

Draft Regional Water Strategy

NSW Murray:
Shortlisted Actions – Consultation Paper

May 2024



Published by NSW Department of Climate Change, Energy, the Environment and Water
dcceew.nsw.gov.au

Title Draft Regional Water Strategy

Sub-title NSW Murray: Shortlisted Actions – Consultation Paper

First published May 2024

Department reference number PUB24/389

Cover image courtesy of iStock. Murray River, Moama.

More information water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies

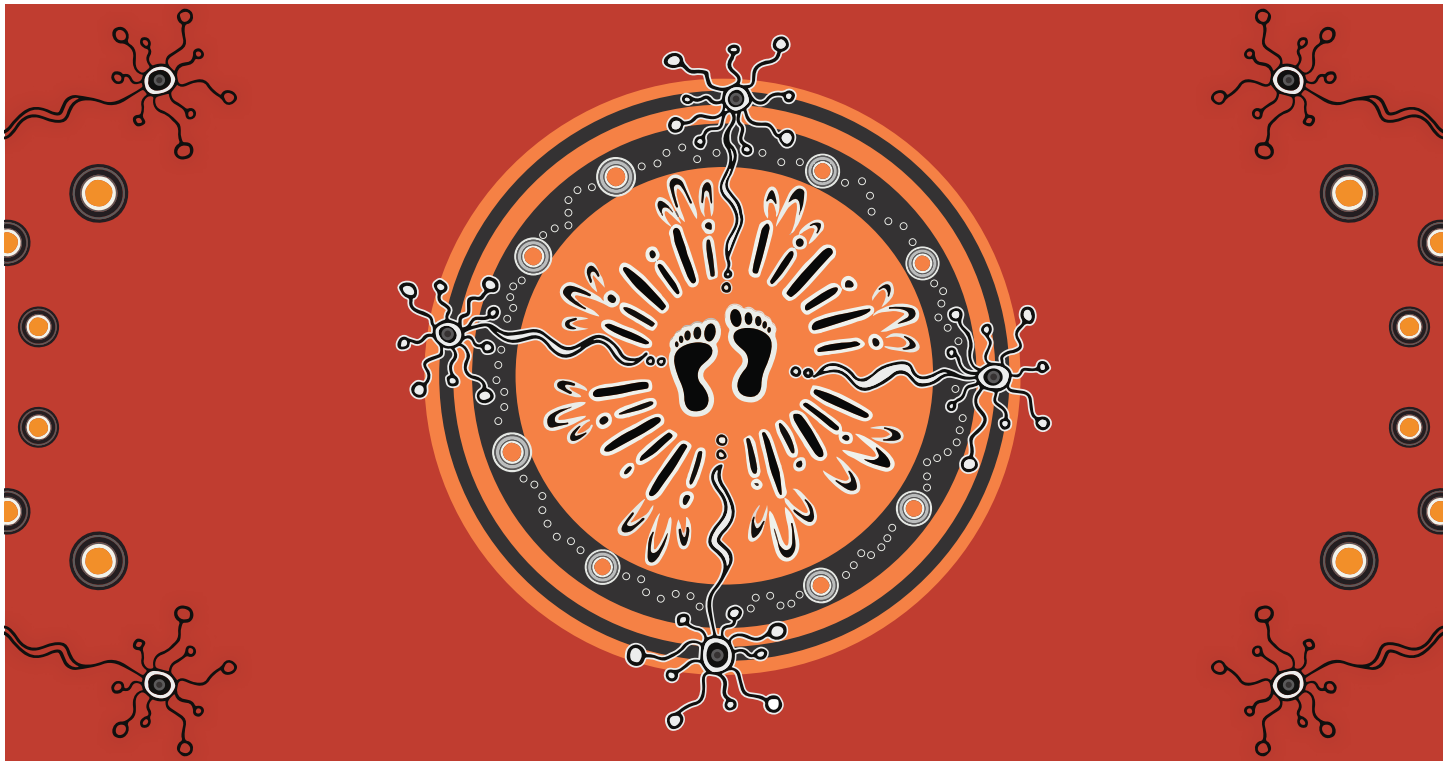
Acknowledgements

Thanks to the Murray Darling Basin Authority, Snowy Hydro Limited, Department of Energy, Environment and Climate Action Victoria, ACT Government and Icon Water for their collaboration in hydrological modelling to inform the development of this strategy.

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Acknowledging First Nations people

The NSW Government acknowledges First Nations people as the first Australian people and the traditional owners and custodians of the country's lands and water. First Nations people have lived in NSW for over 60,000 years and have formed significant spiritual, cultural, and economic connections with its lands and waters.

Today, they practice the oldest living culture on earth.

The NSW Government acknowledges the Bangerang, Barapa Barapa, Barkandji, Bidhawal, Maljangapa, Maraura, Mutthi Mutthi, Ngarigu, Ngiyampaa, Nyeri Nyeri, Tati Tati, Walgalu, Wadi Wadi, Wemba Wemba, Weki Weki, Wiradjuri and Yorta Yorta people as having an intrinsic connection with the lands and waters of the NSW Murray Regional Water Strategy area. The landscape and its waters provide the First Nations people with essential links to their history and help them maintain and practice their traditional culture and lifestyle.

We recognise the Traditional Owners as the first managers of Country. Incorporating their culture and knowledge into management of water in the region is a significant step towards closing the gap.

Under this regional water strategy, we seek to establish meaningful and collaborative relationships with First Nations people. We will seek to shift our focus to a Country-centred approach; respecting, recognising and empowering cultural and traditional Aboriginal knowledge in water management processes at a strategic level.

We show our respect for Elders past and present through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places where First Nations people are included socially, culturally and economically.

As we refine and implement the regional water strategy, we commit to helping support the health and wellbeing of waterways and Country by valuing, respecting and being guided by First Nations people, who know that if we care for Country, it will care for us.

We acknowledge that further work is required under this regional water strategy to inform how we care for Country and ensure First Nations people hold a strong voice in shaping the future for all communities.

Artwork by Nikita Ridgeway.

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Snapshot

The NSW Murray region



110,000
population



40,400
km²



Major regional centres:
Albury, Deniliquin, Corowa,
Moama and Jindabyne



First Nations:

Bangerang, Barapa Barapa, Barkandji, Bidhawal, Maljangapa, Maraura, Mutthi Mutthi, Ngarigu, Ngiyampaa, Nyeri Nyeri, Tati Tati, Wadi Wadi, Walgalu, Weki Weki, Wemba Wemba, Wiradjuri and Yorta Yorta



Major river systems:

Murray, Edward/Kooley–Wakool, Snowy and Swampy Plains rivers
Plus a number of unregulated rivers and creeks



Main groundwater systems:

Upper and lower Murray
Alluviums, Kanmantoo Fold
Belt, Lachlan Fold Belt, Murray–
Darling Basin Porous Rock and
Oaklands Basin



Smaller regional towns:

Tumbarumba, Tocumwal,
Wentworth, Howlong, Finley,
Mulwala, Buronga, Bombala,
Dalgety, Delegate, Berridale
and Berrigan



Connections:

Snowy Scheme, Victoria, South
Australia and the Murrumbidgee
and lower Darling regions



Major water storages:

Dartmouth Dam (situated in
Victoria) with a storage capacity
of 3,856 GL

Hume Dam (situated on the
NSW-Victorian border) with a
storage capacity of 3,005 GL

Menindee Lakes (situated on
the Darling River) with a storage
capacity of 1,731 GL

Lake Victoria (situated in south-
western NSW close to the
South Australian border), with a
storage capacity of 677 GL

Additional dams in the
Snowy Scheme



Key environmental assets:

Millewa Forest, Werai Forest,
Blue Lake and Koondrook-
Perricoota Forest (Ramsar
sites), NSW portion of the
Chowilla Floodplain, Murray and
Snowy rivers and Kosciuszko
National Park

Approximately 159 plant
and animal species listed
as threatened, vulnerable,
endangered, critically
endangered or presumed extinct



Major investments:

Snowy Mountains Special
Activation Precinct, Albury
Regional Job Precinct and
Inland Rail Project



Gross Value Added
(2020–21):

\$10 billion

Key sectors:

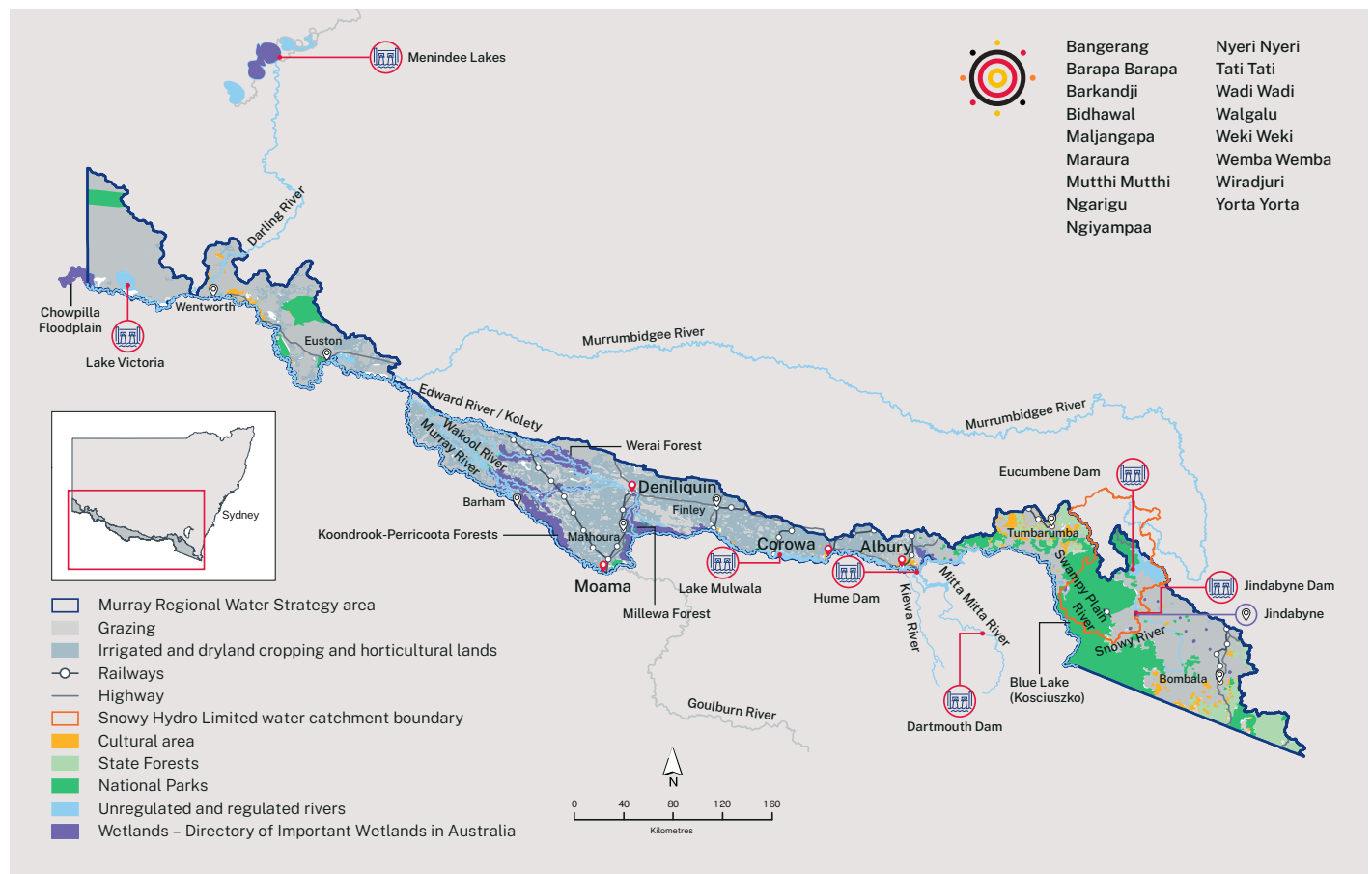
Agriculture, manufacturing,
health care and tourism

The NSW Murray Regional Water Strategy region (Figure 1) lies in southern NSW and includes varying natural landscapes that change from mountainous terrain in the east to flat alluvial plains in the west. The region is home to many thriving regional centres and communities, productive agricultural industries and nationally important wetlands, including 2 that are Ramsar listed.

The region is located within the traditional lands of the Bangerang, Barapa Barapa, Barkandji, Bidhawal, Maljangapa, Maraura, Mutthi Mutthi, Ngarigu, Ngiyampaa, Nyeri Nyeri, Tati Tati, Wadi Wadi, Walgalu, Wemba Wemba, Weki Weki, Wiradjuri and Yorta Yorta Nations. These Nations have been caretakers of the NSW Murray region for over 60,000 years.

The NSW Murray region is part of the broader southern connected Basin, linked hydrologically and through water management arrangements to the Darling and Murrumbidgee rivers and, by extension, to Victoria, Queensland and South Australia. The region also receives inflows from the Snowy Scheme under the rules of the Snowy Water Licence.

Figure 1. Map of the NSW Murray region



Environmental significance of the NSW Murray region

Water is a significant feature of the NSW Murray region's landscape and environment. Environmental assets play a crucial role in the region's liveability and provide recreational and tourism opportunities.

The Snowy and Murray river systems, floodplains, swamps, aquifers, glacial lakes and wetlands provide habitat for many aquatic species, including birds and native fish. The NSW Murray is home to 2 nationally important wetlands and the region's waterways support several threatened or endangered species including the Murray cod, Macquarie perch, Southern bell frog and Corroboree frog. In addition to the waterways, the alluvial sediments of the Murray River also play an important role in supporting groundwater-dependent ecosystems.

Addressing the environmental challenges facing the NSW Murray region

Changes in water use and land use across the region have impacted the health of native aquatic species populations and their ecosystems. Barriers to fish passage, changes to water flow, degradation of in-stream habitat and riparian vegetation, development of hydropower and water infrastructure, poor land management practices and altered flows, have put many native fish species under pressure by reducing water quality and limiting their ability to complete essential stages of their lifecycle.

Water reforms, such as the dedication of water to the environment, have sought to stop further decline and improve the condition and resilience of these environmental assets. However, parts of the catchment are still in poor condition and climate change will increase the risk for many species and ecosystems.

Through strategic planning, the NSW Government aims to further build on these reforms and enhance the natural environment. Strategic actions include improving knowledge of the region's environment and its water needs, introducing measures to support flows and water quality at a catchment level, supporting better cultural involvement in water and improving the long-term outcomes of water for the environment. The draft NSW Murray Regional Water Strategy sets out a suite of actions that will be delivered by the NSW Government to address the region's water-related environmental challenges.



Image courtesy of Vince Bucello. Reed Beds Swamp, NSW.

What is the purpose of this consultation paper?

1

Image courtesy of Destination NSW. Kosciuszko National Park, NSW.

The NSW Government is developing 13 regional water strategies that bring together the best and latest climate evidence with a wide range of tools and solutions to plan and manage each region's water needs over the next 20 to 40 years.

The first draft of the NSW Murray Regional Water Strategy, including a long list of options to address regional challenges, was released in April 2022.¹ Feedback received on the first draft was compiled in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies: What We Heard Report*.²

After public consultation on the draft strategy, the NSW Department of Climate Change, Energy, the Environment and Water (the department) considered all feedback and in December 2022 published baseline hydrological modelling results using the new climate data alongside updated regional challenges.³ Further consultation was held in October/November 2023 to gather stakeholders' views on this additional and revised information.

This consultation paper considers the feedback from stakeholders and additional research to finalise the identification of the key challenges in the region and proposes actions to address these challenges. The detailed process is described in the *Options assessment process: Overview*.

This consultation paper presents the outcomes of this work, summarised in Figure 2.

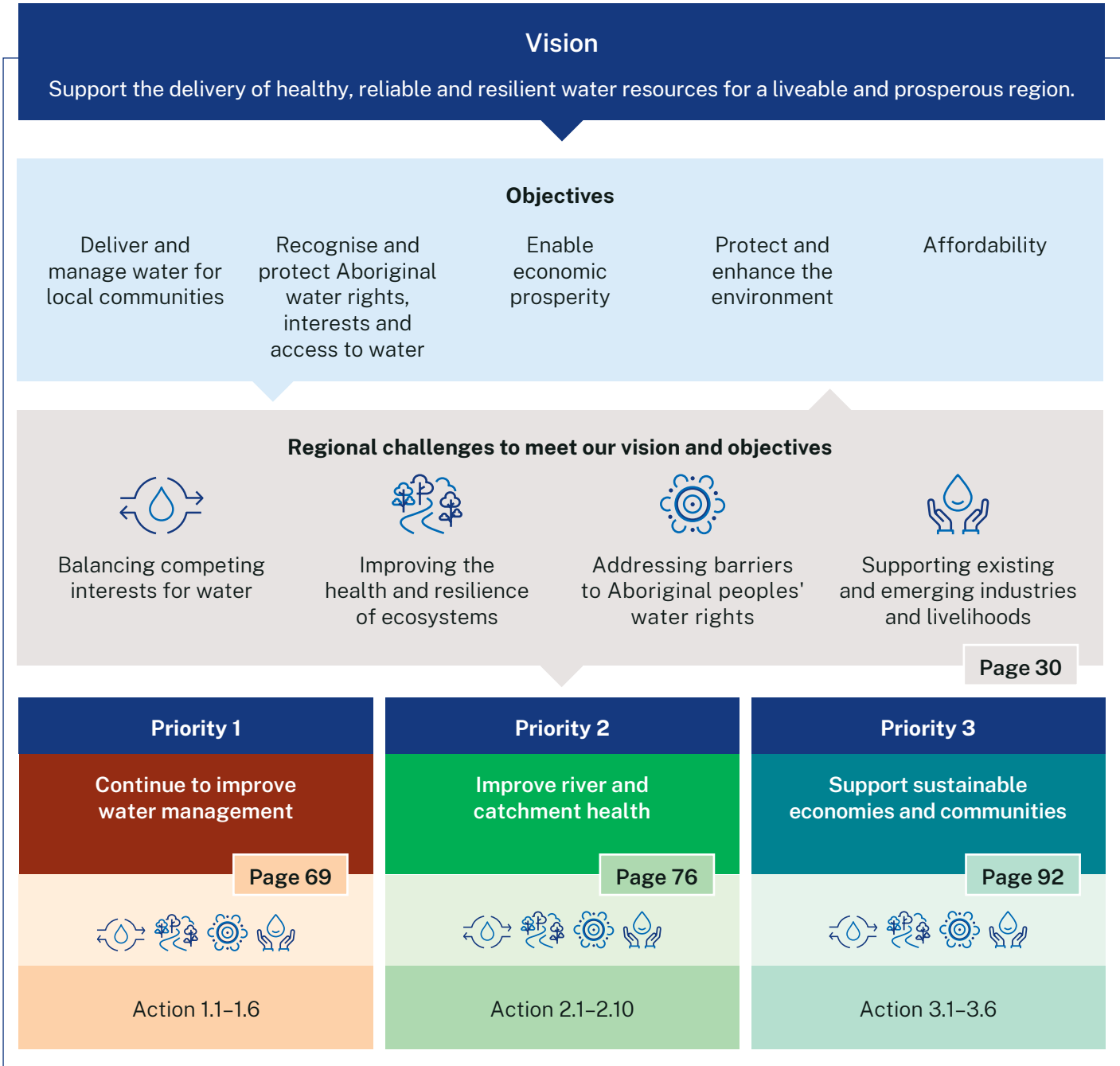
No decisions have been made on the shortlist of proposed actions. The purpose of this consultation paper is to seek your views on what the best actions are to set the NSW Murray region up for the future before a final strategy and an implementation plan are developed.



Image courtesy of Destination NSW. Edward River, Deniliquin.

1. Full descriptions of the region, its water resources and water needs are provided in the draft strategy report and long list of options report. These reports can be viewed and downloaded at: www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murray/murray-regional-water-strategy
2. More information about the *Draft NSW Murray and Murrumbidgee Regional Water Strategies: What We Heard Report* (December 2022) www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murray/murray-regional-water-strategy
3. The results of baseline hydrological modelling for the draft NSW Murray and Murrumbidgee regional water strategies are detailed in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling report* (December 2022), including key implications for water resources in the NSW Murray region. Releasing this base set of results is intended to inform public understanding and discussion about the range of potential climate challenges the water resources of the regions may face into the future. The report is available at: www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murray

Figure 2. Proposed water security challenges and priorities for the NSW Murray region



Why are we developing regional water strategies?

Across NSW, valuable and essential water resources are under pressure. A more variable climate, as well as changing industries and populations, mean we face difficult decisions and choices about how to balance the different demands for this vital resource and manage water efficiently and sustainably into the future. The regional water strategy process identifies these risks and seeks to understand how we can manage and be best prepared for these future uncertainties and challenges.

In addition to understanding and managing future pressures, there are opportunities to consider the role water resources will play in sustaining regional economies, improving liveability and making sure each region remains a great place to live, work, play and visit.

The NSW Government's strategic investments and actions identified through regional economic development strategies are critical to realising this vision. However, all these activities rely on access to water.

The regional water strategies program is helping to provide the evidence base needed to support existing investments, identify new opportunities and sustain successful regional industries of the future.

The regional water strategies will include a wide range of tools and solutions to help better use, share, store and deliver water to ride the highs and lows of water availability and change how water is managed in the future.



Image courtesy of Destination NSW. Bellbridge, NSW.

How do regional water strategies align with other water strategies?

Alignment with state-wide strategies and programs

The NSW Water Strategy, together with the 13 regional water strategies and 2 metropolitan water strategies that underpin it, will form the strategic planning framework for water management in NSW. The NSW Water Strategy was developed in parallel with the draft regional water strategies. The NSW Water Strategy guides the strategic state-level actions that need to be taken, while the regional water strategies will prioritise how those state-wide actions – as well as other region-specific place-based solutions – should be staged and implemented in each region (Figure 3).

As part of delivering the NSW Water Strategy, the NSW Government is delivering other statewide strategies and programs including:

- the draft NSW Aboriginal Water Strategy, co-designed with Aboriginal people, will identify measures to deliver Aboriginal People's water rights and interests in water management
- the NSW Groundwater Strategy will support sustainable groundwater management across NSW
- the Town Water Risk Reduction Program – to identify long-term solutions to challenges and risks to providing water supply and sewerage services to regional towns in collaboration with local councils
- a new state-wide Water Efficiency Framework and Program is reinvigorating water use efficiency programs in our cities, towns and regional centres.

The NSW Water Strategy and the draft NSW Murray Regional Water Strategy also complement other whole-of-government strategies, including government commitments to *Net Zero*⁴ and the *State Infrastructure Strategy*.⁵

The draft NSW Murray Regional Water Strategy also aligns its actions and recommendations with the goals and directions set out in the relevant regional plans (*Riverina Murray Regional Plan 2041*,⁶ *draft Far West Regional Plan 2041*⁷ and *draft South East and Tablelands Regional Plan 2041*⁸) to support growth and development enabled through the Inland Rail Project, Albury Regional Jobs Precinct and Snowy Mountains Special Activation Precinct.

By providing a coordinated approach to support the range of NSW Government policies, we aim to build resilience in regional communities. Our aspiration is to adopt a place-based framework that is flexible and adaptive to changing circumstances and enable government and regional communities to work together to ensure the NSW Murray region is a great place to live, work and visit.

4. More information about the *NSW Net Zero Plan (2020)* is available at: www.energy.nsw.gov.au/nsw-plans-and-progress/government-strategies-and-frameworks/reaching-net-zero-emissions/net-zero

5. More information about the *NSW SIS (State Infrastructure Strategy) (2022)* is available at: www.infrastructure.nsw.gov.au/expert-advice/state-infrastructure-strategy/

6. More information about the *NSW Riverina Murray Regional Plan 2041 (2023)* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/riverina-murray-regional-plan-2041

7. More information about the *draft Far West Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/far-west

8. More information about the *draft South East and Tablelands Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/south-east-and-tablelands

Figure 3. State and regional water strategies: priorities and objectives

NSW Water Strategy core objectives	NSW Water Strategy strategic priorities	Regional water strategy objectives	
Protecting public health and safety	Priority 1 Build community confidence and capacity through engagement, transparency and accountability	Aligned with all regional water strategy objectives	Affordability – identify least cost policy and infrastructure options
Liveable and vibrant towns and cities	Priority 2 Recognise Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes	Recognise and protect Aboriginal people's water rights, interests and access to water – including First Nations heritage assets	
Water sources, floodplains and ecosystems protected	Priority 3 Improve river, floodplain and aquifer ecosystem health, and system connectivity	Protect and enhance the environment – improve the health and integrity of environmental systems and assets, including by improving water quality	
Cultural values respected and protected	Priority 4 Increase resilience to changes in water availability (variability and climate change)	Aligned with all regional water strategy objectives	
Orderly fair and equitable sharing of water	Priority 5 Support economic growth and resilient industries within a capped system	Enable economic prosperity – improve water access reliability for regional industries	
	Priority 6 Support resilient, prosperous and liveable cities and towns	Deliver and manage water for local communities – improve water security, water quality and flood management for regional towns and communities	
Contribute to a strong economy	Priority 7 Enable a future focused, capable and innovative water sector	Aligned with all regional water strategy objectives	

Alignment with the National Water Initiative

Over the last 20 to 30 years there have been significant changes to the way water is managed in the Murray–Darling Basin and NSW Murray region.

The National Water Initiative (NWI),⁹ with commitment from all state and territories, provides for the sustainable, equitable and efficient allocation of water. It aims to achieve better economic, cultural, social and environmental outcomes.

Assessments are undertaken by the Productivity Commission every 3 years under the *Water Act 2007* (Commonwealth) to track the progress of all Australian governments in achieving the objects, outcomes and timelines of the *2004 Intergovernmental Agreement on a National Water Initiative*.¹⁰

All states and territories are working together to renew and modernise the NWI to account for changes in knowledge and technology, and:

- to better consider climate change and extreme events
- improve First Nations involvement and influence in water management
- improve the provision of safe and reliable drinking supplies.

The draft NSW Murray Regional Water Strategy aligns with the opportunities identified by the Productivity Commission's 2020 assessment through specific actions relating to climate change, improving First Nations and Aboriginal communities' involvement in water management and town water quality and security.

Alignment with the Basin Plan

The *Basin Plan 2012*¹¹ aims to achieve a healthy and sustainable Murray–Darling Basin by managing the Basin as a connected system. The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level of take, while continuing to support farming and other industries for the benefit of the Australian community.

Similar to this, the NSW regional water strategies program aims to enable forward planning for sustainable water management in the NSW Murray region for the benefit of local communities, industry and the environment. These initiatives, which would be realised through proposed actions in the draft NSW Murray Regional Water Strategy, may result in changes to NSW water sharing plans or water resource plans or be delivered through targeted programs and projects.

Table 1 outlines the alignment of the draft NSW Murray Regional Water Strategy with the key elements of the Basin Plan. The actions outlined in the draft NSW Murray Regional Water Strategy align with Basin Plan requirements and ensure that the interests of NSW communities are at the forefront of our strategic water planning.

