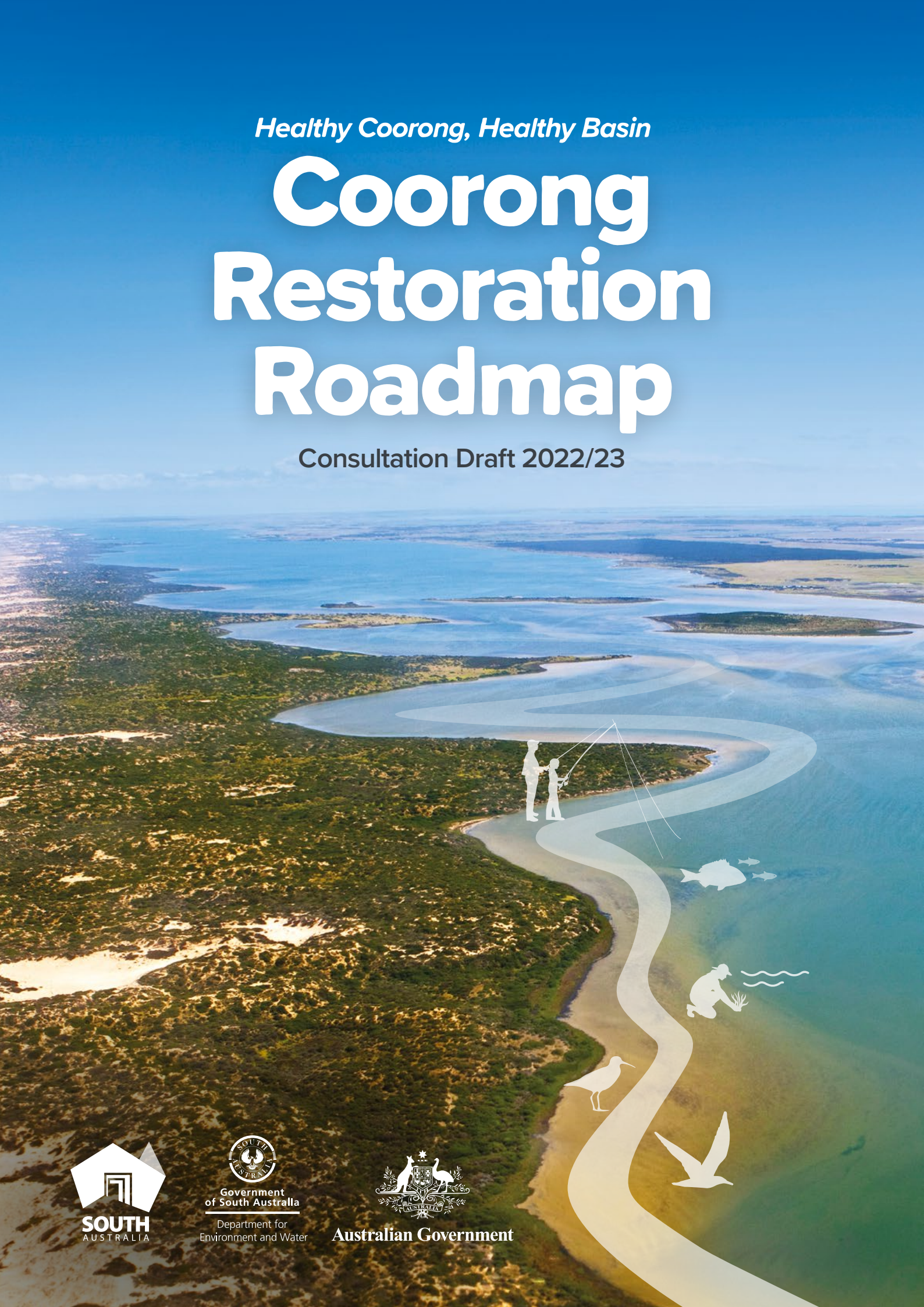
Healthy Coorong, Healthy Basin

Coorong Restoration Roadmap

Consultation Draft 2022/23



SOUTH AUSTRALIA

Government of South Australia
Department for Environment and Water

Australian Government

Foreword

The Coorong is a wetland of local, national and international importance and one of the most significant waterbird habitats in the Murray-Darling system. The condition and value of the Coorong has suffered long-term decline and was further substantially damaged by the Millennium Drought. The long-term accumulation of salt and nutrients with low water levels annually over late spring and summer, have prohibited the recovery of the system to a recognisable healthy state.

In recognition of the Coorong South Lagoon's declining condition and the Ramsar-listed wetland's importance to the health of the Murray-Darling Basin and the Basin Plan's success, *Healthy Coorong, Healthy Basin* (HCHB) is working to improve the ecology, knowledge and management of the Coorong.

In 2019, the South Australian Government released the *Healthy Coorong, Healthy Basin Action Plan*, which outlined the short, medium and long term on-ground works, scientific trials and investigations, management tools and infrastructure activities required from the program to get the Coorong back on track for a healthy future.

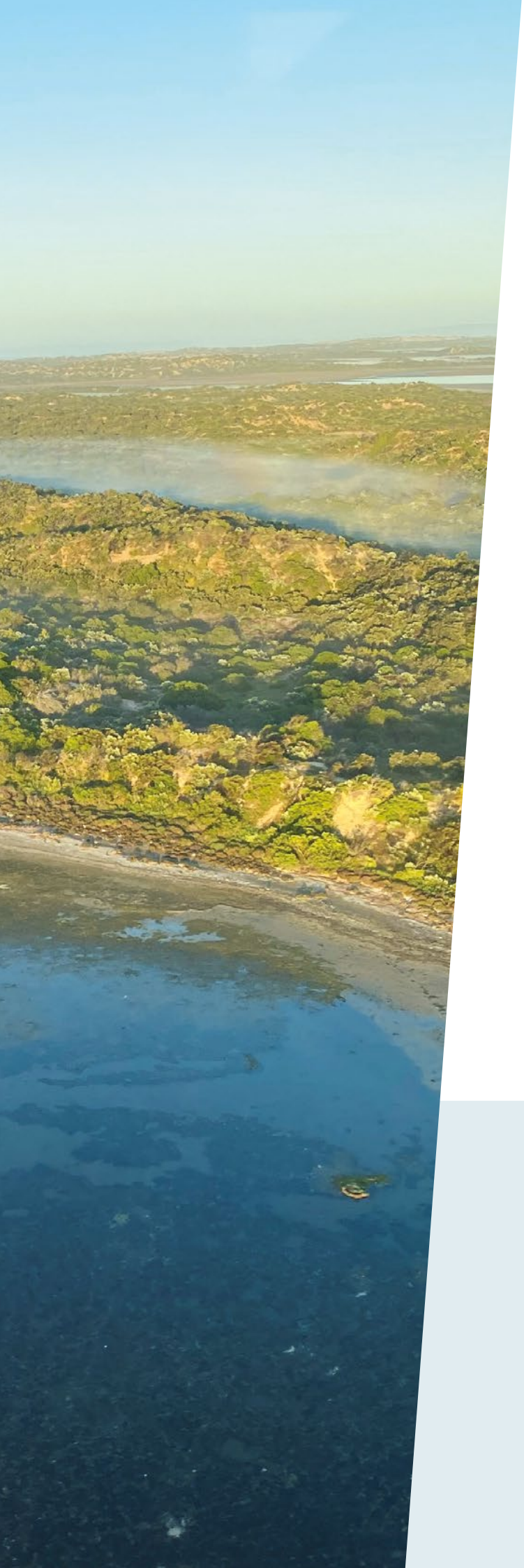
Since then, *Healthy Coorong, Healthy Basin* has completed an unprecedented science program, which has directly informed concurrent feasibility investigations into long-term management options for the site.

