Discussion Paper No.2:
Water Quality Targets for the Coorong, Lower Lakes and Murray Mouth Region.

(Prepared by: River Lakes & Coorong Action Group)
Version. 2, October 2025

1. Introduction

The River Lakes and Coorong Action Group (RLCAG) identified a lack on monitoring sites and insufficient water quality (WQ) parameters measured in the Coorong Lower Lakes and Murray Mouth (CLLMM) region in a Discussion Paper issued in October 2024. This can be found on the RLCAG website here: https://rlcag.org.au/wp-content/uploads/2025/04/review-of-wq-monitoring_rev3.pdf

This discussion paper then identifies how this WQ data that is gathered through monitoring should be used and who should have access to this information. We then need to act on non-compliance with targets, to identify sources of pollutants and who is responsible for mitigation measures.

The main purpose for WQ monitoring is to identify if the water quality is suitable for its proposed use. These purposes can vary but generally water uses are classified in Australia as one of the following:

a) Water for human consumption.
b) Water for human recreational purposes.
c) Water for irrigation or farm animals.
d) Fresh water-dependent ecosystems.

Target values for WQ parameters identify the desired range, median or upper limit for the proposed purpose. Trigger values are also used to identify limits to WQ parameters which if exceeded require further investigation or immediate remediation or safety measure to be put in place to protect the water user.

2. Primary Indicators v Secondary Indicators

An independent variable or primary indicator is the cause or the factor that is changed or manipulated, while a dependent variable or secondary indicator is the effect or the outcome of that change. This is a cause-and-effect relationship. Primary indicators or independent variables are those that drive changes while secondary indicators or dependent variables are those that respond to changes in independent variables.

In climate change, global temperature is the independent variable or primary indicator that is driving secondary indicators such as sea level rise, reduced rainfall and more severe storms. As such targets and trigger values are established for global warming. These values are based

on the relationship between global temperatures and the undesirable outcomes or effects, and efforts are put into controlling or mitigating the primary indicator of global warming.

For the MDB ecosystems, secondary indicators include vegetation health, fish populations and migratory bird numbers, while there are two main primary indicators which are water flows and water quality.

The main focus to date in the management of the MDB has been on **water flows** and little attention has been given to **water quality.** In addition secondary indicators have been the main focus of reporting outcomes with little information on water quality values.

By setting appropriate target values for the primary indicators of water quality, it becomes immediately clear when the ecosystem is not in the desired condition to support healthy secondary indicators and action is required. Also, it is clear which parameter is not in compliance, and the actions can be focused on mitigating that parameter before secondary indicators are adversely affected over time.

The target values need to be established with a good scientific knowledge of the ecosystem and how secondary indicators respond to a range of water quality parameters. Target values need to be Specific, Measurable, Achievable, Relevant and Time-bound, i.e. SMART and will be referred to in this paper as appropriate.

Also, linking flow management to water quality targets allows for adaptive management – adjusting water releases to prevent fish kills, algal blooms, or habitat degradation, as well as cultural and community disconnect.

Environmental water flows for CLLMM region alone does not guarantee healthy ecosystems. Integrating flow quantities with water quality management makes every environmental watering litre more effective. If the delivered water fails to meet water quality targets (e.g. dissolve oxygen, nutrients, turbidity, temperature, pH, salinity, etc), then ecological assets won't respond as expected and cultural, social and economic values will suffer.

Appropriate site specific water quality targets and triggers based on ecological needs of each component of the CLLMM region (i.e. Lake Alexandrina, Lake Albert, River channel to Goolwa barrage including Finniss and Currency Creek inlets, Goolwa barrage to Murray Mouth, Coorong North Lagoon, and Coorong South Lagoon) need to be established to avoid irreversible ecological decline under a changing environment leading to cultural and community devastation.

To ensure cultural and community engagement we need an accessible comprehensive centralised dashboard with regular (e.g. annual) meaningful report cards including water quality, cultural and ecological performance against meaningful targets.

3. Laws and Regulations Controlling WQ

Target water quality values for rivers in Australia are not one-size-fits-all but are instead based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZWQG) and adjusted for local conditions. These guidelines can be found here: ANZWQG Guidelines (see **Appendix A** for Glossary of Terms and Acronyms).

These national guidelines provide a framework and technical support for governments to set local objectives based on the "environmental values" of the waterway. Since waterways vary naturally, trigger values are often refined to account for local conditions. Key indicators and examples are as follows:

- **Nutrients:** Targets aim to prevent excessive nutrients (nitrogen and phosphorus) that lead to algal blooms. The NSW target is fewer than 75% of samples exceeding local guidelines.
- **Dissolved Oxygen (DO):** For drinking water, a minimum of 6.5 mg/L is a target.
- **pH:** A target range of 6.5 – 8.5 is used for drinking water.
- **Electrical Conductivity (EC):** This is a measure of salinity. An example for fresh water is a concentration of 0 − 1,000 µS/cm.

The ANZWQG provides Default Guideline Values for various stressors, such as physical and chemical properties and toxicants. However, it recommends that jurisdictions and water managers collect more localized data to derive site-specific guideline values, which are more accurate.

Because of the flexible national framework, each state and territory has developed its own specific guidelines, regulations, and objectives.

In South Australia, water quality is governed by a framework of legislation and policies managed by both the Environment Protection Authority (EPA) and SA Health. The specific guidelines that apply depend on the water body's purpose, such as drinking water, aquatic ecosystems, or recreational use.

The EPA uses the Environment Protection (Water Quality) Policy 2015 (Water Quality Policy) as its primary tool for protecting South Australian waters, including surface water, marine water, and groundwater.

- **General duty:** The policy places a general duty on all individuals and industries to take "all reasonable and practicable measures" to prevent or minimize harm to water environments from pollution.
- **Targeted protection:** It protects specific "environmental values" like aquatic ecosystems, drinking water, recreational use, aquaculture, and aesthetics.
- **Pollutant controls:** The policy prohibits the discharge of certain pollutants (listed as Class 1 and Class 2) into any water system, including stormwater and groundwater.
- **Licensed activities:** For activities with an environmental authorization, such as waste discharge, the EPA can set specific water quality criteria and discharge limits.
- **Policy review:** The EPA has been reviewing the 2015 policy to enhance groundwater protection, incorporate cultural and spiritual values, and update best-practice schedules.

SA Health and SA Water monitor and regulate drinking water to ensure it meets the *Australian Drinking Water Guidelines*.

- **Health and aesthetic limits**: These guidelines set both health-based and aesthetic (taste, appearance, odour) limits for various chemicals and substances.
- **Example substances:** SA Water publishes a glossary of substances found in drinking water, detailing their typical levels and how they compare to national guidelines. This includes disinfectants, metals, and elements like arsenic and manganese.

SA Health monitors and provides alerts for recreational waters.

- **Contamination risks**: Water quality can be impacted by stormwater runoff, especially after heavy rain, and by events such as algal blooms.
- **Public alerts**: Health advice is issued when a potential risk is identified. For instance, specific beaches or channels may be flagged with warnings, advising against swimming in discoloured or murky water.

4. The Water Act (2007)

The waters of the Murray-Darling basin were one of the most bitterly contested issues during federation, with the states retaining the rights to management of all water issues via Section 100 of The Constitution with the Commonwealth having power only as far as the states agree.

However, it was agreed by the States in 1914 that South Australia, which has no major tributaries to the Murray will receive a guaranteed 1,850 GL/y to be provided equally by NSW and Victoria. This was the beginning of the Murray-Darling Basin Agreement which, although modified several times, is still in effect today.

From this guaranteed flow, South Australia supplies water to irrigators, drinking water to a majority of South Australians including Adelaide and many rural towns, and running water to the sea to flush salt from the system.

The Tasmanian Gordon below Franklin Dam Case in the High Court in 1983, laid the foundation for a shift in the power relationship between States and Commonwealth for water management issues and gave the Commonwealth power to give effect to international treaties, particularly those concerning the environment such as Ramsar Wetlands.

In the early 1990's river flows in the basin were very low due to low rainfall, but more importantly due to over extraction, and with high nutrient concentrations a toxic blue-green algal bloom affected large sections of the rivers in the basin.

