

SUBMISSION

Submission to the Murray-Darling Basin Authority

# Submission to the 2026 Basin Plan Review

1 May 2026

**The Australian Academy of Technological Sciences and Engineering (ATSE) is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems. Bringing together Australia's leading thinkers in applied science, technology and engineering, ATSE provides impartial, practical and evidence-based advice on how to achieve sustainable solutions and advance prosperity.**

The 2026 Basin Plan Review is a critical opportunity to strengthen its effectiveness and ensure the Plan responds to increasing impacts of climate change and growing environmental, social, and economic pressures. A more integrated and evidence-based approach will be essential, supported by stronger governance, improved use of science, data and knowledge, and the meaningful incorporation of First Nations knowledge Systems. The Plan can be framed within a long-term approach, and ATSE encourages articulation of a 50-year vision, consistent with its essay series, [A thriving Murray-Darling Basin in 50 years](#). A stronger forward-looking approach is needed to ensure near-term decisions actively build resilience for future Basin conditions. These reforms will be necessary to secure the long-term environmental, economic, and social sustainability of the Murray-Darling Basin (MDB), including its communities, ecosystems and industries.

ATSE makes the following recommendations to the 2026 Basin Plan Review:

**Recommendation 1:** Establish a national environmental data infrastructure with Commonwealth custodianship, supported by a funded program for data collection, standardisation, sharing, and a structured research, knowledge generation, and translation strategy.

**Recommendation 2:** Embed integrated climate, hydrological, and ecological modelling into the Basin Plan to support evidence-based decision-making.

**Recommendation 3:** Integrate Traditional Knowledge systems into water and land management alongside Western scientific approaches, within national data infrastructure and Basin-scale modelling.

**Recommendation 4:** Strengthen Basin governance by aligning the Basin Plan with the renewed National Water Agreement and updated Water Act, and re-establish an independent National Water Commission with oversight, advisory, and evaluation functions.

**Recommendation 5:** Strengthen cross-jurisdictional coordination by requiring regular review and updating of Water Resource Plans, supported by compliance and enforcement mechanisms, incentives and greater integration of catchment-scale governance.

**Recommendation 6:** Embed water quality as a core objective of the Basin Plan, including a system-wide water quality risk management approach.

**Recommendation 7:** Adopt an integrated catchment management approach that incorporates surface water-groundwater interactions and soil landscapes, to deliver regional solutions that balance the needs of all water users.

**Recommendation 8:** Adopt an outcomes-based approach for native fish recovery by setting species-level objectives and supporting ecological modelling, infrastructure investment, and targeted interventions to address threats and restore populations.

## Enhancing the evidence base for Basin management

The 2026 Basin Plan presents an opportunity to strengthen the technical foundations that underpin Basin water management. The [Water Act 2007](#) requires that the Basin Plan use the best available science to inform strategies that minimise the impact of climate risks. Despite significant research investment, there are opportunities to improve the consistency with which contemporary knowledge is translated into the Basin Plan's policy and implementation. Data, modelling outputs, and scientific insights into the MDB are often fragmented, inaccessible, or not standardised across jurisdictions (Productivity Commission 2023). Despite responsibilities for monitoring being held by federal, state and territory government agencies, it is frequently contracted to several non-government organisations, researchers and catchment management authorities, leading to challenges in evaluation and monitoring (Colloff et al. 2024).

This review can create a Basin Plan that has a more coordinated approach to data governance, which is required to ensure that information is transparent, accessible and quality assured, enabling its effective use in decision-making. The establishment of a national environmental data infrastructure with Commonwealth custodianship can support collaboration across governments, researchers, and stakeholders and prevent

fragmentation. This would be complemented by a structured research translation and knowledge strategy to ensure that emerging science is systematically embedded into Basin Plan implementation. A national environmental data infrastructure can also include open access to modelling assumptions and methodology in addition to datasets, as a foundation for scientific collaboration across institutions and jurisdictions.

Ensuring that data is open, standardised, and accessible is also critical to maintaining scientific integrity and helps when deploying new technologies in water management, as outlined in previous ATSE work, including the [Technologies for Water Management report](#). Coordinated and integrated modelling is required to support adaptive, evidence-based decision-making, leading to improved outcomes for the Basin<sup>1</sup>. Increased data collection and reporting can also assist in effectively integrating the MDB and the 2026 Basin Plan with broader natural resource management (NRM) recovery actions, through defined coordination mechanisms and reporting metrics. Evidence from the 2019 South Australian Royal Commission into the Murray-Darling Basin highlighted the risks associated with data fragmentation and limited access to modelling assumptions (Walker 2019).<sup>2</sup> This demonstrates that restricted access to modelling assumptions can limit transparency, comparability, and robustness of the evidence base.

Aboriginal and Torres Strait Islander peoples have a significant and long-standing connection to, and knowledge of, land and water systems, yet remain underrepresented in Basin governance and hold disproportionately small water entitlements (Hartwig et al. 2021). There is a significant opportunity to better integrate Traditional Knowledge systems into water management. This includes supporting Indigenous-led water research and embedding Traditional Knowledge alongside Western scientific approaches. The Independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee highlighted that Traditional Knowledge was not routinely incorporated into agency decision-making, with the Barkandji People's knowledge of the Darling-Baaka available and relevant but largely overlooked (Office of the NSW Chief Scientist & Engineer 2023). The review identified the need to strengthen the role of Traditional Owner knowledge in natural resource management across the Basin, including in emergency contexts. Existing examples, such as the Ngarrindjeri Regional Authority's role in managing the Coorong and Lower Lakes, demonstrate the value of First Nations-led approaches (One Basin CRC 2026). Embedding these approaches more broadly across the Basin, including formalising mechanisms to utilise Traditional Knowledge in emergency responses, will be key to achieving equitable and sustainable outcomes.

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**Recommendation 3:** Integrate Traditional Knowledge systems into water and land management alongside Western scientific approaches, within national data infrastructure and Basin-scale modelling.