Guided by *International Principles and Standards for the Practice of Ecological Restoration*, this *Healthy Coorong, Healthy Basin* Restoration Roadmap now presents how we will use our key findings and partner with scientists, community and First Nations to implement a strategic restoration program for the Coorong.

Restoring a healthy Coorong is critical for the environment, First Nations, local communities, the South Australian tourism industry, the overall health of the Murray-Darling Basin and the success of the Murray-Darling Basin Plan.

We want your feedback

This draft Roadmap is a 'living document', which will be updated following community and stakeholder consultation in 2022 and 2023.



Contents

Acknowledgement of Country

Aboriginal people are the First Peoples and Nations of South Australia. The Coorong connected waters and surrounding lands have sustained unique First Nations cultures since time immemorial. The *Healthy Coorong, Healthy Basin* program acknowledges the range of First Nations' rights, interests and obligations for the Coorong and connected waterways and the cultural connections that exist between First Nations peoples across the region and seeks to support their equitable engagement. Aboriginal peoples' spiritual, social, cultural and economic practices come from their lands and waters, and they continue to maintain their cultural heritage, economies, languages and laws which are of ongoing importance.

Healthy Coorong, Healthy Basin

Restoring a healthy Coorong is critical for the environment, First Nations, local communities, agricultural and fishing industries, the South Australian tourism industry and the overall health of the Murray-Darling Basin.

The Healthy Coorong, Healthy Basin will contribute to managing the Coorong for ecological health and, through this, support the Coorong, Lakes Alexandrina and Albert Wetland Ramsar site to be a healthy, productive and resilient wetland system that maintains its international significance.

Why is the Coorong important?

The Murray-Darling Basin is one of the most important social, environmental, economic and cultural systems in Australia. River systems die from the mouth up, which is why the Coorong's health is not just important to the entire Murray-Darling Basin, but to the whole country. The nearly 28,000 people who live in the Coorong, Lower Lakes and Murray Mouth region mainly work in agriculture, viticulture, fishing, manufacturing and tourism, with the majority of industries relying on a healthy wetland system to thrive.

The wetland's significance is internationally recognised as part of the Coorong and Lakes Alexandrina and Albert Ramsar listed wetland, supporting endangered migratory waterbirds from across the world, threatened wildlife and rare plants. Its importance is also recognised through international migratory bird agreements.

The Ramsar site provides significant economic and social value to the region and wider South Australia, supporting a thriving tourism industry, commercial fishing, recreation, Traditional Owner uses and other social activities. The health of the Coorong and its connected lands and waters are central to the culture and beliefs of the Traditional Owners – the Ngarrindjeri and the First Nations of the South East.

The Coorong National Park not only plays an important role in conserving this precious environment for First Nations and the public, it also offers a wide range of activities for visitors, from birdwatching and canoeing to fishing, camping and four-wheel-driving in a beautiful wilderness.

The local community is active in advocating for improved management and conservation of the region. During the Millennium Drought, the local community participated in site management including: setting up community nurseries to propagate plants for local revegetation programs, planting vegetation to manage acid sulphate soils, monitoring acid sulphate soils and water quality and installing fencing to protect the lakes' shorelines. This resulted in the community feeling empowered and taking ownership of the program and becoming advocates in the broader community.

The South Australian Government is committed to ensuring that the environmental features of the Coorong that make it internationally significant – its ecological character – are maintained. It's vital that this important wetland is looked after for future generations to benefit plants and wildlife, First Nations culture, local communities, fishing and agriculture industries, the state's economy and for the enjoyment of visitors from across the world.

That's why the South Australian and Australian governments are taking action to restore the health of the Coorong and get this important wetland back on track for the future.

The Coorong at a glance

Population

Nearly 28,000 people live in the Coorong, Lower Lakes and Murray Mouth region

Murray-Darling Basin

Located **at the end of Australia's largest river system**, the Coorong is a critical part of the Murray-Darling Basin

River Murray water

River Murray water flows over the barrages and into the Coorong and Southern Ocean (via the Murray Mouth)

Average 3415 gigalitres/year (1990-2020)

First Nations

Ngarrindjeri and First Nations of the South East

Internationally significant

Listed as a **'Wetland of International Importance'** in 1985. It supports **11** threatened species, **6** threatened migratory waterbird species and **2** threatened ecological communities

South East Flows

Freshwater flows from the South East enter the Coorong South Lagoon via a regulator at Salt Creek

Average 11.43 gigalitres/year (1990-2020)

Tourism

Average **annual tourism expenditure of $130 million** from 779,000 domestic day trips and 335,000 overnight visitors per year (2021)

Significant waterbird habitats

Regularly **supports over 100,000 waterbirds annually**, including over 30,000 migratory shorebirds each summer

Marine inflows (Murray Mouth)

Inflows of tidal marine waters flow through the Murray Mouth into the Coorong

Commercial fishing

The Lakes and Coorong Fishery provides **$8–13 million annually**. Key species are pipis, yellow-eye mullet and mulloway. Freshwater flows increase food sources and trigger breeding and recruitment for Coorong fish

Over-extraction

Murray-Darling Basin flows have reduced due to over extraction in combination with a changing climate. These impacts were exacerbated during the Millennium Drought (2001-2010)

Groundwater

Groundwater enters the Coorong lagoons via active seeps

People and industry need a healthy Coorong wetland system to thrive

The Coorong

The Coorong is an estuarine wetland of local, national and international importance, a major component of the Coorong, Lakes Alexandrina and Albert Ramsar listed wetland and widely regarded to be the most important waterbird wetland in the Murray-Darling Basin.

It is a 140km long, coastal lagoon system, including a North and South lagoon, separated by a narrow constriction at Parnka Point. Salinity generally increases with distance from the mouth from marine (~35g/L) at the Murray Mouth to hypersaline (>60g/L) in the South Lagoon. The site supports extensive and diverse waterbird, fish and plant assemblages as well as threatened ecological communities and species.

The condition and value of the Coorong is largely reliant upon its hydrology, which is driven by releases from the Lower Lakes barrages, ingression of seawater through the Murray Mouth, flows via Salt Creek and annual rainfall and evaporation. Long-term declines in freshwater flows from the River Murray (that are released via the Lakes barrages) were exacerbated by the Millennium Drought (2001 to 2010), which contributed to an absence of water released from the barrages from 2007 to 2010. These changes to the system's hydrology led to an accumulation of salt and nutrients in unfavourable forms. While the Coorong has partially recovered since the return to flows in 2010–11, further action is required to secure its long-term health.

The Basin Plan and Ramsar

The South Australian Government is committed to implementing the Basin Plan in full and ensuring that we have a sustainable, healthy working river for future generations.

The *Water Act 2007* sets out that the purpose of the Basin Plan is to provide for the integrated management of the Basin water resources giving effect to relevant international agreements.

The Basin Plan aims to:

- **promote sustainable** use of the Murray-Darling Basin's water resources to protect and restore its ecosystems, natural habitats and species, and to conserve biodiversity
- **promote the wise use of all water resources** in the Murray-Darling Basin
- **promote the conservation of declared Ramsar wetlands** in the Murray-Darling Basin.

A key objective of the Basin Plan is to ensure that Ramsar wetlands, such as the Coorong, maintain their ecological character.