9. More information about the NWI (*National Water Initiative*) is available at: www.dcceew.gov.au/water/policy/policy/nwi

10. More information about the *Intergovernmental Agreement on a National Water Initiative* is available at: www.dcceew.gov.au/water/policy/policy/nwi

11. More information about the *Basin Plan 2012* is available at: www.mdba.gov.au/water-management/basin-plan

Table 1. Alignment of the draft NSW Murray Regional Water Strategy with the Basin Plan

Basin Plan key elements	Alignment with Regional Water Strategies
Setting limits on how much water can be used through water resource plans and sustainable diversion limits (SDL)	Any actions under the draft NSW Murray Regional Water Strategy will need to be implemented within the legislative requirements set by the Basin Plan, including the level of take in accordance with the SDL. Actions implemented in the strategy may impact future reviews of NSW water resource plans.
Effective delivery of water through adequate infrastructure	The draft NSW Murray Regional Water Strategy is not proposing any significant changes to the extensive River Murray Operations water infrastructure asset portfolio. However, the strategy outlines continuing NSW support for programs run with partner governments to improve delivery of water throughout the Murray River system.
Ensuring adequate volumes of water are set aside for the environment and used effectively and efficiently	The draft NSW Murray Regional Water Strategy does not propose changes to the volumes of water set aside for the environment. It does, however, propose investigations into new and upgraded infrastructure (not currently considered by the <i>Sustainable Diversion Limit Adjustment Mechanism (SDLAM)</i>) that efficiently deliver water to significant ecological assets, as well as improvements to funding arrangements for NSW-held environmental water entitlements. Due to timing, proposed action 2.1 is not considered for Basin Plan water recovery purposes (e.g. SDLAM).
Managing and monitoring water quality in the Basin	The draft NSW Murray Regional Water Strategy includes proposed actions to improve water quality through support for targeted land and waterway management initiatives, investigations into addressing cold water pollution and improved input by water utilities in new development approvals that may impact water quality.
Enabling fair and transparent water trading across the Basin	The proposed actions set out in the draft NSW Murray Regional Water Strategy work within the water trading rules set by the Basin Plan.
Enforcing compliance with the Basin Plan	The actions set out in the draft NSW Murray Regional Water Strategy comply with the requirements of the Basin Plan. The draft strategy does not propose any additional compliance measures beyond current arrangements.
Allowing for flexibility and changes through adaptive management	Each regional water strategy will be reviewed regularly to allow changes in the way water is managed over the long term. This will enable adaptive management to occur and continuous improvement of the long-term strategic management of water in the NSW Murray region.

NSW Alternatives to Buybacks Plan

The NSW Government remains committed to delivering the Basin Plan in full, in partnership with the Australian Government and other Basin governments. However, we have been clear that this must be done in a way that minimises socio-economic impacts and allows regional communities to prosper.

The purchase of water rights by the Australian Government (i.e. water buybacks), as a mechanism to meet the water recovery targets under the Basin Plan, has the potential to cause significant socio-economic impacts. This has been consistent feedback received from stakeholders throughout the southern parts of the Basin.

Analysis suggests that irrigation areas in the southern Basin, such as in the regulated NSW Murray and Murrumbidgee river systems, are likely to be more vulnerable to the impacts of water buybacks due to the reliance on surface water resources, the volume of entitlement in the area and the extent of irrigation infrastructure networks.

To minimise the risks to our Basin communities and industries from large scale water buybacks by the Australian Government, we have developed the NSW Alternatives to Buybacks Plan.¹² The plan explains how we will deliver existing projects and bring forward new projects to contribute to water recovery in ways that have less socio-economic impacts.

The Plan seeks to achieve 2 outcomes:

- maximise the environmental outcomes achieved via the Sustainable Diversion Limit Adjustment Mechanism (SDLAM) that accounts for 605 GL
- maximise recovery towards the 450 GL of additional environmental water from investment in infrastructure, projects and rules-based changes.

While the Plan does not eliminate the prospect of water buybacks in NSW, it outlines the NSW Government's strategy to provide a tangible reduction in the volume of water required to be purchased by the Australian Government to meet recovery targets.

Basin Plan Review

The Murray–Darling Basin Authority (MDBA) will review the Basin Plan in 2026. This is a requirement of the Commonwealth *Water Act 2007* and provides an opportunity to reflect on how the Basin Plan is working. It also enables exploration of responses to the impacts of climate change, and ways to support the Basin into the future.

The MDBA has released its Roadmap to the 2026 Basin Plan Review,¹³ confirming their focus on 4 key themes: climate change, sustainable water limits, First Nations and regulatory design.

The NSW Government is engaged actively with the MDBA and other Basin governments in the review.

12. More information about the NSW *Alternatives to Buybacks Plan* is available at: water.dpie.nsw.gov.au/about-us/how-water-is-managed/alternatives-to-water-buybacks-plan

13. More information on the *Basin Plan review* is available at: www.mdba.gov.au/publications-and-data/publications/roadmap-2026-basin-plan-review

Alignment with water market reforms in the Murray–Darling Basin

The Australian Competition and Consumer Commission (ACCC) inquiry into the water market recommended that governments with responsibility in managing the Murray–Darling Basin focus on 4 major areas for reforming the water market:

- governance of the Basin water markets
- market integrity and conduct
- trade processing and water market information
- market architecture.

In response, the Australian Government released the water market reform: final roadmap report (the Roadmap). The Roadmap includes 23 recommendations to drive water market reform to improve community trust and confidence in the Basin's water markets and to improve compliance in all jurisdictions. All Basin Ministers signed a funding agreement to progress implementation of priority recommendations of the Roadmap to 30 June 2024.¹⁴

The work to address the Roadmap recommendations remains a priority for the NSW Government. However, an additional action under the draft NSW Murray Regional Water Strategy is not needed as this work is already underway.

Implementation of actions under the draft NSW Murray Regional Water Strategy will be undertaken in a manner that aligns with or complements new water market and trade reforms as necessary.

Alignment with state-wide disaster and extreme event planning

Regional water strategies primarily relate to strategic water resource management. For example, regional water strategies set out actions to:

- reduce water security/drought risks, which can also be inputs to local and statewide disaster planning
- mitigate flooding through natural or hard infrastructure – for example actions in regional water strategies relating to catchment revegetation or potential alterations to dams may also influence flood behaviour and can be investigated in flood risk management studies in accordance with the *Flood Risk Management Manual (2023)* which can then inform local or state disaster planning
- mitigate the secondary effects of disasters – for example, actions in regional water strategies to address fish kills and water quality, can also inform state disaster planning.

Local and state-wide disaster and extreme event planning will be covered in the state disaster mitigation plan and local Disaster Adaptation Plans currently under development by the NSW Reconstruction Authority.¹⁵ The Authority will collaborate with councils to develop local Disaster Adaptation Plans, so communities and stakeholders can identify the disaster risks and vulnerabilities unique to their regions.

The Authority is currently also leading the review and updating of the NSW Recovery Plan, last updated in late 2021.

The new NSW Recovery Plan will be a practical, action oriented document, supported by a robust training program and will outline the responsibilities, authorities and mechanisms for disaster recovery in NSW.

Further information relating to local council and state agency roles and responsibilities in relation to flooding is included in a breakout box under Priority 3: Support sustainable economies and communities.

14. See www.dcceew.gov.au/water/policy/markets for updates on progress implementing the recommendations from the Roadmap.

15. State-wide disaster planning is primarily the responsibility of the NSW Reconstruction Authority, which was established in response to the 2022 Flood Inquiry. This is currently in development and will take a prevent, prepare, respond and recover approach. Further information is available at: www.nsw.gov.au/departments-and-agencies/nsw-reconstruction-authority

The regional water strategy's response to flooding

The role of regional water strategies is to support the delivery of healthy, reliable and resilient water resources that sustain a liveable and prosperous region. Local councils are primarily responsible for managing flood risks in their local government areas as outlined in the *Flood Risk Management Manual*. The NSW Department of Climate Change, Energy, the Environment and Water is the lead NSW flood risk management agency and provides technical advice and financial support to assist councils' flood risk management activities.

Further improvements to flood risk mitigation have been considered through the *2022 NSW Flood Inquiry* and the NSW Government's response to the inquiry.¹⁶

Flooding and flood risk management are discussed under Challenge: Supporting existing and emerging industries and livelihoods.

Two proposed actions in the Draft NSW Murray Regional Water Strategy are intended to complement holistic flood management taking place through these channels:

- proposed action 1.2 Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data.
- proposed action 2.4 Support development and implementation of a NSW Murray Floodplain Management Plan and address floodplain structures

Regional water strategy modelling and flood analysis

Regional water strategies are underpinned by climate data and modelling that improves our understanding of past climate conditions and plausible climate futures, providing a more accurate picture of extreme climate events.

The hydrological models used in development of the regional water strategies produce information that helps articulate a region's long-term water security. They provide information regarding the whole waterway system, including catchment inflows, water storage behaviour, river flows and how water is used across the landscape.

The regional water strategies have deliberately modelled a dry climate change scenario to stress-test the system (see section 'Regional water strategies are backed by new climate data' on page 20). Using this together with the paleoclimate informed dataset (which represents climate without human induced climate change) allows us to test the resilience of adaptation options to a wide range of drying conditions. There is still a chance that we could see climate change outcomes outside of the range we have tested, including a wetter scenario. If this eventuates it would be a trigger to review the regional water strategies.

Understanding flooding involves different hydrological approaches that consider short term weather events and hydraulic flood models that require a detailed understanding of the shape of the floodplain and the features that influence flood behaviour. These models are purpose-built to support an understanding of existing flood risk and how this may change with changes in climate, development and landscape. Regional water strategy modelling data operates on longer timescales and so is not appropriate for short term, event-scale flood analyses.

16. More information about the *2022 NSW Flood Inquiry* and the NSW Government's response to the inquiry is available at: www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinquiry

Alignment with local water utility strategic planning

Regional water strategies are region- or catchment-wide strategic plans. They set regional strategic directions to achieve water security across multiple councils and the entire catchment. Local water utility strategic planning identifies the local risks to water services and actions to address those risks.

The modelling undertaken through development of the draft NSW Murray Regional Water Strategy does not replace any analysis undertaken as part of councils' existing strategic planning.

Through the Safe and Secure Water Program, the NSW Government is co-funding:

- development of local water utility strategic planning across the state, recognising the importance of strategic planning to finding solutions to address risks and provide services at adequate standards
- investment in infrastructure to address high priority water security risks for local water utilities
- joint organisation-led regional water supply strategies to help councils identify, analyse and plan regional town water supply solutions.

Since 1 July 2022, a new regulatory and assurance framework has applied to local water utilities in regional NSW. It covers local government councils exercising water supply functions under Division 2 of Part 3 (Chapter 6) of the *Local Government Act 1993*, and utilities exercising water supply functions under the *Water Management Act 2000*. The regulatory and assurance framework is designed to ensure local water utilities manage risks effectively and strategically. Participation by local water utilities is voluntary.

In 2021, the NSW Department of Climate Change, Energy, the Environment and Water committed to ensuring that those local water utilities progressing an integrated water cycle management (IWCM) strategy would not be disadvantaged by the new strategic planning framework. The department continues to engage with all local water utilities that are currently developing an IWCM Strategy, including those funded under the Safe and Secure Water Program.



Image courtesy of Destination NSW. Junction of the Darling River and the Murray River, NSW.

Regional water strategies are backed by new climate data

To improve our strategic water planning, new climate datasets have been developed for the regional water strategies program. These datasets provide a more comprehensive understanding of the climate variability in the NSW Murray region beyond the recorded historical data.

Three climate datasets have been used to understand the key regional challenges and to assess the effectiveness of actions:

1. historical climate data: 130 + years of observed rainfall, temperature and evaporation records collected by the Australian Bureau of Meteorology
2. long-term historical climate data (stochastic data): 10,000 years of stochastically-generated climate data developed using paleoclimatic information from The University of Adelaide
3. dry future climate scenario: modified version of the long-term historical climate data, scaled up or down using the NSW and Australian Regional Climate Modelling (NARCLiM) climate projections (version 1.0). These scaling factors compare the baseline period of 1990–2009 with climate projections for the periods 2020–2039 and 2060–2079. These scaling factors have been applied to every climate timeseries used in the modelling.

Combined, these datasets provide a range of plausible future climate futures that cover a range of wet and dry sequences.¹⁷

Why a dry future climate scenario has been used

Climate change has been considered in the regional water strategies options assessment process by using a dry future climate change scenario. The dry future climate change scenario¹⁸ is the SRES A2, which represents a high carbon emissions scenario and therefore results in higher projected climate change impacts on the region.¹⁹ This is not a forecast of how climate change is expected to eventuate, but it is one possible future outcome.

This scenario assumes that governments around the world will not take any action to reduce carbon emissions. This scenario may not occur as many governments, businesses and communities around the world are already acting on climate change. Using a dry scenario helps to plan strategically and focus on the key challenges facing a region.

Considering the dry future climate scenario together with the two other climate scenarios – the historical scenario and the stochastically-derived long-term historical scenario – is appropriate for this type of strategic-level assessment. It allows assessment of the full range of risks to the water system and helps build understanding of how different options might work under a range of future climate conditions. We will need to complete more refined assessments of climate change risk when we implement many of the regional water strategies actions. These additional assessments will be based on the planning horizon for each action and the latest climate science.

It should be noted that this new climate data and hydrological modelling is not appropriate for operational decisions made under water sharing plans, such as calculating available water determinations, and it will not be used for these purposes.

Our climate science is continuously improving. The climate modelling used to develop the draft NSW Murray Regional Water Strategy is an important first step to better understand the region's climate and the potential vulnerability of our towns, communities, industries and the environment to a more variable and changing climate. We know that the future climate is uncertain, and work is progressing to further enhance understanding of the region's climate and how it affects our vital water resources, including groundwater.

17. For further details about the new climate data and modelling, refer to www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies

18. The scenario uses the regionally downscaled factors from the NARCLiM 1.0 Project to adjust the long-term past climate scenario rainfall and evapotranspiration data. Further information on the NARCLiM 1.0 Project is available on the NSW Government, AdaptNSW website: www.climatechange.environment.nsw.gov.au/climate-projections-used-adaptNSW

19. The SRES A2 assumes a 2°C warming over the regional water strategy planning horizon.

What the future climate could look like in the NSW Murray region

The future climate in the NSW Murray region is uncertain. It may be similar to what was experienced in the past or it may be more variable. Analysis of different climate scenarios indicates that there could be hotter and longer droughts, higher evaporation rates and more unpredictable rainfall events and variable river flows.

Ongoing planning for uncertainties and continued refinement of water-related risks in the NSW Murray region is essential.



More extreme events

Droughts **could become more frequent** and rainfall events **could be more intense**.

Changing rainfall patterns

Average **winter rainfall may drop** by nearly 20% by 2079. Increases in early autumn rainfall may be offset by equivalent decreases in late autumn. **Summer may see increases** in rainfall by up to 17% and **decreases** by up to 30% **in spring**.



Higher evapotranspiration

Average evapotranspiration **could increase** by up to 2% by 2039 and up to 5% by 2079, compared to levels between 1990–2009.



Changes in river flows

On average, total volume of water flowing each year in the regulated and unregulated rivers **could reduce**.

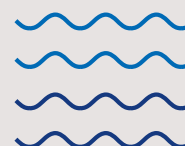




Image courtesy of Vince Bucello. Wetland, NSW.

We want to hear from you

Developing an effective and lasting strategy requires input from communities, towns and industries across the NSW Murray region.

Your feedback is sought on the key regional water-related challenges and proposed actions in this document.

The feedback received on the consultation paper will help to finalise the draft NSW Murray Regional Water Strategy and Implementation Plan.

The final strategy will identify a range of solutions – from policies, plans and regulation through to new technologies and infrastructure – that could mitigate water-related impacts across the region and support thriving regional communities. The strategy will bring together these solutions in an integrated package that is:

- based on the best evidence
- designed to respond to the NSW Murray region's water needs
- directed towards creating new opportunities for the region
- focused on delivering the objectives of the regional water strategies and the NSW Water Strategy.

Assessing benefits and impacts of actions on Aboriginal people and communities

Aboriginal communities across NSW have provided strong feedback that they need specific information on how the shortlisted actions will affect them.

Several of the shortlisted actions will have potential impacts on, or provide benefits to, Aboriginal people and Aboriginal communities. Currently, not enough evidence about these potential impacts and benefits is available to provide a full assessment of the shortlisted actions. Until the department undertakes a more detailed analysis of the specific actions that remain in the final regional water strategy shortlist, some of this information will not be available. Some of the additional analysis may be identified for early action in the strategy's implementation plan, whereas other work will progress as part of the strategic business case for specific options.

At this stage of the process, the types of questions that Aboriginal communities are likely to have about each of the proposed actions are being identified and recorded. The department is also considering what information communities will need to make informed decisions about how specific actions will affect them.

Once the detailed analysis required to progress preferred actions has been undertaken, that information will be shared with Aboriginal communities and their feedback will be sought. That evidence may help to refine a preferred action or identify risks in progressing with an action.



What we have heard so far

2

Image courtesy of Destination NSW. West Albury, NSW.

During the development of the draft NSW Murray Regional Water Strategy we publicly exhibited and conducted targeted consultation on:

- the draft NSW Murray Regional Water Strategy and long list of options from April to May 2022
- the draft NSW Murray Regional Water Strategy: Discussion Paper: Draft regional challenges from October to November 2023
- the draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling from October to November 2023.

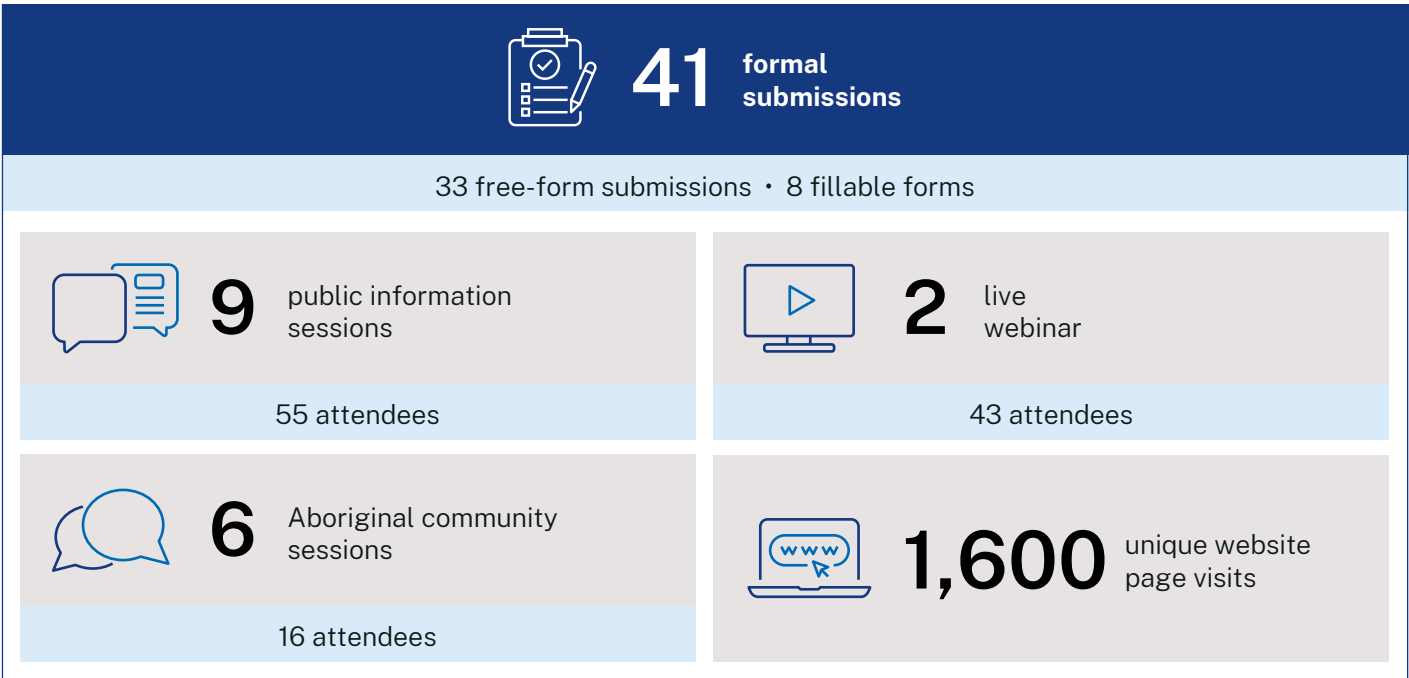
These consultations were held in tandem with that for the development of the NSW Murray Regional Water Strategy.

Feedback from the public exhibition held in 2022 (Figure 4) and targeted consultation sessions held in 2023 (Figure 5) were compiled into community consultation reports, which have been published on the department’s website.²⁰

The reports highlight how the feedback we received has informed the next steps in the development of the draft NSW Murray Regional Water Strategy.

Public consultation 1

Figure 4. Stakeholder engagement during the first public exhibition period (2022)



In the first round of public consultation (2022), there was general support for the development of the NSW Murray Regional Water Strategy, but some stakeholders suggested that insufficient consultation had been undertaken in developing the draft strategy.

Feedback was also received that the next phase of the NSW Murray Regional Water Strategy should be accompanied by an open, transparent and broad-scale consultation process to ensure that all stakeholder

voices are heard, and that a broad cross-section of the community should be represented in the discussion. This consultation paper has been developed in response to this recommendation.

Stakeholders encouraged the department to continue progressing the development of the NSW Water Strategy and regional water strategies. Since then, the NSW Water Strategy and several other regional water strategies have been finalised.

20. More information about the *Draft Murray Regional Water Strategy* (2022) is available at: www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murray/murray-regional-water-strategy

Summary of feedback received during 2022 stakeholder consultation:

Climate data sets and modelling



- Concerns about using a 'worst-case scenario' approach to modelling, including a suggestion the strategies consider wet future conditions as well as dry.
- Support for making data, information and modelling publicly available for transparency and to understand how it has been applied to the strategies.
- The strategy's connection with flooding events and the need to recognise the role the Darling River system plays in Murray River flows were also raised.

Water security, availability and use



- Wide support to understand people's behaviours and assumptions around water availability and use, including during drought.
- Broad support for reviewing the allocation and accounting framework with concern raised over past changes to Available Water Determinations and impact on the reliability of general security licences.
- Concern existing water infrastructure would not meet current and future demands, including the Snowy Scheme, during periods of drought were also raised.
- Concerns around the socio-economic impacts on communities of past Australian Government water buybacks and the need for greater recognition in the strategies around these.

Land and water management and planning



- Strong agreement to acknowledge the inter-connectedness of the Murrumbidgee and Murray regions.
- Strong calls for improvements in inter-jurisdictional water sharing and management.
- Considering water-related constraints when planning for development and land use were considered important.

Environmental health, ecosystems and water quality



- Strong support for improving environmental and economic outcomes, including addressing the impacts of climate change.
- Concern about water quality issues in the region with bushfires and flooding impacts raised as contributors to water quality.
- Concerns regarding SDLAM projects and the Reconnecting River Country Program impacting on riparian land and inundation of productive agricultural land.
- Suggestions to assign additional water allocations to protected areas for effective ecosystem conservation and to review environmental water delivery rules.

Improving water-related opportunities for Aboriginal people



- Strong support for improving opportunities for Aboriginal people in water management and recognising Aboriginal cultural, spiritual ties and locations and connection to Country.
- Suggestions to consider how operational challenges and costs associated with managing Aboriginal water allocation could be addressed.

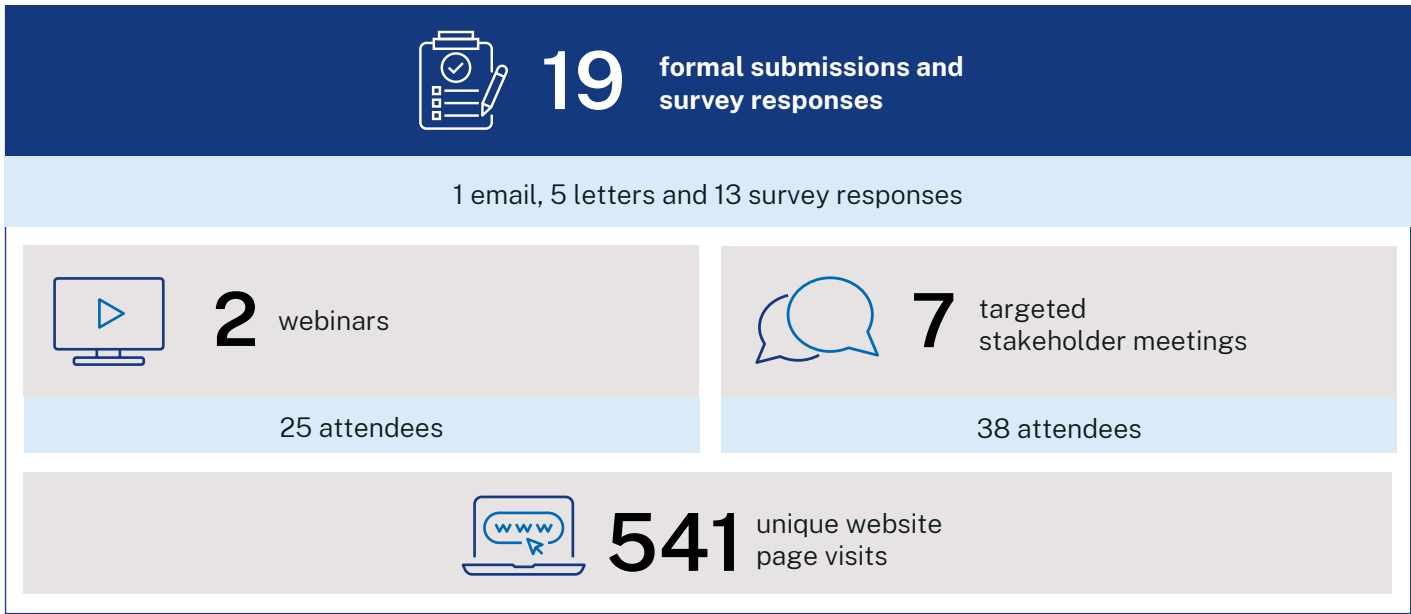
Strategy development and implementation



- Support for aligning the regional water strategies with government commitments, water management plans, policy, reform priorities and legislation.
- Support for further consultation with the community and stakeholders during the development and implementation of the strategy was highlighted.
- Concerns about fatigue from the scope and speed of water reforms that have significant social and economic impacts experienced by the regions as a result of water recovery under the Basin Plan.

Public and targeted consultation

Figure 5. Stakeholder engagement during public and targeted consultation (2023)



During the webinars and targeted consultation sessions (2023), stakeholders were concerned about the use of the dry future climate scenario in the modelling and how significant evapotranspiration will be in the NSW Murray region will be if this scenario eventuates. Stakeholders also wanted further information about the selection of the 3 climate scenarios used in the hydrological modelling.

Support was received for increased water security for towns and general water security users. Improving the health of the environment and ecosystems was considered important. There was also a need to explain how the strategy interacts with the northern/western regional water strategies.

Challenge 1: Ensuring resilient water supplies for regional centres, towns and communities in a changing climate



- Support for installing off-river stream infrastructure and using recycled water.
- It was noted the Common Planning Assumptions can underestimate population projections and this should be considered in the modelling.
- Wanting to understand the impact of climate change of current town water security was also raised.
- It was suggested groundwater is effectively managed in the NSW Murray region, whereas others identified the need for improvement and further investigation of groundwater.
- Concerns around the potential for further Australian Government water buybacks and the need to find alternative measures to avoid further buybacks.

Challenge 2: Improving the health and resilience of aquatic and floodplain ecosystems



- Concern about the impact of flow reductions on water-dependent fish, plants and other ecosystems.
- Suggestion to develop water management plans for protected areas.
- Some stakeholders expressed concern about the Reconnecting River Country Program due to potential environmental and economic impacts.

Challenge 3: Addressing barriers to Aboriginal people's water rights and access



- It was acknowledged water is an essential part of Aboriginal people's culture and there is a need to provide greater access to cultural water, and ensure involvement in water management and decision making.
- Listening to Aboriginal people who have lived sustainably with the environment was considered important.
- Establishing support for the operation and maintenance of ageing water infrastructure on Traditional Owner's land was considered important.

Challenge 4: Supporting agriculture and emerging industries



- Concern the strategy does not focus on flooding risks in the NSW Murray region, but more on a drying climate.
- Some stakeholders suggested additional regulation of the Murray Darling water market and industry use.
- Balancing the water needs of the irrigation sector was considered important, as was encouraging more adaptive irrigated industries.

Since the public and targeted consultation in 2023 the draft NSW Murray Regional Water Strategy has undergone further development which has resulted in significant changes to the key challenge. The amended challenges are presented in Section 3 of this consultation paper.



Image courtesy of Destination NSW. Albury, NSW.

Where
should we
focus first?

3

Image courtesy of Murray Vanderveer. Old Mountain Road, NSW.