The Murray–Darling Basin Ministerial Council established The Living Murray (TLM) in 2002. In 2004, the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory signed the Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin. The Living Murray program's First Step aimed to recover 500 GL of water for the River Murray and focused on improving the environment at six icon sites, including the CLLMM Region.

A cap was put on allocations and a trading scheme was established for water licenses. However allocations were contested by the States and they were not enforced.

The millennium drought (from around 2000 to 2011) was the next crisis which spurred the Howard Liberal government to pass the Commonwealth Water Act of 2007.

This Water Act legislated the requirement to create Water Resource Plans (WRP) which included a Water Quality and Salinity Management Plan (WQMP) for all major river catchments to stop overallocation and environmental degradation.

This was world leading legislation which required allocation of environmental flows to be returned to the river and for a consistent approach and compatible WQ objectives and targets.

The Act also legislated the formation of the Murray-Darling Basin Authority (MDBA) to manage the implementation of the Water Act, 2007 in the Murray-Darling Basin (MDB).

In 2012 the Murray-Darling Basin Plan ('The Basin Plan') was agreed by all the participating States, and this specifies the rules and regulations for management of the MDB. The Basin Plan also set out the evaluation and reporting requirements for the various entities involved in the delivery of the Basin Plan (see **Appendix B**, "Schedule 12—Matters for evaluation and reporting requirements") which include reporting on Water Quality.

An interjurisdictional Water Quality Advisory Panel provides governance and expert advice with regard to the MDBA's role in managing the water quality of the River Murray, its tributaries and storages.

5. Water Quality Targets Required by the Murray-Darling Basin Plan

1) Water Quality and Salinity Management Plans

In accordance with the Basin Plan, the States are responsible for preparing Water Resource Plans (WRP), which must include a Water Quality and Salinity Management Plan (WQSMP), for each catchment in their jurisdiction which must comply with the requirements of the Basin Plan.

Chapter 9 of the Basin Plan sets out an integrated Water Quality and Salinity Management Plan (WQSMP) for the whole of the MDB, providing a framework of objectives and targets. In Division 3 of Part 4 of Chapter 9 'default values' are prescribed for WQ parameters for:

- freshwater water-dependent ecosystems,
- irrigation water, and
- recreational water.

The water quality targets for parameters which are usually the most important for **freshwater-dependent ecosystems** are specified for various parts of the MDB in Schedule 11. These have been derived using the ANZWQG. In addition, long term salinity target are set out in Schedule B, Appendix 1 'End of Valley Targets for Salinity' of the MDBA which is a 95%ile of 800 uS/cm for the whole basin.

Irrigation water is required to meet Schedule 11 water quality targets 95% of the time over a ten (10) year period. In addition, long term salinity targets for irrigation are as set out in Schedule B, Appendix 1 'End of Valley Targets for Salinity' of the MDBA. However, 9.17(3) of Division 3 of Part 4 of the Basin Plan set operating targets of 833 µS/cm for the Southern Basin and 838 µS/cm for the Paroo and Warrego Rivers and 957 µS/cm for the remainder of the Northern Basin.

Water quality targets for **recreational purposes** are as specified in 9.18 of Division 3 of Part 4 of the Basin Plan to be as required by Chapter 6 of the Guidelines for Managing Risks in Recreational Water. These require that fresh recreational waters should not contain:

i. ≥ 10 µg/L total microcystins; ≥ 50,000 cells/mL toxic Microcystis aeruginosa; 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
ii. ≥ 10 mm^3/L for total biovolume of all cyanobacteria material where known toxins are not present; or
iii. Cyanobacteria scums consistently present.

The Australian Drinking Water Guidelines (2011) - Updated November 2018 sets out standards for the quality of raw water for treatment of **water for human consumption**.

The CLLMM Region is part of the Lower Murray 'Target Application Zone' in Schedule 11 and the Default WQ parameters and their recommended values for water-dependent ecosystems are shown in **Table. 1** below.

Should the actual WQ at a site be better or a value derived using the ANZWQG which is better than the target set in Chapter 9 of Basin Plan, then Division 2 Part 10 of the Basin Plan requires that the actual target value should be the better value, as deterioration of water quality is not acceptable.

The Basin States are required to report every five (5) years on progress towards the water quality targets in Chapter 9 for the WRP under their jurisdiction (see **Appendix B**, Matter 12 of Schedule 12 of the Basin Plan)

Target application zones (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 (mg/L; or saturation (%)) (Annual median within the range)	pH (Annual median within the range)	Salinity	Temperature (Monthly median within the range)	Pesticides, heavy metals and other toxic contaminants (values in table 3.4.1 of the ANZECC Guidelines for) (Must not be exceeded)
lM (Lower Murray)	Declared Ramsar wetlands	Streams and rivers	50	100	1000	85-110%	6.5-9.0		between the 20%ile and 80%ile of natural monthly water temperature	the protection of 99% of species
		Lakes and wetlands	20	10	350	90–110%	6.5–8.0		between the 20%ile and 80%ile of natural monthly water temperature	the protection of 99% of species
	Other water-dependent ecosystems	Streams, rivers, lakes and wetlands	50	100	1000	85-110%	6.5-9.0	End-of-Valley targets in Appendix 1 of Schedule B to the Agreement	between the 20%ile and 80%ile of natural monthly water temperature	the protection of 95% of species

Table. 1 – WQ Targets for CLLMM Region Proposed by the Basin Plan (Schedule 11).

2) Water Quality when Managing Environmental Water Flows

River Managers and Holders of Environmental Water must have regard to 'water quality targets for managing water flows' when making flow management decisions (Section 9.14, Division 2 of Part 4 of Chapter 9, of the Basin Plan).

The Basin Plan specifies targets for managing water flows for dissolved oxygen and recreational water (cyanobacteria), that apply across the Basin, and targets for salinity that apply at specified locations. In addition, Basin States, MDBA and Commonwealth Environmental Water Holder (CEWH) are required to report the extent to which regard is had to the targets in the WQSMP when making flow management decisions.

River Managers and Holders of Environmental Water must have regard to the following target values:

(a) to maintain dissolved oxygen at a target value of at least 50% saturation at 25°C and 1 atmosphere of pressure.

(b) for recreational water quality, 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 Water32, which states that fresh recreational water bodies should not contain:

i. ≥ 10 µg/L total microcystins; ≥50 000 cells/mL toxic Microcystis aeruginosa; or biovolume equivalent of ≥4 mm3 /L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume; or

ii. ≥ 10 mm^3 /L for total biovolume of all cyanobacterial material where known toxins are not present; or

iii. cyanobacterial scums consistently present;

(c) the levels of salinity at the reporting sites set out in the following table should not exceed the values set out in the table.

Item	Reporting Site	Target Value (EC) (uS/cm)
1	River Murray at Murray Bridge	830
2	River Murray at Morgan	800
3	River Murray at Lock 6	580
4	Darling River d/s of Menindee Lakes at Burtundy	830
5	Lower Lakes at Milang	1000

The Basin States are responsible for ensuring that the various environmental water holders and environmental water managers, including the managers of planned environmental water, operating in their State have adequate regard to the targets when making decisions about the use of environmental water.

The ultimate aim is for all entities with responsibilities under Basin Plan section 9.14 'Targets for Managing Water Flows' to ensure that they 'have regard' to water quality management in their business planning, operating and reviewing cycles so that water quality can improve over time.

3) Water Quality for Long Term Environmental Watering Plan

In addition to WRP's, each Basin State is responsible for preparing in accordance with Chapter 8 of the Basin Plan a "Long Term Environmental Watering Plan (LTEWP)" for each WRP area that contains surface water. The LTEWP for each WRP area must be developed before or at the same time as the WRP for accreditation.

The purpose of the LTEWP is to achieve the best possible environmental outcomes using the water made available for the environment by the Basin Plan. It is intended to ensure that the size, timing and nature of river flows will maximise benefits to the environment.

The LTEWP coordinates the planning, prioritisation and use of environmental water on a long-term basis through the Basin-wide environmental watering strategy and on an annual basis through the related Basin-wide annual environmental watering priorities.

Priority Environmental Assets (PEA) and Priority Ecosystem Functions (PEF) must be identified in accordance Part 5 of Chapter 8 along with their environmental watering requirements (EWR).