Continued optimisation of the delivery of water for the environment will be critical in achieving Basin Plan objectives of 'Protecting and restoring water-dependent ecosystems and their ecosystem functions' to ensure that ecosystems like the Coorong are resilient to climate change and other risks and threats.

Coorong Policy and Program history

1985

Ramsar listing

The Coorong, and Lakes Alexandrina and Albert Wetland designated a Ramsar Wetland of International Importance

2001-2010

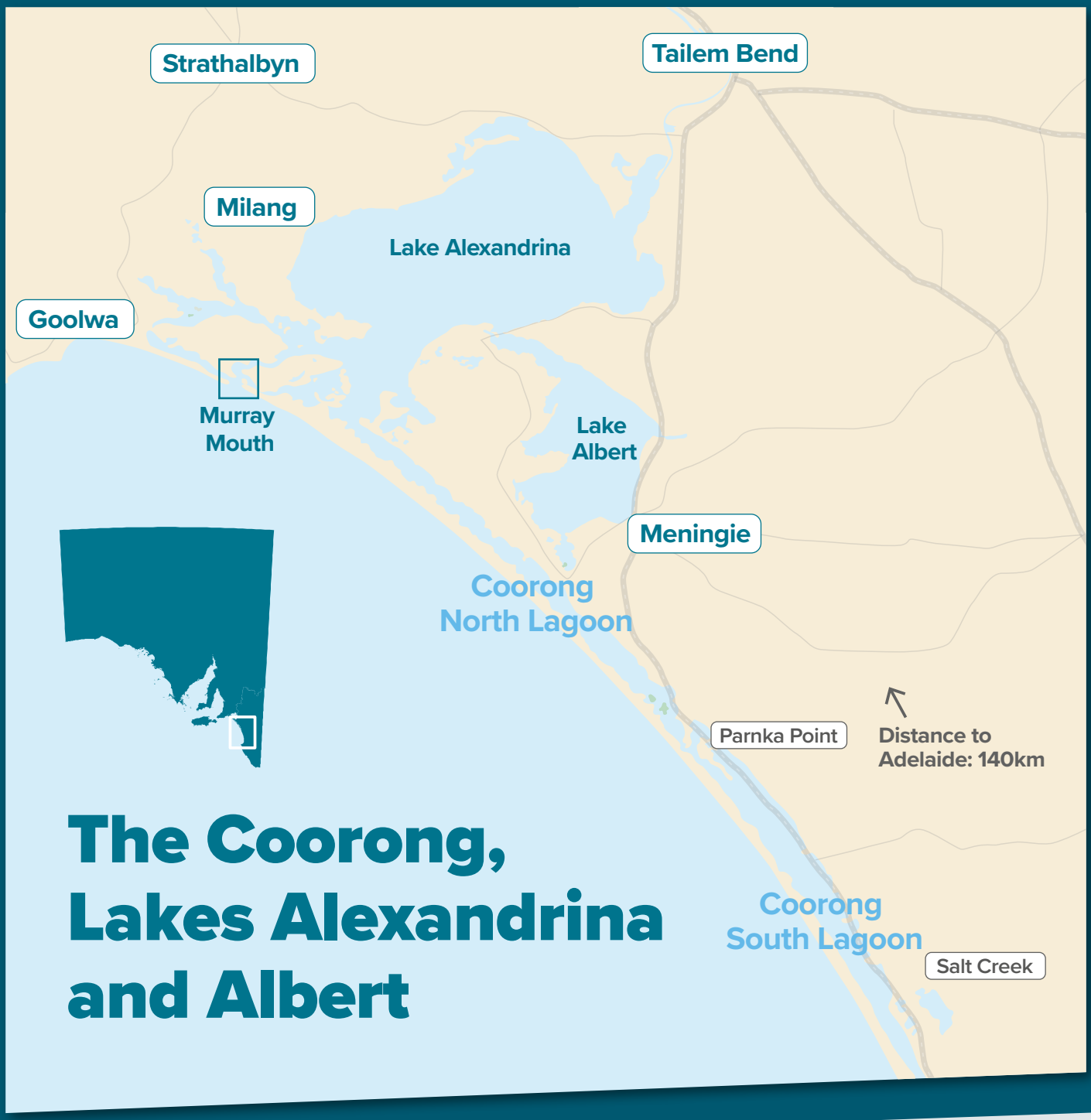
Millennium Drought

Low rainfall and the lowest inflows into the Murray River and Coorong in recorded history

2002

The Living Murray Icon Site program

Hydrological and ecological monitoring informing delivery of water for the environment (Lower Lakes, Coorong and Murray Mouth)



The Coorong, Lakes Alexandrina and Albert

2011-2016

CLLMM Recovery Project

Drought response restoration activities and research

2012 onwards

Murray-Darling Basin Plan adoption and implementation

Plan to manage the Basin as a connected system

2014-2019

South East Flows Restoration Project

Diversion of additional flows from the South East drainage network to the Coorong South Lagoon (via Salt Creek)

2019 onwards

***Healthy Coorong, Healthy Basin* program and Action Plan**

Restoration program in response to ongoing ecological decline in the Coorong. It includes on-ground works, scientific trials and investigations, management tools and potential infrastructure activities

Key HCHB program achievements

In 2019, the South Australian Government released the '*Healthy Coorong, Healthy Basin* Action Plan', which outlined the short, medium and long term on-ground works, scientific trials and investigations, management tools and infrastructure activities required from the program to get the Coorong back on track for a healthy future.

Key achievements to date from the implementation of this Action Plan include:

On-ground Works

- Completed feasibility investigations across 5 sites to restore more than 3000 hectares of **priority wetlands** in the Lower Lakes and South East.
- **Partnered with community and First Nations** to identify priority wetlands for restoration.
- Gained approval for **small – scale wetlands restoration works** to improve the quality and availability of waterbird habitat throughout the Ramsar-listed Coorong and Lower Lakes while longer-term solutions are being investigated and implemented.

Scientific Trials and Investigations

- **Unprecedented investment** in scientific research to fill **key scientific knowledge** gaps regarding key Coorong ecosystem functions to inform the development of targeted and effective management actions.
- Ngarrindjeri Aboriginal Corporation led a **cultural knowledge project** and developed tools for cultural health assessments.
- Developed and applied an **integrated hydrological, ecological, and biogeochemical model** to optimise environmental water delivery decisions and inform feasibility of long-term operational infrastructure in the Coorong.
- Supported **early career researchers** to build science capacity in SA.

Water Resource Optimisation

- **Four new continuous monitoring stations** placed in the Coorong to measure salinity, organic matter, dissolved oxygen, turbidity and pH.
- **Two new meteorological (weather) stations** placed in the Coorong to measure wind speed and direction, temperature, rainfall and solar radiation.
- The **Coorong Water Quality Monitoring Program** collected and analysed over 1,200 water samples between 2019-2022.
- **Data are publicly available** on the WaterDataSA website.

Long-term Operational Infrastructure Investigations

- **Reviewed 20 international case studies** to identify learnings and outcomes that may be transferrable to the Coorong.
- Consulted with scientists, managers, community and First Nations to identify and **shortlist infrastructure options** to facilitate hydrological remediation of the Coorong.
- Used the **best available science and technology** to predict ecological benefits that proposed infrastructure could deliver to the Coorong South Lagoon, including hydrodynamic, ecological and biogeochemical outcomes.
- Completion of multiple large-scale **cultural heritage surveys** undertaken with representatives and Elders from Ngarrindjeri and First Nations of the South East to identify optimal locations for potential infrastructure and management solutions.
- **13 infrastructure engineering concept designs developed**, reflecting the single largest investigation undertaken to improve the health of the Coorong.
- Determined that variants of a **connection between the Coorong South Lagoon and Southern Ocean** (with or without targeted dredging as a complementary action) have **the most potential for improving the health of the Coorong South Lagoon** and should be investigated further in a Design and Approvals stage through 2023-24.