The vision for the NSW Murray region is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous region.

The NSW Murray region is endowed with surface water and groundwater for towns, recreational use, cultural and environmental needs, and industry. Due to the region's highly variable climate, groundwater is an important water source for the region.

As experienced over the last 2 decades, severe droughts can be followed by significant rainfall events and flooding. These extreme events pose challenges for the region, its water resources and all water users.

Like other regions across Australia, the NSW Murray region will likely face a more variable and changing climate in the future. We need to prepare now to do more with less water and make smarter decisions about our water use and management. We need to be armed with better knowledge and information to ensure we protect our most critical water needs.

This strategy identifies 4 key challenges that are immediate priorities for the region:



Balancing competing interests for water.



Improving the health and resilience of ecosystems.



Addressing barriers to Aboriginal people's water rights.



Supporting existing and emerging industries and livelihoods.

Addressing these challenges will help to meet the vision and objectives set for the draft NSW Murray Regional Water Strategy.



Image courtesy of Department of Primary Industries. Irrigation of citrus, NSW.



Challenge: Balancing competing interests for water

In the NSW Murray region, there are many, often competing, interests for water including, town water supply, the environment, electricity generation, irrigated agriculture, tourism and cultural needs.

Balancing the interests of such diverse water uses and stakeholders is made possible by many, complex, inter-related governance and institutional arrangements that are overseen by multiple governments at state and federal levels. Improving how water is shared and managed within these arrangements is often complicated and requires

collaborative and inclusive approaches that address the diverse needs of stakeholders.

For example, changes to the way water are shared by and delivered to NSW water users may require consultation and potentially consent of other governments. Further complications arise from the multiple tributaries that are influenced by highly variable and often different climate drivers and weather events. Growing regional centres and the changing nature of water and land use practices further strain available water supplies.

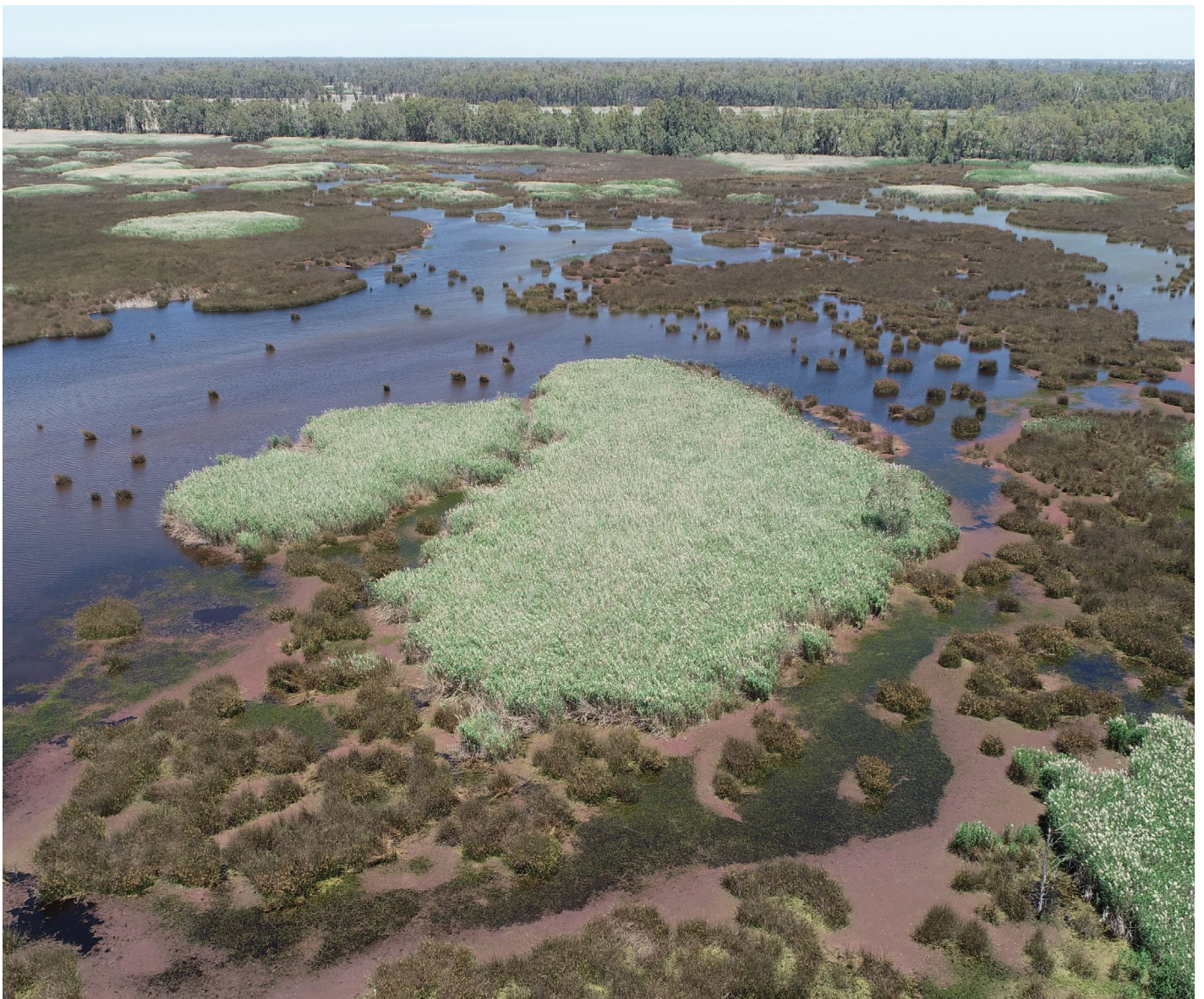


Image courtesy of Vince Bucello. Reed birds nesting area on the Murray River.

Water sources are fully allocated limiting growth of existing and emerging industries

In the NSW Murray region, the use of groundwater and surface water is limited by sustainable diversion limits (SDLs).²¹ The Basin Plan limits the amount of water that can be taken for towns, industries, landholders and other uses that are not licenced.

Long term annual average extraction limits (LTAAEL) are also set out in relevant NSW water sharing plans. These LTAAELs include licensed water access entitlements and basic landholder rights; they do not include other activities that are included in SDLs such as plantations and other unlicensed water use.

Given this, supporting economic growth and industry development in the NSW Murray region will be challenging. For example:

- for existing industries, a change in water needs must be met through either a more efficient or innovative use of water or through the acquisition of licences via the water market
- for new industries reliant on water, acquisition of water access licences or an alternative water supply contract is critical.

The separation of land and water and the introduction of trading markets were created in response to the *National Water Initiative 2004* and in part to systems being fully allocated.

This allows for water to be traded, temporarily or permanently, to where it is wanted or to the highest value use. These markets have been in operation for 20 years. As demonstrated through the ACCC's review into water markets, there are opportunities to adjust the market system to become more flexible in meeting the water needs of businesses.

Another challenge is that the potential benefits of any new water infrastructure seeking to increase supply capacity will be constrained, as long-term water diversions are not permitted to increase under the SDLs.

The Australian Government held a strategic water purchase tender process from 23 March – 19 May 2023 to meet the outstanding Bridging the Gap water recovery targets in NSW and Queensland under the Basin Plan. The outstanding 10 GL/year of surface water in the NSW Murray that was required to meet the SDL is expected to be recovered through this process once contracts are finalised. Delivery of SDLAM projects remains ongoing and whether the 605 GL offset can be met will only be determined by the MDBA when it conducts its reconciliation process in 2026.

The *Water Amendment (Restoring our Rivers) Act 2023* commenced in December 2023 and allows the Australian Government to use voluntary water purchases, or buybacks, to contribute to the Basin Plan's 450 GL target of additional environmental water. Whilst the NSW Government supports the full implementation of the Basin Plan, we do not support buybacks due to potential unacceptable socio-economic risks. To address this risk, we have developed the NSW Alternatives to Buybacks Plan,²² which details how we will deliver on existing and new projects to protect our Basin communities and industries from large scale water buybacks. Further details are provided in the Alignment with the Basin Plan section on page 14.

21. More information about *Sustainable Diversion Limits* is available at: www.mdba.gov.au/water-use/water-limits/sustainable-diversion-limits

22. More information about the NSW Alternatives to Buybacks Plan is available at: water.dpie.nsw.gov.au/about-us/how-water-is-managed/alternatives-to-water-buybacks-plan

Sustainable diversion limits (SDLs)

Sustainable diversion limits (SDLs) represent the long-term average amount of water that can be used for consumptive purposes. In general, they are based on the amount of water being taken just prior to the Basin Plan coming into effect (2009) minus the shared and local reductions needed to reduce long-term water use to sustainable levels. They apply to each SDL resource unit (based generally on catchments for surface water and hydrogeology and planning boundaries for groundwater).

Compliance with the SDL is determined at the end of the water year by the Inspector General of Water Compliance. Where an exceedance of the SDL²³ in a resource unit is determined by the Inspector General, and the state does not have a reasonable excuse, the state may be required to place limits on water take to bring the level of take back within the limits required by the SDL.

Eleven of 20 NSW WRPs are accredited, including the Murrumbidgee groundwater and surface water WRPs, 8 are with the MDBA for accreditation and the Namoi Surface Water is awaiting resubmission. The formal assessment of SDL compliance by the Inspector-General of Water Compliance will commence for the accredited WRPs for water year 2024/25.

NSW is committed to working as quickly as possible with the MDBA to get all water resource plans accredited. It is important to note that existing NSW water sharing plans ensure that rules and limits are in place, and the department reports on compliance with SDLs each year to the MDBA.

Investigating potential underuse of surface water against sustainable diversion limits in the NSW Murray region

Stakeholders have raised and supported the need to develop a better understanding of people's behaviours and assumptions around water availability and use, including investigating existing water management rules and behaviours that may be leading to underuse in the region. This issue requires further analysis. A working group consisting of industry stakeholders and NSW and Australian government agencies has been established to explore water-related issues, including the issue of potential underuse.



Image courtesy of iStock. Hume Lake, Albury.

23. For surface water SDL resource units, an exceedance occurs when the cumulative balance on the relevant Register of Take is a debit amount equal to or greater than 20% of the SDL.

Water is not always considered in land use planning processes

Water resources are not always considered early in the planning process, which can create inefficiencies and challenges in capitalising on the broader regional opportunities these changes, and investments could bring.

The Riverina Murray Regional Plan 2041,²⁴ draft Far West Regional Plan 2041²⁵ and draft South East and Tablelands Regional Plan 2041²⁶ highlight that access to water is critical for some land uses, but is not always considered upfront in the planning process.

This can lead to population and industry growth in areas without enough water available, which creates greater pressure on stressed water resources.

A better understanding of water availability in the NSW Murray region will provide more guidance to manage growth within towns such as Albury and Murray River Council towns. It will also provide guidance on suitable locations for industrial growth and new development. Ensuring water resources are integrated in the commencement stage of the strategic planning process through effective government collaboration is essential to optimise the use and sharing of water and enable the growth of towns in a fully allocated system.

To address this challenge in the NSW Murray region the following action is proposed:

- proposed action 1.5: Improve consideration of water in strategic planning and processes. See page 74.



Image courtesy of Department of Primary Industries. Small farm dam.

24. More information about the *NSW Riverina Murray Regional Plan 2041* (2023) is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/riverina-murray-regional-plan-2041

25. More information about the *draft Far West Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/far-west

26. More information about the *draft South East and Tablelands Regional Plan 2041* is available at: www.planning.nsw.gov.au/plans-for-your-area/regional-plans/south-east-and-tablelands

Cross-border influences and complexities

The NSW Murray region forms part of the southern connected Basin (Figure 6). Managing water across regions in the southern connected Basin is complex. Interstate agreements and rules govern how water in the Murray River catchment is shared, traded and delivered between NSW, Victoria and South Australia, including rules for water released from the Snowy Scheme.

The water resources of the Murray River system are shared between NSW, Victoria and South Australia in accordance with the Murray–Darling Basin Agreement.

This is a legal instrument that embodies the long history of collaboration between state and Australian government agencies to manage the southern connected Basin. Schedule 1 of the *Water Act 2007* (Commonwealth) sets out rules and provides a framework of powers and responsibilities.

Cross-border water management at such a large scale can be challenging at times, and particularly because any changes to the Agreement must be agreed (by consensus) by the Murray–Darling Basin Ministerial Council. There is a need for inter-jurisdictional discussion about the current settings of the Agreement, and how current river operations can be improved or optimised to ensure our river systems can be adaptively managed.

Figure 6. Schematic of the southern connected Basin



Water is managed and shared under the *Water Management Act 2000* with specific rules for water sharing set out in respective surface water and groundwater water sharing plans.²⁷

During public consultation, strong representation was received for improving to inter-jurisdictional water sharing and management, noting the complexity of interstate agreements and rules.

27. More information about water policy and planning is provided in the *Regional Water Strategies Guide* is available at: water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/rhs-cta/regional-water-strategies-guide-and-fact-sheets

Delivery constraints and changing water use patterns in the regulated Murray River create challenges for management of the system

The region's water resources underpin key economic drivers, including agriculture and other water dependent industries, and the sustainable management of water resources will be critical to economic prosperity in the NSW Murray region.

The mix of industry and crops in the region is changing, with horticulture expanding and value-added agricultural industries expected to grow over the next 20 years. This is likely to drive further changes in water use patterns.

Long distances from storages to end users, channel constraints and minimising unseasonal flooding and inundation of low-lying lands impact the delivery of consumptive and environmental water to the regulated Murray River during periods of peak demand.

With an increase in water demand in the Lower Murray River the need to convey water through the Barmah Choke at maximum capacity to meet demand has degraded river banks. Over the past three decades the capacity of the Barmah Choke has fallen progressively from 11,500 megalitres (ML)/day in the 1980s to 9,200 ML/day in 2019, reducing daily delivery rates from Hume Dam. Getting water to where it is needed is often difficult and there is a potential for future supply shortfalls.

To avoid unseasonal flooding of the Barmah Forest, high flows in the river are now also restricted from January to April each year to ensure water remains within the riverbanks. Irrigation demands are highest at this time, meaning that high flows regularly need to be delivered through the reach for several months.

As a result of the declining choke capacity and the need to restrict unseasonal flooding, there are adverse impacts on the environmental, cultural, social and economic aspects of the river.

Delivery and system shortfalls

When the required volume of water cannot be delivered to users when and where it is needed it is called a shortfall. Delivery shortfalls occur when actual water use is higher than predicted irrigation and water for the environment needs. System shortfalls occur when the combined capacity of the system (storage and conveyance) is unable to supply all downstream requirements over the full season.

Some of the factors that can impact water delivery include climate, trade, demand patterns and river channel capacity.

The MDBA, NSW, Victoria (VIC) and South Australia work together to manage water delivery shortfall risks. Management strategies include: using tributaries or other storages, restricting trade through the Barmah choke and adjusting operations based on forecast weather.

There have been no capacity or shortfall impacts since 2002.

Temporary water restrictions can be placed on water users in the event of a shortfall occurring and are usually undertaken by the relevant state water agency. These restrictions are very rare. However, changes in climate, timing and location of demand and land use, combined with the river system's capacity to carry volumes of water, mean these events are increasing in probability.

The risk is greatest for users downstream of the Barmah Choke as this restricts the maximum regulated flow and for much of summer the flow is at its maximum. Upstream of the Choke the maximum flow rate is well above the normal flow rates, allowing peaks in demand to be met.

Through the Barmah-Millewa Program, the MDBA is leading work to address reduced flow capacity through the Barmah-Millewa Reach.²⁸

28. More information about the MDBA (Murray Darling Basin Authority) Barmah-Millewa Program is available at: www.mdba.gov.au/water-management/river-murray-operations/barmah-millewa-program

Barmah-Millewa Program

The Barmah–Millewa Program aims to identify options to improve the movement and efficiency of water delivery through the Barmah–Millewa Reach and protect the health and cultural integrity of the river.

To begin to address delivery constraints, the program completed a feasibility study in 2022. The study investigated and assessed the feasibility of options to maintain, and where, possible, reinstate the capacity to deliver water downstream of the Barmah-Millewa Reach. This feasibility study was presented to the Murray–Darling Ministerial Council on 24 February 2023.

The study identified a range of options that may be technically feasible to help address this issue. Basin Ministers have agreed to further investigate a suite of options in 2023 and 2024 to try to halt the declining capacity through the reach and reinstate +500 ML/day of capacity.

Inundation of low lying lands is impacting productivity and livelihoods

Low lying areas, including wetlands, floodplains and private lands can be inundated by regulated flow deliveries for both environmental and consumptive purposes. During public consultation, landholders indicated that at times, more than 30% of their productive land can be unusable due to inundation. However, currently, rivers connect to wetlands and floodplains less often than is needed to maintain healthy ecosystems, due to river regulation and extraction. Constraints in delivering water for the environment restrict the effective use of this water, contributing to the continual decline of the health of Country, including the species depending on these environments to survive.

While stakeholders in general support restoring this balance some have expressed concerns that sometimes they are managing their farming operations on a daily basis depending on the flows of the adjoining river. This has led to concerns about the impact on productivity and uncertainty in their business arrangements.

As a result, stakeholders are calling for better flow notification systems and more consultation in relation to water management practices that directly impact their ability to manage and maintain the productivity and sustainability of their land.

This issue can be further compounded by additional factors including the need for pre-releases from dams during flood events and energy sector requirements that rely upon hydro-electricity generation.

Balancing the needs of landholders to use and access their land with fluctuating flow deliveries requires ongoing consultation and collaboration to identify long-term, enduring, and cost-effective solutions.

These challenges are likely to be exacerbated by future climate change-driven extreme events, such as changing precipitation patterns, increased evapotranspiration, longer dry periods and more intense floods.

Details about the Reconnecting River Country Program, which focuses on relaxing or removing constraints on the delivery of water for the environment in the NSW Murray region, can be found in, Challenge: Improving the health and resilience of ecosystems on page 44.

To address this challenge in the NSW Murray region the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 72.
- proposed action 2.8: Implement the Reconnecting River Country Program in the Murray. See Page 89.

There are water security and quality risks for regional centres, towns and communities

Many of the towns in the NSW Murray region rely exclusively on surface water. However, groundwater forms a part of the supply to many towns, including Deniliquin, Berridale and Tumbarumba.

Severe droughts such as the Millennium drought resulted in reduced water available to towns and major centres like Albury, with significant implications for water dependent businesses and social amenity as councils introduced water restrictions to conserve water for critical human needs.

Climate change could increase the risk of severe droughts in the Murray region, placing towns and communities at risk of future shortfalls. New modelling²⁹ suggests that there are risks of surface water shortfalls³⁰ for Albury, Corowa, Deniliquin and Murray River Council.³¹

For example, under a dry future climate scenario with static population levels, supply shortfalls for these places could significantly increase by 2060–79 with critical shortfalls for all towns presented in Table 2. Further investigation highlights that towns with water demand close to their water entitlement limits are more likely to record modelled shortfalls compared to towns that have demand levels much lower than their entitlement.

Regional areas are becoming increasingly attractive places to work and live, and significant population growth is expected over the next 20 to 40 years, which will increase town water supply demands. In particular, Albury has forecasted high population growth rates. Table 2 shows that with population growth projections to 2061, supply shortfalls increase significantly for all towns presented. Albury, Corowa and Murray River Council present a complete year of shortfalls (365 days in a year for a probability of 1 in 1000 years) with at least 50% of the demand not met under the Dry Future Climate Change scenario. We will need to work with each council to understand what this information means for their local area.



Image courtesy of Destination NSW. Township, Albury.

29. A detailed description of the climate scenarios and other results for town water supply shortfalls are presented in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling report* (December 2022). The report is available at: www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murray

30. Shortfalls are measured by the number of days where a town's surface water supply is less than an identified level of demand (e.g. 5%, 10%, 25%, 50% and 75%).

31. Wagga Wagga, Narrandera and Coleambally were not assessed because a large part of their supplies come from groundwater, which is not able to be modelled with the new climate data at this time. Griffith and Leeton were also not assessed, as they take water from within large irrigation schemes.

Table 2. The number of days with town water supply shortfall with a probability of 1 in 1,000 years³²

Town	Demand	Long-term historical climate			Dry future climate change scenario		
Current demand							
	No population growth	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met
Albury	Current population	182	140	115	365	365	365
Corowa	Current population	186	154	133	365	365	365
Deniliquin	Current population	94	87	68	365	363	327
Murray River Council	Current population	129	118	100	365	365	365
Future population demand (2061)							
	Population growth over 40 years period (%)	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met	At least 10% of demand not met	At least 25% of demand not met	At least 50% of demand not met
Albury	95%	365	365	281	365	365	365
Corowa	9%	199	169	140	365	365	365
Deniliquin	1%	97	87	69	365	363	327
Murray River Council	56%	365	228	163	365	365	365

Note: Further results can be found in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies: Climate and hydrological modelling report*.³³

32. A detailed description of the climate scenarios and other results for town water supply shortfalls are presented in the *Draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling report* (December 2022). The report is available at: www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murray

33. To access the report please visit: dpie.nsw.gov.au/_data/assets/pdf_file/0009/548316/draft-nsw-murray-and-murrumbidgee-modelling-results-report.pdf

These assessment results are a high-level comparative assessment to identify where town water supply shortfall risks occur across the region. They are not appropriate for detailed purposes like secure yield analyses or other strategic planning which is the responsibility of and done by Local Water Utilities (LWU).

The department provides specific guidance to LWUs under its Regulatory Assurance Framework on achieving the outcome of understanding water security for effective strategic planning. LWU strategic plans incorporate a secure yield study to identify the capacity and sizing of headworks infrastructure to meet the required Levels of Service.

Regional water strategy town water supply shortfall analysis vs town water security analysis

Town water supply shortfall analyses, used by the NSW Government in the regional water strategies program, assess the difference between the available supply in a water source at the point of extraction against the climate adjusted demand of the local water utility. A supply shortfall will exist on a day when the demand is greater than the available supply. These assessments do not factor in customer levels of service (LoS)³⁴ nor water restriction rules imposed by local water utilities on customers. The aim is to understand, at a high level, where vulnerabilities in town water supplies might exist across a region.

This is a different assessment to town water supply security analyses, that are undertaken by individual local water utilities. These security analyses are about understanding how town water demands for defined customer levels of service (LoS) can be met under a range of water availability conditions by the local water utility's supply headworks. Town water security analyses are often referred to as 'secure yield' analyses, being the maximum annual demand that can be supplied from the headworks whilst meeting the nominated LoS and its operating environment (licence and works approval conditions, water sharing plan rules, etc.).

As such, these 2 kinds of analyses are used for different purposes, with the town water supply security analyses considering customer requirements at a far greater level of detail, leading to a more nuanced understanding of water supply risks by individual local water utilities.

The results of the modelling coupled with the implications of projected population growth and the levels of local water utility licence entitlements held by each council, will have varying implications for councils and local water utilities in the region.

We will work with them to understand what the information means for their local area. Consideration of the new climate modelling data and future water availability risk will be important to understand shortfall risks and assess the performance of regional water strategy options.

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 72.
- proposed action 3.4: Support towns and local water utilities to understand and manage their future water security risks. See page 100.
- proposed action 3.5: Consider an enduring level of supply to support regional towns and centres. See page 102.

34. LoS incorporates frequency, duration and severity of TWS restrictions with an underlying principle of 'not to run out of water'.

Changes in land use are impacting water quality

Land management has a direct effect on water quality in downstream waterways. Local water utilities have highlighted concerns that wastewater discharges from intensive agricultural farming and processing operations and poor catchment health collectively reduce the quality of raw water supplies. This creates significant challenges for supplying clean water to towns. There is a need to improve coordination of legislation and regulations for inter-related issues such as land management and water quality.

Town water supplies along the Murray River are impacted periodically by blue-green algal blooms which can result in toxins in raw water supplies. Toxins are expensive to treat and algal biomass can clog filters, which reduces their output.

Water supplied from Lake Jindabyne and the Bombala River to the towns of Jindabyne and Delegate³⁵ respectively are affected by turbidity during floods and high river flows, resulting in a constrained ability to treat water and temporary boil-water alerts. More intense storms and an increased likelihood of bushfires will put further pressure on maintaining town water quality. Local councils and the NSW Government are preparing for this by investing in upgrades to water treatment facilities.

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 2.6: Encourage best practice land management. See page 87.
- proposed action 2.9: Support (ongoing) river restoration in the upper NSW Murray and Snowy catchments. See page 90.



Image courtesy of Department of Primary Industries. Algal bloom, Murray River.

35. These towns are included in the strategy area because of the strong hydrological links created by the Snowy Scheme.



Image courtesy of Department of Primary Industries. River Red Gum.



Challenge: Improving the health and resilience of ecosystems

Development has changed flow variability, reduced water quality, and altered the distribution of water throughout the catchment. These factors are impacting the health and resilience of the region's ecosystems. The challenge is to maintain and restore the region's water-dependent ecosystems by using water effectively during wet, moderate and dry periods.

There has been extensive work in recent decades to improve ecosystem health in the southern regions. Since 2004, through water sharing plans, the Basin Plan and other initiatives, the NSW Government and other Basin governments have introduced an environmental flow regime to restore healthy flows. Water for the environment is managed through a combination of planned and held environmental water, and environmental watering works to enhance floodplain inundation at key environmental sites informed by the long-term water plan.³⁶

While these reforms and initiatives have addressed many of the fundamental issues, some challenges remain that are impacting the health and resilience of riverine ecosystems and important species and ecosystems under stress.

Altered flows are affecting ecosystem health

Water infrastructure, river regulation and water extraction have influenced flow variability, water quality and the distribution of water throughout the catchment. Despite extensive reform initiatives³⁷ to improve water for the environment, the challenges of an altered flow regime continue to affect ecosystems in the NSW Murray region.

The current flow regime of the NSW Murray region is very different to predevelopment conditions, with the degree and type of hydrological change varying within the catchment.

The construction and operation of Hume and Dartmouth dams, the Snowy Scheme, and other infrastructure have resulted in:

- declines in medium and high-flow frequencies
- change to the seasonality of flows
- regulated flow patterns being more common with a sizeable loss in natural flow variability, reduced inundation of wetlands and floodplains and decreased long-term average flows
- significant reduction in flows to the Snowy and Montane rivers.

These outcomes have affected communities of vegetation, waterbirds, fish and other aquatic animals (such as platypus and turtles), including some threatened species.

Climate modelling estimates that under a dry climate future there could be further changes to flows in the NSW Murray region with significant decreases in flows compared to those seen under the historical climate (Figure 7).

A future with reduced flow could constrain attempts to restore the health of key environmental assets along the NSW Murray River including Koondrook-Perricoota forests, mid-Murray anabranches and fish populations within the main river channel.

However, under a repeat of the long-term historical climate scenario, there could be a future with similar water availability to the lived experience, which would ease the pressure on key ecological assets and functions.

36. More information about the *Murray-Lower Darling Long Term Water Plan: Part A Murray-Lower Darling catchment (2020)* is available at: www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murray-lower-darling
37. Initiatives established through the Murray-Darling Basin Plan since 2004 and programs such as Reconnecting River Country Program and the Snowy Water Inquiry.