PEAs are identified on the basis that they can be managed with environmental water and meet one or more identifying criteria (detailed in Schedule 8), which includes:

- Being formally recognised in international agreements, or with environmental watering can support the species mentioned in the international agreements listed in s. 4 of the Act,
- Being in a natural or near-natural state, rare or unique,
- Providing vital habitat,
- Supporting Commonwealth, State or Territory-listed threatened species or communities,
- Supporting, or being capable of supporting with environmental watering, significant biodiversity.

The PEFs are also identified on the basis they can be managed with environmental water and meet one or more identifying criteria (detailed in Schedule 9), including that the ecosystem function:

- Supports the creation and maintenance of vital habitats and populations,
- Supports the transportation and dilution of nutrients, organic matter and sediment,
- Provides connections along a watercourse,
- Provides connections across floodplains, adjacent wetlands and billabongs.

The EWR for a PEA or PEF may include volumes, duration or timing of flows, specific water levels as well as WQ requirements. The WQ requirements may require the WQ targets in the WQSMP to be revised if they are more rigorous than those otherwise proposed.

6. Water Resource Plan for the CLLMM Region

As identified in the Water Act, 2007, there are twenty (20) separate Surface Water Resource Areas in the MDB as shown in **Figure. 1**. Each WRP must provide for the management of the water resources of the WRP area and be consistent with the requirements of the Basin Plan.

There are three (3) WRP areas in South Australia:

- South Australian River Murray WRP (including the surface waters and flood plain of the River Murray and Lakes Alexandrina and Albert).
- East Mount Lofty Ranges WRP (including groundwater and surface water).
- South Australian Murray Region WRP (includes groundwater and surface water in the remaining area including the Coorong).

The CLLMM Region is split between two (2) WRP areas, with the Coorong being part of the South Australian Murray Region and the remainder of the CLLMM Region being in South Australian River Murray WRP area.

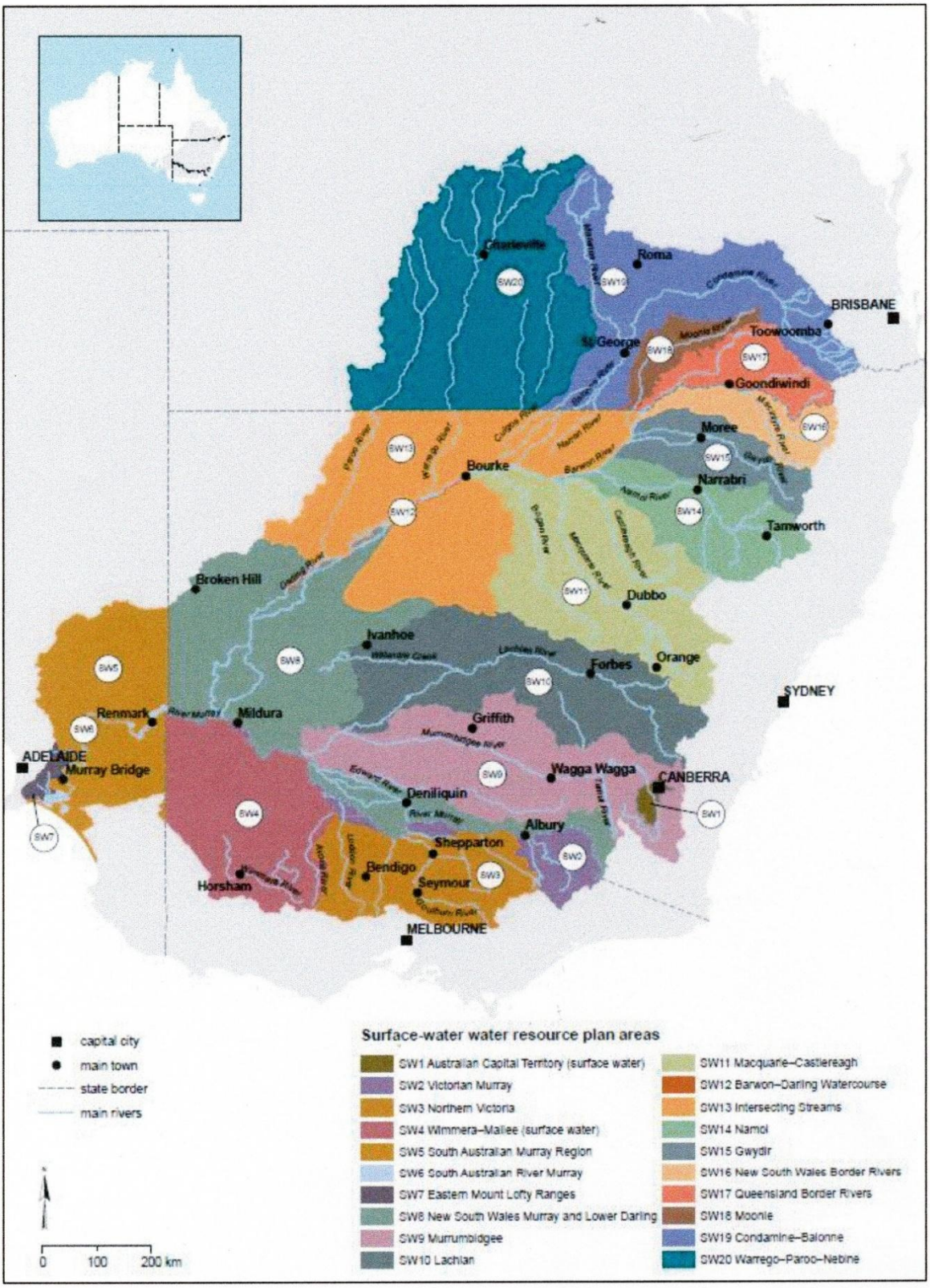


Figure. 1 – Water Resource Plan Areas

The South Australian River Murray WRP accepts the WQ targets as set out in the Schedule 11 of the Basin Plan while the South Australian Murray Region WRP also accepts the WQ targets set out in the Basin Plan but acknowledges that the WQ target values proposed for the Coorong are inappropriate based on analysis detailed in a CSIRO study, "Utilizing the Coorong, Lower Lakes and Murray Mouth Water Quality and Microalgae monitoring data to evaluate indicators for the Ecological Character Description, Oliver RL, et al, 2015". The South Australian Murray Region WRP states that "Until these updated management triggers have been described, the current default Basin Plan targets will remain in place."

The Coorong, Murray Mouth and Lower Lakes have long been managed as a single environmental asset and are recognised as a wetland of international importance under the Ramsar Convention on Wetlands. It is therefore appropriate for the River Murray LTEWP to include the Coorong and comprise environmental water management arrangements for the Coorong, Murray Mouth and Lower Lakes as a complete PEA.

Hence, the River Murray LTEWP includes the Coorong even though it is considered by the Basin Plan to be part of the SA Murray Region WRP area. The River Murray LTEWP for the South Australian River Murray WRP area is the key South Australian plan prepared under Chapter 8 of the Basin Plan, and it identifies the PEAs, PEFs and their EWRs.

7. Development of WQ Targets for the CLLMM Region.

The original LTEWP for the CLLMM region was prepared in 2015 and was updated in November 2020 following the release of the SA Murray River WRP in 2019.

The current LTEWP (November, 2020) did not alter the WQ targets which are the WQ targets as set out in the Schedule 11 of the Basin Plan except for salinity which are:

- Barrage outflows sufficient to maintain electrical conductivity in Lake Alexandrina at a long-term average of 700 µS/cm, below 1,000 µS/cm 95% of years and below 1,500 µS/cm 100% of the time (Heneker, 2010)
- To support aquatic habitat: maintain a salinity gradient from 0.5 ppt to 35ppt between the Barrages and Murray Estuary area, < 45 ppt in the North Lagoon and from 60 ppt to 100 ppt in the Southern Lagoon (Lester, et al., 2011).

A "Review and Update of the Ecological Objectives and Targets for the Coorong, Lower Lakes and Murray Mouth Priority Environmental Asset", DEW TR-2025-4, February 2025 recommended the following updates to WQ targets in the SA River Murray LTEWP for lakes Alexandrina and Albert:

- Salinity in Lake Alexandrina is maintained at the long-term (1975-2000) annual average of 700 EC, below 1000 EC 95 % of years and below 1500 EC all of the time and salinity in Lake Albert at a long-term annual average of 1,000 EC, below 1400 EC 95 % of years and below 1800 EC all of the time.
- Maintain daytime and night-time dissolved oxygen levels within the Australian Water Quality guidelines.