First Nations Partnerships

- Employment of **community-based First Nations project officers** who facilitate First Nations voices being incorporated into *Healthy Coorong, Healthy Basin* planning and implementation.
- Delivery of **cultural awareness training** to facilitate deeper understanding of cultural values of First Nations and their connection to Country.
- Employment of **Coorong National Park Cultural Rangers** working with scientific researchers and at the forefront in management of the Coorong National Park.
- Ngarrindjeri and First Nations of the South East contribution to content for the forthcoming Coorong and Lakes Alexandrina and Albert **Ramsar Management Plan.**

Community Partnerships

- **Extensive community consultation** processes, including meetings, discussion forums, webinars and surveys.
- Established and consulted with the ministerially appointed **Coorong Partnership**, which included community representation across conservation, recreation, science, agriculture, local government, tourism, fishing, heritage and First Nations culture.
- **Annual science forums and regular community E-newsletters.**
- Successful **Coorong Bioblitz** event in 2021 to engage community in on-ground activities.
- The **Science and Citizens of the Coorong video**, developed with the Murraylands and Riverland Landscape Board, was shown as part of the Scinema International Film Festival, which was accessible globally online.

Restoration principles

Purpose of the Roadmap

Guided by *International Principles and Standards for the Practice of Ecological Restoration*, this Coorong Restoration Roadmap sets out key processes and principles to restore the Coorong from its current state. It will guide the development of an integrated restoration program to improve ecological function and support the ecological character of the site for many years to come. In line with these key principles, the Department for Environment and Water (DEW) will continue its commitment to involve local communities, First Nations, and key stakeholders in the development and implementation of key restoration actions outlined in this Roadmap.

Ecological restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER, 2004).

Healthy Coorong, Healthy Basin **aims to implement actions and interventions that seek to reinstate desired ecological processes and functions rather than 'full restoration' to a historical state. Options being investigated include long-term infrastructure and ecological restoration actions, along with monitoring activities and engagement.**

Key principles:

Restoration of the Coorong will be underpinned by National and International Standards for the Practice of Ecological Restoration:

Engage Stakeholders

Draw on many types of **knowledge**

Use clear **targets, goals, objectives** and measurable indicators

Informed by **natural reference systems** while considering environmental change

Support **ecosystem recovery** processes by repairing, rehabilitating and/or restoring ecological function

Include activities that form part of a **restorative continuum** and gain cumulative value when applied at large scales

Include activities that seek the highest level of **recovery** possible

Adapted from: International Principles and Standards for the Practice of Ecological Restoration, 2nd Edition. National standards for the practice of ecological restoration in Australia.

Engage stakeholders

We acknowledge the interests and contributions of diverse stakeholders. Restoration activities will give consideration to both conservation and socioeconomic values (including cultural values).

Community engagement

The future health and sustainability of the Coorong relies on community advocacy and ongoing involvement in the long-term management of the Coorong, as well as a broader understanding of the Coorong across the wider Murray-Darling Basin and its importance to the whole system.

Ongoing foundational engagement activities involve:

- Informing the community through community updates and communication of significant milestones throughout the program.
- Involving the community and stakeholders ahead of major decision points.
- Consulting the community and stakeholders ahead of final decisions through facilitating workshops, meetings and online consultations.
- Flexibility in our willingness to adapt to stakeholder needs.

Future engagement in Coorong Restoration activities will shift to focus on:

- How the proposed restoration and long-term management options in the Coorong will ultimately support Basin Plan outcomes and benefits for community, First Nations and broader stakeholders in the Coorong and across the Murray-Darling Basin.
- Building closer relationships with key stakeholders potentially impacted by the proposed restoration and mangement activities.
- Building awareness and knowledge of *Healthy Coorong, Healthy Basin* across broader Murray-Darling Basin communities ahead of any significant investment decisions.

> ***"The unique ecology of the Coorong, with its international Ramsar reputation, is at serious risk of collapse. Its restoration, based on sound science and with community support, must now be our priority."***
>
> ***HON DEAN BROWN AO***
> ***COORONG PARTNERSHIP CHAIR***

First Nations partnerships

The Ngarrindjeri and First Nations of the South East are the Traditional Owners of the lands and waters of the Ramsar site. Ngarrindjeri people have occupied, enjoyed, managed and used their inherited lands and waters within the area of the River Murray (Murrundi), Lower Lakes, Coorong (Kurangk) and adjacent areas since the Kaldowinyeri (Ngarrindjeri Creation). The health of the Coorong and surrounding lands and waters is intrinsically linked to the health of the Ngarrindjeri and First Nations of the South East. These First Nations communities have historical and on-going rights, interests and cultural obligations in the region.

DEW will continue to partner with First Nations Peoples to:

- protect and promote Traditional Owner culture and heritage and their unique relationship with and responsibilities for their Country
- improve ecological outcomes through the respectful application of cultural knowledge to site decision-making (including co-designing actions and initiatives)
- facilitate First Nations economic development through employment opportunities to look after the health of their Country.

The *Healthy Coorong, Healthy Basin* First Nations Partnerships project has been a recognised action to build strong and capable Aboriginal communities under the Premier's Aboriginal Affairs Action Plan 2021-2022. Importantly, this partnership continues to build on meaningful relationships with Ngarrindjeri and First Nations of the South East and between the two communities.

First Nations project partners

> ***"The First Nations Partnership project has been a crucial part of building positive partnership and ongoing relationships between DEW and Ngarrindjeri Aboriginal Corporation. The Partnership has enabled the Ngarrindjeri people to meet their cultural obligation to care for and manage Country. The HCHB First Nations Partnership project has been extremely effective and we have encouraged our new partners to follow a similar process."***
>
> ***TIM HARTMAN,***
> ***CEO NGARRINDJERI ABORIGINAL CORPORATION.***

> ***"The South East Aboriginal Focus Group was established in 2004 to represent the interests of the First Nations People of the Southeast. The First Nations Partnership project has helped strengthen links between the department and First Nations People of the South East and allowed for genuine partnership. This has been integral in building trust between First Nations and the HCHB project team."***
>
> ***ROBYN CAMPBELL,***
> ***HCHB PROJECT OFFICER AND BURRANDIES CEO.***

Draw on many types of knowledge

Coorong restoration activities will continue to be informed by a strong scientific evidence base, practitioner knowledge (land, water and restoration managers), cultural knowledge, and local knowledge.

Healthy Coorong, Healthy Basin First Nations Partnerships will continue to seek both cultural and program outcomes through two-way knowledge sharing between Elders and Coorong Restoration project teams on Country. First Nations research projects, cultural heritage surveys, and First Nations project officers and cultural ranger positions have been funded and supported by *Healthy Coorong, Healthy Basin* to ensure that cultural knowledge is incorporated into restoration planning and implementation.

The program will also continue to draw on a wide range of knowledge and experience to underpin decision making, including working with existing and emerging community reference groups, landscape boards, scientific reference groups and expert panels. We will continue to demonstrate flexibility in our approach and adapt to community needs and values for the site.

Science informing restoration

In 2018, the Goyder Institute for Water Research Expert Panel reviewed the current condition of the Coorong South Lagoon and determined that the key ecological features that make this system unique and valuable are still in place, including the north-south salinity gradient, the large areas of mudflat habitat and the species of plants, invertebrates, fish and birds. However, the concentration, abundance and distribution of many parameters and species have dramatically altered. The Expert Panel determined that the system is now in a vulnerable state, with little capacity to absorb continued and cumulative environmental stress.