Figure 7. Effect of long-term climate scenarios on the NSW share of median yearly flows (GL/year) in the NSW Murray River at Doctors Point, and in the Murrumbidgee River at Balranald near the confluence with the Murray River

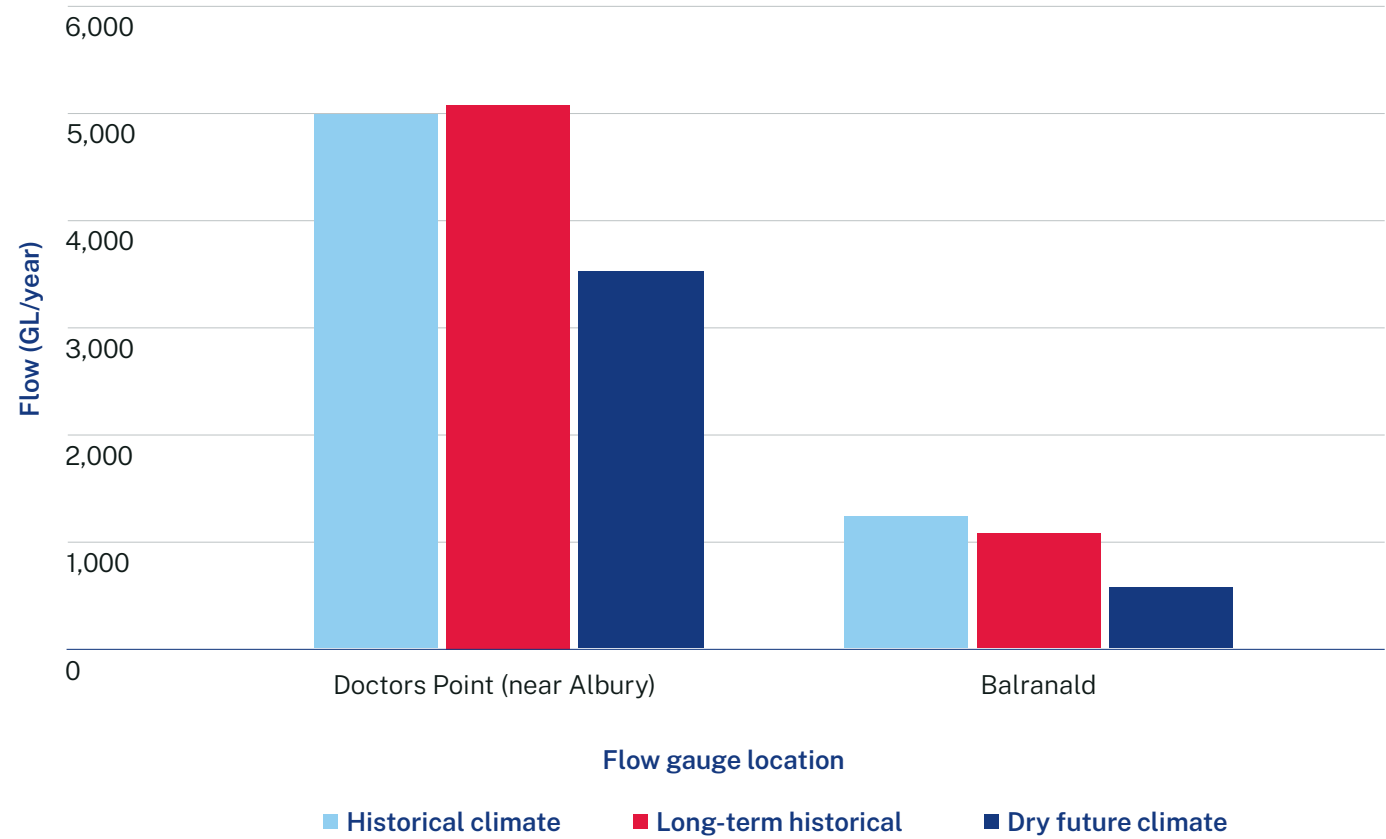


Image courtesy of Destination NSW. Lake Mulwala, NSW.

Addressing altered flows and improving water for the environment

Sustainable Diversion Limit Adjustment Mechanism (SDLAM) program

SDLAM is a program designed to achieve similar or improved environmental outcomes in the Southern Murray–Darling Basin for rivers, wetlands and wildlife using less water as part of the Basin Plan.

Five SDLAM projects across the southern NSW have received an additional \$115 million and more time, until 31 December 2026, to deliver critical water infrastructure supporting the Murray and Murrumbidgee rivers, communities, wetlands and wildlife.

- Koondrook-Perricoota-Forest Project – mitigating third-party impacts of water releases on landholders adjacent to the forest and creating breeding opportunities for thousands of native waterbirds and fish in the wetlands. It includes building critical levees, replacing regulators and removing constraints to improve flows.
- Mid-Murray Anabranches Project – improving connectivity between the Murray and Edward Rivers, and other surrounding creeks. It includes constructing new bridges and rock crossings, upgrading levees and access roads, as well as removing barriers to fish movement.
- Lower Murray: Locks 8 and 9 project – restoring and enhancing the river habitat across the interconnected Frenchmans Creek and Carrs, Capitts and Bunberoo Creek systems. It includes installing new regulators and fishways, upgrading fish passages and changing the operating principles for weirs 8 and 9 to reinstate a more variable watering regime.
- Murrumbidgee and Murray National Parks Project – improving the delivery of environmental water in the Yanga and Murray Valley (Millewa) National Parks. It includes building sills, upgrading regulators and removing earthen embankments including levees.
- Yanco Creek Modernisation Project – modernising infrastructure to enable smarter use of water in the Yanco Creek system. It includes replacing water regulators and constructing and restoring fish passages.

There are also additional projects outside of the SDLAM Acceleration Program. Work on these projects will not stop. We will continue to refine these projects and to seek the views of our community and industry.

The Reconnecting River Country Program³⁸

This program aims to improve wetland and floodplain connectivity by striking a balance between economic, social, cultural and environmental outcomes across southern NSW. It forms part of the SDLAM program, which aims to achieve improved environmental outcomes using existing water for the environment.

The program focuses on relaxing or removing some of the constraints or physical barriers impacting the delivery of water for the environment in the NSW Murray region from Hume to Wakool.

The NSW Government will continue to collaborate with stakeholders to ensure issues are identified and a suite of tools developed to mitigate any potential effects before making changes to existing rules, policies or infrastructure. This may include new or upgraded infrastructure, easements or changes to river operating rules, which will be developed collaboratively with stakeholders as the program progresses (see Action 2.8 Implement the Reconnecting River Country Program in the NSW Murray region, page 89).

38. More information on the Reconnecting River Country Program is available at: www.dpie.nsw.gov.au/water/water-infrastructure-nsw/sdlam/reconnecting-river-country-program

Snowy Water Licence Review

The construction of the Snowy Scheme caused a significant decline in the health of the Snowy River and other montane rivers regulated by the scheme. In response, the 1998 Snowy Water Inquiry resulted in the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID). The SWIOID established environmental flow rules that would see more water and higher flows delivered to the Snowy River from a new outlet at Jindabyne Dam. A portion of flows was also returned to a number of other montane rivers. These environmental flows improved the health and condition of the Snowy River.

Every 10 years, the Snowy Water Licence is subject to reviews under the *Snowy Hydro Corporatisation Act 1997* (Commonwealth), with the second review being completed in 2018 and the next scheduled to commence in 2027. These reviews focus on a range of administrative and technical issues including exploring better ways to deliver environmental flows.

The NSW Department of Climate Change, Energy, the Environment and Water is continuing to implement the actions of the 10-Year Snowy Water Licence Review in collaboration with the Snowy Technical Working Group (TWG). The TWG is made up of representatives from the Victorian, South Australian and Commonwealth Governments, the Murray–Darling Basin Authority and Snowy Hydro. An integrated water model of the Snowy, Murray and Murrumbidgee systems has been developed. This was used to analyse priority issues and assess potential changes to the Snowy Water Licence relating to water releases to the Murray and Murrumbidgee rivers (including the upper Murrumbidgee). This modelling is the first time an evidence-based tool has been available to test changes to licence rules. The department has completed ecological, social and economic studies to assess potential licence changes relating to improving outcomes from environmental flow releases to the Snowy River. The TWG is currently deliberating on a package of options.

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment. See page 82.
- proposed action 2.2: Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands. See page 83.
- proposed action 2.8: Implement the Reconnecting River Country Program in the Murray. See page 89.
- proposed action 3.3: Investigate innovative ways to improve runoff in water supply catchments. See page 98.



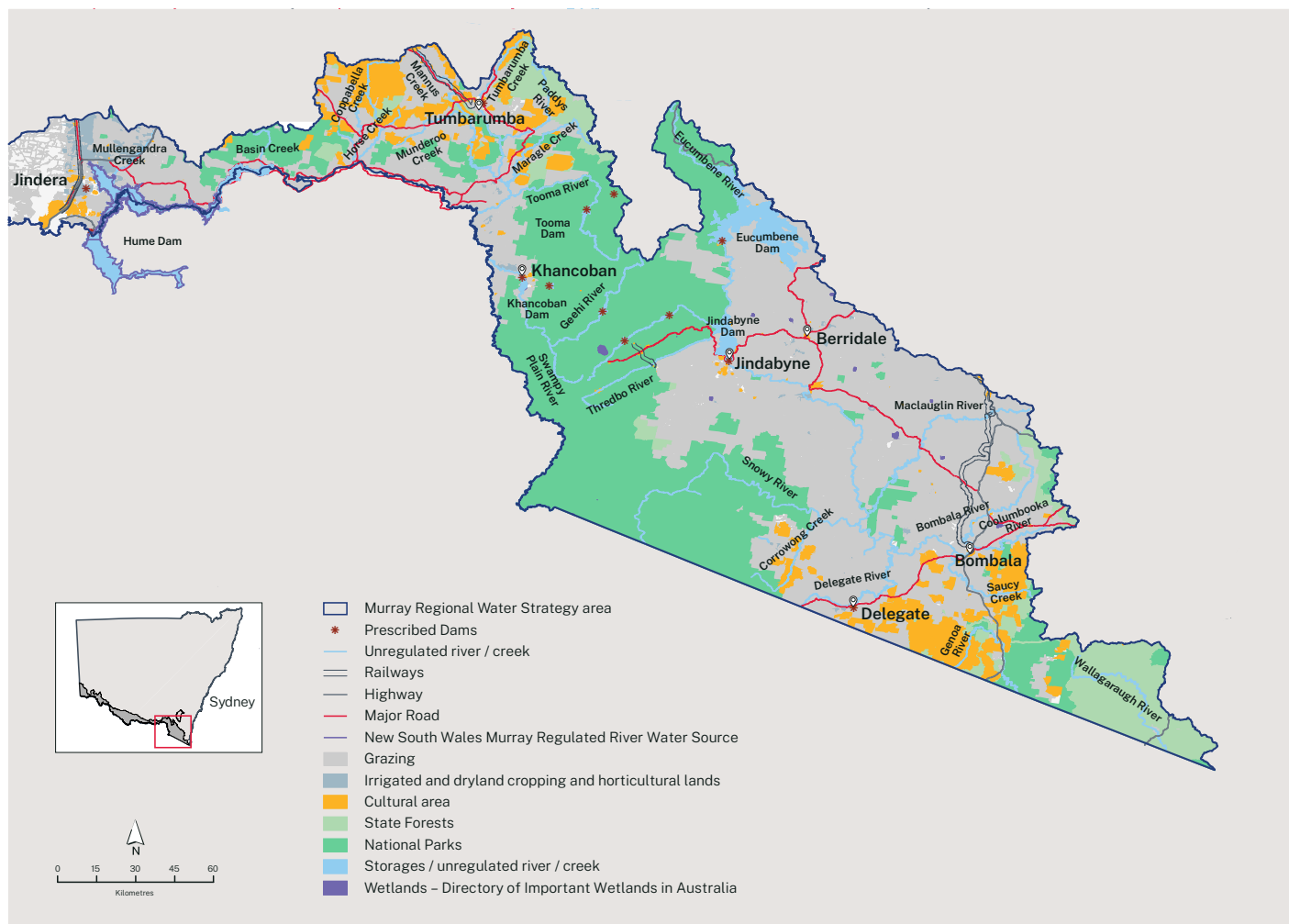
Image courtesy of Destination NSW. Kosciuszko National Park, NSW.

Parts of the upper catchment
are in poor condition

The upper NSW Murray River catchment (Figure 8) covers over approximately 5,200 km² of land on the NSW side of the Murray River. Also within the NSW Murray region, is the Snowy River catchment which covers around 9,070 km².

Much of this is pastoral rural land but there are also large areas considered to have a high degree of natural significance including areas declared World Heritage Area and Wilderness (such as Kosciuszko National Park). It is home to rare and threatened fish species such as Flathead galaxias, Southern pygmy perch, Purple-spotted Gudgeon, Trout cod and Macquarie perch, and threatened species of frogs, birds and plants.³⁹

Figure 8. The upper NSW Murray catchment



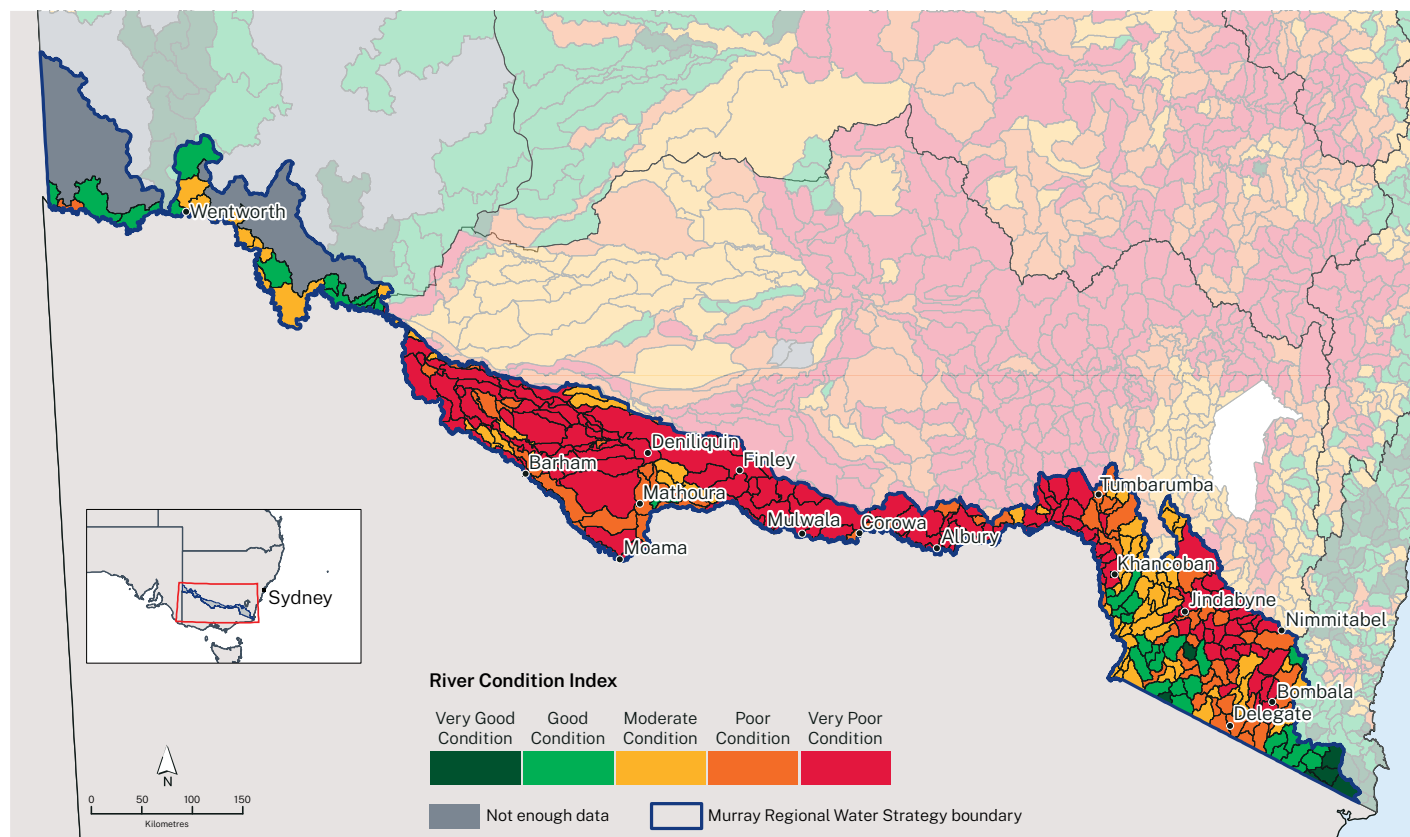
Historical and current land and water management including the development of the Snowy Scheme, has impacted the ecology of the upper NSW Murray River and Snowy River catchments resulting in altered stream flows, increased rates of sedimentation, weed infestations, poor biodiversity outcomes including

declines in fish populations, and loss of aquatic and riparian habitats. Some areas are in very poor condition as assessed under the department's *NSW River Condition Index*⁴⁰ (Figure 9).

39. www.dpi.nsw.gov.au/fishing/threatened-species/what-current

40. More information about the *NSW River Condition Index* is available at: water.dpie.nsw.gov.au/science-data-and-modelling/surface-water/monitoring-changes/nsw-river-condition-index

Figure 9. River Condition Index for NSW Murray



Restoring unregulated river flow patterns that better resemble the natural hydrological regime helps to reinstate critical processes, such as transporting of organic matter, nutrient cycling, and habitat creation. These processes, when functioning properly, improve the overall ecological health of the river, and contribute to better water quality.

A significant cause of reduced flow in the Snowy River is due to the flow diversion created by Jindabyne Dam, an integral component of the Snowy-Murray Development of the Snowy Scheme. The dam led to massive reductions in flow, reducing the natural annual average flow to a trickle flow release. In a partial recognition of this issue, in 2002, environmental flows were made available through the Snowy Water Initiative Outcomes Implementation Deed (SWIOD). However the volumes available are limited to an average of 21% of Mean Annual Flow. These reduced flow rates mean that the river cannot adequately flush sediments downstream, and large sand slugs, weed infestation and habitat simplification are all prevalent throughout the Snowy River, with a significant loss of biodiversity.

Under the Snowy Water License and SWIOD, current environmental flow rules for the Snowy River require monthly flow release schedules to be set a year in advance and daily release schedules to be set before the start of each month, meaning it can be difficult to issue releases to respond to natural events or requirements. Further, allocations may only be used in the year they are provided, not strategically carried over into potentially drier future years. These inflexibilities further restrict the effectiveness of the available water to deliver environmental outcomes.

Intense bushfires also create catchment and river-based challenges as loose soil, ash, debris and nutrients wash into watercourses and cause serious impacts such as fish deaths and contamination of town water supplies. Over periods lasting up to and exceeding a century, there can be significant declines in run-off volumes as forests regrow, which reduces river flows. The 2019–2020 bushfire season burnt around 5.6 million ha within NSW, including over 450,000 ha across the Snowy Valleys and Snowy Monaro local government areas and led to declines in water quality and conditions for native fish.

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 2.9: Support (ongoing) river restoration in the upper NSW Murray and Snowy catchments. See page 90.
- proposed action 2.10: Investigate improvements to the flow regime of the Snowy and Montane Rivers. See page 91.

It could be more difficult to deliver water for the environment in the future

During dry periods less water may be available to be released for the environment. In some instances, there may be limited opportunities to maintain critical environmental needs such as refuge river pools, core wetland areas and seed banks in soil. Similar to consumptive water users, dry conditions also reduce the reliability of water entitlements held by NSW and Commonwealth environmental water holders.

The NSW regulated Murray River has a large volume of licensed environmental water (421 GL in registered entitlements is managed by the Commonwealth Environmental Water Holder and around 252 GL is managed by NSW).⁴¹

These entitlements are managed for the benefit of the environment to deliver water to specific sites (such as wetlands) and support ecosystem functions. In addition, there are the River Murray Increased Flows and Snowy River Increased Flows⁴² and the Barmah–Millewa Forest Environmental Water Allocation.

Just like any other licence holder, the amount of water available to the environment through held environmental water entitlements and environmental water allowances varies year to year depending on water availability in storages. This variability is considered as part of the annual planning process by environmental water managers.⁴³ Under a dry future climate scenario, as with all other water entitlement holders, a future with lower water availability would constrain efforts to achieve environmental watering objectives and outcomes.

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment. See page 82.
- proposed action 2.2: Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands. See page 83.



Image courtesy of iStock. Murray River, NSW.

41. NSW Murray Regulated River Water Source, held environmental water dashboard. Retrieved from: www.dpie.nsw.gov.au/water/environmental-water-management-in-nsw/environmental-water-data/held-environmental-water-data/held-environmental-water-dashboard

42. River Murray Increased Flow and Snowy River Increased Flows are held environmental water entitlements, with water released from the Snowy Scheme for environmental purposes in the Murray and Snowy rivers.

43. The NSW and Commonwealth environmental water holders own and manage a total of 660 GL of water entitlement, which is 26% of total regulated NSW Murray River entitlement. The majority of this water is in general security entitlements.

Ecological communities are at risk

A number of ecological communities are at risk in the region.

Native fish are under stress from physical and operational barriers. The ability to sustain the native fish of the NSW Murray region is impaired by physical structures such as dams, weirs and floodplain infrastructure that do not have fishways and restrict the ability of native fish to move, to breed and find ideal habitat.

Native vegetation has declined in condition and extent due to a reduction in flood frequency and duration and an increase in land clearing. Groundwater-dependent ecosystems (GDEs) would be at risk if groundwater is increasingly extracted due to a drying climate or for other reasons and if there is reduced recharge of groundwater from surface water. High priority GDEs are located in the catchment from the east of Howlong to the west at the NSW–South Australia border.

A drier and more variable climate will increase the stress on ecological communities. Events such as

intense bushfires can have serious effects. The 2019–20 bushfire had a severe effect on populations of the endangered Macquarie Perch from a loss of streamside vegetation that resulted in increased sediment loads and ash to wash into streams leading to loss of habitat and poor water quality (including low dissolved oxygen). After long droughts followed by floods, hypoxic (low oxygen) blackwater events can often occur that cause the death of fish and other aquatic animals (see breakout box below).

Water releases from Hume Dam can display temperature decreases of 10 degrees or more in summer, which can extend more than 200 km downstream. Cold water pollution has a significant damaging impact on riverine ecological function, particularly in summer. An almost complete loss of historic populations of Murray Cod, Trout Cod, Macquarie Perch and Freshwater Catfish from Hume Dam to Yarrawonga Weir has been experienced as a result of cold water pollution.

Every year, unscreened pumps in the NSW Murray region extract large numbers of native fish and other aquatic species such as crayfish and turtles. Adult fish, as well as juveniles, larvae and eggs, are diverted and isolated in irrigation channels.

Hypoxic blackwater and fish deaths

Large-scale hypoxic blackwater events, such as those that occurred in 2011, 2016 and 2022 are driven by biological processes, but are exacerbated by water resource developments and potentially a changing climate. These events caused widespread fish and crustacean deaths across the southern Murray–Darling Basin. However, fish deaths that are likely linked to hypoxic blackwater have been reported in the southern Basin and the Barwon–Darling since the late 1800s, so there is some evidence that such events have occurred prior to major water resource developments.⁴⁴

Most large-scale hypoxic blackwater events happen after prolonged periods where floodplains have not been regularly inundated either due to prolonged dry periods, or due to water resource developments that restrict such inundation. This leads to extensive build-ups of organic material, such as leaf litter, which is then washed into the river during flood events – feeding a boom in microscopic organisms that consume the available oxygen. Temperature is a critical factor in hypoxic blackwater generation, as bacterial production increases with warmer temperatures. Another critical factor with hypoxia is that the oxygen carrying capacity of water physically decreases as water temperature increases, reducing available oxygen. This means that a warming climate is likely to increase the likelihood of these events.

WaterInsights data by WaterNSW⁴⁵ includes dissolved oxygen values for some river gauges in NSW which can give an indication of the likelihood of a hypoxic blackwater event.

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment. See page 82.
- proposed action 2.3: Mitigate the impact of infrastructure on native fish. See page 84.
- proposed action 3.3: Investigate innovative ways to improve runoff in water supply catchments. See page 98.

44. More information on Blackwater can be found at: water.dpie.nsw.gov.au/our-work/allocations-availability/drought-and-floods/hypoxic-blackwater

45. WaterNSW data can be found at: realtimedata.watnsw.com.au/water.stm



Challenge: Addressing barriers to Aboriginal people's water rights

Water is an essential part of Aboriginal people's culture and heritage but the current water management framework is not meeting the needs and aspirations of Aboriginal people.

There is limited understanding of the cultural significance of water to Aboriginal people

There is a limited understanding and acknowledgement of the spiritual connection Aboriginal people have to healthy waterways and important cultural sites.

As the first managers and carers of this natural resource, Aboriginal people have rights and a moral obligation to care for water under their law and customs. These obligations connect across communities and surface water and groundwater connected systems.

Aboriginal people rely on the health of water and their waterways for well-being and continued practice of cultural traditions. If a site dries up or has ongoing poor water quality, the traditional story or meaning can be lost. When the cultural and spiritual values of water are sustained by providing water that is sufficient in both quantity and quality, then many other components of Aboriginal life will be healthy.

A significant number of cultural sites in the NSW Murray region are on floodplains and many cultural activities focus on floodplain areas. Development on floodplains, such as levees, has altered the passage of flows and resulted in some cultural assets that are disconnected from main waterways.

To address this challenge in the NSW Murray region, the following action is proposed:

- proposed action 2.7: Support place-based initiatives to deliver cultural outcomes for Aboriginal people. See page 88.

The current water management framework limits the ability of Aboriginal people to access water

While Aboriginal people currently can access rights to water through water use entitlements, the framework is complex and confusing and can be difficult to navigate. In addition, current water access rights may limit Aboriginal people's access to water for economic purposes and there are some remote Aboriginal communities that have limited access to clean drinking water.⁴⁶

The current water management framework inhibits access to culturally significant areas and waterways and there is limited acknowledgement of the impact of current river operations on the environmental and cultural value of these sites.

Development of a policy framework around cultural flows is in its infancy in Australia.

Cultural flows are not provided for explicitly in the *Water Management Act 2000*, relevant water sharing plans or releases from the Snowy Scheme. In recent years, environmental water managers have made efforts to achieve cultural and ecological co-benefits⁴⁷ and Aboriginal people continue to contribute important knowledge to inform the management of water for the environment in the NSW Murray region. However, these efforts are distinct from how Aboriginal communities envision cultural flows, where water is owned and managed by Aboriginal people and used as per the Echuca Declaration.⁴⁸

The costs associated with accessing water are also prohibitive. While some licence and annual fees are waived, there are costs associated with purchasing and maintaining related water infrastructure such as pumps and pipes. Although governments have at times set aside funding to help Aboriginal people invest in water entitlements, these commitments have often been 'in principle' and many are yet to be implemented. This lack of funding to manage and access water is compounded when land is handed back to traditional owners.

To address this challenge in the NSW Murray region, the following action is proposed:

- proposed action 3.1: Support the development of new water-related Aboriginal business opportunities in the NSW Murray region. See page 96.



Image courtesy of Destination NSW. Yindymarra Sculpture Walk, Albury.

46. Improved access to clean drinking water for remote Aboriginal communities is currently being addressed through the department's Aboriginal Communities Water and Sewerage Program. The Aboriginal communities in the region that are part of the Aboriginal Communities Water and Sewerage Program include: Brungle, Three Ways and Balranald Reserve Endeavour Drive.

47. More information can be found at: www.environment.nsw.gov.au/topics/water/water-for-the-environment/murray-and-lower-darling/annual-environmental-water-priorities-2023-24

48. The national cultural flows research project is working to secure a future where First Nations' water allocations are embedded within Australia's water planning and management regimes to deliver cultural, spiritual and social benefits, as well as environmental and economic benefits. Further information is available at: www.culturalflows.com.au

There are restrictions with the Aboriginal cultural water access licencing framework

In NSW, Aboriginal people can apply annually for an individual Aboriginal cultural water access licence.⁴⁹ If granted, this licence can provide up to 10 ML/year of water for cultural purposes,⁵⁰ but it cannot be associated with commercial activities or provide direct or indirect economic benefit. Once the cultural project is completed, the entitlement is removed.

No (high security) Aboriginal cultural water access licences have been granted to Aboriginal people since the *Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources* commenced on 1 July 2004. The *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* is the only water sharing plan to have granted a high security (Aboriginal cultural) access entitlement.

Some culturally significant sites in the NSW Murray region have been identified and assessed for water management strategies. Through the Aboriginal Waterways Assessment Program,⁵¹ 2 sites have been assessed in the NSW Murray catchment: the Werai Forest by the Barapa Barapa and Wemba Wemba nations and the Millewa Forest by the Bangerang and Yorta Yorta nations. The Murray Lower Darling Long-Term Water Plan identifies water management strategies to maintain and improve the long-term health of the Werai Forest and other sites in the NSW Murray region. To nourish these important sites, genuine and ongoing consultation with Aboriginal people is vital.