Even as early as 2015, these WQ targets for parameters other than salinity were seen to be inadequate as noted in the CSIRO study, "Utilizing the Coorong, Lower Lakes and Murray Mouth Water Quality and Microalgae monitoring data to evaluate indicators for the Ecological Character Description, Oliver RL, et al, 2015" which states:

> "Across all of the CLLMM sites the water quality management targets for TN, TP, turbidity and chlorophyll-a were regularly exceeded and seemed inappropriate for the CLLMM region. Development of specific CLLMM targets were often warranted."

No cultural or community health indicators have been developed to-date for the CLLMM region. Environmental water releases need to be aligned with community and cultural flow performance indicators and targets need to be developed for issues such as:

- Cultural water accessed and its quality,
- Presence and condition of species of cultural importance,
- Community satisfaction with water quality.

8. WQ Monitoring Programs in CLLMM Region

For a more detailed review of WQ monitoring in the CLLMM Region, readers are encouraged to read RLCAG's Discussion Paper No.1: WQ Monitoring in the CLLMM Region which is available on RLCAG's website: https://rlcag.org.au/wp-content/uploads/2025/04/review-of-wq-monitoring_rev3.pdf .

WQ monitoring is carried out under the River Murray Water Quality Monitoring Program (RMWQMP) to monitor water quality on an ongoing basis and has been operating since 1978. Water samples are collected at regular intervals from 28 sites along the River Murray and across its tributaries in New South Wales, Victoria and South Australia.

The MDBA manages this program on behalf of Basin governments, maintaining a uniform system for measuring, analysing and presenting data. Samples from each of these sites are analysed for a range of characteristics, including:

- electrical conductivity (indicator of salinity)
- pH (indicator of acid or alkali)
- temperature
- turbidity
- total phosphorus
- total nitrogen
- soluble organic carbon
- silica
- sulphate and bi-carbonate
- chlorophyll and phaeophytin (indicators of algal health).

This program seeks to understand long-term changes in water quality in the basin system and assess conditions under which water quality may be compromised e.g. bush fires, blackwater events, tributary effects. The dataset is reviewed every 10 years (approximately) with respect to the analysis of trends, and how these trends might change over time.

Only two (2) of these monitoring sites are in the CLLMM region; one at Milang on Lake Alexandrina and one (1) on the upstream side of the barrage at Goolwa.

The SA Government have an extensive WQ monitoring system with a telemetry system that offers near real-time water observations from surface water and groundwater monitoring networks including water levels, flows, some water quality (salinity, pH and DO) and meteorology, in a variety of interactive views, e.g. map, plot (chart) and table (list). Features include data filtering and export reports. This information is available on a DEW website: https://water.data.sa.gov.au/

There is a specific porthole for data relating to the Coorong which can be found here: https://data.sa.gov.au/data/dataset/coorong-water-quality-monitoring

SA's EPA conducted WQ monitoring during and after the millennium drought at sites in the Lower Lakes as shown in **Figure 2** and published their findings in a report "CLLMM Water Quality Monitoring Program 2009-2016", which recommended:

- Ambient water quality monitoring should be continued at historical sites (see Figure 2) and increased in frequency, parameters (e.g. add metals and acidity) and number of sites during low flow or lake drawdown events.
- It is necessary to consider the water quality in various CLLMM regions (e.g. Lake Albert, Lake Alexandrina, North and South Coorong Lagoons) individually due to differing morphology, hydrological regime and ecology, as well as taking a whole-of-system approach for future management.

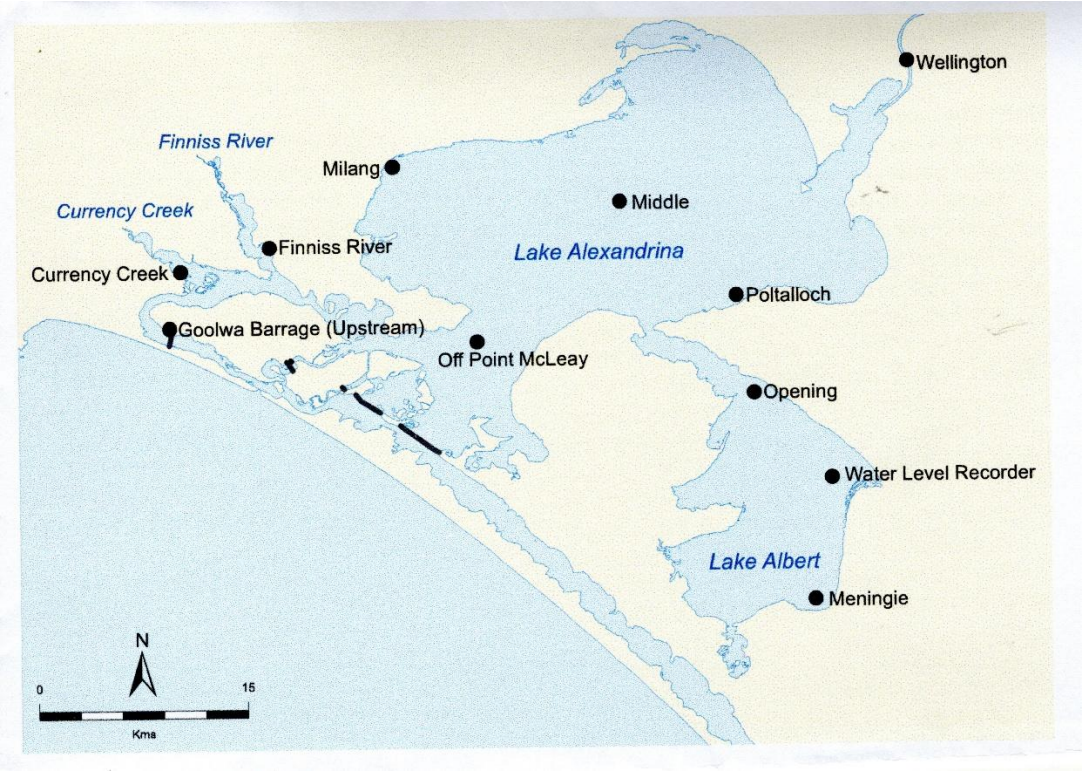


Figure 2 – EPA Monitoring Sites in the Lower Lakes 2009-2016

In addition to the Basin wide RMWQMP and the SA Government Water Data website, the South Australian Government conduct a number of WQ monitoring programs including:

- The Living Murray (TLM) Program
- Healthy Coorong Healthy Basin
- Regional Wetland Monitoring

This WQ data is collected mainly for specific research projects over limited time periods and is not readily available to the public but is included in research reports often available on the relevant website.

None of the WQ monitoring programs give regard to WQ targets or triggers other than salinity.

RLCAG's Discussion Paper No.1 on WQ Monitoring makes the case that:

1. It is critical that a long-term water quality monitoring program that adequately addresses multiple needs is in place across the CLLMM area. To achieve this, a thorough review of the historical and existing water quality monitoring is required to establish the most efficient monitoring program for the study area. This will make recommendations on:
    - sufficiency of sites (and the possible need for further sites – see **Figure 2**),
    - the frequency and timing of sampling, and
    - the parameters to be monitored.
2. A commitment of adequate funding to deliver the water quality monitoring program for the long term.
3. It is critical to increase the accessibility of WQ data to public / researchers / industry, including through expansion of DEW's Coorong Automated Dashboard and/or other publicly accessible sites.
4. Utilise outcomes of the water quality monitoring program to enhance existing or develop new hydrodynamic models, identify WQ Targets and trigger levels and establish integrated management systems for timely decision making.

9. Compliance of Current Monitoring with WQ Targets

Use of the current target water quality values for compliance has been very limited except perhaps for salinity for which the target water quality values have been revised from the ANZWQG default values to be more relevant for the various elements of the CLLMM system, as discussed above.

SA's EPA recommended in their report "CLLMM Water Quality Monitoring Program 2009-2016", the following:

- Existing CLLMM water quality triggers should be revised and included in the Basin Plan and State guidelines. These need to consider the deterioration in water quality that has been observed over time and the ecological impacts.