In response, *Healthy Coorong, Healthy Basin* delivered an unprecedented investment in targeted scientific research (2019-2022) to inform restoration and future management of the Coorong. This work was delivered with significant collaboration with the Goyder Institute for Water Research, including partners from CSIRO, Flinders University, the University of Adelaide and SARDI, and a long term partnership between DEW and the University of Western Australia. The Ngarrindjeri Aboriginal Corporation was the key partner leading the Ngarrindjeri knowledge research project.

Healthy Coorong, Healthy Basin's Scientific Trials and Investigations project (2019-2022) included more than 70 researchers and 20 government scientists, with a strong focus on early career researchers to build capacity in SA. Research has included interdisciplinary expertise across hydrology, biogeochemistry, aquatic ecology, quantitative modelling, First Peoples knowledge and social science; facilitating innovative science to help solve complex problems in the Coorong.

Key outcomes include:

- Ensuring that management decisions are informed by the best available science.
- Identification of knowledge gaps, collection of data, and the synthesis and translation into management decisions.

Scientific case for action

Current state of the Coorong

Our latest scientific understanding of the current state of the Coorong draws on two decades of research conducted under The Living Murray Program (since 2002), CLLMM Recovery (2011-2016) and *Healthy Coorong, Healthy Basin* (from 2019). Targeted science delivered under these programs has provided us with a comprehensive understanding of the structure and dynamics of the Coorong ecosystem and allowed us to develop informed approaches to ecosystem recovery.

The science is clear that the Southern Coorong (South Lagoon and the central Coorong from the Needles southward) has suffered long-term decline and is currently in a degraded state characterised by:

Hyper-eutrophic (high nutrient) conditions

- High phytoplankton and filamentous algal blooms, chlorophyll a, nitrogen and phosphorous levels.
- Repeated, rapid, internal transfer/recycling of nutrients between the sediment and algae.
- Limited conversion of nutrients into a form that can be released to the atmosphere.

Limited connectivity and flushing

- Reduced water flows have led to build-up of sand and sediments, causing a restriction of flows at the Murray Mouth (which requires dredging) and at Parnka Point (the constriction point between the North and South lagoons of the Coorong.
- Reduced flushing of the Coorong has led to a long-term accumulation of salt and nutrients in the system.

Poor habitat quality

- The quality of water and sediments has declined in the Southern Coorong.
- Healthy nutrient cycling processes are inhibited by extreme organic loads and poor sediment condition.
- Algal blooms are prevalent in spring and summer, exacerbating high nutrient conditions, and interfering with waterbird foraging and reproduction of native aquatic plants.
- Monosulfidic black oozes are organic and sulfide rich sediments that have formed over large areas of the Southern Coorong, causing sediments to become uninhabitable for aquatic plants and macroinvertebrates.
- The abundance and/or distribution of some invertebrate, plant, fish and waterbird species has declined as a result of declines in habitat conditions.

WHAT WE HEARD:

“Options for improving the ecology of the South Lagoon should be determined by scientific evidence, given water availability and constraints.

Use clear targets, goals, objectives and measurable indicators

Restoring ecological function will be facilitated through the identification of clear targets, goals, objectives and measurable indicators.

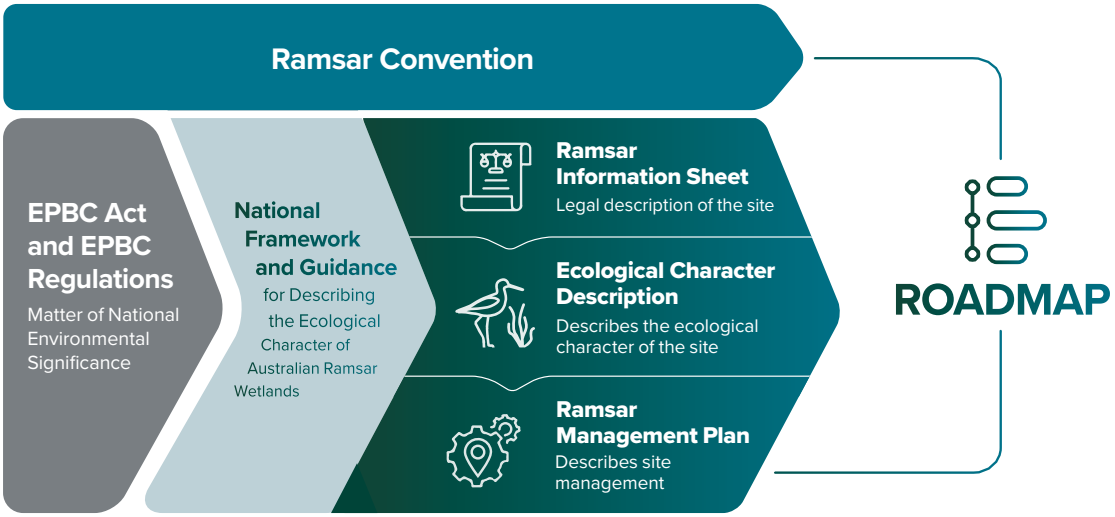
Basin Plan and Ramsar targets

The Roadmap will be implemented in alignment with *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) requirements to protect and maintain the ecological character of Ramsar-listed wetlands. Specifically, the roadmap will focus on the restoration of ecological function to support ecological character of the site, which also assumes continued optimisation of environmental water delivery in line with the Basin Plan.

Restoration under the *Healthy Coorong, Healthy Basin* program is aligned to clear targets and objectives of the Basin Plan and Ramsar Management Plan, including those for:

- Surface water salinity
- Barrage flows
- A functioning and resilient foodweb, including plants, macroinvertebrates, fish and waterbirds.

A monitoring and evaluation plan will be developed to monitor progress using restoration targets.



Monitoring and evaluation

Monitoring and evaluating condition and ecological responses in the Coorong is critical in our ability to detect changes, both positive and negative. In turn this improves our ability to:

- Respond quickly and appropriately if change is detected
- Support adaptive site management, including the management of water for the environment
- Evaluate program outcomes.

Monitoring activities will ensure that high priority baseline data are available to assess the future impacts and benefits of potential infrastructure and ecological restoration actions. Key activities will include:

- Continued on-ground water quality monitoring
- Critical on-ground ecological monitoring, including measures of habitat quality, baseline data for cultural and impact assessments, and measuring responses of native species to management interventions.

The restoration of the Coorong is critical to achieving Basin Plan outcomes. DEW will continue to support full implementation of the Basin Plan by working with partners and water holders to coordinate the effective delivery of water for the environment.

Informed by natural reference systems while considering environmental change

The Coorong is a unique, diverse and dynamic coastal ecosystem, impacted by long-term environmental change. Our Coorong reference system is based on a 'desired state' conceptual model and will also refer to additional case studies.

What are we trying to achieve?

In 2020, leading scientists and environmental managers came together to build a shared understanding of the existing and emerging scientific knowledge of the Southern Coorong. Following these discussions, and drawing on various scientific reports, the document, *"Desired state of the Southern Coorong discussion paper"* was produced to communicate an up-to-date, shared scientific understanding of the desired state of the Southern Coorong. It describes the current and desired states for the ecosystem and details why long-term management options being explored through *Healthy Coorong, Healthy Basin* are needed.