Feedback indicates there are challenges in the way water is accessed and managed in Werai Forest, despite having a cultural water management strategy. Costs associated with water infrastructure (as outlined above) and insufficient training and resources, can limit the operation of such infrastructure and impact how and where water moves through a site.

Cultural water access licence provisions are being reviewed

The NSW Government recognises First Nations/Aboriginal People's rights to water. We aim to embed water for First Nations/Aboriginal People in the water planning and management regime in NSW to deliver cultural, spiritual, social, environmental and economic benefit to communities.

While there are provisions for accessing water for cultural purposes in NSW,⁵² these do not currently meet the needs and obligations of First Nations/Aboriginal People to care for Country or achieve the cultural water flows and water management aspirations set out in the 2007 Echuca Declaration.

In addition, policy settings limit the use of cultural water entitlements so that no direct economic benefit can be gained and are silent on secondary economic benefit. Only 7 cultural water entitlements have ever been issued, with only 2 remaining in use today.

The Aboriginal Water Program (AWP) is delivering several initiatives to give greater recognition to Aboriginal people's water rights and interests, including clarifying the purposes for which cultural water can be used. Several other key pieces of work also provide the foundation for the way forward, including the National Cultural Flows Research Project.⁵³

In early 2023, the Cultural Watering Plan project⁵⁴ conducted an expression of interest process for a pilot program. A large number of applications were received, of which six were selected to participate in the program. The AWP team has been working with these diverse Aboriginal community groups across NSW to develop Cultural Watering Plans for their communities. The plans address the significance of cultural water, explore options for water access and ownership, and establish monitoring mechanisms. The findings will be used to guide reviews of existing water policy and planning frameworks, and to bridge gaps in how we communicate with First Nations/Aboriginal People.

The NSW Government will keep working with First Nations/Aboriginal People and organisations and apply the processes developed in A Pathway to Cultural Flows in Australia.⁵⁵

49. In NSW, the *Water Management (General) Regulation 2018* allows for applications to be made for any category of specific purpose access licence, subcategory Aboriginal Cultural, for Aboriginal cultural purposes. This ensures that applications can be made for an Aboriginal Cultural licence throughout NSW in both surface water and groundwater. These licences allow the take of water independent of Native Title rights.

50. Cultural purposes include drinking, food preparation, washing and watering domestic gardens, as well as for Aboriginal cultural uses such as manufacturing traditional artefacts, hunting, fishing, gathering, recreation and ceremonial purposes.

51. Murray Lower Darling Rivers Indigenous Nations. Un-dated. Using the *Aboriginal Waterways Assessment Tool: A Handbook for practitioners*. See: mldrin.org/what-we-do/aboriginal-waterways-assessment/

52. More information about *Cultural water access* for Aboriginal people is available at: water.dpie.nsw.gov.au/plans-and-programs/aboriginal-water-program/cultural-water-access-for-aboriginal-people

53. More information about *National Cultural Flows* is available at: www.culturalflows.com.au/

54. More information about *Cultural Watering Plans* is available at: water.dpie.nsw.gov.au/plans-and-programs/aboriginal-water-program/cultural-watering-plans

55. More information about the Pathway to Cultural Flows in Australia is available at: www.mdba.gov.au/node/6339

There are limited opportunities for Aboriginal people to participate in water management

A historic lack of water entitlements held by Aboriginal people is a significant obstacle for representation in decisions concerning water management that advance the economic and social needs of Aboriginal people.

Aboriginal people have raised concerns that water management in the region and across NSW is largely seen as an allocation problem between agriculture, towns and environment. It is thought this approach overlooks the interests, values, knowledge and rights of Aboriginal people and their cultural obligation to Country, including their understanding that waterways are living ecosystems that need to be cared for and protected.

There is concern from Aboriginal people that our understanding of the extent of culturally significant sites within the region is limited and needs to be better considered in water management decisions. There is also concern about limited understanding of how cultural obligations to care for land and water connect across communities and language groups, extending to downstream communities, throughout catchments and over connected surface and groundwater systems.

Increasingly, it is acknowledged that Aboriginal knowledge and experience needs to be recognised as an essential element to managing natural resources in Australia. However, significant gaps remain. Opportunities are still limited for Aboriginal people to co-manage activities or participate in water-related decision-making processes because:

- consultation timeframes and processes do not allow the time needed to adequately meet Aboriginal cultural governance processes. This erodes trust and prevents important relationships between Aboriginal people and water managers being established
- the complex set of state and federal laws and systems around water management is often not explained in a culturally appropriate manner
- there are a lack of resources and support for Aboriginal people and Aboriginal community groups to enable their engagement in water management processes
- monitoring, evaluation and reporting do not include Aboriginal input in design, implementation and assessment.

While governments are committed to improving engagement with Aboriginal people and communities, significant progress is still needed before it can be considered a mature, knowledge sharing partnership.

To address this challenge in the NSW Murray region, the following action is proposed:

- proposed action 1.4: Foster ongoing arrangements for participation of local Aboriginal people in water management. See page 73.



Image courtesy of Destination NSW. Wagirra Trail and Yindymarra Sculpture Walk, Albury.

NSW Water Strategy⁵⁶ prioritises Aboriginal people's water rights

The NSW Government recognises systemic issues need to be addressed at a state-wide level to better enable the exercise of First Nations/Aboriginal People's rights and access to water. This is reflected in Priority 2 of the NSW Water Strategy, which recognises First Nations/Aboriginal People's rights and values and aims to increase access to and ownership of water for cultural and economic purposes.⁵⁷

Actions being taken under the NSW Water Strategy are:

- 2.1 Strengthen the role of First Nations/Aboriginal People in water planning and management
- 2.2 Develop a state-wide Aboriginal water strategy
- 2.3 Provide Aboriginal ownership of and access to water for cultural and economic purposes
- 2.4 Work with First Nations/Aboriginal People to improve shared water knowledge.

Draft NSW Aboriginal Water Strategy

The NSW Government is developing a draft NSW Aboriginal Water Strategy in collaboration with First Nations and Aboriginal people. The strategy will empower First Nations and Aboriginal people to contribute to water management and planning decisions and identify ways to increase water rights.

We listened to Aboriginal communities, Traditional Owners and representative organisations through discussions on water strategies and planning, identifying 6 important principles that matter to Aboriginal people:

- culture
- health and well-being
- caring for Country
- meaningful engagement
- economic benefit
- shared cultural and environmental benefits.

Feedback will be sought on the draft strategy in 2024 through peak Aboriginal organisations and Regional Aboriginal Water Committees. The NSW Aboriginal Water Strategy will be finalised and published in mid to late 2024.

56. NSW Water Strategy available at: dpie.nsw.gov.au/water/our-work/plans-and-strategies/nsw-water-strategy

57. More information about Priority 2 of the NSW Water Strategy is available at: water.dpie.nsw.gov.au/plans-and-programs/nsw-water-strategy/toward-2050/priority-2



Image courtesy of Natasha Childs. Murray Valley National Park, NSW.



Challenge: Supporting existing and emerging industries and livelihoods

Agriculture, agribusiness and hydroelectricity are the major water-reliant industries in the NSW Murray region. The region's water resources also support indirect water users, including tourism and manufacturing. Patterns of land use are changing and industries are expected to grow over the next 20 years. While there is potential for future development in high value industries, a shortage of reliable water supplies may hinder this growth. A key challenge for the region is to support new and existing industries within the context of a variable and changing climate and fully committed water resources.

Less reliable surface water may impact water reliant industries that are important to the regional economy

The NSW Murray region forms part of a region known as Australia's 'food bowl' with a reputation as one of Australia's premium agricultural areas due to its contribution to the country's agricultural production and economy. The diverse landscape, climate and transport links in the region support a wide range of agricultural industries that rely on the region's water resources.

Water use by annual crops in central and eastern NSW Murray region local government areas varies significantly between wet and dry years. Comparatively, water use by permanent plantings has remained relatively constant and there was even an increase in irrigation area and volume from 2018 to 2019. Although total water use for industries is bound by the sustainable diversion limits, changes within and between industries – including the growth of permanent plantings in the western parts of the NSW Murray region – is altering the geographical use of water in the catchment, trade patterns and seasonal water demand.⁵⁸

Attracting new, high-value industries and supporting economic diversification is a strong focus for the NSW Murray region. Access to reliable water is important to

achieving a more diverse employment and economic base. The Inland Rail Project, upgrades to the Newell Highway and other initiatives will enable the region to leverage its position along nationally significant rail and road corridors, encouraging further industry development and job growth. The Snowy Mountains Special Activation Precinct will help stimulate economic growth and investments made by the NSW Government, while the Albury Regional Jobs Precinct will leverage the region's established industries to grow existing businesses and attract new businesses.

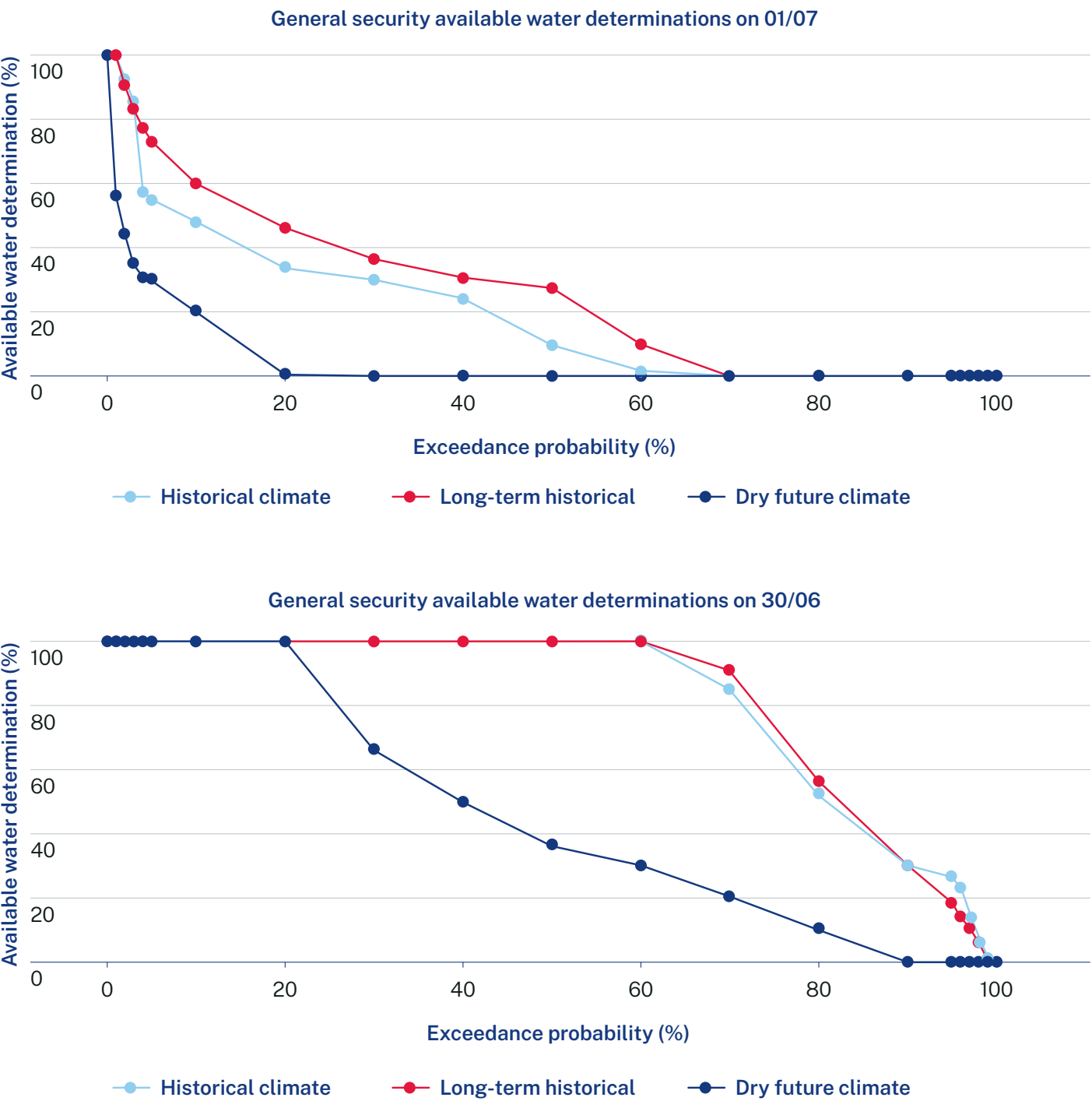
The new climate data and modelling highlights that with the current rules and infrastructure under a dry future climate scenario, general security allocations may be significantly reduced compared to the historical climate scenario – both at the start of the irrigation season and end-of-year (Figure 10).

Reduced allocations at the beginning of the irrigation season would mean that irrigators would be less likely to plant annual crops. Combined with less water added to accounts throughout the year, this would likely constrain economic activity in the region.

However, the modelling indicates that end-of-season high security allocations, perform well across all the modelled scenarios, including the dry future climate scenario. This means that, while there may be some delays in when allocations are added to accounts throughout the year, high security allocations could continue to perform well indicating that reserves are sufficient (Figure 11).

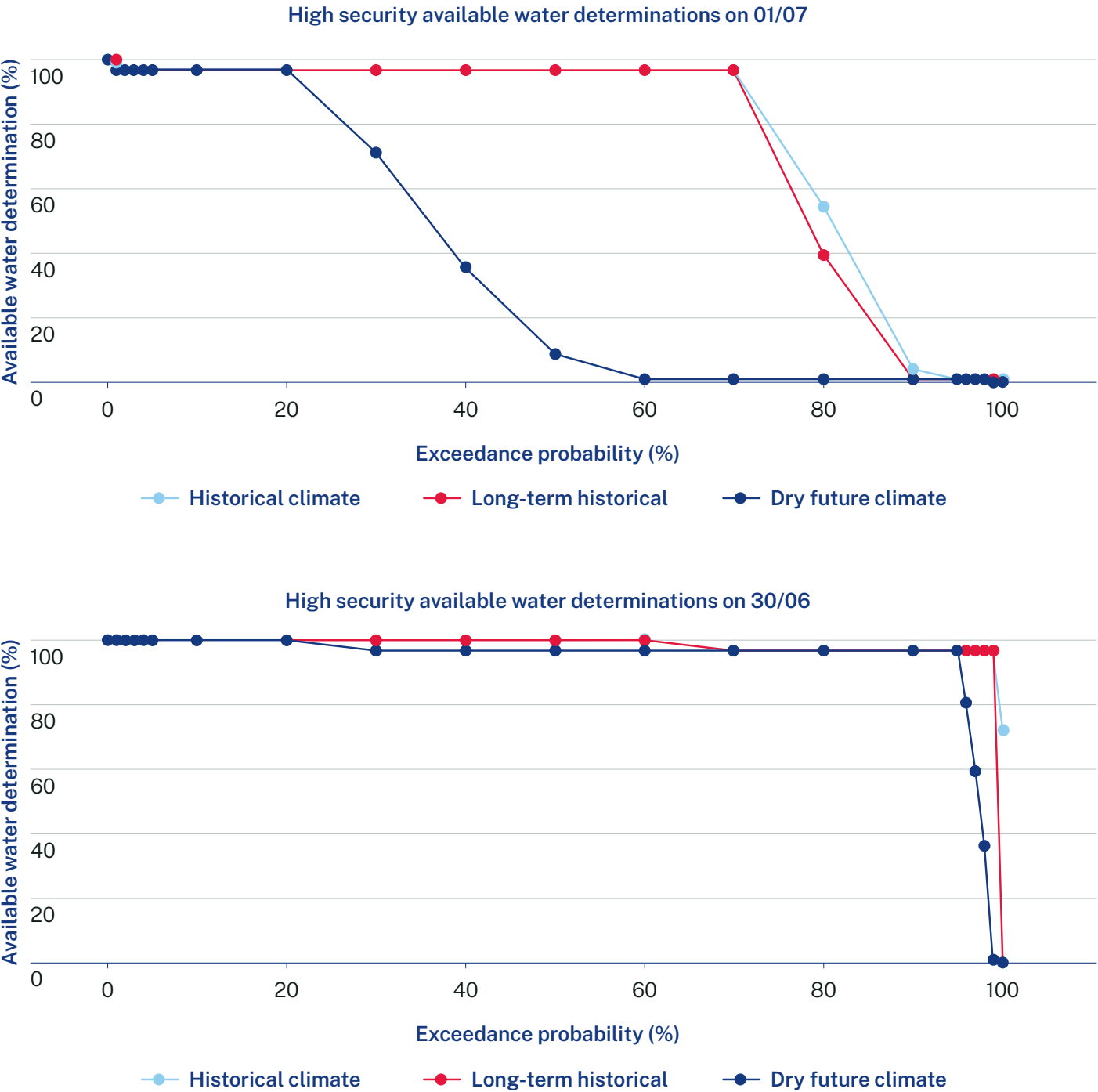
⁵⁸. NSW Department of Planning and Environment 2022, *Draft Murray Regional Water Strategy*, www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/regional-water-strategies/public-exhibition/murray/murray-regional-water-strategy

Figure 10. Impact of dry future climate scenario on NSW Murray general security available water determinations for 1 July (top) and 30 June (bottom)⁵⁹



59. Note the results do not include carryover.

Figure 11. Impact of dry future climate scenario on NSW Murray high security available water determinations for 1 July (top) and 30 June (bottom)



Despite the Murray River being one of the most reliable river systems in inland NSW, climate change has the potential to constrain industry and economic growth across the region. Climate change may result in reduced water availability and increased uncertainty for the region's industries. Changes in temperature and seasonality has the potential to force changes to the type of crops that are suitable for the region. More extreme events, such as droughts, floods and bushfires, could cause large-scale economic and social losses for the agricultural sector and communities.

Limited understanding of future water availability and publicly available climate information can lead to poor investments, business decisions and drought and flood security planning. This can also constrain the uptake of opportunities in alternative water supplies.

A description of the climate scenarios and these and other results about water availability are presented in the *Murray and Murrumbidgee Regional Water Strategies: Climate and hydrological modelling report*.⁶⁰

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 72.
- proposed action 3.6: Improve public access to climate information and water availability forecasts. See page 102.

Crop vulnerability assessments

The impacts of climate change are likely to disrupt primary industries in many ways including changes to agricultural productivity, crop yields and pasture availability, as well as changes in the spread of pests, weeds and disease.

Understanding the extent of these changes and the associated vulnerability of primary industries is critical for managing risks and making sound adaptation decisions. At the same time, climate change may offer new opportunities for producers. Understanding the timing and nature of potential opportunities is essential for producers to prepare to maximise any benefit.

The NSW DPI, under the NSW Climate Change Research Strategy,⁶¹ is undertaking crop vulnerability assessments to address this issue. Through a consistently applied approach, with consultation and review by industry, the Vulnerability Assessment analyses potential climate change impacts and adaptation strategies for 28 commodities across cropping, extensive livestock, horticulture and viticulture, forestry and fisheries. The project also analyses the impacts of climate change on 14 related biosecurity risks that are relevant to each sector.

The Vulnerability Assessment has 2 key objectives:

- improve the understanding of climate change risks and impacts
- provide evidence of the value of adaptation strategies to reduce the identified climate impacts.

The assessment applies a standard methodology across all commodities and with the related biosecurity risks. This enables comparisons between commodities across NSW and aims to inform strategic industry planning and policy.

The assessment is being conducted in 4 stages:⁶²

- identifying industry needs for, and current activities, in climate change risk and adaptation
- reviewing previous climate change impact and adaptation research and current activities for each industry
- developing a vulnerability assessment to capture climate change exposure risk and sensitivity of key primary producers
- conducting spatial and economic analysis to evaluate climate risk and adaptation options for primary industries.

60. The Department of Planning and Environment, *Climate and hydrological modelling: Murray and Murrumbidgee Regional Water Strategies*, available at: www.dpie.nsw.gov.au/murray-regional-water-strategy

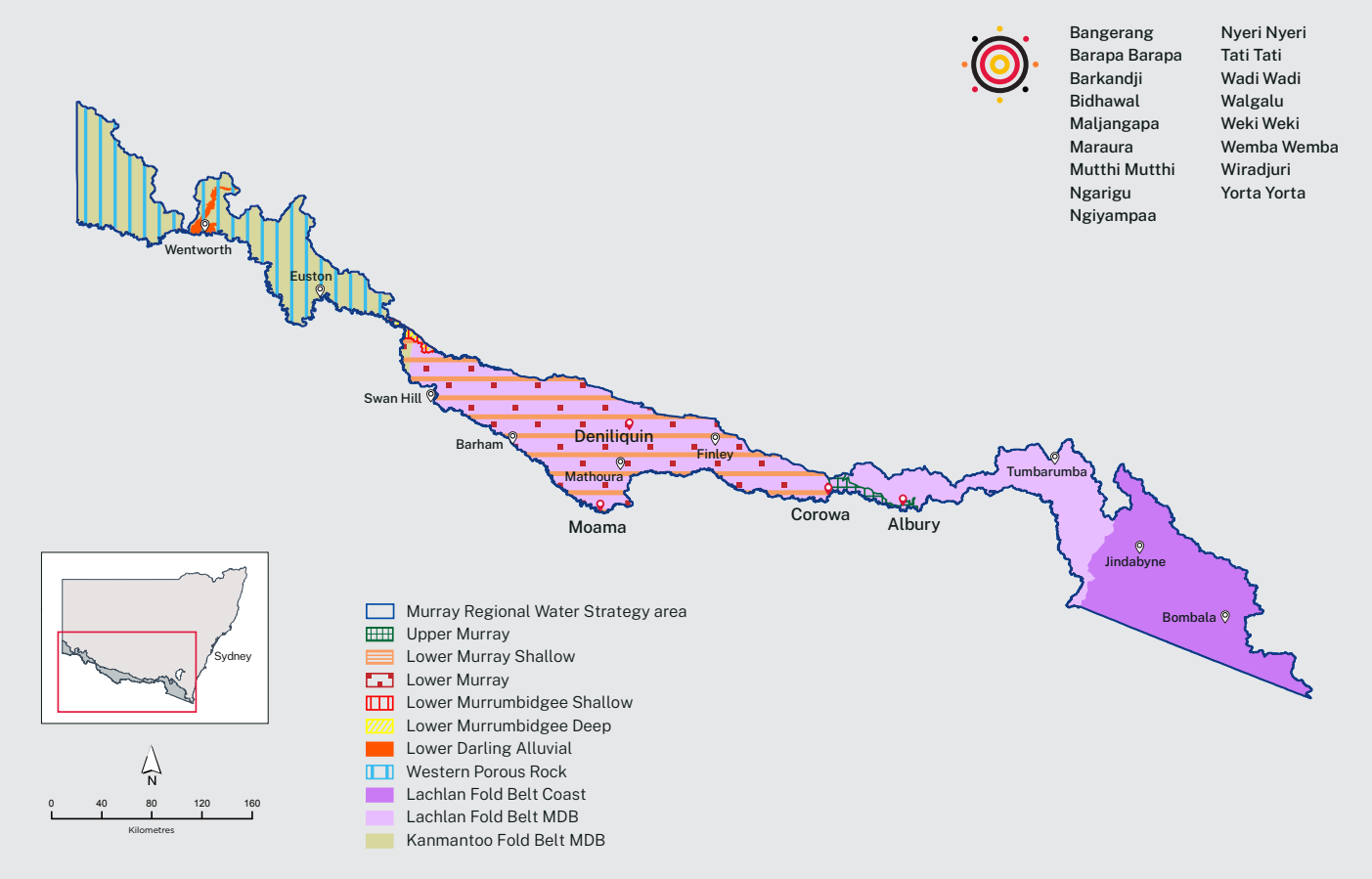
61. More information available at: www.dpi.nsw.gov.au/dpi/climate/about-dpi-climate/climate-change-research-strategy

62. More information can be found at: www.dpi.nsw.gov.au/dpi/climate/about-dpi-climate/climate-change-research-strategy/project-6-vulnerability-assessment

There are gaps in our understanding of groundwater resources

Sustainable use of the region’s groundwater sources (Figure 12) is critical to support towns, industries, and the environment. During drought, reliance on groundwater can increase significantly to support the region’s industries and communities.

Figure 12. NSW Murray groundwater sources



Note: The Billabong Creek Alluvial Groundwater Source is located in the Murrumbidgee Region but is managed under the Water Sharing Plan for the Murray Alluvial Groundwater Sources.

In the NSW Murray region, there is a high reliance on alluvium water sources for irrigation, especially in the Lower Murray (deep) Groundwater Source. Historically, there have been declines in groundwater levels across the central part of alluvial groundwater sources (for example, around Deniliquin and Blighty of up to 8 m, and up to 4 m around Finley⁶³), where the majority of extraction is occurring. Such declines in groundwater levels represents a risk to groundwater-dependent industries, particularly agricultural businesses with critical water demand requirements such as permanent plantings, and to groundwater dependent ecosystems and communities (see Challenge: Improving the health and resilience of ecosystems for more information about the region’s

groundwater-dependent ecosystems). In the last 4 years, use in groundwater sources has decreased due to wet conditions and greater surface water availability.

During drought, demand for and pressure on the NSW Murray region’s fully allocated alluvial groundwater sources (Figure 13) increases as groundwater is often used to supplement or replace surface water sources. Although knowledge of groundwater sources in the NSW Murray region has improved, understanding future risks to groundwater systems under different climate projections and population growth scenarios is vital to support industries, ecosystems and towns.

63. Department of Industry 2019, *Appendix A: Murray Alluvium Water Resource Plan – Ground Water Resource Description*, www.dpie.nsw.gov.au/water/our-work/plans-and-strategies/water-resource-plans/status/murray-alluvium

Figure 13. Average level of use and commitment (2015–2023) of alluvial aquifers in the NSW Murray region



Groundwater knowledge is built over years from investigation, research, metering and monitoring bore data and groundwater models. But the limited number of monitoring sites compared to surface water and the inherent complexity of the subsurface environment mean that there are gaps in our knowledge of groundwater.

The NSW Government has invested in monitoring and understanding groundwater systems over many decades.⁶⁴ However, these systems change over time in response to changes in groundwater use and the climate. Groundwater levels fall and recover seasonally with annual pumping cycles and over multi-year periods where they decline in dry years and recover in wet years. Groundwater models can be used to assess the long-term (decadal and multidecadal) trends in aquifer behaviour, accounting for the impact of water extraction.

The models simulate the behaviour of aquifers over time, including recharge, contamination plumes, the movement of water and the take of water through bores and are needed for defining long-term sustainable levels of extraction for future reviews of water sharing plans. Continuing to invest in monitoring and updating of groundwater system models will need to be a priority.

There are also groundwater quality risks in the NSW Murray region. The Lower Murray Shallow Groundwater Source, notably saline in the western part, has had rising groundwater levels causing waterlogging and salinity in the past. There is potential for this to occur in future if not managed appropriately.

64. Read more about groundwater science undertaken by the NSW Government at: water.dpie.nsw.gov.au/science-data-and-modelling/groundwater-management-and-science

There are saline groundwater discharges in the lower part of the Billabong Creek from the Billabong Creek Alluvial Groundwater Source. This is currently managed by the Billabong Creek Salt Interception Scheme. Pollution from different land uses is an emerging threat to these systems and the ecosystems they support and better understanding of these changes and threats is needed to protect and manage the resource for the future.

Historically there have been salinity issues in the mid-Murray region due to land clearing and expansion in irrigation, most notably in the Blighty, Green Gully and Wakool areas. Implementation of the Murray Land and Water Management Plan, drainage infrastructure and improved irrigation methods have effectively addressed this issue.

However, expansion of irrigation in the Lower Murray, is contributing to increased salinity discharge of groundwater to the Murray River. There are a number of salt interception schemes in the Lower Murray in both NSW and Victoria, that mitigate the salinity risk to downstream water users and communities when salinity levels exceeds 600 EC (electrical conductivity). Table 3 summarises challenges in each groundwater source and their related areas.