## Establishing robust governance structures for Basin management

A robust governance approach that integrates existing and future water management policies and legislation can be supported by the Basin Plan. It is important that the Basin Plan is not developed in isolation but is situated within a coherent national water policy framework, while being linked to other National Resource Management (NRM) and conservation programs. Processes underway to improve

<sup>1</sup> Modelling in this context includes linking ecological models, including fish, vegetation, and bird responses, with hydrological and climate models to produce realistic predictive targets. Requirements for hydrological modelling include incorporating ecologically significant flow components, including overbank flows, flow pulses, and variability, and connecting these to ecological outcomes. Improved modelling is particularly important for understanding key uncertainties, including floodplain water capture, the impacts of water efficiency projects on return flows, and the relative contributions of climate change and extraction to declining streamflow (Williams and Grafton 2019).

<sup>2</sup> The Commission found that CSIRO researchers undertaking the Multiple Benefits Project were not provided access to the MDBA's detailed modelling assumptions and methodology, limiting the ability to undertake robust comparisons between independent and agency models (Walker 2019). This constrained the confidence with which comparative ecological outcomes could be assessed.

national water policy, including the Commonwealth signing the new National Water Agreement and undertaking a review of the Water Act 2007, can be aligned with current Basin Plan processes to support nationally coherent water governance outcomes. As highlighted in ATSE's past engagements with the Basin Plan and other water reform consultations, there remains a need for a renewed National Water Commission to provide the cross-jurisdictional authority and coordination for national water reform, including supporting the long-term sustainability of the Basin. Enhancing the strategic role of the Basin Ministerial Council may also further support cross-jurisdictional coordination and actions, while improved operational alignment between the MDBA and the Commonwealth Environmental Water Holder could strengthen environmental water delivery and outcomes.

Cross-jurisdictional coordination remains a key challenge, with existing arrangements often failing to deliver integrated or efficient outcomes sufficient to address system-wide pressures. As state and territory governments retain primary responsibility for Basin-related regulation and legislation, including catchment management and land planning, there is a risk that review processes may be constrained by limited integration with the Basin Plan (Colloff et al. 2024).

Strengthened independent oversight mechanisms are required to improve accountability and long-term system performance, as well as to build trust with Basin communities, irrigators, industry and all stakeholders. As of 2024, five of seven economic targets, relating to irrigated agriculture and the capital value of land, showed improvement. However, from 20 First Nations, environmental, social and compliance indicator targets, only two environmental targets were met (Colloff et al. 2024). Further inquiry into the factors that prevented these targets from being met, including through a comprehensive Basin-wide reporting and monitoring system led by a National Water Commission, can assist in assessing the progress of the 2026 Basin Plan. This reporting and monitoring system could incorporate a multidimensional risk assessment framework spanning environmental, social, economic, and governance (ESG) dimensions, strengthening transparency, consistency of reporting, and stakeholder engagement across jurisdictions.

Water Resource Plans (WRPs) are a central component of the Basin Plan but are often limited by inconsistent review cycles, limited transparency and weak coordination across jurisdictions. Governance can be strengthened at the catchment scale by implementing requirements for regular review and updates of WRPs, to improve responsiveness to changing climate, environmental, and socio-economic conditions. This can be supported by clearer enforcement mechanisms to ensure jurisdictions meet their obligations and maintain alignment with Basin-wide objectives. A catchment-led approach within WRP development can empower regional bodies and communities to contribute to the planning and implementation of Basin management. Formalising the role of Catchment Management Authorities (CMAs), or similar regional bodies, in the review and delivery of WRPs can improve management and alignment between state and regional NRM strategies. Previous CMA governance arrangements in NSW and Victoria provide useful examples of the potential effectiveness of this model, as outlined in the NSW CMA case study in the appendix. Additionally, introducing targeted incentives may support jurisdictions in regularly reviewing and updating their WRPs, improving responsiveness to changing conditions.<sup>3</sup>

**Recommendation 4:** Strengthen Basin governance by aligning the Basin Plan with the renewed National Water Agreement and updated Water Act, and re-establish an independent National Water Commission with oversight, advisory, and evaluation functions.

**Recommendation 5:** Strengthen cross-jurisdictional coordination by requiring regular review and updating of Water Resource Plans, supported by compliance and enforcement mechanisms, incentives and greater integration of catchment-scale governance.

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<sup>3</sup> These incentives could include Commonwealth co-investment programs, operational funding for state and territory water departments and catchment management authorities, and low-interest loans for infrastructure upgrades, modelling improvements, and data integration systems within Basin jurisdictions.

## Prioritising water quality in the Basin Plan

Water quality is a critical but underemphasised component of the Basin Plan. The Basin provides drinking water to more than 2.3 million Australians, in addition to supporting 120 waterbird species, over 50 native fish species and 30,000 wetlands (Verhoeven et al. 2024). Australia's population is expected to nearly double by the year 2071, and 80% of new arrivals will choose to live in cities and regional towns, requiring better-integrated urban water management to manage pressures on water systems and supply high-quality water (Australian Bureau of Statistics 2023). Water quality in the MDB is being further degraded by climate change and other anthropogenic pressures.<sup>4</sup> Diffuse pollution from agricultural runoff, urban stormwater, and land use change remains a significant and ongoing contributor and is likely to intensify under climate change. Emerging pressures, including those associated with data centres and the energy transition, will add to these challenges. In particular, the growth of data centre infrastructure to support artificial intelligence and digital services is a significant emerging pressure on Australia's water resources<sup>5</sup>. Despite this, the Basin Plan does not yet fully account for the cumulative impacts of climate change, growing demands from technological advancements and land use change on water quality. There is a clear need to strengthen the use of integrated data, expert knowledge, and scenario-based modelling to assess and manage these risks. This can include a framework for assessing and planning for the water needs of data-intensive industries and the extension of the use of the NABERS certification system to incorporate enforceable, locally contextualised water-use metrics for data centres.