The desired state for the Southern Coorong is a resilient and naturally variable system, which provides habitat to support waterbird, fish, plants and invertebrate populations. To reach the desired state of the Coorong, we need management strategies to improve the ecosystems' ecological function. Such strategies need to:

- regularly export salt and nutrients from the system;
- result in only short periods of restricted connectivity and hypersalinity; and
- promote functional food webs that are complex and resilient and include high-value aquatic plants, invertebrates, fish and waterbirds.

Healthy Coorong, Healthy Basin is developing and implementing a range of restoration actions that will contribute to recovery of ecological function and resilience in the Coorong to a more desired state that can be achieved under current and future water availability scenarios.

Current State

Hyper-eutrophic conditions

- High nutrient loads
- Algal blooms
- Repeated, rapid, internal transfer and recycling of nutrients

Limited connectivity and flushing

- Reduced water flows leading to sediment build-up and restricted connectivity
- Limited salt and nutrient export resulting from reduced flushing of the Coorong

Poor habitat quality

- Water quality, sediments and black oozes at sediment interface
- Nutrient cycling processes inhibited by extreme organic loads and sediment condition
- Decline in the abundance and/or distribution of some invertebrate, plant, fish and waterbird species

Actions

Potential for Coorong infrastructure

- Hydrological remediation to initiate system recovery

Regional wetland management

- Water level management infrastructure to provide complementary shorebird foraging habitat

Ecological Restoration Project

- Scalable on-ground actions to reinstate ecological processes and augment system recovery

Desired State

Mesotrophic conditions

- Moderate levels of water column chlorophyll *a*, nitrogen and phosphorous
- Nutrient exchange between the sediment, water and atmosphere and uptake into aquatic plants

Improved connectivity and flushing

- Reduced nutrient retention
- Increased flushing
- Naturally variable salinities including some periods of hypersalinity and a range of lower salinities between years

Habitat quality improved

- Sediments are oxygen rich
- Black oozes and algal blooms near-absent
- Abundant and resilient populations of invertebrates, plants, fish and waterbirds

First Nations site managers

- Co-design and deliver
- Facilitate ongoing connection to Country

Long-term outcomes

A healthy, productive and resilient Coorong, which maintains its international significance

Improved water quality and habitat conditions to support healthy and thriving waterbird, fish, plant and invertebrate populations

First Nations connection to Country where land, waters and people are healthy and spiritually alive

Community and economic values supported, including recreation, tourism and industry

Monitoring and evaluation
The condition and responses of key environmental values

First Nations Partnerships
Promote and incorporate cultural knowledge through co-design and partnerships

Community Partnerships
Engaging, consulting and partnering with community to shape and implement actions

Support ecosystem recovery processes by repairing, rehabilitating and/or restoring ecological function

Restoration will include a range of activities that contribute to overall restoration goals and are implemented with consideration to ecological, social and financial conditions at appropriate spatial and temporal scales. Restoration activities will be developed with regard to ecosystem processes that function at site, regional and broader landscape scales where possible.

The initial phase of *Healthy Coorong, Healthy Basin* (2019-2022) has focused on filling scientific knowledge gaps and conducting early feasibility assessments for infrastructure to achieve desired outcomes in the Coorong and regional wetlands. These works have delivered a clearer understanding of the current environmental problems and potential actions we need to take to establish a pathway to recovery for the Coorong.

We are actively refining existing tools and operations to **improve site management**, and the South Australian Government is now prepared to further investigate and implement an integrated suite of urgent management interventions to **repair ecosystem functions** in the Coorong. **Initating recovery** of fundamental hydrological processes in the Coorong will help rehabilitate the site by exporting salt, nutrients and organic matter and promoting healthy nutrient cycling. This step will set the system on a trajectory to **partial or full recovery** of key ecological functions of the desired state so that the Coorong continues to provide important habitat for native species.

Nutrient problems in the Coorong

Nutrients enter the Coorong ecosystem through water that flows into the system from multiple sources. These nutrients are incorporated into the Coorong's ecological cycle through interactions between water, sediment, microbes, plants and animals.

We now know that nutrient levels and cycling processes in the Southern Coorong are in an unhealthy, hyper-eutrophic state (i.e. contain high nutrient and organic matter loads). Nutrients remain trapped within the South Lagoon because there is insufficient 'flushing' of water and nutrients out to the North Lagoon and ocean via the Murray Mouth. Narrow constrictions and expansive shallow areas (particularly in spring-summer) reduce connectivity and water flow between the North and South lagoons. Excess nutrients accumulate and promote the growth of phytoplankton and filamentous algal blooms, which break down on the sediment surface, increasing sediment nutrient and organic carbon loads. Organic matter is then decomposed by bacteria that consume oxygen and create anoxic (no oxygen) sediments. These processes have led to the formation of black, organic and sulfide-rich sediments called 'monosulfidic black ooze', which are now predominant over large areas of both the South and North lagoons of the Coorong. These monosulfidic black ooze and hypersaline (high salinity) conditions are toxic to macroinvertebrates and aquatic plants.

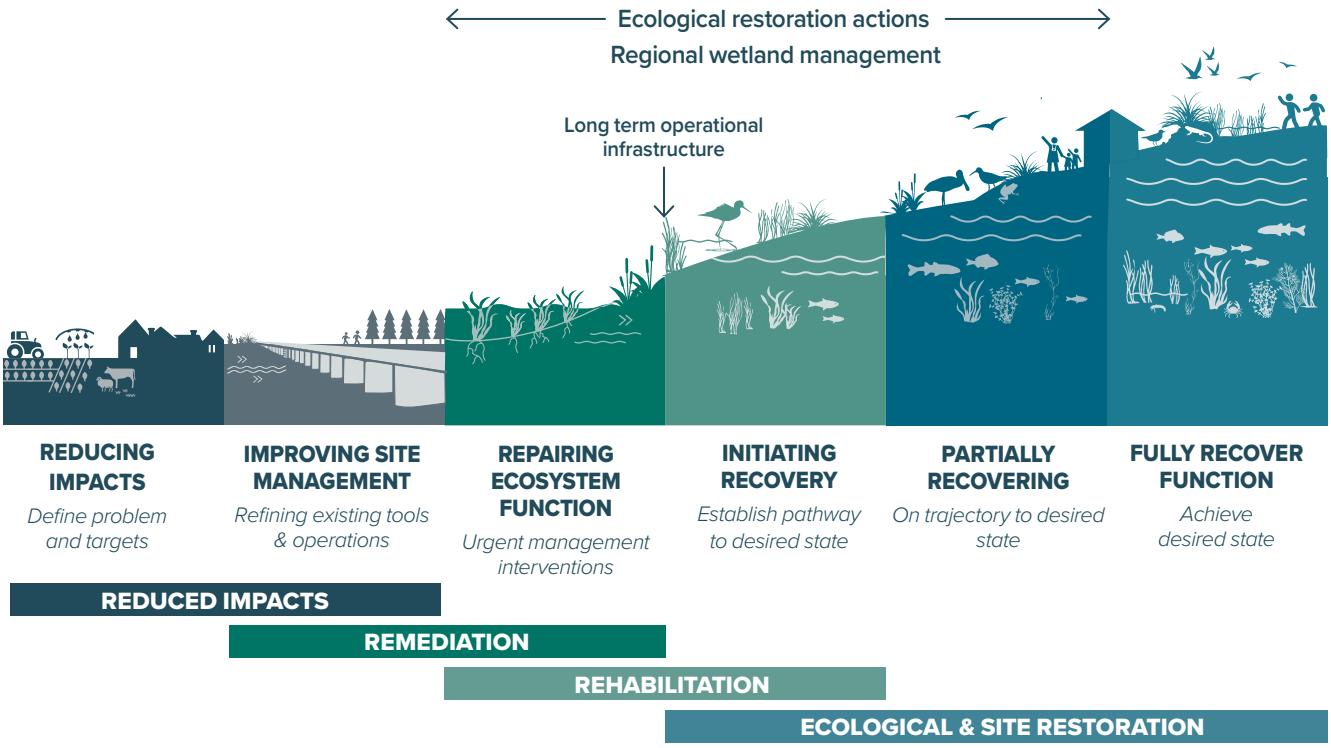
The most effective way to reduce monosulfidic black ooze in the Coorong is to minimise organic matter (e.g. algal) accumulation and promote water flows that export salt and nutrients. Enhanced lagoonal flushing, via increased seawater exchange or facilitated export of South Lagoon water to the ocean would decrease organic matter availability for sulfate reducing bacteria, reducing anoxic conditions and monosulfidic black oozes.