Table 3. Challenges in each groundwater source in the NSW Murray region

Groundwater source	Challenges	Areas/towns affected/related
Upper Murray Groundwater Source		Hume Dam to Corowa
Lower Murray (deep) Groundwater Source	Increasing salinity	Deniliquin, Finley
Lower Murray Shallow Groundwater Source	Rising watertable and soil salinisation ⁶⁵	Berriquin Irrigation District, Wakool
Billabong Creek Alluvial Groundwater Source	Saline groundwater discharge into Billabong Creek	Walla Walla, Walbundrie
Western Murray Porous Rock	Salinity issues	Southern border, Lake Victoria
Lachlan Fold Belt	Relatively limited use with some areas of intense groundwater utilisation due to locally favourable groundwater availability and water quality Presence of GDEs.	

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 1.1: Improve understanding and management of groundwater sources. See page 72.
- proposed action 2.5: Continue to invest in modelling to improve groundwater knowledge in the NSW Murray region. See page 86.
- proposed action 3.2: Reduce uncertainty in groundwater security for regional towns and industry. See page 96.

65. Read more about Groundwater annual reports at: www.dpie.nsw.gov.au/water/our-work/science-data-and-modelling/groundwater-management-and-science/groundwater-annual-reports

Predicting and managing floods is difficult

Floods are a vital natural process that support the region's ecosystems, providing benefits such as groundwater recharge, lateral connections between rivers, wetlands and floodplains, nutrient and carbon exchanges, and breeding cues for wildlife. They also fill our dams. Floods are also responsible for the productive soils valued by landholders on the NSW Murray's floodplains.

Flooding in the NSW Murray region is often experienced when elevated or flooding flows are passing through Hume Dam and tributary inflows further downstream, either from NSW or Victoria, build upon those flows to exceed flood thresholds. The timing of convergence of all these flows is highly variable and responsive to many factors, which means that flooding in the NSW Murray region is difficult to predict.

Hume Dam provides a high degree of flood protection to downstream communities when the storage is low. About 70% of flood events in the upstream catchment have been stored in Hume Reservoir since 1979. However, in wetter years when dam levels reach full supply, there is very limited capacity to mitigate flood events as the dam cannot store water above the Full Supply Level. Floodwaters entering from upstream must therefore be released with only limited reduction in flood peak heights. This can make it difficult to manage floods and has potentially significant impacts to people and businesses by creating risks to safety and well-being, disrupting communities, damaging infrastructure, and causing major financial and economic losses.

To address this challenge in the NSW Murray region, the following actions are proposed:

- proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data. See page 72.
- proposed action 2.4: Support development and implementation of a NSW Murray Floodplain Management Plan and address floodplain structures. See page 86.



Image courtesy of Destination NSW. Wentworth Wharf.

Drought and flood risk mitigation planning roles and responsibilities

Local councils and various State agencies have responsibility for drought and flood preparedness and planning.

Drought mitigation planning

Under the Regulatory and Assurance Framework for Local Water Utilities, local water utilities (LWUs) must demonstrate that their local strategic water planning addresses water security, including drought planning. The NSW Department of Climate Change, Energy, the Environment and Water supports local councils to undertake this strategic planning, including providing guidance to LWUs to assist them to achieve this.

Flood mitigation planning

The MDBA and state governments manage major storages in the River Murray system, with the aim to ensure dam structures remain safe during floods.

WaterNSW operates state-owned dams during a flood event in line with the *WaterNSW Act 2014*, its operating licence and the Water Sharing Plan/works approvals that outline how dams are operated during floods along with airspace operation rules.

The department's Biodiversity Conservation and Science group is primarily responsible for providing flood risk management advice to government and supporting local councils to meet their flood risk management planning responsibilities for urban communities. These activities are undertaken in line with the NSW Flood Prone Land policy and the NSW Flood Risk Management manual and its supporting toolkit and the Floodplain Management Program.

The department's Water group is responsible for the development, review and replacement of rural floodplain management plans under the *Water Management Act 2000*. These plans coordinate development on declared floodplains by establishing management zones and setting clear and consistent rules and assessment criteria for each zone. The plans also identify and protect flood-dependent ecological and cultural assets and identify risks to life and property from the effects of flooding. Work is underway to replace the historical floodplain management plans in the NSW Murray region with a single floodplain management plan and associated declared floodplain. This work is anticipated to be completed by 2025.

The NSW Reconstruction Authority is currently developing a State disaster mitigation plan and supporting local councils to undertake local and regional disaster planning. The State disaster mitigation plan will:

- identify potential strategies and actions for reducing the impact of disasters,
- assess and consider the impacts of climate change on disasters, and
- determine priority projects for regions to mitigate the impact of disasters.

The State disaster mitigation plan will also set priorities for the plan, disaster adaptation plans and strategic plans under the *Environmental Planning and Assessment Act 1979*.

Other disaster planning and response roles

Under the *State Emergency and Rescue Management Act 1989* and *NSW State Emergency Service Act 1989*, the NSW State Emergency Service is the emergency management lead agency.

Under the *NSW Reconstruction Authority Act 2022*, the NSW Reconstruction Authority is also responsible for reconstruction and recovery following disasters and other emergencies, including:

- facilitating, coordinating and directing the recovery, planning and rebuilding of affected communities, including repairing and rebuilding land and infrastructure and other development
- balancing constraints to enable a focused, timely and expedited recovery of affected communities.

The department's Water group plays a support role during emergency incidents including drought and flooding, by providing technical assistance and advice regarding emergency water security options or damaged local water infrastructure.

Other State agencies administer various funding and support programs to assist councils with disaster planning (such as the Regional Drought Resilience Planning Program administered by Regional NSW).

Addressing the challenges

4

Image courtesy of Destination NSW. Lake Mulwala, Mulwala.

To address the challenges in the NSW Murray region, the draft Regional Water Strategy Identifies 3 regional priorities and proposes actions for each priority.

The regional priorities are:

1. Continue to improve water management
2. Improve river and catchment health
3. Support sustainable economies and communities.

These priorities and proposed actions aim to improve the NSW Murray region's readiness to adapt to a more variable climate and support the difficult decisions needed to deliver healthy, reliable and resilient water resources for the region's future.



Image courtesy of Destination NSW. Wakool River at Coonamit Bridge, Dilpurra.

Priority 1

Continue to improve water management

Effective water resource management in the NSW Murray region requires a holistic and integrated evidence-based approach, involving the cooperation of various stakeholders, government bodies, and the community. Regular reviews and the flexibility to adjust management strategies to respond to evolving conditions are essential for long-term sustainability.

Continual improvement in management of water resources is required in the region to maintain ecosystem health, support agriculture and other industries, preserve cultural values and safe guard the well-being of communities that rely on the river.

Proposed actions under this priority focus on:

- continuing to incorporate best available evidence and climate data into the water management framework
- improving the way water and land planning processes are integrated
- fostering collaboration with Aboriginal groups.

The success of these actions will require working collaboratively with large water users in the region and updating rules based on the best available science and operational knowledge.

What is already happening



The NSW Government is investing in several initiatives to improve the management of both surface water and groundwater.

The **NSW Water Strategy** includes actions to improve water management, such as action 4.2 to review water allocation and water sharing in response to new climate information and action 4.4 to better integrate land use planning and water management.

The **Aboriginal Water Strategy** will identify a program of measures to deliver on First Nation's water rights and interests in water management and is being developed with Aboriginal people and communities.

The NSW Government has developed a state-wide **Groundwater Strategy** that identifies the key risks to our groundwater resources and the associated management challenges for NSW. The strategy sets out the actions required to respond to these challenges and provides a logical framework for funding of groundwater management reform work over the next 20 years.

Legend



Balancing competing interests for water



Improving the health and resilience of ecosystems



Addressing barriers to Aboriginal people's water rights



Supporting existing and emerging industries and livelihoods

Table 4. Overview of proposed actions for Priority 1 - Continue to improve water management

Proposed action	Summary	Challenges addressed
Action 1.1 Improve understanding and management of groundwater sources	Improve water management by: • better understanding the water requirements of and potential risks to groundwater-dependent ecosystems • updating the approach to reviewing extraction limits • preparing a framework to act on declining groundwater levels • developing a regional water quality monitoring program.	  
Action 1.2 Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data	The water sharing plans covering the NSW Murray region are due for renewal in 2024, 2026 and 2030. This provides an opportunity for new climate data to be considered in the reviews of these plans. This will allow a review of the drought rules, further investigate conversion of small portions of general security entitlements to high security and aspects of the surface water allocation and trading framework, as well as testing the adequacy of current flood operation rules.	  
Action 1.3 Build climate evidence base for the next Snowy Water Licence Review	A detailed review of this licence will commence in 2027. This provides the opportunity to include varying climate change scenarios into an agreed inter-jurisdictional model package that could be the main source for testing changes to the Snowy Water Licence, water management policy and operational rules relating to the Snowy Hydro system.	  
Action 1.4 Foster ongoing arrangements for participation of local Aboriginal people in water management	Support the Regional Aboriginal Water Committee in the NSW Murray region to ensure continued involvement in water management activities and decision making.	 

Proposed action	Summary	Challenges addressed
Action 1.5 Improve consideration of water in strategic planning processes	Work across government to better integrate future strategic land use and water planning so that water resources can be considered upfront in future land use planning processes. This action would also consider projected population and industry growth trends and identify water-related gaps in the current land use planning framework in the NSW Murray region.	   
Action 1.6 Review the Murray–Darling Basin Agreement	Under this action, NSW would advocate for the Agreement to be reviewed and updated so that it can be aligned with an updated understanding of a changing and more variable climate.	 



Image courtesy of Visit River Country, Destination NSW. Koondrook Barham Redgum Statue River Walk, Barham.

Proposed action 1.1: Improve understanding and management of groundwater sources

Over the decades, the NSW Government has invested in improving understanding and management of groundwater systems.⁶⁶ However, these systems change over time in response to changes in groundwater use and the climate. There are also emerging threats to these systems and the ecosystems they support, such as pollution from different land uses.

These changes and threats need to be better understood to adapt groundwater management frameworks to protect and manage this valuable resource for the future. Continuing to invest in groundwater science and increasing knowledge of groundwater sources and their dependent ecosystems, water quality and changes to aquifers is critical to future management of this important resource.

This action could address and build upon the priorities and actions outlined in the NSW Groundwater Strategy, including:

- developing and implementing an updated and adaptive approach to reviewing extraction limits for high-priority groundwater sources to ensure sustainable access to groundwater by consumptive users and the environment under a changing climate
- developing a groundwater level management framework with actions to manage any local water level decline (identified through water level and quality parameters) to provide sustainable access to groundwater by users and the environment
- developing and implementing an approach that provides clarity on the management of groundwater sources where the total entitlement is greater than the long-term average annual extraction limit
- continue to undertake research to better understand water requirements and the potential risks to groundwater-dependent ecosystems to inform management decisions
- developing a regional water quality monitoring program.

Filling these gaps in knowledge of groundwater systems would provide important information for groundwater system models and inform reviews of water sharing plans, water licensing and approval decisions, and land management.

Proposed action 1.2: Improve strategic water management and decision-making frameworks by incorporating new climate and modelled data

Current water sharing arrangements are based on the last 120 to 125 years of recorded data. This limits understanding of how vulnerable the region could be to the climate variability experienced prior to when records began, or to future extreme wet and dry events under climate change.

The development of new climate data and modelling allows the NSW Government to update regulatory frameworks to be more responsive to a range of current and future climate conditions.

Understanding of the drivers of our current climate has increased over recent years. There is the opportunity to incorporate this knowledge into the way water is managed. A key element is incorporating this information into the review of the region's water sharing plans to improve the way the system is managed. This could support the refinement of current rules or the development of new rules to improve how the impacts of drought or the benefits of 'wet' years are handled. This may also support improvements in how water is shared, leading to greater certainty for water users.

The unregulated and regulated water sharing plans of the NSW Murray region are due for renewal in mid-2024 and 2026 respectively. This provides an opportunity to consider the new climate data in these reviews. The various groundwater water sharing plans covering the NSW Murray region are due for replacement in 2030 and the new climate data could be incorporated into these plans as well.

Using the new climate data set, this action would:

- review and update water sharing plans for the NSW Murray region
- review aspects of the surface water allocation framework to improve adaptability to climate variability, including for 'wet', 'moderate' and 'dry' periods, discourage water over-ordering and cancelling orders at short notice, better facilitate trade, enhance understanding of future transmission and evaporation losses, further investigate conversion of small portions of general security entitlements to high security, investigate changes to carryover and identify opportunities to further improve transparency
- explore alternative mechanisms such as conversion factors for water trades (for example, a study to quantify volumetric impacts of trading water downstream)
- test the adequacy of current flood operation rules under different climate scenarios.

66. Read more about groundwater science undertaken by the NSW Government here: water.dpie.nsw.gov.au/our-work/science-data-and-modelling/groundwater-management-and-science

Proposed action 1.3: Build climate evidence base for the next Snowy Water Licence Review

Regulation of the Snowy Water Licence is legislated under the *Snowy Hydro Corporatisation Act 2002* and operated through the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) and licence. A review of the licence is undertaken every 10 years. A detailed review of the Snowy Water Licence will commence in 2027.

River system models have been integrated as part of the development of the draft Murrumbidgee and NSW Murray regional water strategies and further refined through the Snowy Water Licence Review Implementation Program. The work done to date is significant because it provides the first evidence-based climate tool to support decisions around the Snowy Water Licence.

However, for the licence review, the model requires further work to include varying climate change scenarios to understand the implications of a potentially drying climate. This would involve the development of inter-jurisdictional data sharing arrangements on model inputs and further model refinements to more accurately reflect current and expected future Snowy Scheme infrastructure and operations, observed conditions and better address uncertainty. For example, this work would result in an agreed inter-jurisdictional model package that could be the main source for testing changes to the Snowy Water Licence, water management policy and operational rules relating to the Snowy Scheme and downstream receiving river systems. This would include testing how climate change impacts water availability to the environment and downstream water users under different rules, policies or operational scenarios.

Proposed action 1.4: Foster ongoing arrangements for participation of local Aboriginal people in water management

Water is sacred to Aboriginal people. We know from years of discussions with Elders and other representatives that they need to have more of a say in guiding water planning, so their rights and cultural values are considered at the local level. The first step in improving Aboriginal people's involvement in water management is an effective governance, engagement and knowledge-sharing arrangement. To be successful, the makeup and function of representative groups need to be determined and led by local communities.

The NSW Government established a Regional Aboriginal Water Committee in the NSW Murray region in 2023 to involve Aboriginal people in water management activities and decision-making.

One of the first roles of the committee is to contribute to the development of the NSW Aboriginal Water Strategy.

Other roles of the committee are to:

- empower Aboriginal communities to participate in water programs
- build new relationships across water
- ensure Aboriginal rights and values are considered in water planning, programs and projects
- enable exchange of water knowledge in regional communities
- assist departmental staff to identify those key stakeholders from a local Aboriginal community who should be engaged and consulted where required
- share appropriate knowledge to benefit water management
- work in partnership with the department and other water agencies to contribute to water policy review and development.

The committee will operate until 30 June 2025, with further funding needed for ongoing arrangements into the future.

This action supports Priority Reform 1 in the National Agreement for Closing the Gap – to enter formal partnerships and decision-making arrangements and develop place-based partnerships to respond to local priorities.

Proposed action 1.5: Improve consideration of water in strategic planning processes

Water resources are not always considered upfront in broader strategic land planning processes. This can create inefficiencies and challenges around capitalising on the broader regional opportunities created by these processes and associated new investment. Poor coordination between strategic land and water planning can also impact existing water users and the environment and can lead to population and industry growth in areas with pre-existing water availability constraints. This can increase pressures on already stressed surface and groundwater resources.

There are opportunities to better integrate water resources in strategic planning processes, which will also help to more closely integrate future iterations of the regional (land use) plans (*draft South-East and Tablelands, draft Far West and Riverina Murray regional plans*)⁶⁷ and future iterations of the regional water strategies.

During consultation we heard broad support for progressing this action, which has implications for both urban and rural developments. There was also a suggestion to foster partnerships between government, stakeholders and communities, including inter-jurisdictional relationships, to support better integration of these planning processes.

This action would:

- assess population growth trends and regional and local development trends to identify spatial changes in water demand, growth in town water needs and sources of potential future flood risks – such as new developments

- discuss if and how to make decisions on which areas of the region should be elevated regarding water security risk due to being planned strategic growth areas or having a concentration of particular industries
- identify any water-related gaps in the current land use planning framework and assess the adequacy of the current land use planning controls to protect water resources, riverfronts and riverine land uses
- assess current land uses and land use trends in the NSW Murray region to help identify spatial changes in industry water demand, and identify potential sources of point and non-point source pollution risks
- review opportunities to disseminate information effectively to developers and councils about water availability and water quality in their areas and any known or identified risks to water resources, waterways and riparian corridors
- enable County Councils to be included in the development planning approval process as a service/utility provider so that they can respond appropriately to development applications
- conduct a long-term study of the impacts of climate variability and climate change on future water availability (both surface water and groundwater) to determine the impacts on water dependent industries in the NSW Murray region (both primary and secondary) – including those reliant on NSW town water supply systems. This study would make use of the new climate data.

Note that the regional water strategies are not proposing to prohibit particular land uses in NSW regional areas. Land use planning will continue to be managed under the *Environmental Planning and Assessment Act 1979*.

Land uses and the *Environmental Planning and Assessment Act 1979*

The main statute governing land use planning in NSW is the *Environmental Planning and Assessment Act 1979* (EP&A Act). Other relevant legislation that affects land use includes the *Local Government Act 1993*, *Crown Land Management Act 2016*, *Aboriginal Land Rights Act 1983* (ALR Act), *Mining Act 1992*, *Biodiversity Conservation Act 2016* (BC Act) and *Water Management Act 2000*. Federal statutes, such as the *Water Act 2007* and the *Environmental Protection and Biodiversity Conservation Act 1999*, also affect land use outcomes in the region.

Under the EP&A Act, strategic planning occurs at the state, regional and local levels. Planning at the local level is primarily the responsibility of councils, while the NSW Government is responsible for ensuring that NSW's goals are achieved at the regional level, in partnership with councils.

In 2015, the EP&A Act was amended to legally require the preparation of regional plans, set out what the plans need to address and provide for their regular review.

Prior to the release of regional plans in 2017, there was no regional level framework for strategic planning. Since then, the strategic planning framework has been strengthened at the local level with the preparation of local strategic planning statements, which provide an opportunity for a council to set out the strategic vision for the future of the local government area. Each council in the NSW Murray region has a local strategic planning statement and a requirement to review the statement at regular intervals.

67. For more information about the Regional plans visit: www.planning.nsw.gov.au/plans-for-your-area/regional-plans

Proposed action 1.6: Review the Murray–Darling Basin Agreement

The Murray–Darling Basin Agreement (the Agreement), Schedule 1 to the Commonwealth Water Act 2007, sets out rules and arrangements for sharing water in the southern connected Basin. It is an enabling framework agreement between the Commonwealth and the NSW, Victorian and South Australian Governments, and agreement of all parties is required to amend it. The broad water sharing arrangements of the Agreement have remained the same since the original was established in 1914. Apart from changes made in 2011 to address issues identified during the Millennium Drought, the last substantive amendments occurred in 1970 after 10 years of negotiations and led to the construction of Dartmouth Dam and an increase to South Australia’s entitlement.

Since that time, there has been an increased understanding of climate variability and change, and considerable changes in the way water is managed and used in the southern Basin. The ability to meet

the ever-changing water needs of NSW communities, Aboriginal people, industries and the environment will become increasingly challenging. Recent fish deaths and the need to balance reserves for human and environmental needs during droughts are examples of these challenges.

Proposed action 1.6 would involve NSW advocating for a substantive review and update to the Agreement. Undertaking a review would require the support from the Australian Government and all Basin States. This review could include (but not be limited to) how water is shared between jurisdictions during periods of critical drought, how consumptive and environmental needs are met during drought periods, and ways to better consider the local and environmental impacts of operational issues (such as additional dilution flows and how water is called on from storages including the Menindee Lakes).

If agreement is obtained to proceed with the review, this would be progressed through existing forums, including the Murray–Darling Basin Ministerial Council and the Basin Officials Committee, noting that any changes to the Agreement must be by consensus between NSW, Victoria, South Australia and the Australian Government.



Image courtesy of Destination NSW. Lake Jindabyne, NSW.

Priority 2

Improve river and catchment health

Improving river and catchment health brings a range of benefits. It enhances water availability by promoting groundwater recharge, attenuating floods and maintaining base stream flows, promotes good water quality and supports biodiversity, cultural values and recreational opportunities.

To improve catchment health, our management systems and decision-making processes need to use a holistic, whole-of-catchment approach.

Actions proposed under this priority focus on:

- coordinating efforts across stakeholder groups and supporting landholders to build awareness and capacity for best practice natural resource management and sustainable agriculture
- improving water resource health through better land management that considers Aboriginal knowledge and culture, to benefit users at a local, whole-of-catchment and regional scales
- limiting or removing pressures and impacts directly related to water infrastructure.



Image courtesy of Vince Bucello. Overhead view of Murray River near Moama.



The **Murray-Lower Darling Long Term Water Plan**⁶⁸ has been developed to describe flow regimes that are projected to maintain or improve environmental outcomes in the region. It identifies water management strategies for maintaining and improving the long-term health of the NSW Murray region's riverine and floodplain environmental assets and the ecosystem functions they perform. The NSW Water Strategy includes a commitment to consider long-term water plans to protect and enhance ecological systems.

The Natural Resource Commission is currently undertaking an independent review of the *Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers* by the end of the 2025–26 financial year. This review will help identify opportunities to improve water sharing provisions and associated outcomes.

The *Water Quality Management Plan* developed for the *NSW Murray and Lower Darling Surface Water Resource Plan*,⁶⁹ the *Murray Alluvium Water Resource Plan*,⁷⁰ *NSW Murray-Darling Basin Fractured Rock Water Resource Plan*⁷¹ and the *NSW Murray-Darling Porous Rock Water Resource Plan*⁷² aims to provide a framework to protect, enhance and restore water quality for the region.

The **Protecting Our Places Grants Program**⁷³ encourages and empowers Aboriginal communities to protect, conserve and restore landscapes and waterways that are important to them to achieve long-term beneficial outcomes for the environment.

Implementing the recommendations from the first 10-Year Snowy Water Licence Review has involved development of an integrated water model of the Snowy, Murray and Murrumbidgee systems and exploring improvements to the delivery of environmental flows through the Snowy River Increased Flows program. The next Snowy Water Licence Review, due to commence in 2027, will focus on a range of administrative and technical issues, including exploring better ways to deliver environmental flows.

The **River Murray Joint Venture Program**⁷⁴ includes programs and project management activities to meet the NSW Governments responsibilities under the *Murray Darling Basin Agreement*. Key activities include:

- The Basin Salinity Management Strategy 2030⁷⁵ is a program of coordinated salinity management focused on maintaining salinity within the Murray-Darling Basin at appropriate levels to protect economic, environmental, cultural and social values. As part of the strategy, NSW and joint venture partners from South Australia, Victoria and the MDBA maintain a salinity accountability framework and continually invest in managing salinity and improving understanding of salinity risks.
- NSW and joint venture partners operate and maintain 3 Salt Interception Schemes at Mallee Cliffs, Burronga and Upper Darling to significantly reduce the input of saline groundwater into the river system. In addition, one state-owned scheme located adjacent to Billabong Creek (north of Albury) is operated and managed under this program of works.
- The Living Murray Indigenous Partnership Program⁷⁶ supports meaningful First Nations involvement in planning and managing iconic sites along the Murray River.
- The River Works Program⁷⁷ includes local projects addressing erosion control and stream channel revegetation and activities by organisations such as local Landcare groups to remove riparian weeds removal, stream bank stabilisation and promoted 'waterway friendly' farming practices.

Recently, the Restoring Our Rivers Bill passed through the Australian Senate. The bill provides increased funding and an extension of two and a half years to complete delivery of several SDLAM projects.

68. More information at: www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/murray-lower-darling

69. More information at: water.dpie.nsw.gov.au/our-work/plans-and-strategies/water-resource-plans/status/nsw-murray-and-lower-darling-surface

70. More information at: water.dpie.nsw.gov.au/our-work/plans-and-strategies/water-resource-plans/status/murray-alluvium

71. More information at: water.dpie.nsw.gov.au/our-work/plans-and-strategies/water-resource-plans/status/nsw-mdb-fractured-rock

72. More information at: water.dpie.nsw.gov.au/our-work/plans-and-strategies/water-resource-plans/status/nsw-mdb-porous-rock

73. More information at: www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/protecting-our-places

74. More information at: water.dpie.nsw.gov.au/our-work/water-infrastructure-nsw/regional-projects/river-murray-joint-programs

75. More information at: www.mdba.gov.au/publications-and-data/publications/basin-salinity-management-2030-strategies-and-reports

76. More information at: www.mdba.gov.au/climate-and-river-health/water-environment/living-murray/indigenous-partnership-program

77. More information at: www.dpie.nsw.gov.au/water/our-work/water-infrastructure-nsw/regional-projects/river-murray-joint-programs



The Australian Government committed \$15.2 million to investigate and identify a safe, effective and integrated range of measures to control carp populations in Australia. \$10.4 million was allocated to the Fisheries Research and Development Corporation to undertake a feasibility assessment, referred to as the **National Carp Control Plan**.

The **NSW Water Strategy** sets out actions under Priority 3 to improve river, floodplain and aquifer ecosystem health and system connectivity. These provide a strong foundation for actions taken in the NSW Murray Regional Water Strategy. They include:

- taking landscape-scale action to improve river and catchment health
- adopting a more intense, state wide focus on improving water quality
- monitoring and reporting on environmental water delivery and management to inform adaptive management and reporting
- maintaining a water science strategy and prospectus that provides sector-wide guidance on future science, research and development.

The NSW Government and other local organisations are delivering programs that support the adoption of best practice land management by local landholders to improve productivity and reduce land and water degradation. These programs include:

- restoration of riparian habitat for targeted species
- irrigation audits
- guidelines for fertiliser application
- improved management of farm runoff and water quality
- adaptive farms for sustainable landscapes, and improved capacity to prepare and recover from droughts and bushfires
- community engagement and extension to consolidate and increase awareness of natural values
- control of weeds and pest animals.

Landcare groups and the Local Land Services are focusing on projects to improve river health and address land degradation, including:

- erosion intervention in waterways protection in the West Hume Landcare area through changed land management practices that will reduce the impacts of sedimentation
- **Refreshing Rivers Program** is a 10-year project to improve waterway health across the Murray-Riverina region by encouraging the adoption of river-friendly land management practices. This includes the development of Waterway Management Plans that are tied to Social/cultural, environmental, and economic outcomes
- the Murray Local Land Services **NRM Core Services Project** aims to improve the condition of wetlands and waterways by increasing community awareness of natural values, build landholders capacity to manage natural resources and improve resilience of significant aquatic species and ecosystems.

Extension services are also provided by the Natural Resource Access Regulator to help landholders, agricultural producers, irrigators and others understand water laws and their environmental responsibilities.



Image courtesy of Destination NSW. Murray River, Albury.

