53	52
Pump	Cyanobacteria														49	52	52	52	52	53	52	52	52	52
River Murray	Dissolved oxygen											28	52	52	52	52	49	51	51	51	52	48	52	52
Morgan	рН	50	50	49	52	51	52	50	50	49	51	53	52	53	52	52	47	51	50	50	51	50	52	52

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Locations	Parameters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sample	Phosphorus	50	50	49	52	51	52	50	50	50	51	53	51	52	52	52	47	51	50	50	51	50	52	52
Pullip	Cyanobacteria	47	12	12	32	52	58	55	51	51	50	52	52	53	51	49	48	50	51	51	50	52	49	52
River Murray Blanchetown Sample Pump	Dissolved oxygen														22	52	53	52	52	52	52	53	52	52
	рН														27	65	53	52	52	52	52	53	52	52
	Cyanobacteria														48	52	52	52	52	53	52	52	52	52
River Murray	Dissolved oxygen											41	52	52	52	52	53	52	52	52	51	52	53	52
Swan Reach	рН				9	12	13	15	13	9	22	17	26	26	52	52	53	52	52	52	51	51	53	52
Sample Pump	Phosphorus										18	14	13	13	39	39	40	39	39	39	38	38	40	39
	Cyanobacteria				15	25	27	33	39	34	51	51	53	51	53	52	52	52	52	52	51	52	52	52
River Murray Swan Reach	Dissolved oxygen														21	52	53	52	52	52	51	52	53	52
Town Sample	рН														26	65	53	52	52	52	51	52	53	52
Pump	Cyanobacteria														48	52	52	52	52	52	52	52	52	52
River Murray	Dissolved oxygen								10	39	39	42	52	51	52	52	53	61	51	52	52	53	52	52
Mannum	рН				10	12	13	12	21	40	40	29	26	26	52	52	53	52	51	52	52	53	52	52
Sample Pump	Phosphorus				10	12	13	12	13	13	13	14	13	13	39	39	40	39	38	39	39	40	39	39
	Cyanobacteria			16	51	52	50	51	53	51	51	52	52	51	53	52	52	52	52	51	53	52	52	52
River Murray Cowirra	Dissolved oxygen														22	51	48	47	52	52	51	50	52	48
Cowirra Sample Pump	рН														26	64	48	47	52	52	51	50	52	48
	Cyanobacteria														49	51	42	52	53	51	52	49	52	48

Locations	Parameters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
River Murray	Dissolved oxygen														21	53	52	52	52	52	53	52	52	52
Sample	рН														26	66	52	52	52	52	53	52	52	52
Pump	Cyanobacteria														48	52	52	52	52	53	52	52	52	52
River Murray Murray	Dissolved oxygen								9	45	38	41	51	51	50	52	52	62	52	50	53	53	52	52
Murray Bridge	рН				42	50	52	52	52	52	50	52	52	51	52	52	43	52	52	50	53	52	52	52
Sample Pump	Phosphorus				42	51	51	74	52	52	52	52	52	51	52	53	52	52	52	50	53	52	52	52
	Cyanobacteria			15	53	52	50	44	53	51	51	51	51	51	50	52	51	52	51	52	52	52	52	52
River Murray	Dissolved oxygen											43	52	52	52	52	53	52	52	52	52	53	52	52
Tailem Bend	рН				41	51	52	51	52	49	51	53	52	52	51	52	42	51	52	52	50	53	52	52
Sample Pump	Phosphorus				41	51	52	51	52	50	51	52	52	52	51	52	52	51	52	52	50	53	52	52
	Cyanobacteria			15	52	52	58	56	51	51	51	52	52	52	51	45	46	51	52	50	53	52	51	52
	Dissolved oxygen					4	3	11	5															
Lake Alexandrina	рН					5	12	64	56	47	52	51	53	50	51	52	52	53	52	52	51	52	52	53
Milang	Phosphorus					5	12	11	8															
	Cyanobacteria	25	25	26	25	24	25	30	23	19	19	20	12				27	52	52	51	53	50	51	52
Lake Alexandrina Goolwa	Dissolved oxygen					4	4	10	9															
	рН					5	11	14	58	52	52	53	52	50	51	52	53	52	52	52	52	52	53	52
Barrage	Phosphorus					5	11	11	11															
upstream -	Cyanobacteria	58	58	59	59	49	27	10	6					5	53	52	25							

Site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Murray Mouth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	16	13	12
Tauwitchere	3	4	5	12	8	4	4	3	4	4	4	0	0	5	13*	16	0	1	14	0	0	0	0
Mark Point	3	4	6	12	8	0	0	0	0	0	0	0	0	5	7*	3	0	0	0	0	0	0	0
Long Point	3	4	6	12	8	4	4	4	4	4	4	0	0	5	13*	16	0	1	14	15	16	14	12
Noonameena	3	4	6	12	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	14	12
Bonneys	3	4	6	12	8	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0	16	13	12
McGrath Flat North	3	4	6	12	8	0	0	0	0	0	0	0	0	0	10	15	0	1	14	8	0	0	0
Parnka Point	3	4	6	12	8	4	4	4	4	4	4	0	0	0	10	16	0	1	14	8	0	0	0
Villa de Yumpa	3	4	6	12	8	0	0	0	0	0	0	0	0	5	14*	14	0	1	14	15	16	14	12
Stony Well	3	4	6	12	8	0	0	0	0	0	0	0	0	0	10	16	0	1	14	15	16	14	12
North Jacks Point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Policemans Point	3	4	6	12	8	0	0	0	0	0	0	0	0	0	10	0	0	1	14	8	0	0	12
Snipe Point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	11	0	1	14	15	16	14	12
South Salt Creek	3	4	6	12	8	4	4	4	4	4	4	0	0	5	7*	13	0	0	0	7	16	14	12
1.8 km west of Salt Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	12	0	1	14	15	16	14	12
3.2 km south of Salt Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	15	0	1	14	8	0	0	0
2003, 2004, 2022: one e	extra pl	H sam	pling p	oint for	yellow	v high	lighteo	d sites							•								
2015: pH was collected	4 time	s for *	sites a	nd no pl	H reco	rds fo	r othe	r sites															
2016: no pH records for	r all sit	es																					
2022: green highlighted	l, 13 tu	urbidity	y samp	ling poi	nts at	Long	Point																
2022: orange highlighte	ed, 16 t	total n	itroger	n sampli	ng po	ints at	Snipe	Point															
2022: one less total pho	sphor	us reco	ord for	purple	highlig	ghted	sites																
2023: pH records are 9.	0 for a	ll sites	that w	ere sam	pled;	11 tota	al nitro	ogen r	ecords	at Vil	la de Y	′umpa	; 11 tc	tal ph	osphorus	s record	ds at g	rey hig	hlighte	ed sites	5		

Table A. 2. Coorong discrete data frequency – number of samples available in the year. Parameters include pH, total nitrogen, total phosphorus and turbidity.