Reduced salinities (<60g/L) and nutrient loads will further promote system recovery by promoting native seagrass and benthic macroinvertebrate recolonisation. Sediments are oxygenated by burrowing of native worms and bivalves (macroinvertebrates) and the roots of native aquatic plants, which further facilitates exchange of nutrients back into the atmosphere.

Healthy Coorong, Healthy Basin is investigating options to improve flushing and export of organic matter, algae and nutrients from the Coorong. The Roadmap includes a range of restoration activities that will work together to recover ecological function, including healthy nutrient cycling processes, in the Coorong.

Include activities that form part of a restorative continuum and gain cumulative value when applied at large scales

Healthy Coorong, Healthy Basin restoration actions will include a range of management interventions that collectively contribute to the recovery of ecological function along a Restorative Continuum.



The Restorative Continuum illustrates how the implementation of restorative activities at all levels can optimise broad scale ecological and social outcomes (adapted from SER 2019)

Restoration activites in the *Healthy Coorong, Healthy Basin* program are being investigated and developed to support the recovery of ecosystem values that have been lost or degraded. A range of restorative activities will allow us to successfully progress through the stages of the 'Restorative Continuum', and contribute to ecological recovery. The Restorative Continuum provides a context for the staged progression of restorative activities to maximise their success.

Include activities that seek the highest level of recovery possible

Ecological restoration aims for the highest practicable level of recovery possible, even if outcomes have long timeframes or require various interventions.

Key *Healthy Coorong, Healthy Basin* activities that will contribute to ecological recovery include:

- **Regional wetland management:** providing regional-scale complementary shorebird foraging habitat in the Lakes and South East while restoration is underway in the Coorong.
- **Potential long-term operational infrastructure:** broad-scale hydrological remediation of the Coorong to export excess salt and nutrients and initiate system recovery.
- **Ecological Restoration Project actions:** local-scale nutrient management, sediment remediation and facilitating restoration of aquatic plants and macroinverebrates to augment active ecosystem recovery.

The long-term impacts of water over-allocation across the Murray-Darling Basin, exacerbated by the Millennium Drought, have degraded the Coorong to the point where it is at risk of losing some of the elements that make it an iconic wetland of local, national and international importance. Recovery of complex ecosystems, such as the Coorong, from long term and cumulative change will involve similar or longer recovery timelines. This Roadmap includes actions appropriate to the different stages of desired, long term outcomes.

The functional designs of all restoration activities (including potential infrastructure) are being optimised to achieve the highest possible level of ecological recovery in the Coorong.

Regional wetland management

Long-term operational infrastructure

Ecological Restoration Project actions

Regional wetland restoration

Waterbirds move within and between networks of wetlands in their search for food and habitat as the condition of individual wetlands varies across seasons, largely in response to water availability. Recent *Healthy Coorong, Healthy Basin* research has tracked waterbirds moving between habitats along the Coorong and into regional wetlands, including those in the Lower Lakes and South East of South Australia.

In 2022, *Healthy Coorong, Healthy Basin* commenced regional wetland restoration activities to ensure that habitats for key Coorong South Lagoon waterbird species exist within the broader regional landscape at critical times.

These activities aim to improve the availability and quality of habitat for migratory and non-migratory shorebirds outside of the Coorong in the short- to medium-term, while broader restoration of the Coorong is underway. Small-scale wetland management infrastructure will be constructed at priority wetland sites within proximity to the Coorong to manage water at levels that improves the extent, quality and duration of inundation.

Expected benefits of regional wetland restoration include:

- Increased availability and quality of shallow water foraging habitat for Australian and migratory shorebirds.
- Improved access tracks for birdwatching and recreational activities.
- Supporting restoration of wetlands that have significant cultural and ecological value to Ngarrindjeri people.
- Supporting key community restoration priorities.

Shorebirds are a type of waterbird that feeds by wading in shallow water or probing in mudflats. Shorebirds are usually found in intertidal habitats or inland wetlands in Australia.

Long term operational infrastructure

The latest science emphasises the need for increased system scale flushing (frequency and magnitude) to reduce and support reversal of eutrophic conditions in the Coorong South Lagoon. This flushing will help to:

- export nutrients, algae and organic matter, reducing sediment nutrient loads and allowing light penetration for native aquatic plant growth
- reduce hypersaline conditions, facilitating reestablishment of benthic macroinvertebrates
- reduce formation of hypersaline, sulfide-rich sediments that are toxic and uninhabitable for native species.

Operators currently have very few tools to manage flows efficiently and effectively within the Coorong, in particular the South Lagoon. The current management levers available to manipulate flows and water levels in the South Lagoon include:

- River Murray environmental flow provisions
- barrage operations
- Murray Mouth dredging
- flows from the South East.

The efficacy of current management levers is limited by freshwater flows, meaning that in times of drought and lower water availability, desired water levels and quality cannot be achieved. Long term, large scale infrastructure could deliver the required system flushing at scale by introducing:

- a new water source that is available across all climatic and water availability conditions
- an alternate management lever that enables efficient and effective management.

Since 2020, the Coorong Infrastructure Investigations Project has engaged with community, First Nations and stakeholders through Options, Investigations and Feasibility stages to develop a significant evidence base regarding long-term management solutions. The current status of this project is described in more detail within the *Coorong Infrastructure Investigations Feasibility and Future Directions* document.

Feasibility investigations identified that three variants of a connection between the Coorong South Lagoon and Southern Ocean (with or without targeted dredging as a complementary action) have the most potential for improving the health of the Coorong South Lagoon. All three infrastructure variants export salt and nutrients from the Coorong.

Circulation

Pump in at one location and out at another, with lower visual impact discharge

Provides the best ecological outcomes for the Coorong South Lagoon

Bidirectional

Pump in or out at one location, with separate pumping stations

Provides the 'next best' ecological outcome for the Coorong South Lagoon

Pump Out

Lower visual impact discharge, with dredging

Included in the event that further investigations of the other options prove prohibitive

These options will be considered by the project with and without dredging as a complementary action, with concepts refined, as required.

These three infrastructure concepts will now progress through further investigations, design and approvals. This remains an investigations project and no decision has been made to proceed with any particular option. Community, First Nations and stakeholder consultation will continue throughout the process and before any decision to proceed with any particular option is made.

Should a suitable long-term management option for the Coorong South Lagoon be identified, appropriate approvals will be obtained and a decision made by governments to proceed with its construction. The earliest that any on-ground infrastructure implementation could commence would be in 2025.

Integrated Operations

Our long-term vision includes Coorong management levers being guided by a Integrated Operations approach to coordinate large-scale environmental watering and associated site infrastructure operation.