Current approaches tend to focus on acute events, such as fish kills and algal blooms, leading to reactive management responses while overlooking underlying and deteriorating baseline conditions. A shift toward proactive, long-term water quality management is needed. This includes expanding from incident-based responses to Basin-wide condition monitoring and trend detection, enabling earlier intervention and prevention. At the same time, recovery actions following acute events require strengthening to address long-term ecological impacts.

The Basin Plan can adopt a more comprehensive, long-term approach that integrates water quality and quantity within a Basin-wide water quality framework. This could involve introducing regulated floodplain harvesting, enforceable downstream flow thresholds, integrated Basin-wide water accounting, and coordinated environmental flow management. This approach would include implemented objectives and targets, strengthened data governance, and improved inter-jurisdictional coordination, supported by integrated catchment management. For example, a Basin-wide cyanobacterial management strategy would combine short-term mitigation (e.g. treatment for drinking water and in-system controls) with long-term prevention through nutrient management at the catchment scale. The successful Basin Salinity Management Strategy 2030 demonstrates the value of agreed Basin-wide policy, long-term bipartisan and bilateral agreements at Commonwealth and State governments' levels, and commitment of and resourcing by governments at all levels, working with communities and industry groups (Verhoeven et al. 2024).

Systematically assessing future water quality risks by integrating monitoring data, expert knowledge, and climate and land use scenario modelling, and using this evidence to develop targeted, catchment-specific responses would strengthen the Basin Plan and would mirror successful approaches for water management in other jurisdictions<sup>6</sup>. This approach to water quality would also need to be supported by investment in infrastructure and intervention options to enable long-term water quality improvement.

<sup>4</sup> Threats include salinity, nutrient enrichment, sediment loads, toxic contaminants, rising temperatures, and cyanobacterial blooms (Verhoeven et al. 2024).

<sup>5</sup> Recent Australian research indicates that Melbourne's data centres currently consume approximately 50 litres of water per second, with projections that this will increase to 3,000 litres per second as AI demand grows, equivalent to the water consumption of 100,000 homes (Ragusa and Crampton 2026). Despite this, analysis of Australian federal and state legislation, policy and planning instruments finds that no document explicitly addresses data centre water use or water security. Australia's primary sustainability rating system for data centres, the National Australian Built Environment Rating System (NABERS), contains no water efficiency component. Australia is falling behind comparable jurisdictions, including Malaysia, Singapore, India, Indonesia and several US jurisdictions that already have water-use requirements for data centres (Ragusa and Crampton 2026).

<sup>6</sup> For example, recent studies by Scotland's Centre of Expertise for Waters (CREW) have found that a 1.5 °C temperature rise will result in cyanobacterial blooms in all Scottish lochs (May et al. 2022). High amongst the CREW

Urban water systems are also facing increasing pressure from population growth and climate change. While primarily a state responsibility, there is an opportunity for the Basin Plan to promote more integrated and nationally consistent approaches. Existing systems, often based on legacy infrastructure, are not well-suited to emerging challenges. Aligning water management with urban planning, climate resilience, and liveability objectives, particularly in the context of urban densification, would enable more flexible, efficient, and decentralised solutions, supported by improved cross-jurisdictional coordination.

**Recommendation 6:** Embed water quality as a core objective of the Basin Plan, including a system-wide water quality risk management approach.

## Strengthening integrated catchment management

Integrated catchment management (ICM) remains a critical but underdeveloped component of the Basin Plan. The current division of responsibilities between Basin and state institutions is not delivering adequate environmental or water quality outcomes. Strengthening ICM will require coordinated, regional approaches that bring together and balance the needs of communities, landholders and government. Notably, landholders manage a significant proportion of Basin landscapes and can be encouraged by the Basin Plan to be active partners in land and water stewardship (ABARES 2026). In particular, the agricultural sector, which is central to regional economies, employment, and national food production, can be supported to adapt and innovate in a water-constrained environment (Murray-Darling Basin Authority 2025). Additionally, structured and meaningful engagement with local communities and First Nations groups will be essential to delivering effective regional solutions and valuing the different needs of all water users.

A gap in current management is the limited integration of surface water and groundwater systems. This is particularly evident in northern Basin systems, where rivers have shifted from gaining to losing systems due to groundwater extraction.<sup>7</sup> The Basin Plan can commit to a clear, time-bound pathway for integrated management of connected systems, including surface water, groundwater, floodplain harvesting, and storage; supported by shared data, a common evidence base, and community co-management. The Barwon-Darling case study (see Appendix) demonstrates the importance of managing these systems as interconnected rather than discrete components.

Floodplain harvesting represents a significant and under-accounted component of water extraction in the northern Basin. The estimated mean annual take in northern NSW (2004–2020) is 778 GL (range 632–926 GL), with Basin-wide estimates of 1,200–1,500 GL (Brown et al. 2022). This extraction is not fully captured within Sustainable Diversion Limit (SDL) frameworks, creating a substantial gap in water accounting. Without comprehensive licensing, transparent reporting, and effective enforcement, floodplain harvesting risks undermining environmental water recovery (Grafton 2019). A revised Basin Plan can explicitly regulate floodplain harvesting, require downstream flow thresholds to be met before extraction, and implement integrated, publicly accessible water accounting across surface water, groundwater, and climate variability. Additionally, sustainable soil-landscape management is an important consideration that is largely absent from the Plan. An integrated approach is needed to implement a seasonal wetting and drying regime across rivers and adjacent wetlands (Fitzpatrick et al. 2024). This would reduce risks associated with prolonged drying and rewetting, including the accumulation of acidity and oxidation products in soils and floodplains, as demonstrated in the case study on Land and Water Degradation from Acid Sulfate Soils (Appendix). Such management would support more resilient and sustainable landscapes under a changing climate.

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recommendations to the government is that successful mitigation of climate change impacts on Scottish standing waters should focus on adaptive land management aimed at reducing nutrient inputs, especially phosphorus (May et al. 2024).