The latest review of the RMWQMP dataset analysed the data for the period 1978 – 2021 plus other relevant long term WQ monitoring data available from other sources (RMWQMP Data Trends Analysis 2021, La Trobe Uni., CFE Publication No. 276).

Key findings of this report include:

- The overall level of most parameters increases downstream.
- The general pattern of WQ parameters is one of decreasing levels [WQ deteriorating] except water temperature.
- For lower Murray sites, salinity (EC) has more than halved with particularly strong decreases since 2010, likely due to salt interceptor schemes.
- Most parameters are currently at or slightly above ANZWQG trigger values, set according to their position in the catchment.

The water quality data for the Coorong over the last few decades has been recently synthesised (Mosley et al., 2020, 2023). Key findings were:

- Reduced inflows from the River Murray, due to upstream water extraction and River Murray regulation has occurred over the last 50 -100 years. There has also been reduced flood frequency and net evaporation has increased due to climate change. These factors have led to a long-term decline in flushing of the Coorong.
- Over the last 20 years large areas of the Coorong have been persistently hyper-saline (salinity > 80 g/L) and hypereutrophic (total nitrogen, TN > 4 mg/ L , total phosphorus, TP > 0.2 mg/L , chlorophyll a > 50 mg/L).
- Water quality was particularly poor during the Millennium Drought, where inflows were the lowest in recorded history.
- High total nutrient concentrations correlate with reduced flushing due to diminished freshwater inflows and increasing evapo-concentration, particularly in the South Lagoon.

The main focus for water quality in the CLLMM region has been on salinity and this has achieved good results in lowering overall salinity levels or at least shown that more effort is required to reduce salinity levels back to target values which will support the ecosystems such as the Coorong Southern Lagoon.

Hence it is clear that meaningful water quality targets need to be developed, similar to what has been done for salinity, which will give a meaningful indication of the ability of the water in the system to support the particular ecosystems present in the CLLMM region.

In addition, meaningful community and cultural health objectives and targets need to be established as little effort or resources have been utilised in this area.

10. Proposed WQ Targets for CLLMM Region.

Reliance on the ANZWQG default target values for water quality in the CLLMM region has rendered these targets relatively meaningless and give little guidance as to the adequacy of the water quality in the region to support healthy ecosystems. This is particularly relevant given the changes occurring due to climate change.

The report "Challenges and adaption needs for Water Quality in the Murray-Darling Basin in Response to Climate Change", Verhoeven, et al, 2024, states that:

- Drier conditions, increasing temperatures, and changes to flow are already impacting on water quality particularly during periods of low flows. Even if other anthropogenic activities remain unchanged, the threats to future MDB water quality will increase with worsening climate change.
- The predicted threats to WQ including:
    - Salinity
    - Nutrients
    - Sediments
    - Metals and other toxic compounds
    - Temperature
    - Low Dissolved Oxygen levels
    - Cyanobacterial Blooms and Toxins
    - Blackwater Events
- These threats occur locally but can also magnify downstream under low flow conditions. We predict that the downstream impacts of these threats will be further magnified under future more sustained low flow conditions.
- Volumetric water policy and management reforms for the MDB provided a starting point for improved MDB water management in the 2000's, but they addressed water quality issues in only a limited way.
- Recommend development or updates to water quality objectives and specific, measurable, achievable, relevant and time-bound (SMART) targets.

In a report prepared for DEW, "Draft Water and Sediment Quality Objectives for the Coorong", Mosely & Leydon, December 2023, the Australian Water Quality Guidelines framework was used to identify suitable water and sediment quality indicators for the Coorong. The draft water quality targets proposed for the Coorong are shown in **Table. 2** below.

Proposed Indicator	Draft Guideline Value	Current Default Values
Salinity – South Lagoon - North Lagoon	< 60 g/L (90% of time) < 100 g/L (100% of time) < 50 g/L (100% of time)	na
Total Nitrogen	< 1.7 mg/L (100% of time)	< 0.35 (annual median)
Ammonium	< 0.05 mg/L (100% of time)	na
Nitrate	< 0.01 mg/L (100% of time)	na
Total Phosphorous	< 0.1 mg/L (100% of time)	< 0.01 (annual median)
Filterable Reactive P	< 0.01 mg/L (100% of time)	na
Chlorophyll a	< 8.7 ug/L (100% of time)	na
Dissolved Oxygen	90 – 110% Saturation (100% of time)	90 – 110% (annual median)
Turbidity	< 10 NTU (100% of time)	< 20 (annual median)
Rapid Assessment Protocol Sediment Condition Score	> 10 (100% of time)	na

Table. 2 – Draft WQ Targets for the Coorong based on ANZWQG Framework

Due to the sensitive nature of the ecosystems in the Coorong, consistency of water quality is considered more important than long term average water quality. In addition, it confirms the need to develop and adopt more meaningful WQ targets rather than using ANZWQG default values as the ecosystems in the CLLMM region are unique as demonstrated by its listing as a Ramsar Wetland of International Importance.

There is a clear need to develop more appropriate WQ objectives and targets for each component of the CLLMM region (i.e. Lake Alexandrina, Lake Albert, River channel to Goolwa barrage including Finniss and Currency Creek inlets, Goolwa barrage to Murray Mouth, Coorong North Lagoon, and Coorong South Lagoon.).

These need to be developed based on the ANZWQG management framework and a high level of understanding of the environmental systems and processes to identify water quality target and triggers for the management of this waterway and wetland. Considerable research has been carried out in this regard, which include:

- critical components, processes and services as developed in the recently released Ramsar Management Plan prepared for the CLLMM Wetland, "Ramsar Management Plan: the Coorong and Lakes Alexandrina and Albert Wetlands", DEW, 2022 – published October 2025.
- ecological objectives and targets for managing environmental water to achieve healthy and functional ecosystems in the Coorong, Lower Lakes and Murray Mouth Priority Environmental Asset as part of the SA River Murray LTEWP (2020) which has 8 ecological objectives and 29 ecological targets for the CLLMM PEA (**Appendix C**),

Development of appropriate WQ targets will enhance monitoring and evaluation efforts and will contribute to Australia's reporting obligations for the CLLMM Ramsar Wetland site under the Ramsar Convention on Wetlands of International Importance.

This process will also contribute towards DEW's reporting obligations for the LTEWP and other obligations under the Basin Plan (see **Appendix B**, "Schedule 12—Matters for Evaluation and Reporting Requirements") as well as other key state and national legislation, such as commitments under the Native Title Act, 1993.

11. Reporting of WQ in the CLLMM Region.

Reporting of WQ data and information should be centralised for multiple needs and readily available to decision makers, researchers and the general public in a format that can be readily understood.

MDBA and DEW have regular (weekly) reporting of water flows, storage and levels but do not have any regular reporting of water quality for the CLLMM area other than the raw data on the SA Government Data website; https://water.data.sa.gov.au/

Report cards are an assessment and communication product that compare outcomes against predefined objectives or targets. They effectively integrate and synthesise large, and often complex, sets of information into simple scores that can easily be communicated to decision makers and the general public.

As shown in Figure 3 below (Costanzo & Kirkwood, "Waterway Health Report Cards, An Australian Perspective", Australian Water Partnership, 2020), reporting needs to be tailored for the particular audience it is meant for. Less technical and more synthesising of

information is required for audiences that may have less technical skills. As we move up the pyramid, there should be less emphasis on technical knowledge and the need for target values to demonstrate compliance becomes more important.