Legend



Balancing competing interests for water



Improving the health and resilience of ecosystems



Addressing barriers to Aboriginal people's water rights



Supporting existing and emerging industries and livelihoods

Table 5. Overview of proposed actions for Priority 2 – Improve river and catchment health

Proposed action	Summary	Challenges addressed
Action 2.1 Rehabilitate ecologically and culturally important sites within the mid and lower catchment	This action aims to improve habitat for native plants and animals, and improve water quality, river health and ecosystem resilience in the regulated river areas of the NSW Murray region.	 
Action 2.2 Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands	Governments, irrigation infrastructure operators, Aboriginal people and landholders working together through voluntary partnerships to deliver water for the environment to reach ecosystems on public and private lands.	   
Action 2.3 Mitigate the impact of infrastructure on native fish	Progress work to install fish passages at priority sites and build on existing government commitments to encourage and provide incentives for the installation of diversion screens at priority sites. This action would also restore and restock degraded native fish habitats and explore solutions to address cold water pollution.	 
Action 2.4 Support development and implementation of a Murray Floodplain Management Plan and address floodplain structures	Support the development of a valley-wide, connected floodplain management plan and address floodplain works and structures that adversely impact the environment and Aboriginal cultural assets and values.	 
Action 2.5 Continue to invest in modelling to improve groundwater knowledge in the NSW Murray region	Continue to improve groundwater system models that underpin water management planning in the NSW Murray region. This would include developing multi-disciplinary models that incorporate socio-economic, physical and groundwater data.	   
Action 2.6 Encourage best practice land management	Support private landholders to adopt best practice land management in priority waterways by offering resources, tools and advisory services in grazing, farming, erosion control, biodiversity and habitat restoration. This action would, align with other catchment improvement initiatives, focusing on catchments where river reaches have a high recovery potential or improvements are critical to achieving catchment health objectives.	 

Proposed action	Summary	Challenges addressed
Action 2.7 Support place-based initiatives to deliver cultural outcomes for Aboriginal people	Support Aboriginal organisations and communities to develop tailored projects for their communities. This action would aim to move away from centralised decision-making and develop a flexible program that can be adapted and is driven by the principle of self-determination. It would include a demonstration river reach, programs to engage Aboriginal youth in water and landscape management, and improved access to sites of cultural significance.	
Action 2.8 Implement the Reconnecting River Country Program in the NSW Murray region	Removal of constraints to enable the flexible use of water for the environment to increase the frequency and extent rivers connect to their wetlands and floodplains.	
Action 2.9 Support (ongoing) river restoration in the upper NSW Murray and Snowy catchments	Develop and fund a collaborative and coordinated Snowy and upper NSW Murray River catchment recovery program that integrates a range of river recovery actions. This would build on and enhance existing programs, as well as exploring improvements in environmental water management through the review of the Snowy Water Inquiry Outcomes Implementation Deed.	  
Action 2.10 Investigate improvements to the flow regime of the Snowy and montane rivers	This action would investigate a range of opportunities to restore a sustainable flow regime, with partner governments and stakeholders in the Snowy and montane rivers.	



Image courtesy of Caitlin Headon. Boomanoomana, NSW.

Proposed action 2.1: Rehabilitate ecological and culturally important sites within the mid and lower catchment

The mid and lower Murray catchments of the NSW Murray region contain ecologically and culturally important sites.

The mid-Murray consists of expansive floodplains and anabranches including the Edward/Kolety–Wakool and Niemur rivers. This area is highly developed and contains some of the region’s larger towns, including Albury. Many significant dryland and irrigated agricultural industries are in the mid-Murray. Delivery constraints in the mid-Murray River and an expansion of permanent plantings and environmental water use downstream means getting water to where it is needed is often difficult.

The lower Murray starts at the confluence of the Murrumbidgee River with the Murray River, flows along the semi-arid Mallee plains and is joined by the Darling River as it flows to the South Australian border. Although not part of this strategy, the Menindee Lakes system is an important southern connected storage that is used together with Lake Victoria to meet consumptive and environmental demands in the Lower Murray. Irrigated nut plantations have grown in this part of the region, increasing water demand.

This action aims to rehabilitate regionally significant riparian, wetland and floodplain reaches to improve habitat for native plants and animals and improve water quality throughout the river system.

It would complement previous environmental restoration initiatives by:

- exploring further opportunities for new or upgraded environmental watering works
- improving monitoring of ecological outcomes
- making changes to the funding model of NSW-held environmental water portfolios.

Potential examples include, but are not limited to:

- upgrading existing or installing new water delivery infrastructure (such as channels, levees, regulators, escapes and pumps) to provide water to wetlands
- upgrading existing infrastructure that restrict or no longer support flows to key sites (for example, road crossings, box culverts and bridges)⁷⁸
- upgrading Werai and Millewa Forest regulators and restoring Merran, Waddy and St Helena creeks (including Lake Tooim connection)
- developing a better understanding of the tolerable ecological limits of the Barmah Choke and Edward/Kolety–Wakool system
- collaborating with Aboriginal people and communities to maintain and preserve water-related cultural sites and landscapes
- developing a system to prioritise areas to protect or rehabilitate – for example, based on detailed habitat mapping data, native fish conditions, threatened species distribution, the River Styles Framework, severity of land degradation and environmental management outcomes
- funding the management of the NSW-held environmental water portfolio from consolidated revenue, rather than having to rely on the sale of allocation to generate the required revenue
- review opportunities to reduce the reliance placed upon held environmental water portfolios to address water quality incidents, noting that this is not the role of held environmental water portfolios
- reviewing the effectiveness of previous measures to manage native species and mitigate invasive species, such as carp, to inform more effective long-term actions.

Note that these proposed projects are not expected to be completed within the time available to be considered under the SDLAM (by 31 December 2026) and therefore will not be put forth for SDLAM consideration.

78. Some of this work would complement work proposed under the SDLAM program.

Proposed action 2.2: Encourage partnerships with the irrigation sector for environmental water delivery to public and private lands

Water for the environment is typically delivered to watercourses and wetlands situated on public lands such as nature reserves and national parks. However, partnerships between the irrigation industry and environmental water managers have also enabled the delivery of water for the environment to private lands. For example, Murray Irrigation Limited has delivered over 205 GL of environmental water to wetlands, ephemeral creeks and rivers within its footprint since 2001.

In addition, Murray Irrigation has secured a \$33.5 million Commonwealth grant to fund an innovative environmental water initiative, Restoring Murray Waterways. This project aims to upgrade existing infrastructure within the Murray Irrigation channel network and on private land to deliver environmental water to creeks and wetlands in the Murray Irrigation Area that only receive water in times of extreme flooding.

There is significant potential to expand on this, by governments, irrigation infrastructure operators and land holders working together through voluntary partnerships. Outcomes achieved could be enhanced by complementary on-ground measures such as drawing upon First Nations and landholder knowledge and scientific research.

Modernised supply networks allow precise control and measurement of water. In turn, this will support the precise delivery of environmental water, which means that specific environmental outcomes and at-risk ecosystems can be targeted with accuracy and control. It will also help to demonstrate the full accountability and benefits of publicly-held environmental water. Landholders and people within the community will be able to be actively involved in environmental management, creating a sense of ownership, collaboration and participation – key to rebuilding confidence in water management

This action proposes to explore additional opportunities to deliver water to wetlands using irrigation networks through voluntary partnerships between land holders, irrigation infrastructure operators and governments, including integrating First Nations knowledge and scientific research.



Image courtesy of Vince Bucello. Great Darling Anabranch near Wentworth.

Proposed action 2.3: Mitigate the impact of infrastructure on native fish

Many species of native fish need to move freely within and between rivers and waterways to source food, avoid predators and find shelter, escape the impacts

of drought, and seasonally spawn, migrate and recruit. Improving conditions for native fish will increase their resilience and the resilience of all aquatic communities. Water infrastructure such as dams, weirs and pumps is impacting this movement by creating physical barriers, removing and killing juvenile fish, and creating conditions – for example cold water – too far removed from a natural state.

Implementing the NSW Fish Passage Strategy

Priority 3 of the NSW Water Strategy includes an action to address threats to native fish through 3 state-wide, catchment scale initiatives: implementing the NSW Fish Passage Strategy; addressing cold water pollution through interventions such as temperature monitoring and mitigation technology; and investing in fish-friendly water extraction technology at priority sites in each region.

Improve fish passage at priority sites as guided by the NSW Fish Passage Strategy

Currently, native fish can only move freely through the NSW Murray system during high flows when water flows over weirs and other instream barriers. Removing barriers to fish movement and allowing fish to breed and find food and essential habitat is critical to supporting resilient native fish populations in the NSW Murray region.⁷⁹

The NSW Fish Passage Strategy outlined several priority sites for improving fish passage in the NSW Murray region. These include:

- Lake Victoria: Inlet Regulator, Control Regulator, Outlet Regulator
- Mildura Weir Lock 11
- Euston Weir Lock 15: replacement of fish lock gates
- Torrumbarry Weir
- Yarrawonga Weir
- Murray Anabranches.

Implement diversion screens at priority pumps

Since European settlement, the Basin has undergone significant ecological decline. Native fish populations have declined dramatically, at least 26 of the 46 native fish species found here are now listed as rare or threatened, and many ecological processes have been interrupted. A key impact of irrigation in the Basin is the entrainment, injury and/or death of tens of millions of native fish annually – estimated at 3.5 native fish per ML of water extracted.⁸⁰

In NSW alone, over 4,500 water pumps are operated for irrigation. In the Murray River, the total take by irrigated agriculture in 2020–2021⁸¹ was 2,221.64 GL, potentially impacting over 7.77 million native fish in this time. Almost all of this take is either unscreened or infrastructure use outdated ‘trash racks’, which provide limited or no protection for native fish and burden farmers with unnecessary maintenance expenses caused by incoming debris (over \$500,000 annually in some cases).

Modern fish-protection screens are automated, self-cleaning technologies that keep fish and debris in natural waterways and out of irrigation infrastructure. The screens work by reducing the velocity of water entering a pump intake, without reducing the volume of water that can be extracted. The technology is proven to work and is available for any type of water diversion, of any size. In NSW, 25 modern screens have been installed to date with 42 more with manufacture underway and scheduled to be installed by 2025.

Modern fish-protection screens can maximise the benefits of the Murray–Darling Basin Plan (the Basin Plan), by reallocating water from agriculture to the environment. The technology protects 90% of native fish that would otherwise be entrained, and effectively eliminates the impacts of debris on water infrastructure. The installation of screens reduces point-source mortality of native fish and helps stimulate widespread adoption of this best practice by irrigators, delivering significant and enduring ecological, economic, social and cultural benefits.

This action would build on existing government commitments that continue to encourage and provide incentives for installing diversion screens at priority pump sites in the NSW Murray region.

79. More information at: www.dpi.nsw.gov.au/fishing/habitat/threats/barriers

80. Boys et al 2021, *Native fish losses due to water extraction in Australian rivers: Evidence, impacts and a solution in modern fish and farm friendly screens*, Ecological Management and Restoration, Vol 22, Issue 2.

81. Murray–Darling Basin Authority (2022). Annual Water Take Report 2020–2021. MDBA, Canberra. Available at: www.mdba.gov.au/sites/default/files/publications/annual-water-take-report-2020-21.pdf

Restore priority habitats of threatened fish species

Reduced and degraded habitat for native fish in the NSW Murray region has led to many species becoming threatened or locally extinct. Restoring habitats can improve the resilience of native fish, which would lead to overall improvements in river function such as the restoration of complex food webs and enhanced water quality.

In some areas, native fish species are locally extinct. Once habitats have been restored, a conservation restocking program would be required for some species in some areas. Community groups and organisations (such as the Tri-State Murray NRM Regional Alliance⁸²) are working together to build surrogate breeding populations of threatened fish species.

In collaboration with existing initiatives, this action would seek to restore habitats in the following areas:

- Mannus Creek
- Hume-Yarrawonga reach
- Yarrawonga-Tocumal reach
- Millewa Forest
- Torrumbarry-Barham reach
- Edward/Kolety-Wakool rivers
- Murray-Murrumbidgee junction floodplain
- Lower Murray, Frenchmans Creek/Lake Victoria floodplains.

Progress cold water pollution mitigation

Cold water pollution has damaging impacts on riverine ecological function, particularly in summer when biological cues such as fish spawning are disrupted. Water releases from Hume Dam can display temperature decreases of 10 degrees or more in summer, which can extend more than 200 km downstream. In the Murray River, there has been a loss of trout cod, Macquarie perch and freshwater catfish from Hume Dam to Yarrawonga Weir.⁸³

While variable-level offtakes can be operated to reduce cold water pollution risks, in warmer months the presence of potentially toxic surface algae often means that it is not possible to use the variable-level offtake to take warmer surface water. As it is not currently possible to remove the risk of algal blooms in Hume Dam, additional actions to manage cold water pollution need to be taken.

Through this action, WaterNSW and the Department of Regional NSW would continue to:

- advance understanding of the improvements in fish populations that can be achieved by addressing cold water pollution
- progress investigations into alternative infrastructure improvements, new technologies and operational changes to find a preferred solution for the NSW Murray region.



Image courtesy of Gunther Schmida. Rainbow fish, Murray Darling.

82. More information at: www.necma.vic.gov.au/Projects/Current-projects/tristate-murra

83. More information on cold water pollution can be found at: water.dpie.nsw.gov.au/our-work/science-data-and-modelling/surface-water/water-quality

Proposed action 2.4: Support development and implementation of a NSW Murray Floodplain Management Plan and address floodplain structures

During the first public exhibition of the draft NSW Murray Regional Water Strategy stakeholders raised concerns about existing structures on floodplains in the NSW Murray region and their impact on the environment and Aboriginal cultural assets and values. We also heard concerns about the increased risk to life and property from existing and new structures on floodplains following the recent flooding in the region.

In 2021, the department's Water group completed a review under section 43 of the *Water Management Act 2000* and is currently progressing the replacement of 5 localised floodplain management plans (FMPs) for the NSW Murray region with one valley-wide FMP and associated declared floodplain.⁸⁴

A whole-of-valley approach to floodplain management will benefit some of the NSW Murray region's most critical wetlands that are located at the end of the regulated system and ensure healthy floodplains that support healthy catchments.

As part of developing the NSW Murray FMP, the department would:

- develop new hydraulic models
- identify existing flood works (approved and unapproved)
- identify flood dependent ecological assets and Aboriginal cultural assets and values.

In addition to supporting the development and implementation of the NSW Murray FMP, this action would address existing structures on floodplains that adversely impact the environment and Aboriginal cultural assets and values and increase the risk to life and property. Progressing this action would require:

- working with NRAR and WaterNSW to bring unapproved or non-compliant structures on floodplains into compliance and considering options to accelerate this process in the NSW Murray region. This could include rolling out a program like the Improving Floodplain Connections Program⁸⁵ for the region.

Proposed action 2.5: Continue to invest in modelling to improve groundwater knowledge in the NSW Murray region

The NSW Government uses computer-based water system models to inform many decisions in regional water management. Groundwater system models simulate the behaviour of aquifers over time, including groundwater recharge and the take of water from bores. They help analyse seasonal patterns and longer-term trends in groundwater levels. Models also help to understand the potential risks to groundwater-dependent ecosystems and to groundwater quality.

Groundwater models can also:

- provide regional information to support local water utilities in planning for future water supply
- provide a better understanding of the impacts of groundwater extraction on other users of a groundwater source to improve the assessment of licence applications
- help to understand the potential risks to groundwater-dependent ecosystems and to water quality
- incorporate new understanding on interconnectivity between surface water and groundwater
- integrate socio-economic and physical data
- consider the potential impacts of climate change and how that will influence the behaviour of groundwater resources into the future.

84. More information is available on the replacement floodplain management plans at: water.dpie.nsw.gov.au/our-work/floodplain-management/plans/southern-floodplain-management-plans

85. The *Improving Floodplain Connections Program* is currently being delivered in the Northern Basin. More information is available at: water.dpie.nsw.gov.au/our-work/floodplain-management/improving-floodplain-connections-program

Continuing to improve these models as new data becomes available will be particularly important for managing and sharing limited water resources, and predicting and mitigating the impacts of increasingly variable and extreme conditions in the NSW Murray region.

To progress this action, the department would:

- update, calibrate and peer review numerical models for the NSW Murray region
- upgrade and expand the monitoring bore network to fill in data gaps that are essential for improving our models. Additional and replacement monitoring bores are critical to ensure there is sufficient data to build and calibrate models
- incorporate shifts in demand and changes in rainfall patterns that are likely driven by climate variability
- incorporate new understanding on interconnectivity between surface water and groundwater
- develop multi-disciplinary models incorporating socio-economic and physical data, as well as groundwater volume, level, and quality data
- develop approaches to help use the models to inform future water level and quality management practices.

Proposed action 2.6: Encourage best practice land management

Best practice land management improves on-farm water balance and quality of water. This action proposes to build on existing programs to support private landholders to adopt best practice land management in priority waterways across the region.

Landholders play a key role in improving ecosystems and habitats through best practice land management. Many landholders have adopted best practice land and water management in the NSW Murray region; however, we heard that some landholders need support in recognising potential improvements they could adopt in managing their land and water requirements. Furthermore, feedback received through recent water engagements with local landholders indicated some are frustrated with the lack of extension services available to help them understand the rules, obligations and opportunities for accessing and managing farm water needs.

Support for this action would be provided largely through natural resource management and sustainable agriculture advisory services and on-ground projects, with a focus on:

- stock grazing management
- carbon and regenerative farming
- soil disturbance and erosion management
- soil condition and ground cover management
- native vegetation and biodiversity management
- streambank and riparian vegetation protection and restoration
- structural instream habitat restoration works
- drainage and fertiliser use management.

A suite of fit-for-purpose tools would be used to build landholder capacity in knowledge, skills, access to networks and resources. These tools could include:

- one-on-one consultation sessions
- providing advice and referrals for information
- online resources including information webinars, podcasts and social media updates
- field days and demonstration sites
- identifying funding models, including landholder incentives.

The delivery of this program would align with and complement the framework developed in proposed action 2.9 Support (ongoing) river restoration in the upper NSW Murray and Snowy catchments. This would ensure that support for improvements in private landholder land and water management practice is directed to catchments where river reaches have a high recovery potential or improvements are critical to achieving key catchment health objectives. Implementation of this action could support existing programs and be delivered in partnership with other government agencies, as well as local Aboriginal and community groups.

Proposed action 2.7: Support place-based initiatives to deliver cultural outcomes for Aboriginal people

The Australian Government's Closing the Gap report and Local and Regional Voice program have highlighted that Aboriginal people have expressed the desire for strong and inclusive partnerships, in which local communities set their own priorities and tailor services and projects to their unique situations. Demonstrated successful initiatives are typically those that are tailored to local circumstances and are place-based, well resourced and locally driven. Often, these initiatives cannot be scaled up.

This action would provide NSW Government support for Aboriginal organisations and communities to develop tailored projects for their communities. It aims to move away from centralised decision making to develop a flexible program that is driven by the principle of self-determination – local communities 'speaking with their voice' to make decisions about which programs are needed for their community and their region.

To progress this proposed action in the NSW Murray region:

- the Cultural Watering Plans project would be continued to include further communities in the region⁸⁶
- access to Country would be improved, including to sites that have local significance. This could include opening up local parcels of public land that have access to waterways but are otherwise gated or locked – such as Travelling Stock Reserves or Crown roads
- a demonstration reach would be established, using cultural knowledge and science to rehabilitate riparian land, through planting of native species and caring for Country
- programs that engage Aboriginal youth in water and landscape management would be established, with the aim of building cultural awareness and giving a sense of ownership and cultural connectivity
- local programs that identify and record significant water-dependent sites in the NSW Murray valley would be established, with information stored in a culturally appropriate way.

Incorporating Aboriginal knowledge and culture into catchment management

As custodians of Australia's land and water for tens of thousands of years, Aboriginal people have developed a rich spiritual connection to Country and have a large body of culture and knowledge.

A more holistic approach to improving catchment health involves working collaboratively with Aboriginal people, drawing on their knowledge and experience, and integrating their perspectives, approaches and values into water and catchment management frameworks.

We need to develop whole-of-system governance structures that are supported and understood by Aboriginal people and to give Aboriginal people direct input to water management decision making. We also need to provide Aboriginal people with opportunities to manage water using their culture and knowledge and to create improved economic opportunities and environmental outcomes. Restoring degraded spiritual and cultural sites is also an important act of reconciliation.

NSW's obligation under the Basin Plan

The NSW Government has obligations for the development of water resource plans under Chapter 10, Part 14 of the Basin Plan. These plans must identify Aboriginal people's objectives and desired outcomes for managing water resources in each region. A requirement under the Basin Plan is ensuring there is adequate consultation with First Nations in developing water resource plans.

The objectives and outcomes stated by the Aboriginal Nations in the NSW Murray water resource plans will be the basis for further initiatives focussed on considering and supporting Aboriginal people's objectives and outcomes in water resource management.

86. More information is available on *Cultural Watering Plans* at: water.dpie.nsw.gov.au/plans-and-programs/aboriginal-water-program/cultural-watering-plans

Proposed action 2.8: Implement the Reconnecting River Country Program in the NSW Murray region

The Reconnecting River Country Program is a key Murray–Darling Basin initiative essential to creating healthier functioning river systems in the Murray and Murrumbidgee valleys.

Currently, rivers connect to wetlands and floodplains less often than is needed to maintain healthy ecosystems, due to river regulation and extraction. Water for the environment aims to restore the balance, however constraints restrict the effective use of this water contributing to the continual decline of the health of Country, including the species depending on these environments to survive.

A constraint is any physical, policy or operational barrier limiting the flow of water in river systems. There are a range of flow constraints in the Basin, some examples include:

- physical restrictions such as low-lying watercourse crossings, weirs and levees
- operational restrictions such as river operation rules and practices
- policy barriers such as existing legislation.

The program is proposing to remove constraints to enable the flexible use of water for the environment to increase the frequency and extent rivers connect to their wetlands and floodplains. Removing constraints is critical to achieving the Murray–Darling Basin Plan's improved environmental outcomes and making best use of existing water recovered from communities.

The program is currently in the development phase, and is working with landholders, First Nations people, public land managers and local communities on key aspects of its development.

If the program proceeds to delivery, greater flexibility to manage water for the environment would create healthier river systems providing a range of benefits for native vegetation, native fish, waterbirds, turtles, frogs and other wildlife.

Healthier river systems would provide generational benefits for local communities and the broader Basin community.



Image courtesy of iStock. Murray River, NSW.

Proposed action 2.9: Support (ongoing) river restoration in the upper NSW Murray and Snowy catchments

Historical and current land and water management has impacted the ecology of the upper NSW Murray and Snowy river systems resulting in altered stream flows, increased rates of sedimentation, weed infestations, loss of fish numbers and species, and loss of aquatic habitats.

This action would develop and fund a coordinated Snowy and upper NSW Murray River catchment recovery program, collaboratively with stakeholder organisations, First Nations and other state/territory and federal government agencies.

Progressing this action would include:

- coordinated environmental water management and legislated protection for environmental flow releases
- enhancing and building upon the existing upper Murray River Works Program and other catchment management programs such as the upper Murray peatlands protection project
- management of pest species
- threatened species re-introductions
- developing a monitoring and evaluation framework
- improve understanding and potentially addressing runoff impacts created by farm dams.

Investing in catchment management and prioritising source water protection helps reduce water treatment costs

By implementing effective catchment management practices, the quality of the source water can be improved. This means that the water entering treatment plants is already of higher quality, requiring less intensive treatment. When source water is cleaner, this reduces the need for expensive and complex treatment processes, such as advanced filtration or chemical dosing, which can be energy-intensive and costly.

Catchment management focuses on preventing pollution at the source rather than relying solely on water treatment plants to remove contaminants. By addressing pollution sources, such as industrial discharges or agricultural runoff, early on, the need for costly remediation measures at water treatment plants is minimised. Prevention is generally more cost-effective than dealing with pollution after it has entered the water supply.

Water treatment plants are expensive to build and maintain. Effective catchment management can help preserve the lifespan and efficiency of treatment infrastructure by reducing the load on the systems. With cleaner source water, the equipment and facilities at treatment plants are subject to less wear and tear, resulting in reduced maintenance costs and increased longevity. By investing in catchment management and prioritising source water protection, water treatment costs can be significantly reduced in the long term.

Proposed action 2.10: Investigate improvements to the flow regime of the Snowy and montane rivers

The combination of Snowy Scheme flow diversions and land use practices continue to produce several challenges in the upper Murray and Snowy rivers catchments, such as a poor and declining river health, compromised cultural values and endangered species.

This action would investigate a range of opportunities to restore a sustainable flow regime, with partner governments and stakeholders and could include:

- undertaking scientific studies to address key knowledge gaps concerning river health
- designing a program to identify and record significant water-dependent sites, undertake aboriginal waterways assessments and cultural watering plans in line with proposed action 2.7 Support place-based initiatives to deliver cultural outcomes for Aboriginal people
- a review of the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) 2002
- continuing to explore, with partner governments and stakeholders via a review of the SWIOID or Snowy Water Licence, improvements in environmental water management, including:
 - introduction of carry-over allocations for Snowy Rivers Increased Flows
 - improving flexibility to allow changes to be made to scheduled daily flow releases to respond to natural flow events or environmental requirements
 - allowing flow releases to have more natural variation within a 24 hour period rather than being held constant for that time
 - increasing annual volumes of water releases from Jindabyne Dam.
- revision of the Murray-Lower Darling Long Term Water Plan⁸⁷
- investigation of energy generation trade-offs associated with any proposed changes to flow releases
- long-term resourcing of monitoring to understand the response of riverine ecosystems to improved management and ecological condition.



Image courtesy of Destination NSW. Thredbo, Snowy Mountains.

87. More information on long term water plans is available at: www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/all-long-term-water-plans

Priority 3

Support sustainable economies and communities

Regional cities and towns in the NSW Murray region could face increasing risks to the security of their water supplies over the coming decades. Agriculture, energy generation and tourism will continue to be important to the region's economy into the future. It is vital to understand the risks and challenges to our industries and communities to better manage water

supply. It is also important that operational, planning and development decisions take into account the likely reliability and security of future water supplies.

The actions shortlisted under this priority would support improved industry and community resilience to climate-related and other challenges.

What is already happening



The NSW Government has developed the **NSW Alternatives to Buybacks Plan** to detail how we will deliver on existing and new projects to protect NSW Basin communities and industries from large scale water buybacks. Further details are provided above (refer to Alignment with the Basin Plan section above). It is expected that the Commonwealth will progress with water purchases but will also make funding available for community adjustment to manage and mitigate negative social and economic impacts arising from water purchases towards the 450 GL water recovery target.

Funding of \$3.9 million has been provided under **Future Ready Communities** to promote resilience and develop drought resilience plans that assess drought impacts and responses. Individual plans can focus on intra- or inter-industry diversification, leadership and social capital building, and planning council works. The Future Ready Regions Strategy and Future Ready Communities Pilot Program includes a commitment to upgrade the Enhanced Drought Information System to provide farms with world-leading weather and climate data so they can make better business decisions, and to support councils to develop drought resilience plans.

Funding of \$48 million has been provided for the **Farms of the Future Program**⁸⁸ to support on-farm connectivity and encourage farmers to adopt agtech to boost their productivity, water efficiency and drought preparedness.

Aboriginal water rights are being advanced, including setting a target of 3% of water entitlements to be owned by Aboriginal people and organisations under the National Agreement on Closing the Gap. The state-wide **Aboriginal Water Strategy** will identify measures to deliver on Aboriginal people's water rights and interests in water management.

The **Climate Change Research Strategy** is supporting projects that help primary industry sectors adapt to climate change.

The NSW Government has supported local councils to develop **regional economic development strategies** (REDS) based on the concept of a Functional Economic Region. The REDS set a clear economic development strategy for the region. An update was completed for the Murrumbidgee region in 2023.⁸⁹

Regional Plans across NSW were updated in 2023. These plans set a 20 year framework, vision and direction for strategic planning and land use to ensure regions continue to be vibrant places for people to live, work and visit.

88. More information available at: www.dpi.nsw.gov.au/dpi/climate/farms-of-the-future

89. More information available at: www.nsw.gov.au/regional-nsw/regional-economic-development-strategies



The NSW Government has developed region-specific information about drought management. The **NSW Drought Hub** provides resources to assist stakeholders to prepare and manage for drought. Region-specific actions in the Murrumbidgee Regional Water Strategy will also improve management of future droughts.