<sup>7</sup> In highly stressed systems such as the Barwon–Darling, hydrological evidence shows that groundwater extraction reduces river baseflows, while surface water extraction and floodplain harvesting reduce groundwater recharge, progressively degrading both rivers and aquifers (Vertessy et al. 2019; Brown et al. 2022). These pressures are further exacerbated by climate change, including increased evaporative losses and reduced recharge (MDBA 2026; Gonzalez et al. 2024). While reforms to improve longitudinal connectivity are important, they risk being undermined if declining inflows from floodplains, groundwater, and storage losses are not addressed.

**Recommendation 7:** Adopt an integrated catchment management approach that incorporates surface water-groundwater interactions and soil landscapes, to deliver regional solutions that balance the needs of all water users.

## Supporting thriving species and ecological health

Environmental Water Requirements (EWRs) are not consistently achieved across the MDB. Approximately 65% of assessed sites have not met EWR thresholds over recent decades, particularly for bankfull and overbank flows that sustain floodplain and wetland ecosystems (Sheldon et al. 2024). While environmental water recovery under the Basin Plan has improved small fresh events in some systems, the failure to achieve key overbank and floodplain inundation events limits ecological recovery. This suggests that current SDLs and Basin-wide Environmental Watering Strategy are insufficient to meet long-term ecological requirements, even under historical climate conditions. Under projected impacts of climate change, this gap is likely to widen further, reinforcing the need for an EWR-led approach to water allocation and operational rules that explicitly prioritise ecological flow thresholds.

Impacts on native fish species demonstrate the need to meet EWRs and implement targeted support for these populations. The severity of native fish decline in the MDB is starkly illustrated by consecutive mass mortality events in the Darling-Baaka River. The NSW Chief Scientist and Engineer's independent review of the 2023 Menindee fish deaths found that these events are symptomatic of broader, long-term ecosystem degradation driven by altered flow regimes, fish passage barriers, cold-water pollution, and habitat loss (Office of the NSW Chief Scientist & Engineer 2023). The review also noted that observed improvements in some species are largely attributable to stocking programs for recreational fishing, rather than natural ecological recovery. A structural constraint is restricted fish movement. Migration is effectively limited to the reach between Lake Pamamaroo and the Menindee Main Weir, concentrating biomass in a confined section of river that is highly vulnerable to hypoxic events (Office of the NSW Chief Scientist & Engineer 2023). This reflects inadequate fish passage infrastructure and demonstrates that environmental water releases alone are insufficient to prevent future mass mortality events. Notably, many of these issues have been identified in previous reviews, with recommended actions not fully implemented.

These findings reinforce the need for an outcomes-based approach to native fish recovery that integrates ecological modelling with targeted infrastructure and flow interventions. Infrastructure upgrades, particularly fishway construction and modification at priority sites within the Menindee Lakes system, can be treated as core components of Basin Plan implementation rather than supplementary actions. The Basin Plan can also include measurable fish passage milestones that are tracked independently of broader recovery programs that have experienced repeated delays. Ecological modelling that explicitly links fish population trajectories to infrastructure performance, flow regimes, and habitat connectivity may also be embedded within the Plan's performance framework to support adaptive management and accountability.

**Recommendation 8:** Adopt an outcomes-based approach for native fish recovery by setting species-level objectives and supporting ecological modelling, infrastructure investment, and targeted interventions to address threats and restore populations.

## Appendix

### NSW Catchment Management Authorities: A case study on proposed integrated catchment management and governance

#### 1. Overview

Catchment Management Authorities (CMAs) in New South Wales (NSW) represented a significant institutional innovation in natural resource management (NRM), embedding regional-scale governance to address complex interactions between environmental, social, and economic systems. Established through the 2003 NRM reforms, CMAs aimed to operationalise integrated catchment management by aligning community priorities, scientific knowledge, and government policy (Natural Resources Commission 2010).

This case study examines the CMA model as a regional delivery mechanism, highlighting its governance framework, implementation approach, and key outcomes. It demonstrates how decentralised, community-engaged governance contributed to improved coordination, adaptive management, and more effective on-ground environmental outcomes, while also identifying areas for continued reform.

#### 2. Context and Background:

Catchment Management Authorities were responsible for managing water catchments across New South Wales until their transition into Local Land Services in 2014. Their establishment reflected a broader national shift toward integrated catchment management, with similar regional bodies operating across Australia in varying institutional forms.

The NSW reforms introduced in 2003 were widely regarded as leading reforms in the field of NRM. They responded to the longstanding policy challenge of balancing environmental sustainability with social and economic demands on natural landscapes (Natural Resources Commission 2010). Central to this approach was the recognition that catchments are dynamic systems shaped by interactions between human communities and biophysical processes.

The reforms introduced a comprehensive governance framework, including:

- The establishment of 13 regionally based CMAs to deliver locally tailored NRM outcomes
- A state-wide targets framework to guide strategic priorities
- The NSW Standard for Quality Natural Resource Management, developed by the Natural Resources Commission, to ensure consistency and accountability
- Catchment Action Plans (CAPs), which set regional priorities and investment strategies
- Independent auditing and oversight mechanisms to drive performance and continuous improvement

The Standard defined best practice across key areas, including knowledge use, appropriate scale, collaboration, community engagement, risk management, monitoring and evaluation, and information management. While mandatory for CMAs, it also served as a broader benchmark for NRM across the state (Natural Resources Commission n.d.).

This institutional model clarified the roles of central agencies while empowering regional bodies to deliver on-ground outcomes in partnership with communities. It also established advisory structures, including the Natural Resources Advisory Council, to incorporate diverse stakeholder perspectives into decision-making.

#### 3. Outcomes and Impacts:

Catchment Action Plans (CAPs) became the central mechanism for guiding NRM across the 13 regions. These plans integrated government priorities, scientific evidence, and community values into strategic investment frameworks, enabling coordinated action across stakeholders, including government agencies, landholders, industry, and local organisations.