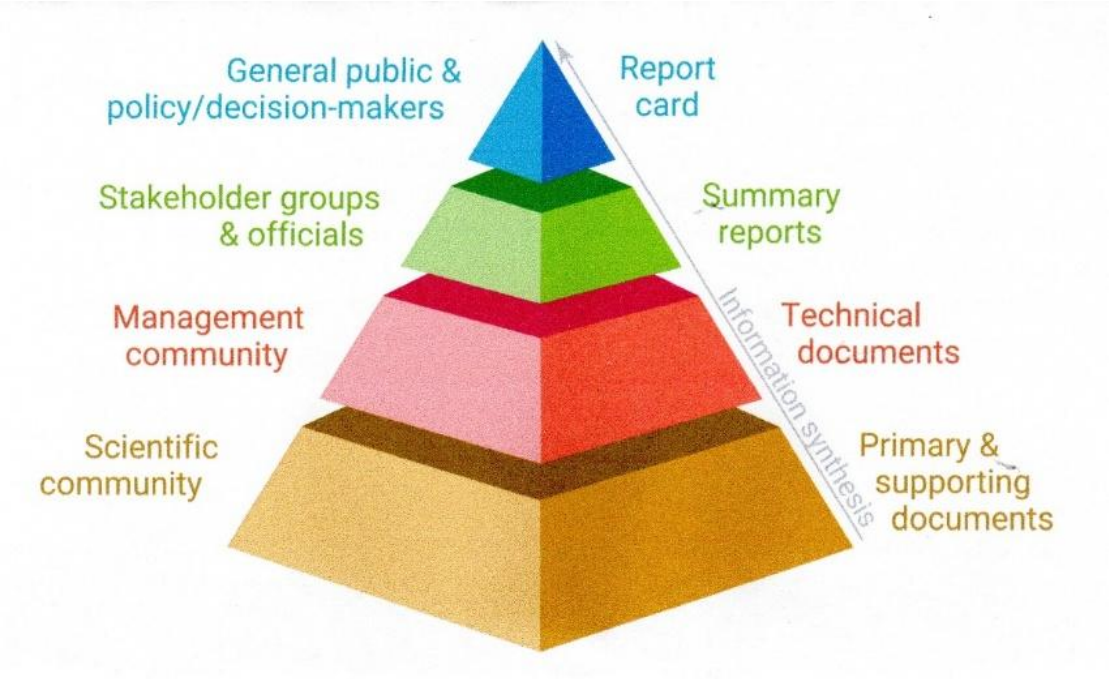


Figure 3 – Reporting Pyramid

There are numerous primary research and technical documents available through all the Federal and State Government departments, the MDBA, and numerous research institutes and organisations, however the number of sources for information at the Report Card level for General Public and Policy/Decision Makers is much more limited.

The MDBA do prepare an Annual Report Card for the CLLMM region with the most recent report for 2023-24 shown in **Figure 4** or available on their website: https://www.mdba.gov.au/water-use/water-environment/progress-and-outcomes-improving-system/lower-lakes-coorong-and-murray . The report card, however, does not mention water quality but reports secondary indicators of ecological health.

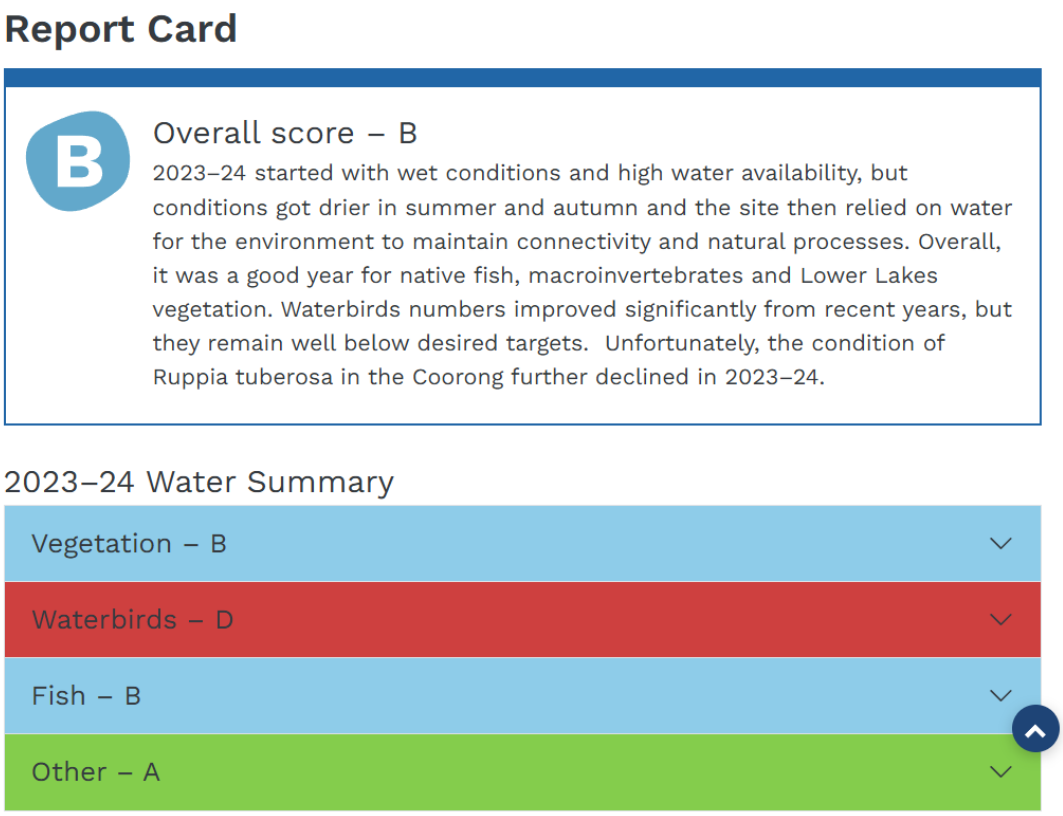


Figure 4 – MDBA Report Card for CLLMM Region

Another example of a Report Card is shown in **Figure 5** for Darwin Harbour. The report is far more appealing and conveys the relevant information much clearer and less reliant on scientific knowledge making it more suitable for the general public. This report card can be found here: https://environment.nt.gov.au/water/darwin-harbour/darwin-harbour-region-report-cards/darwin-harbour-water-quality-report-2024

A suitable Annual Report Card for the CLLMM region needs to convey compliance with both primary and secondary indicators of environmental health.

The primary indicators (or independent variables) being:

- **flow** (including quantities, timing and levels), and
- **water quality** e.g. nutrients, turbidity, dissolved oxygen, salinity, etc.).

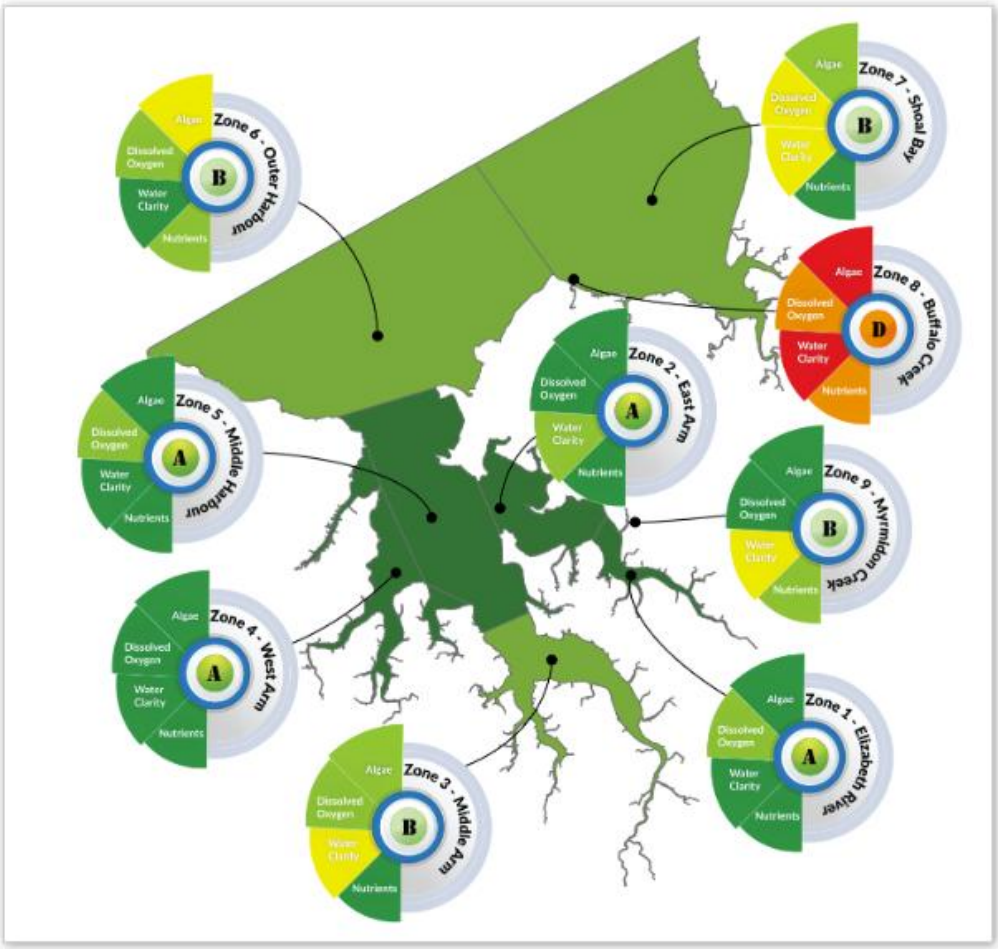
The secondary indicators (or dependent variables) would be those currently used i.e. vegetation, waterbirds, fish, etc.