An integrated operations approach will allow greater risk management while achieving site scale and cumulative benefits across the Coorong.

Ecological Restoration Actions

The Southern Coorong requires an integrated management approach to recover biogeochemical and ecological functions. Operation of long term, large scale infrastructure will support the repair of ecosystem function through the export of excess salt and nutrients. While desired salinity regimes can be achieved under infrastructure operation, additional strategies are needed to repair the natural ecosystem functions that reduce nutrient loads and improve foodweb functioning.

Ecological Restoration Actions under investigation include:

- Short-term removal of algae accumulating on shorelines: to reduce localised organic matter and nutrient deposition, and improve shorebird access to food in mudflats.
- Restoration of benthic macroinvertebrate and aquatic plant communities, encouraging oxygenation of sediments to reduce sediment nutrient loads and re-establishing food sources for fish and waterbirds.

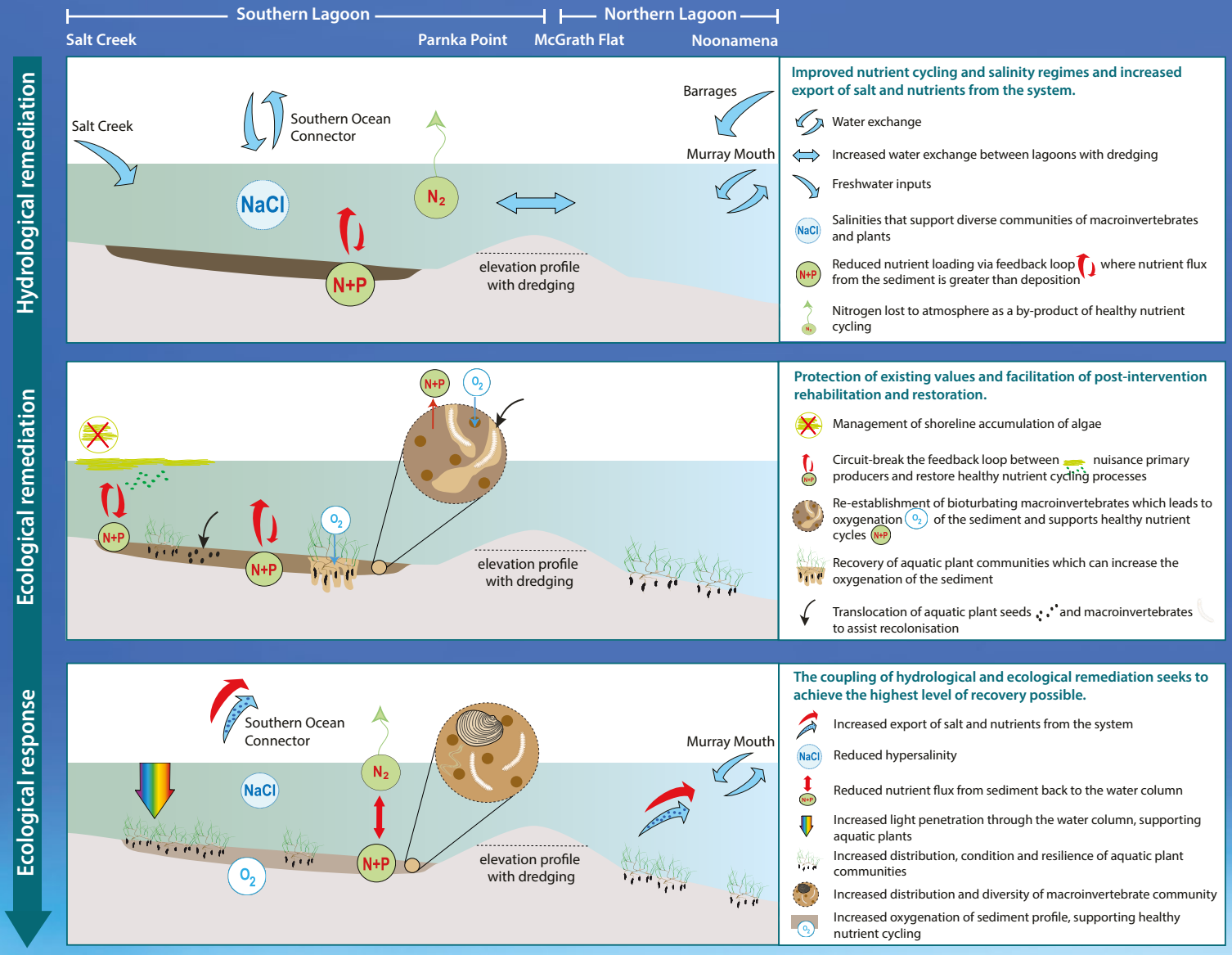
Feasible ecological restoration activities will generally be targeted to more localised areas, where extra effort is needed to repair poor conditions, to 'kick-start' native species restoration by establishing source populations of aquatic plants and macroinvertebrates in strategic locations and/or add further value to larger scale hydrological remediation. Ecological restoration actions will fit within a staged plan, with some actions required, before, during and/or after the potential hydrological remediation via Coorong infrastructure. All ecological restoration actions will be designed and implemented to reduce impact on the surrounding environment and foster partnerships with First Nations and the community.

Combining local ecological restoration actions with system scale restoration activities couples the benefits of hydrological remediation with ecological remediation to hasten and improve ecological restoration outcomes (refer to conceptual diagram).

Case study: Coorong aquatic plant restoration

Native aquatic plants (Ruppia) were successfully translocated to the Coorong as a restoration action under the CLLMM Recovery project. Seed-laden sediments were translocated from Lake Cantara to five restoration sites in the Coorong between 2012-2014. Eight years later, these five sites show significant improvement in aquatic plant biomass, seed bank and the number of turions (underground reproductive structures) produced. As a result of this previous work, we can utilise tried and tested translocation methodologies as part of a aquatic plant restoration strategy in the Coorong.

Conceptual diagram of the linkages between hydrological remediation (infrastructure), ecological remediation (ecological restoration activities) and ecological restoration outcomes.



Proposed *Healthy Coorong, Healthy Basin* restoration activities form an integrated package that work at the regional- and local-scale to seek the highest level of recovery possible in the Coorong.

HCHB activity timeline

First Nations and community engagement is a foundational and ongoing activity throughout the program.

Water quality and nutrient monitoring is a continuous and ongoing activity throughout the program.

**current as at October 2022*

2019 to 2022
Scientific Trials & Investigations

2019 to 2020
Coorong Infrastructure options identification and shortlisting

2018
Coorong Community Summit

Goyder Expert Panel

2020 to 2021
Regional wetland management feasibility investigations

Mid 2020 to mid 2022
Coorong infrastructure investigations, concept designs and feasibility assessment

2018 | **2019** | **2020** | **2021**

2019
Healthy Coorong, Healthy Basin Action Plan launched

2020
Coorong Partnership established

June 2020
State of the Coorong Discussion paper (updated in 2021 & 2023)

Late 2022 to Mid 2024
Implement regional wetland management infrastructure

2023 to 2024
Further investigations, detailed designs and approvals for potential Coorong infrastructure

2025 onwards
Potential construction of Coorong infrastructure

Continued implementation of Ecological Restoration Actions

2022 | 2023 | 2024 | 2025

Late 2022
Ramsar Management Plan

Restoration Roadmap

Mid 2023 onwards
Implement feasible Ecological Restoration Actions

SOUTH AUSTRALIA

Government of South Australia
Department for Environment and Water

Australian Government