The CMA model delivered several notable outcomes:

- Improved regional engagement and governance: CMAs successfully increased community participation in NRM, giving regional stakeholders a more direct role in balancing ecosystem health with economic and social needs. This marked a shift away from less effective top-down approaches.
- Strengthened adaptive management: CMAs matured into credible regional institutions capable of iterative learning and improvement. Independent audits by the Natural Resources Commission demonstrated measurable progress, including improved performance in successive CAP implementation cycles.
- Enhanced integration of science and practice: CMAs effectively translated scientific knowledge into practical, landholder-focused interventions, supporting behaviour change and improved land stewardship.
- Progress toward environmental outcomes: Monitoring, Evaluation and Reporting (MER) frameworks provided increasing confidence that on-ground activities were contributing to long-term improvements in resource condition, although outcomes were often incremental and required sustained effort.
- Innovation in systems thinking: Some CMAs began applying resilience thinking to better understand and manage complex landscape systems. This approach helped identify priority intervention points, improve targeting of investments, and strengthen the alignment of environmental, social, and economic objectives.

Overall, the governance model established in 2003 was considered to be operating effectively by 2010, with key institutions, planning frameworks, and accountability mechanisms in place (Williams 2012).

#### 4. Opportunities for future:

Despite the strengths of the CMA model, several opportunities for improvement were identified:

- Strengthening cross-jurisdictional coordination: While CMAs operated effectively at the regional scale, greater integration with broader state and national frameworks - such as those overseen by the Murray-Darling Basin Authority - remains critical.
- Improving data integration and monitoring systems: Enhancing data consistency, accessibility, and long-term monitoring would support more robust evaluation of outcomes and inform adaptive management.
- Enhancing investment prioritisation: While some CMAs demonstrated strong capability in targeting investments, this was not consistent across all regions, indicating a need for strengthened analytical and decision-making frameworks.
- Maintaining community engagement and trust: Continued emphasis on local participation and co-design will be essential to sustaining behavioural change and long-term stewardship.
- Embedding resilience and systems thinking: Expanding the application of resilience-based approaches could further improve the capacity of catchment systems to respond to climate variability and emerging pressures.

## The Barwon–Darling River: A Case Study in Connected Land and Water Management

### 1. Overview

The Barwon–Darling is a highly connected and increasingly stressed surface water–groundwater system where changes in one component rapidly affect others. Long-term system health depends on integrated management of land and water use, floodplain processes, groundwater, and river flows.

Hydrological research shows consistent patterns:

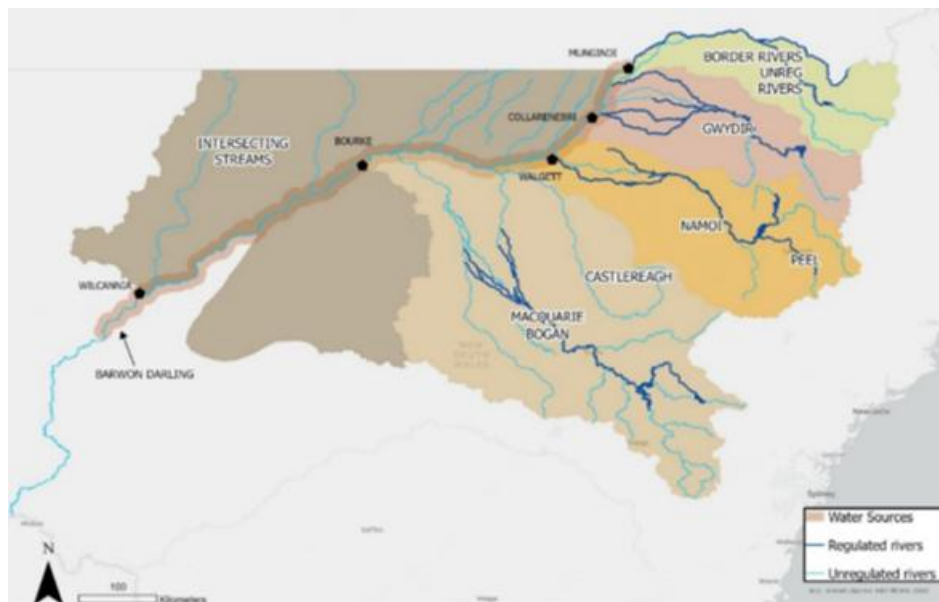
- Groundwater extraction reduces river baseflows.
- Surface water extraction and floodplain harvesting (FPH) reduce groundwater recharge, degrading both surface and subsurface resources over time.
- Climate change accelerates evaporative losses from surface storage and reduces aquifer recharge, increasing the prevalence of losing river conditions.

Incremental approaches—such as flow targets, rule changes, or enhanced environmental watering risk being undermined if inflows from overbank flow and groundwater continue to decline. The Basin Plan must therefore commit to a clear plan and timetable for integrated system management, otherwise implementation will be delayed for yet another decade.

### 2. The Barwon Darling: A Highly Connected System Under Stress

The Barwon Darling is the major river system in the northern Basin (Figure 1).

Figure 1. Major Rivers in the Northern Murray-Darling Basin



(NSW Department of Climate Change 2026)

The Barwon Darling integrates flows from multiple catchments (Figure 2). Multiple lines of scientific evidence show that it is a tightly coupled surface water–groundwater system under increasing stress due to extraction, FPH, groundwater use, and climate change.