The targets for flows could be compliance with Environmental Watering Requirements and targets for Water Quality would be the new appropriate targets that need to be established in accordance with the ANZWQG framework.

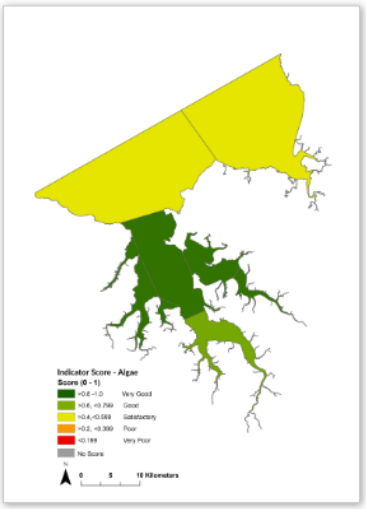
In addition, an Annual Report Card for the CLLMM region also needs to cover cultural and community health objectives and targets. Little to no monitoring has been done in this area to-date and objectives and targets need to be developed.

2024 water quality report

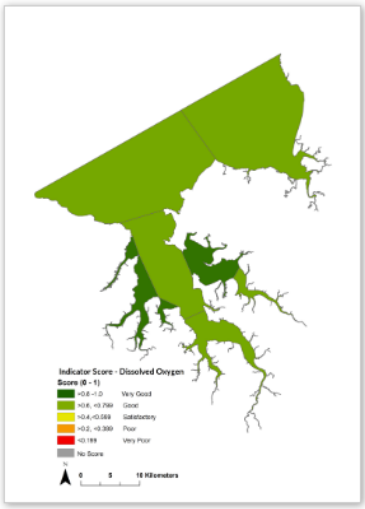
Darwin harbour water quality at a glance 2024 PDF (5.4 MB)



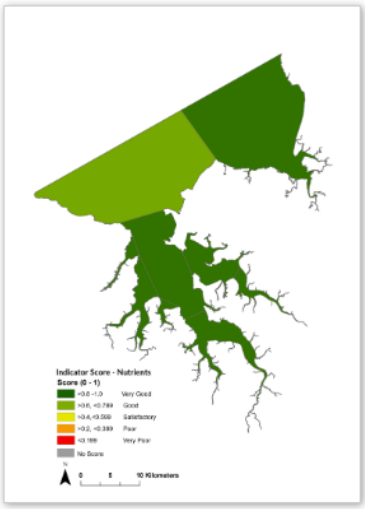
Overall water quality index



Indicator - algae



Indicator - dissolved oxygen



Indicator - nutrients

Figure 5 – Annual Report Card for Dawin Harbour

12. Recommendations

Development of appropriate WQ targets will provide clarity and purpose to WQ monitoring and reporting programs. Appropriate WQ targets will also enhance evaluation and reporting efforts such as Australia's reporting obligations for the CLLMM Ramsar Wetland and will also contribute towards DEW's reporting obligations for the LTEWP and other obligations under the Basin Plan (see **Appendix B**) and other state and national legislation. Appropriate WQ targets will also give clarity to reports for the public and decision makers.

Recommended actions:

1) It is critical that a long-term water quality monitoring program that adequately addresses multiple needs is in place across the CLLMM region. To achieve this, a thorough review of the historical and existing water quality monitoring is required to establish the most efficient monitoring program for the study area. This will make recommendations on:
    a. sufficiency of sites (and the possible need for further sites – see Figure 2),
    b. the frequency and timing of sampling, and
    c. the parameters to be monitored.

2) Developed appropriate (Specific, Measurable, Achievable, Relevant and Time-bound SMART) WQ objectives and targets based on the ANZWQG management framework for each component of the CLLMM region including:
    a. Lake Alexandrina,
    b. Lake Albert,
    c. River u/s of Goolwa barrage including Finniss and Currency Creek inlets,
    d. Goolwa to Murray Mouth,
    e. Coorong North Lagoon, and
    f. Coorong South Lagoon).

3) Include WQ information including compliance with targets in regular (weekly) flow reports issued by MDBA and DEW.

4) Community and cultural flow performance indicators and targets need to be developed for issues such as:
    a. Cultural water accessed and its quality,
    b. Presence and condition of species of cultural importance,
    c. Community satisfaction with water quality.

5) Prepare Annual Report Card which includes compliance with targets in each component of the CLLMM Region including:
    a. **Primary indicators** (or independent variables) of:
        i. **flow** (including quantities, timing and levels), and
        ii. **water quality** e.g. nutrients, turbidity, dissolved oxygen, salinity, etc.).
    b. **Secondary indicators** (or dependent variables) would be those currently used i.e. vegetation, waterbirds, fish, etc
    c. **Community & cultural indicators** as developed in Recommendation No. 4.

6) Establish the main WQ threats, how WQ can be improved and clear pathways of responsibility so that actions can be taken in response to non-compliance with appropriate target WQ values.

Appendix A – Glossary of Terms and Acronyms.

ANZWQG — Australia New Zealand Water Quality Guidelines.

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

Basin Plan — Murray–Darling Basin Plan (MDBA 2012).

BWS — Basin-Wide Environmental Watering Strategy – published by the Murray-Darling Basin Authority, a legislative requirement under Chapter 8 of the Basin Plan

CLLMM — Coorong, Lower Lakes and Murray Mouth.

DEW — Department for Environment and Water.

EC — Electrical conductivity; commonly used as a measure of water salinity as it is quicker and easier than measurement by Total Dissolved Solids (TDS). TDS(mg/L) = k x EC(µS/cm) where k = 0.5-0.8 depending on water chemistry.

Ecological processes — All biological, physical or chemical processes that maintain an ecosystem.

Ecological values — The habitats, natural ecological processes and biodiversity of ecosystems.

Ecosystem services — All biological, physical or chemical processes that maintain ecosystems and biodiversity.

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

Lower Lakes — Lakes Alexandrina and Albert.

LTEWP — Long-Term Environmental Watering Plan – a legislative requirement under Chapter 8 of the Basin Plan.

MDBA — Murray-Darling Basin Authority.

PEA — Priority Environmental Asset – defined in section 8.49 of the Basin Plan as an environmental asset that can be managed with environmental water.

TLM — The Living Murray Program – a long-running collaborative programme between the Murray-Darling Basin Authority and partner governments aimed at restoring the health of the River Murray system by recovering 500 gigalitres of water and constructing major water management structures at six environmental icon sites.

WRP area — Water resource plan area – identified for the purpose of implementing the Basin Plan, the water resource plan areas are listed in Chapter 3 of the Basin Plan.

WQSMP — Water Quality and Salinity Management Plan – to be part of Water Resource Plans for each catchment in accordance with the Basin Plan.

Appendix B

Schedule 12—Matters for evaluation and reporting requirements

Note 1: The matters listed in this Schedule relate to the objectives and outcomes against which the effectiveness of the Basin Plan will be evaluated (see section 13.05). The matters are also matters on which the Authority, the Basin States, the Department and the CEWH are required to report (see section 13.14). The Authority may publish guidelines under section 13.16, and enter into agreements under section 13.15, in relation to the reporting requirements.

Note: 2 Category A matters are subject to 5 yearly reporting and Category B matters are subject to annual reporting, subject to an agreement being made under section 13.15.

In this Schedule, ***CEWH*** means the Commonwealth Environmental Water Holder.

Item	Matter	Reporter	Category	Relevant Chapter
	Basin Plan as a whole			
1	The transparency and effectiveness of the management of the Basin water resources.	Authority	A	Chapter 5
2	The protection and restoration of water-dependent ecosystems and ecosystem functions in the Murray-Darling Basin, including for the purposes of strengthening their resilience in a changing climate.	Authority	A	Chapter 5
3	The extent to which the Basin Plan has affected social, economic and environmental outcomes in the Murray-Darling Basin.	Department, Authority	A	Chapter 5
4	The effectiveness of the management of risks to Basin water resources.	Basin States, Authority	B	Chapters 4, 5 and 10
5	The transition to long-term average sustainable diversion limits.	Department	B	Chapters 5 and 6
6	The extent to which local knowledge and solutions inform the implementation of the Basin Plan.	Basin States, Authority, CEWH	B	Chapters 6, 8 and 10
	Environmental watering plan			
7	The achievement of environmental outcomes at a Basin scale, by reference to the targets in Schedule 7.	Authority, CEWH	A	Chapter 8
8	The achievement of environmental outcomes at an asset scale.	Basin States	A	Chapter 8
9	The identification of environmental water and the monitoring of its use.	Basin States, CEWH, Authority	B	Chapter 8
10	The implementation of the environmental management framework (Part 4 of Chapter 8).	Basin States, CEWH, Authority	B	Chapter 8
	Water quality and salinity			
11	The fitness for purpose of the Basin water resources.	Authority	A	Chapters 5 and 9
12	Progress towards the water quality targets in Chapter 9.	Basin States, Authority	A	Chapter 9
13	The implementation, where necessary, of the emergency response process for critical human water needs.	Basin States, Authority, Department	B	Chapter 11
14	The implementation of the water quality and salinity	Basin States,	B	Chapter 9

Item	Matter	Reporter	Category	Relevant Chapter
	management plan, including the extent to which regard is had to the targets in Chapter 9 when making flow management decisions.	Authority, CEWH		
	Water trading rules			
15	The facilitation, by efficient and effective water markets, of tradeable water rights reaching their most productive use.	Authority	A	Chapters 5 and 12
16	The implementation of water trading rules.	Basin States, Authority	B	Chapter 12
	Water resource planning			
17	The certainty of access to Basin water resources.	Authority	A	Chapters 5 and 10
18	The efficiency and effectiveness of the operation of water resource plans, including in providing a robust framework under a changing climate.	Basin States, Authority	A	Chapter 10
19	Compliance with water resource plans.	Basin States	B	Chapter 10
20	The prioritisation of critical human water needs.	Basin States	B	Chapters 10 and 11
21	The accountability and transparency of arrangements for water sharing.	Basin States	B	Chapter 10

Appendix C

Ecological objectives and targets identified in the 2020 SA River Murray LTWP for the CLLMM Priority Environmental Asset title.

(Table taken from O'Connor, et al. (2015). Note, additional target detail and supplementary information, and the source reference for the target information have not been transferred into this long-term plan and should be sourced from Table 1 in O'Connor, et al. (2015).)

Type	Ecological objective	Ecological targets
Waterbirds	Maintain or improve waterbird populations in the Coorong and Lower Lakes	Abundances, area of occupation and extent of occurrence of TLM target waterbird species to be above defined median reference values (median of data from the 15 years between 2000 and 2014) (Paton, 2014a)
		Detect annual breeding activity in waterbird species that are expected to breed annually at the site and at least two breeding events in any four consecutive years in species that breed regularly at the site (Department of Environment Water and Natural Resources, in prep (a))
		Provide functional mudflat habitat to sustain active shorebird foraging behaviour during November-March with a foraging effort of <50%. (Murray-Darling Basin Authority, 2014e)
		Maintain abundances of 12 waterbird species (Table 22 in Appendix 4) at or above 1% of the total flyway population size (Department of Environment Water and Natural Resources, in prep (a))
Fish	Maintain a spatio-temporally diverse fish community and resilient populations of key native fish species in the lower lakes and Coorong	A spatio-temporally diverse fish community is present including all 23 fish families stated in the Ramsar site draft Ecological Character Description (Department of Environment Water and Natural Resources, in prep (a))
		Annual detection of juvenile Catadromous fish at abundances ≥ that of defined 'Recruitment Index' values (44.5 for *Congolli*, and 6.1 for *Common galaxias*) (Bice, et al., 2014)
		Annual detection of migration for Anadromous species (short-headed and pouched lamprey) at index values of >0.6 (Bice, et al., 2014)
		Maximise fish passage connectivity between the Lower Lakes and Coorong, and between the Coorong and the sea by allowing fishways to operate year-round (Murray-Darling Basin Authority, 2013b)
		Maintain or improve abundances of Murray hardyheads and pygmy perch so that 'Relative Abundance Index' values of ≥1 are achieved on an annual basis (Wedderburn, 2014)

Type	Ecological objective	Ecological targets
		Detect recruitment success of Murray hardyheads and pygmy perch at least every second year (Wedderburn, 2014)
		Maintain or improve abundances, distribution and recruitment of black bream and greenback flounder with population condition score ≥3 (Ye, et al., 2014a)
		Facilitate regular recruitment and a broader distribution of juvenile mulloway (Ye, et al., 2014a)
		Maintain an average Catch-Per-Unit-Effort (CPUE) of small-mouthed hardyhead sampled in spring/early summer of > 120 for adults, and >790 for juveniles (Ye, et al., 2014b)
		Maintain the proportional abundance of small-mouthed hardyhead juveniles at >60% in 75% of defined monitoring sites within the CLLMM (Ye, et al., 2014b)
Macroinvertebrates	Maintain or improve invertebrate communities in estuarine and lagoon sediments	Macroinvertebrate taxonomic distinctness falls within the expected ranges of a regional reference (Dittmann, 2014)
		The distribution of macroinvertebrate species remains within or above the species-specific reference level for their index of occurrence (Dittmann, 2014)
		The area of occupancy where abundance and biomass are at or above the reference level should be >20% of the monitoring sites (Dittmann, 2014)
		The macroinvertebrate community has a higher multivariate similarity to the community present in years with flow than without flow (Dittmann, 2014)
	Maintain habitable sediment conditions in mudflats	Median grain size of sediments in the Coorong and Murray Mouth will remain between 125 – 500 µm (Dittmann, 2014)
		Sediment organic matter content between 1 and 3.5 % dry weight in the Coorong and Murray Mouth (Dittmann, 2014)
Vegetation	Restore *Ruppia tuberosa* colonisation and reproduction in the Coorong at a regional and local scale	A continuous distribution of *Ruppia tuberosa* beds along a 50 km section of the southern Coorong (excluding outliers) (Paton, 2014b)
		Within the abovementioned distribution, 80% of the monitored sites should have *Ruppia tuberosa* plants present in winter and summer (Paton, 2014b)
		50% of sites with *Ruppia tuberosa* to exceed the local site indicators for a healthy *Ruppia tuberosa* population (Paton, 2014b)
		Support a resilient *Ruppia tuberosa* population with seed densities of 2000 seeds/m^2 by 2019 and 50% of sites having 60% cover in winter and a seed bank of 10,000 seeds/m^2 by 2029 in the Coorong South Lagoon (Paton, 2014b)

Type	Ecological objective	Ecological targets
	Maintain or improve aquatic and littoral vegetation in the Lower Lakes	Maintain or improve diversity of aquatic and littoral vegetation in the Lower Lakes as quantified using the LLCMM vegetation indices (Nicol, et al., 2014b)
Water quality	Establish and maintain stable salinities in the lakes and a variable salinity regime in the Murray estuary and Coorong.	Barrage outflows sufficient to maintain electrical conductivity in Lake Alexandrina at a long-term average of 700 µS/cm, below 1,000 µS/cm 95% of years and below 1,500 µS/cm 100% of the time (Heneker, 2010)
		To support aquatic habitat: maintain a salinity gradient from 0.5 ppt to 35ppt between the Barrages and Murray Estuary area, <45ppt in the North lagoon, and from 60ppt to 100 ppt in the South lagoon (Lester, et al., 2011)
Ecosystem processes	Maintain a permanent Murray Mouth opening through freshwater outflows with adequate tidal variations to improve water quality and maximise connectivity between the Coorong and the sea	Maintain an open Murray Mouth, as indicated when the Diurnal Tidal Ratio (DTR) at Goolwa exceeds 0.3, with minimum DTR values of 0.05 and 0.2 at Tauwitchere and Goolwa respectively (Murray-Darling Basin Authority, 2013b; DWLBC, 2008)
		Maintain a minimum annual flow required to keep the Murray Mouth open (730—1,090 GL/year) (Murray-Darling Basin Authority, 2013b)

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