Figure 2. Inflows to the Barwon-Darling River

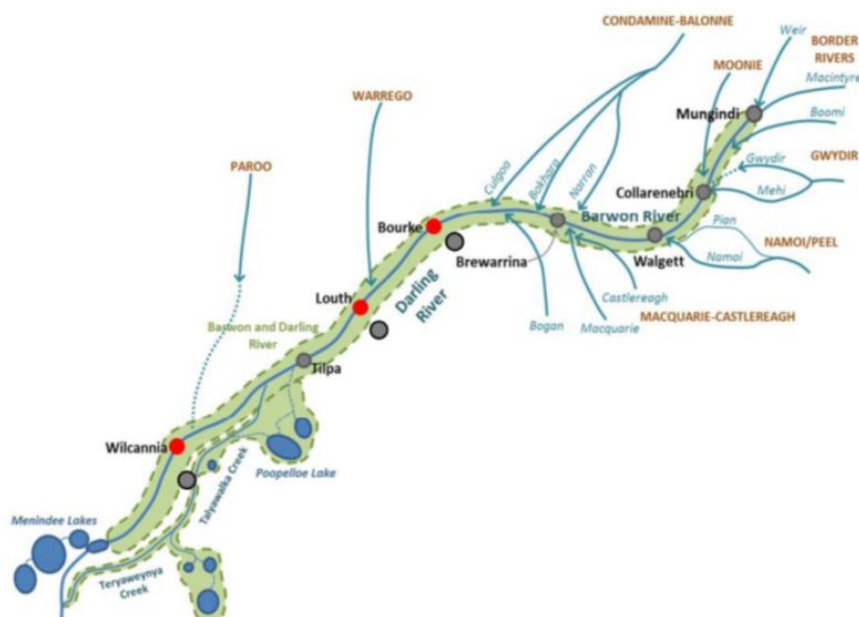


Figure 1 Stylised map of the Barwon-Darling River (Source MDBA)

(NSW Department of Climate Change 2024)

## 2A. Surface water extraction and floodplain harvesting (FPH)

FPH and surface water extraction have substantially reduced flows in the Darling River south of Bourke, with more frequent no-flow and very low-flow periods. High irrigation diversions have contributed to major ecological problems, including the widely reported fish kills (Vertessy et al. 2019). Low flows have also led to chronic water quality failures (Brown et al. 2022).

FPH volumes in the northern Basin are significantly underestimated in existing Sustainable Diversion Limits (SDLs). Brown et al. estimate mean annual FPH at ~778 GL - almost twice the NSW DPIE estimate. Current SDLs allow only 251 GL for the entire northern Basin, suggesting that SDLs in some valleys are overstated. The MDBA has acknowledged that FPH reductions will be required to maintain SDL compliance.

## 2B. Groundwater surface water interactions

Many rivers in the Barwon Darling (see figure 1) are highly connected to alluvial aquifers. These aquifers are recharged during high flow events and sustain river flows during dry periods. Reduced overbank flows and channel–floodplain connectivity, driven by surface water extraction and FPH, have suppressed this recharge. Increased groundwater extraction further draws down aquifer levels and pressures.

Climate change amplifies these effects. As a result, many river reaches have already transitioned from gaining to losing, contributing to more frequent low-flow and no-flow periods (MDBA 2026; Gonzalez et al. 2024).

## 2C. Climate change and storage losses

Climate change is increasing evaporative losses from surface storages and reducing aquifer recharge, amplifying pressure on storage systems (Murray-Darling Basin Authority 2025). Losses from shallow on-farm storages are estimated at 400 gigalitres across northern basin floodplain management areas, equivalent to 30-42 % of on-farm losses of water - a major opportunity cost for downstream water users. Notably FPH is not counted in SDL estimates (Brown et al. 2022).

### 3. Assessment of proposed policy responses

MDBA's 2026 Basin Plan Discussion Paper includes proposals to improve longitudinal northern basin river connectivity, including flow-based connectivity objectives at key locations, infrastructure upgrades and new operating rules in the Menindee Lakes.

The MDBA proposals build on NSW's draft northern basin connectivity strategy (NSW Department of Climate Change 2024), which includes operational, enforceable rule changes intended to deliver longitudinal connectivity improvements across northern valleys in different climatic conditions. These changes include:

- End-of-System Flow Targets, protection of freshes and baseflow in regulated rivers.
- Extended Resumption-of-Flow Rules to prevent extended dry periods.
- A connectivity Environmental Water Allowance (EWA) and a high-security planned environmental water account to deliver flows in extended dry periods.
- A framework for establishing priorities and rules to improve connectivity in unregulated systems.

However, NSW proposes deferring action on lateral and vertical connectivity - including groundwater, floodplain processes, and climate change - until after longitudinal connectivity reforms.

While the NSW proposals would help restore flows in the Barwon–Darling, their effectiveness will be undermined if declining inflows from floodplains and aquifers continue. The MDBA should therefore embed a 10-year plan and timetable for integrated management to prevent further delays and increase system resilience to climatic shocks.

### 4. Proposal for adaptive integrated land and water management to improve river connectivity in the Barwon Darling

Adaptive and integrated land and water management will promote more effective and faster restoration of system connectivity and health.

#### 4A. Integrated management of surface water, groundwater and floodplain harvesting

Key actions include:

- Incorporating the impacts of surface water, groundwater, and FPH extractions into SDL reviews for the Namoi and Gwydir groundwater areas.
- Including indicators of impacts of extractions on connected resources in revised Water Resource Plans.
- Aligning environmental watering programs with changing extraction regimes, recharge trends, shifts in baseflow and persistence of losing-reaches.

#### 4B. Integrated management of surface water and groundwater storage

Actions include:

- A comprehensive stocktake of surface and groundwater storages.
- A Basin-wide integrated storage strategy, with guiding principles for state implementation.
- Reducing evaporative losses by shifting some storage underground via managed aquifer recharge and water banking, and other technologies.

#### 4C. Community participation, shared data and a common evidence base

Recommended measures include:

- Support for Landholders and First Nations communities to participate in local adaptive water management, decision-making and monitoring.
- Development of shared definitions, targets and monitoring frameworks for connectivity.
- Shared datasets recommended measures on storages, evaporation and leakage.

## 5. Conclusion

The Barwon-Darling provides a compelling practical illustration of why the next Basin Plan should integrate the management of surface water, groundwater, FPH and environmental watering in a coherent adaptive management framework. This will provide a platform for adaptive integrated land and water management and enhance community resilience to climate change and drought over the next decade.

## Land and Water Degradation from Acid Sulfate Soils: Case Studies in Adaptive soil-landscape management

### 1. Overview

This case study examines the impacts and management of degraded soil landscapes across three regions of the MDB, focusing on water quality risks arising from:

1. Prolonged drying during drought (including bushfire impacts),
2. Rewetting and reflooding, and
3. Excavation activities such as drains and dams.

These processes have contributed to a range of soil–landscape degradation issues, including acidification, salinisation, erosion, clay dispersion (sodicity), waterlogging, compaction, and the production of noxious gases and monosulfides (Fitzpatrick et al. 2024). The case studies focus on:

- Murray Darling Basin wetlands (Case Study #1).
- Coorong, Lower Lakes and Murray Mouth Region (Case Study #2).
- Lower Murray Reclaimed Irrigation Area (Case Study #3).

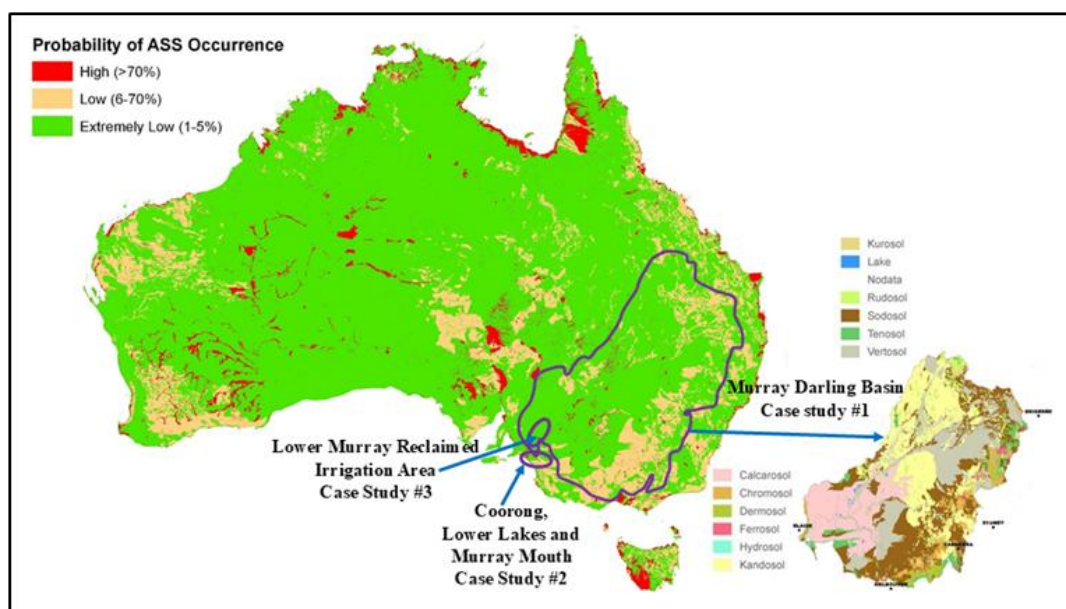


Figure 1. Map showing: (i) occurrences of Australian acid sulfate soils (Fitzpatrick et al. 2011) and (ii) localities of 3 case study regions in the MDB where acid sulfate soils were investigated.

Collectively, these case studies demonstrate that degradation is being exacerbated by prolonged drought, climate change (i.e. reduced rainfall and increased evaporation) and poor water management. Monitoring, analysis and evaluation of data are central to adaptive management and should be treated as a core requirement rather than an optional enabler to this process.

### 2. Management Challenges and Impacts

The Millennium Drought (2007–2010) resulted in unprecedentedly low water levels across many MDB wetlands and the Lower Lakes, exposing acid sulfate soils and triggering widespread oxidation. This led to significant soil and water acidification, particularly in the Lower Lakes and the Lower Murray Reclaimed Irrigation Area, requiring costly interventions such as regulators and limestone dosing (Fitzpatrick et al. 2024).

Although high flows in 2010–11 partially improved surface water quality, a legacy of acidified soils and pore water remains, with uncertain long-term ecological consequences. Research undertaken across the three

case study regions indicates that maintaining water levels above 0 mAHD can reduce the risk of localised acidification events.

The oxidation of pyrite to form sulfuric acid and sulfuric soils due to extreme drought conditions, climate change, excessive water extraction, and in water catchments across the MDB has been shown to offer the first visible warning against larger and imminent environmental water problems. Acid sulfate soil materials can be compared with the well-known ‘canary in the mine shaft’, because external drivers can render the various acid sulfate soil materials either relatively stable (i.e. wetting, reflooding or reducing), or susceptible to rapid change (i.e. under drying or oxidising conditions). These various types of acid sulfate soils can provide critical information about deteriorating environmental situations (Fanning et al. 2017; Fitzpatrick et al. 2024).

These submerged or subaqueous soils with acid sulfate soil characteristics are often “*out of sight, out of mind*” because they occur under rivers, wetlands and lakes (Simmons 2018). The 3 case studies below highlight the complex cumulative adverse impacts on reduced water supply and declining water quality in regions across the MDB, linked to exposure to hidden hazards. These hazards have led to major irreversible environmental impacts arising from exposure and oxidation of acid sulfate soils:

1. Ongoing degradation of catchment health due to drought, bushfires and reflooding,
2. Severely degraded systems requiring urgent intervention, particularly in irrigation areas, and
3. Compounding pressures from climate change are reducing both water availability and quality.

### **3. Recommendations: Monitoring and evaluation of findings will enable decision-makers to use adaptive management**

The MDBA’s 2026 Basin Plan Discussion Paper does not include a coordinated strategic approach to acid sulfate soil assessment and management.

To address this gap, the next Basin Plan should incorporate targeted strategies to manage soil–landscape degradation and associated water quality risks, particularly those arising from drought-driven drying, reflooding events, and excavation activities. Key actions include:

1. Develop and implement adaptive management strategies in high-risk regions, with a focus on drought resilience and climate adaptation.
2. Strengthen monitoring and assessment of acid sulfate soils and salinity risks, recognising that sustainable water management must address both water quantity and soil–landscape condition.
3. Prioritise environmental protection of soil and water resources in wetlands and lakes as a foundation for long-term sustainability.
4. Apply established remediation and management approaches for acid sulfate soils.
5. Support adaptive management of water use, informed by a comprehensive understanding of soil–landscape processes and viable economic alternatives.

### **4. Conclusions**

These case studies demonstrate that adaptive soil landscape management is a minimum requirement for maintaining the long-term health and sustainability of MDB ecosystems and water resources.

They also highlight the need for the Basin Plan to better integrate the identification and management of acid sulfate soils with surface water, groundwater and environmental water management within a coherent adaptive framework. Strengthening this integration will improve environmental resilience and support the sustainable functioning of agricultural and natural landscapes under increasing climate pressures.

## Discussion Paper Feedback Questions

### What do you think of the issues and options presented in the [Discussion Paper](#)?

ATSE agrees that it is appropriate to reflect on the changing conditions and broader context in which the Murray-Darling Basin Plan (MDBP) operates, including climate change, evolving operating conditions, and outcomes beyond water provision. This includes strengthening consideration of environmental, social, cultural, and economic dimensions, as well as the meaningful inclusion of Aboriginal and Torres Strait Islander peoples. Current language remains general in relation to participation and consultation. There is a need to more precisely define science in the context of Aboriginal and Torres Strait Islander expertise and how this integrates with data, data sovereignty and cultural knowledge.

This is a critical consideration for a successful evolution of the Basin Plan framed within a long-term, 50-year outcomes perspective, while retaining its statutory 10-year planning cycle. A stronger forward-looking approach is needed to ensure near-term decisions actively build resilience for future Basin conditions. Addressing climate change risks is appropriately prioritised but should be embedded as a structural driver across all elements of the Plan.

ATSE strongly supports the Basin Plan's focus on maximising environmental water outcomes, improving river connectivity in the northern Basin, enhancing floodplain and wetland health, responding to native fish decline, improving water quality, investing in infrastructure and critical human water needs, strengthening regulatory design, and improving the use of science and knowledge. However, ATSE notes that water quantity continues to dominate the framework, while water quality and fit-for-purpose water outcomes remain insufficiently integrated as core system objectives.

While issues are summarised into core themes, the proposed options are often framed at a high level and read as statements of intent rather than implementable actions. In many cases, there is insufficient clarity on how options would be operationalised, how they relate directly to specific issues, and what governance, regulatory, or measurement mechanisms would support implementation. Strengthening the explicit link between issue, option, and implementation pathway would significantly improve transparency and accountability. Further, limited evidence is provided to demonstrate how issues and options were identified.

### Are there other issues and options that should be considered?

The Basin Plan would be strengthened by adopting a clearer, long-term, outcomes-based framework. ATSE encourages articulation of a 50-year vision, consistent with its essay series [A thriving Murray-Darling Basin in 50 years](#), which identifies desired outcomes including a healthy environment, resilient regional communities, Aboriginal and Torres Strait Islander self-determination, sustainable food systems, technological transformation, improved productivity, and alignment with the Sustainable Development Goals.

The Basin Plan can also integrate the identification and management of acid sulfate soils with management of surface water, groundwater and environmental water quality in a coherent adaptive management framework. This can build environmental resilience and help improve the function of agricultural landscapes through effective management of the natural resource base.

There is also a need to better recognise the role of surface water–groundwater interactions, integrated catchment processes, and system connectivity, including floodplain harvesting. Improved integration of hydrological, ecological, and climate modelling is essential to support more informed and adaptive Basin management. Ecological outcomes should be more explicitly defined in terms of recovery trajectories, not only condition monitoring. Investment in environmental water should be linked to measurable population and ecosystem recovery targets.

ATSE also supports embedding a multidimensional risk assessment framework within the Basin Plan, incorporating environmental, social, economic, and governance (ESG) dimensions. This would support

communication, stakeholder engagement, monitoring and reporting and overall transparency across jurisdictions.

### **What do you see as the priorities, and why?**

**Governance and institutional alignment:** Strong governance is the most critical enabler of Basin Plan success. The effectiveness of the Plan depends on clear alignment between Commonwealth, State and Territory responsibilities, and coordination with broader reforms, including a potential National Water Commission, a National Water Agreement, and review of the Water Act 2007. Without institutional coherence, implementation gaps will persist regardless of policy design. Water Resource Plans should also be fully implemented and enforced, with stronger consideration of long-term system interactions, including groundwater–surface water connectivity and cultural water needs. Clear compliance mechanisms and incentives are required to ensure consistency across jurisdictions.

**Integrated data, knowledge, and modelling systems:** A Commonwealth-hosted, shared national data and knowledge platform is essential to support transparency, consistency, and evidence-based decision-making. This should include hydrological, ecological, climate, and socio-economic data, with open and equitable access for all stakeholders. Strengthened data integration would improve modelling capability and support adaptive management.

**Integrated catchment management:** The Basin Plan would benefit from stronger integration of land and water management. Current legislative arrangements limit the extent to which catchment-scale drivers of water quality and ecosystem health can be addressed. Options to strengthen integration between Basin policy and state-based catchment management should be explored, including options that may require broadening the legislation and the Basin Plan.

**Water quality as a core system objective:** Water quality should be elevated to a central objective of the Basin Plan, alongside water quantity. Climate change, population growth, and land-use pressures are increasing risks to water quality and reducing the availability of fit-for-purpose water for environmental, cultural, and consumptive use.

**Ecological outcomes and recovery-focused management:** Ecological monitoring should be strengthened through the inclusion of predictive ecological modelling (fish, birds, vegetation) alongside hydrological modelling. This can support an outcomes-based approach that links flow regimes, infrastructure performance, and habitat connectivity to measurable ecosystem recovery targets.

*ATSE thanks the Murray-Darling Basin Authority for the opportunity to respond to the 2026 Basin Plan Review. For further information, please contact [academypolicyteam@atse.org.au](mailto:academypolicyteam@atse.org.au).*

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