The NSW Government has launched a new \$5.95 million **Aboriginal Ranger Program** to enhance Aboriginal people's connection to Country and provide meaningful career pathways. This structured employment and development program is designed to attract and retain talented Aboriginal people to build public sector capabilities. A key goal is to give participants accelerated exposure to Local Land Services and its operations. Trainees will be equipped with transferable skills and a sound understanding of the workings of the public sector. The program will create broadscale employment and training opportunities for Aboriginal people and communities across NSW.

The **NSW Extreme Events Policy framework** includes a staged approach and provides a range of measures for water managers to extend remaining supplies for critical needs as conditions deteriorate. As an extreme drought is prolonged, water managers will progressively introduce more stringent restrictions on access to water by different water users. The NSW Department of Climate Change, Energy, the Environment and Water's website has a summary of the types of actions that the department may take as the drought becomes more critical.⁹⁰

The open data framework recently published by the department outlines how open data will be managed and driven to improve transparency and data sharing. This is part of a policy to provide more open and easily accessible data.



Image courtesy of Destination NSW. Lake Hume Resort, Luke Hume Village.

90. More information available at: water.dpie.nsw.gov.au/about-us/how-we-work/legislation-and-policies/extreme-events-policy

Legend



Balancing competing interests for water



Improving the health and resilience of ecosystems



Addressing barriers to Aboriginal people's water rights



Supporting existing and emerging industries and livelihoods

Table 6. Overview of proposed actions for Priority 3 – Support sustainable economies and communities

Proposed action	Summary	Challenges addressed
Action 3.1 Support the development of new water related Aboriginal business opportunities in the NSW Murray region	Support Aboriginal business development opportunities in the NSW Murray region, some of which may require access to water resources. This action would also investigate ways to expand water-related employment opportunities for Aboriginal people in the NSW Murray region.	 
Action 3.2 Reduce uncertainty in groundwater security for regional towns and industry	This action focuses on enhancing groundwater security in the NSW Murray region, which is crucial for towns and industries. It addresses varying quality and availability issues, especially during droughts. Strategies include monitoring contaminants, developing innovative salinity solutions filtration tech, and collaborating with councils to promote for sustainable groundwater use and develop a policy for managed aquifer recharge.	 
Action 3.3 Investigate innovative ways to improve runoff in water supply catchments	This action explores expansion of cloud seeding activities for increased snowfall and investigates strengthening bushfire management to preserve crucial runoff processes and water quality.	 
Action 3.4 Support towns and local water utilities to understand and manage their future water security risks	Supports towns and local water utilities to manage future water security risks. This action involves risk analysis, upgrading water models, exploring alternative supply options, and promoting urban efficiency measures, including stormwater harvesting and smart metering. Various programs and collaborations would aim to enhance water system efficiency and conservation.	 
Action 3.5 Consider an enduring level of supply to support regional towns and centres	Shift away from managing water security based on acceptable risk towards ensuring an enduring level of supply for regional towns. This action involves developing guidance for local water utilities to adopt this approach, considering factors such as community needs and willingness to endure water restrictions.	 

Proposed action	Summary	Challenges addressed
Action 3.6 Improve public access to climate information and water availability forecasts	Improve existing platforms and products to provide information about water availability and climate change in a format tailored for water users and their business planning needs in the NSW Murray region.	



Image courtesy of Jason King. River Red Gums.

Proposed action 3.1: Support the development of new water-related Aboriginal business opportunities in the NSW Murray region

During our consultation on the draft NSW Murray Regional Water Strategy, we heard about the need for economic development and business opportunities in the region that are led by Aboriginal communities. Stakeholders showed strong support for initiatives that result in employment opportunities for Aboriginal people and particularly Aboriginal youth. However it was stressed these roles needed to be based in the community. Training opportunities, particularly for Aboriginal youth, were also identified as a key priority.

Investing in regional Aboriginal businesses can help diversify incomes in the region, create employment for local Aboriginal youth and improve social and economic outcomes for Aboriginal people. Realising some of these opportunities may require access to surface water or groundwater resources.

The NSW Government is supporting Aboriginal business development opportunities in the NSW Murray region through a range of programs including the Aboriginal Partnership Program⁹¹ led by the Department of Regional NSW. The program will support government agencies and communities in progressing economic development opportunities. A dedicated Aboriginal Partnership Manager will work with Aboriginal organisations, businesses, and individuals to identify and develop new business opportunities or better manage existing ones and access support or grant funding.

Other support is also available through the NSW Department of Aboriginal Affairs, the NSW Aboriginal Land Council and the National Indigenous Australians Agency.

Through this proposed action, existing programs and support would be leveraged to identify and progress new water-related Aboriginal business, employment and training opportunities, including by establishing cultural water officers and/or river rangers.

Proposed action 3.2: Reduce uncertainty in groundwater security for regional towns and industry

Groundwater is an important water source for towns, communities and industries across the NSW Murray region. Groundwater availability and quality varies across the region according to the geology and location.

During drought, groundwater use tends to increase as surface water becomes less available. Groundwater in the NSW Murray region is used for agricultural, industry, stock and domestic purposes and town water supply.

There are many groundwater bores in the Upper Murray Alluvium. Most groundwater bores are used for stock and domestic purposes. However, there are also bores used for irrigation that can extract moderate to high volumes of water each year. Groundwater from this source is also used as the main water supply for the township of Balldale.

There is heavy reliance on the Lower Murray Deep Alluvium for irrigation, particularly east of Wakool to Finley. The Billabong Creek Alluvium has a low level of use compared to the Upper Murray Alluvium and Lower Murray Deep Alluvium, and is mainly used for stock and domestic purposes, with some use for irrigation. The Billabong Creek Alluvium provides town water supplies for Walbundrie, Walla Walla, Culcairn and Holbrook.

Groundwater in some areas of the lower Murray region is known to have elevated levels of salinity that limit or prevent its use. Opportunities for information sharing and developing affordable desalination and filtration technology will support the region in utilising groundwater more effectively and sustainably.

91. More information available at: www.nsw.gov.au/regional-nsw/regional-aboriginal-partnerships-program

Consistent with the NSW Groundwater Strategy, this action would:

- collaborate with councils to understand groundwater resource availability and quality at a local scale
- continue to develop a policy framework for managed aquifer recharge
- consider sustainable groundwater use in regional planning and development initiatives
- develop a groundwater level management framework with actions to manage any local water level decline. This would include establishing groundwater condition limits to ensure fair and ongoing access to groundwater for towns, industries and the environment
- review the regulation of basic landholder rights, including stock and domestic basic landholder rights in and around urban centres
- support development of innovative salinity solutions for groundwater communities and industry.

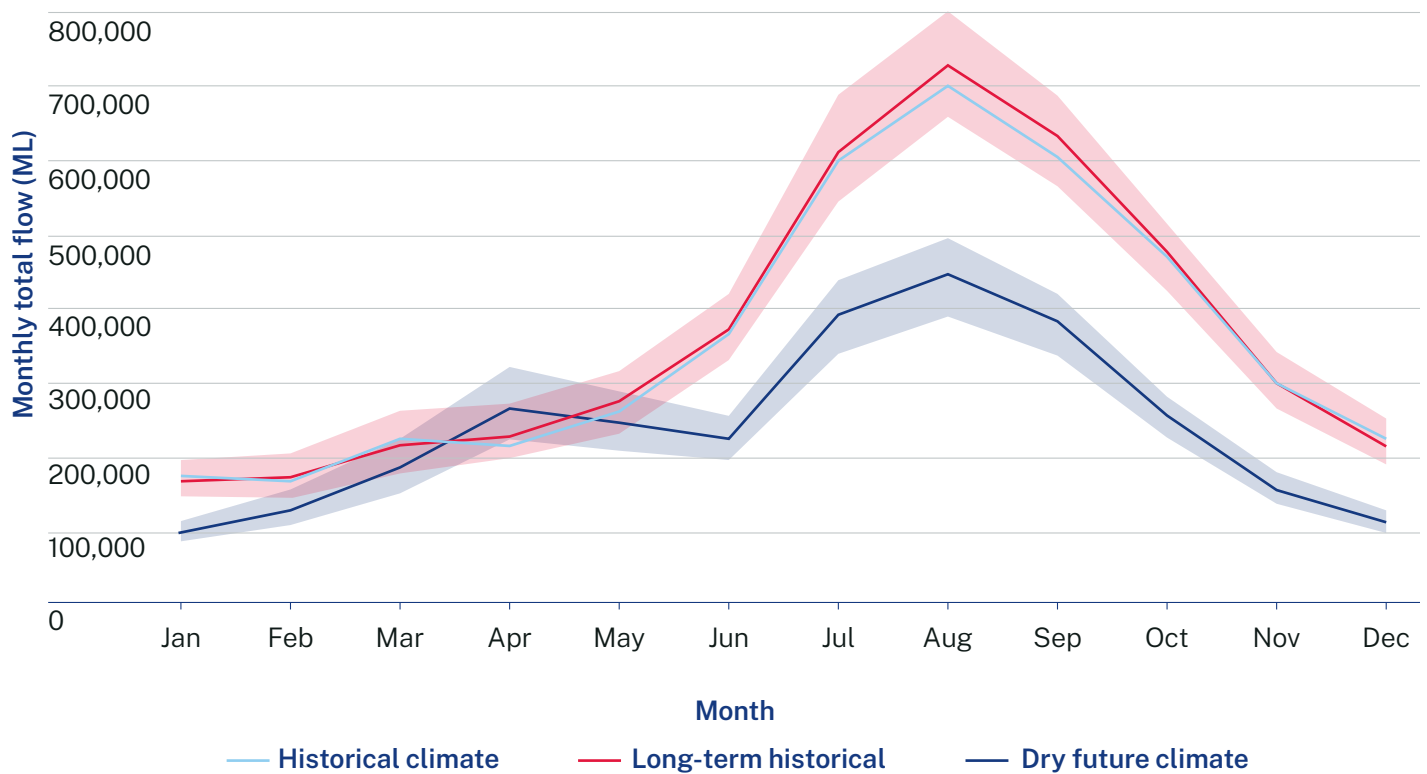


Image courtesy of iStock. Township, Albury.

Proposed action 3.3: Investigate innovative ways to improve runoff in water supply catchments

New climate and modelling data (Figure 14) highlights that under the dry future climate scenario there would be a significant decrease in the inflow volume into the shared storages of the NSW Murray River system – particularly during the traditional dam filling period of winter/spring.

Figure 14. Impact of climate scenarios on seasonal inflows into the NSW share of the shared Murray system storages



In the un-dammed upper Murray and Snowy catchments, climate data indicates that median flows would be lower and cease-to-flow events more prevalent under a dry future climate. This has implications for the unregulated systems in the upper NSW Murray and inflows into the major dams of the regulated systems.

Cloud seeding (Glaciogenic seeding) is a weather modification technique that introduces a seeding agent (silver iodide) into suitable clouds to encourage the formation and growth of ice crystals. This enhances the amount of snow or rain falling from the cloud.

Snowy Hydro has been trialling snowfall cloud seeding since 2004 over an area of approximately 2,110 m² from just south of Thredbo through to Kiandra. An independent scientific evaluation of this trial found cloud seeding increased precipitation by an average of 14% during targeted events, with no adverse effects on precipitation downwind of the target area and no adverse environmental effects.⁹²

The additional snowfall improves snow conditions for winter sports, as well as providing more meltwater for energy production and subsequent release to the Murray and Murrumbidgee rivers for irrigation, town water supply and the environment.

A drying, more variable climate will also increase the severity of already-problematic bushfires in the region, leading to significant changes to hydrological runoff processes. When intense fires occur in catchments such as the Snowy Mountains and upper Murray, they can have profound impacts on water quality in the short-term and also diminish the volume of rainfall that is converted into runoff for streams and dam inflows over the long term.

As such, the regions's key watersheds need to be better managed to avoid adverse fire regimes and associated water-quantity and water-quality impacts and to improve runoff. Progressing this proposed action would involve investigations by the NSW government to better understand:

- the feasibility of expanding cloud seeding operations (beyond Snowy Hydro's operational program) in key water supply catchments to improve snowfall in the upper NSW Murray catchment
- how bushfire management could be strengthened, with investment from the water sector, to preserve and rehabilitate vitally important runoff processes. This would include investigating the feasibility of including rainfall runoff processes as a strategic bushfire management priority and identifying the associated fire management activities.

Using Snowy Hydro infrastructure to store consumptive water

A feasibility study into commercial arrangements for storing or banking water in Snowy Hydro Ltd infrastructure was completed in November 2022. The study included stakeholder engagement with irrigation organisations, the Australian Government and state agencies from Victoria and South Australia. A risk assessment and examination of the key criteria required for commercial arrangements identified the following high risks and issues:

- administration needs
- potential impacts on South Australia storage rights
- Murray–Darling Basin agreement for Victoria's share
- equitability of user access
- water for environment calculations (RMIF)
- the need to change multiple legislative instruments and relatively low level of interest of stakeholders.

92. NSW Natural Resources Commission, 2012. Cloud seeding trial: www.nrc.nsw.gov.au/completed/cloud-seeding

Proposed action 3.4: Support towns and local water utilities to understand and manage their future water security risks

There is increasing competition for limited water resources and there are key knowledge gaps regarding water use and losses in the NSW Murray region. Increased climate variability and climate change is likely to reduce water security and reliability for towns and industry.

Additionally, significant population growth of regional centres and towns is expected over the next 20 years, which will increase demand on town water supply. The major areas for growth are expected to be Albury City, Murray River and Greater Hume Shire councils.

Climate modelling has shown that, with current demand levels, the risk of surface water shortfalls for Albury Council, Murray River Council and the smaller towns of Tumbarumba and Bombala is already significant. This risk could increase significantly as growing populations in Albury and the Murray River municipality generate higher demand for water. Under a dry future climate scenario, the risk of surface water shortfalls increase for many towns in the NSW Murray region.

More needs to be done with less water under a more variable future climate. Community, business and government expectations are that water needs to be used more efficiently to reduce domestic and industry

demand. With potential shortfalls and expected growth in the NSW Murray region, water efficiency and demand measures could be used to help reduce demand on water sources and make existing water supplies go further.

To progress this action, the NSW Government would:

- support councils and local water utilities with guidance to confirm the level of risk through town water security analysis using the new climate data
- support councils and local water utilities to investigate options for town water security
- investigate capability to purchase or trade additional water entitlements
- investigate potential alternative supply options from groundwater
- investigate innovative water management options for towns and industry such as stormwater harvesting and use of recycled water by industry, within or near towns
- investigate urban water efficiency measures including:
 - water restrictions to limit town water use during dry periods and prolong water supplies
 - installation of rainwater tanks and greywater systems on houses and commercial buildings, encouraging water-efficient appliances
 - reducing leakage from pipes
 - smart metering and pricing.

Safe and Secure Water Program

The \$1 billion Safe and Secure Water Program, established in 2017, is managed by the department and co-funds vital water and sewerage projects across regional NSW. This co-funding assists non-metropolitan councils, local water utilities, county councils, water supply authorities and joint organisations to deliver projects that provide safe, secure and sustainable water and wastewater services to regional NSW.

In the NSW Murray region, funded projects include Murray River Shire, Edward River and Albury.

Town Water Risk Reduction Program

The NSW Government is collaborating with local water utilities and the wider sector on the Town Water Risk Reduction Program. This program is delivering a new approach to working together that enables local water utilities to access the capacity and capabilities of State Government entities, including agencies and State-owned corporations, to manage risk and priorities in town water systems more strategically and effectively.

Several pilots have been initiated to trial new approaches to local water utility strategic planning. In the NSW Murray region, Balranald Council has been successful in becoming a participant in the program.

NSW Water Efficiency Program

The NSW Water Efficiency Program for urban areas is collaborating with key stakeholders to increase investment in water system efficiency, water conservation and demand management. This aims to delay the timing and reduce the scale of investment in new supply infrastructure.

Regional Leakage Reduction Program

A key aspect of the Water Efficiency Program is addressing network leakage and water loss. The need to focus on local water utilities' network leakage and water losses became apparent during the drought and has been reinforced during consultation with councils and the wider sector as part of the Town Water Risk Reduction Program. Several councils in the NSW Murray region have participated in the Regional Leakage Reduction Program, with Wentworth receiving grants for co-funded projects under this program.

Aboriginal Communities Water and Sewerage Program

The program provides ongoing leak repair and education projects to promote water-wise behaviour and demand management measures within Aboriginal communities.

Smart Approved WaterMark – Smart Water Advice Program

The NSW Government and Smart Approved WaterMark are partnering with local water utilities and councils to provide subsidised subscriptions to the Smart Water Advice Program. Subscribers to Smart Water Advice receive water efficiency tips and advice, interactive tools and information to share with their communities.

Local water utility performance data

The NSW Government provides and maintains a public web-based database for NSW regional water utilities to annually report their current water supply and sewerage data. Performance monitoring and benchmarking are required under the National Water Initiative and provide assurance to the NSW Government that the requirements of the *Water Management Act 2000* are being met (i.e. each local water is performing satisfactorily).

Proposed action 3.5: Consider an enduring level of supply to support regional towns and centres

The current approach to managing water security for regional cities and towns relies on defining an ‘acceptable risk’ of running out of water. Existing NSW Government guidelines suggest town water supplies should meet a minimum level of service that roughly correlates to supplies being able to withstand a drought that has the probability of occurring 1 in 1,000 years. This level of risk may not be appropriate for large towns where there are no last resort options, such as water carting, in extreme droughts.

Metropolitan water utilities such as Sydney Water and Hunter Water have shifted their focus away from an ‘acceptable level of risk’, recognising that running out of water is a risk that neither the communities they supply nor government will tolerate, regardless of the probability of it happening. Instead, they are exploring the concept of ‘enduring supply’ to inform long-term water supply planning.

The enduring supply concept involves determining the amount of water needed to meet the minimum needs of the community during periods of prolonged and extreme drought, irrespective of how long the drought lasts.

Determining the enduring level of supply is informed by:

- the minimum amount of water needed for the cities or towns to keep running
- how long residents and businesses are willing to endure severe water restrictions
- the willingness of communities to pay for increased water security.

This action would develop guidance for local water utilities to use the enduring supply approach. This could include, but not limited to guidance about:

- highlighting the benefits and opportunities of adopting ‘enduring supply’, and how it differs from other local water utility strategic planning processes
- key steps involved and what assumptions and data are required
- the kinds of rainfall-independent solutions that could be involved
- levels of stakeholder consultation required.

Proposed action 3.6: Improve public access to climate information and water availability forecasts

All parts of the community and government need access to reliable and timely information to make informed decisions and effectively engage in water planning and decision making. Having transparent and accessible data to contribute to discussions around drought and flood management was a key point raised by stakeholders.

An incomplete understanding of the risks relating to future water availability can lead to poor investments, poor business decisions, poor drought security planning and loss of opportunities to invest in alternative water supplies. For example, towns and communities may be unaware of the higher risk not just to their essential water supplies but also to their local economies when a significant proportion of the economy is based around irrigated and rainfed agriculture – both of which suffer heavy impacts during extended severe droughts.

Having an incomplete picture of how, when and where water is used also has implications for water quality and water-dependent habitats. Longer and more severe droughts increase the risk of debilitating ecosystem damage, fish deaths and severe blue-green algae outbreaks. Better understanding of potential future climate scenarios will improve our ability to plan for, and mitigate, ecosystem risks.

The NSW Government will consult with stakeholders on their information needs and the best ways to communicate with them. We will design and deliver suitable training and information products and platforms that communicate information such as:

- 12-month climate outlooks and how these could influence water allocation decisions and other operational water-sharing decisions, which could help water users make informed decisions on managing their allocations using carryover or trading water on the market
- indications of potential water allocations, provided ahead of the 1 July start of the water year, where possible, to support business planning
- potential implications of long-term climate data for:
 - surface water availability and water quality
 - the likelihood of consecutive years of low or no water availability
 - periods when access to water allocations may be restricted by delivery problems in the regulated river system
 - groundwater availability.

- improvements over time in flow forecasting capabilities and investment in science and analytics to better understand rates of return of flows from floodplains into rivers
- how future use may affect the condition of groundwater resources
- a decision framework for how available water determinations are made based on use, compliance triggers and carryover
- information about groundwater resources and how they are managed to assist councils and other water users to make more informed decisions about their water supply security.
- deliver upfront education and clarity to new industries and government on potential water sources, given that the surface water sources and some groundwater sources are already fully allocated and there is potential for reduced water availability in the future
- encourage new industries to have comprehensive drought management plans as they set up in the region
- modernise communication around commence-pump and cease-to-pump targets being met in real time.

We will also:

- increase the frequency of surface water data collected – specifically during high-flow and flood periods, including updating the reliability and accuracy of gauging stations
- take a proactive approach to understanding the water quality and quantity requirements of emerging industries to inform policy development and planning decisions

The work will build on or complement existing state and national information platforms and products, including the WaterNSW's WaterInsights and Water Information dashboards.

Increasing the amount of publicly available climate-related information, including short-term and long-term water availability forecasts, will help businesses in the NSW Murray region plan with greater certainty. It will also support farm-level climate adaptation decisions.



Image courtesy of Vince Bucello. Murray Valley Regional Park, NSW.

Collecting more data and better data

The NSW Government is undertaking programs aimed at improving its understanding of water flows and water use in the NSW Murray region.

Climate risk data

The NSW Government has recently published the long-term climate variability risk data that supports the regional water strategies. This is the first step in providing water users with better access to information on the future risks to water availability. The stochastic datasets for rainfall and potential evapotranspiration for the NSW Murray region and a number of other NSW regions are available on the SEED portal.⁹³

Non-urban water metering framework⁹⁴

It has been almost 5 years since new metering rules were put in place for non-urban water users. More than 70% of large commercial water users with irrigation pumps bigger than 500 mm have installed accurate, tamper-proof meters. The installation of meters by thousands of smaller water users will also provide opportunities for improving water sharing management and arrangements.

The non-urban metering rules are being reviewed to assess progress since the rules were put in place, and to determine how the rules can be improved and compliance with them made easier. Recent consultation was recently held and a what we heard report will be published soon.

Hydrometric Network Review⁹⁵

NSW is currently undertaking a review of its hydrometric (river gauge) network. The review is looking at the coverage and data quality obtained from the existing hydrometric network and identifying ways to improve the information collected.

The gauging stations will deliver transparent, accurate and accessible data in real time to water users, communities and stakeholders alike, building on more than 1,300 monitoring sites already available in real time to the public. Information available from the new stations will include stream levels, flow volumes and water quality.

These sites will enhance the network so we can better manage stream connectivity, compliance, environmental water release, and extreme events. The new stations will add even more localised data, helping to better understand local conditions so we can better balance the needs of water users and the environment, and better prepare for floods and droughts.

Water users can access the data through tools including WaterNSW's Water Insights portal⁹⁶ and WaterLive App and the Bureau of Meteorology's Water Information Portal⁹⁷ and Water Data Online.⁹⁸

93. More information available at: www.seed.nsw.gov.au

94. More information available at: water.dpie.nsw.gov.au/our-work/nsw-non-urban-water-metering

95. More information available at: water.dpie.nsw.gov.au/science-data-and-modelling/data/hydrometric-network-review

96. More information available at: waterinsights.watarnsw.com.au/

97. More information available at: www.bom.gov.au/water/

98. More information available at: www.bom.gov.au/waterdata/



Image courtesy of Destination NSW. Murray River, Barmah National Park.

How to have your say

A large, bold, white number '5' is superimposed on the lower-left portion of the image. The background is a photograph of a vineyard with rows of grapevines stretching into the distance under a cloudy sky. The vines are green and leafy, supported by wooden posts and wires. The ground is covered with dry grass and some weeds.

Image courtesy of Destination NSW, Courabyra Wines, Tumbarumba.

When will the actions be implemented?

A critical feature of the final NSW Murray Regional Water Strategy will be ensuring actions and investments that are needed now and those that will or may be needed further into the future are clearly identified. The strategy considers a 20-year timeframe aiming to chart a progressive journey that enables us to meet existing challenges, identify and prepare for foreseeable coming challenges and lay the groundwork for adapting to future uncertainties and changed circumstances.

After public consultation, an implementation plan will be developed that will set out when each action will commence and what will be achieved by when. The implementation plan will also identify key partners for delivering these actions, including local councils, government agencies, local community and industry groups and local Aboriginal communities.

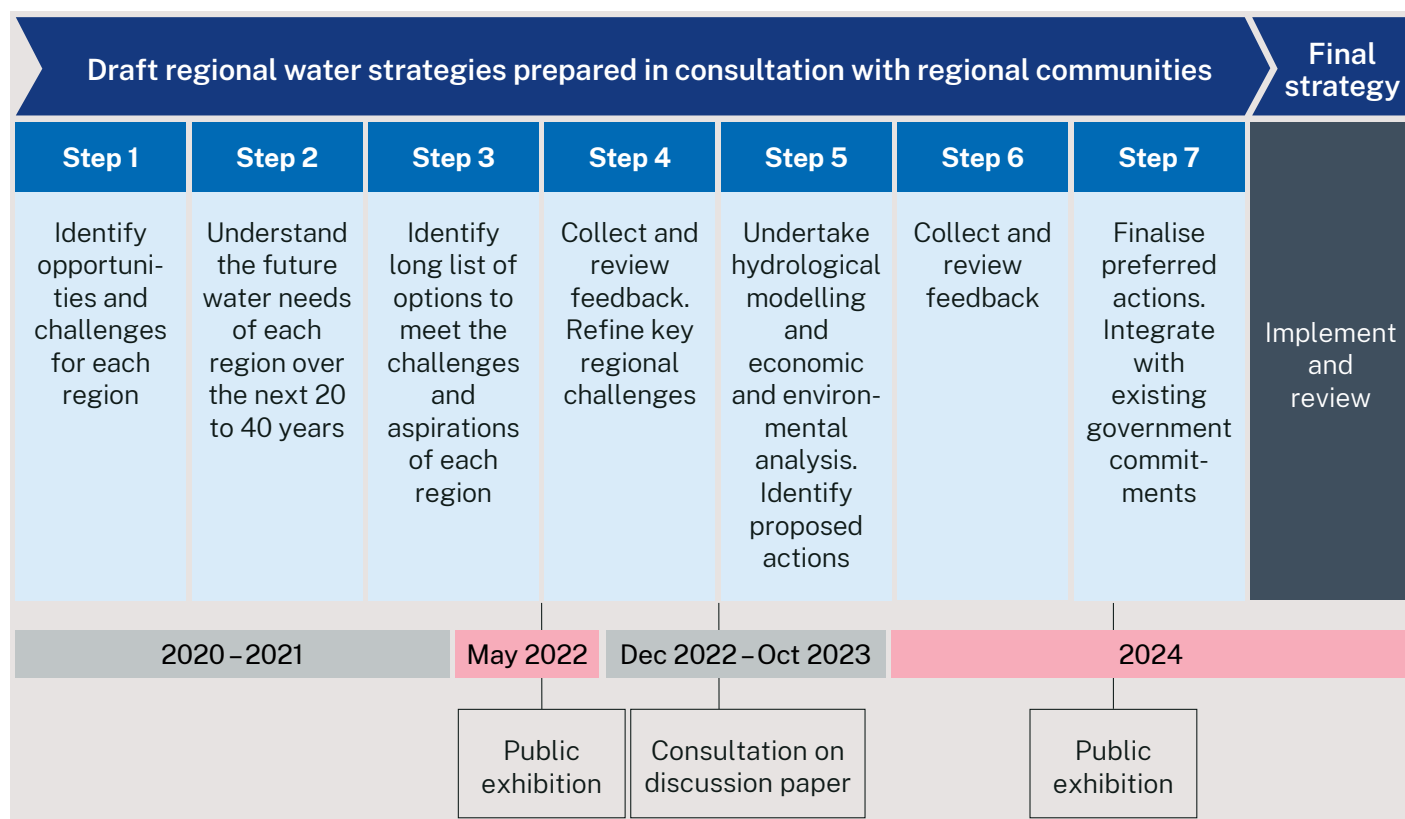
Not all actions will be commenced at once. The availability of funding and the progress of existing government commitments will be a key consideration in planning when and how the actions will be implemented. The regional water strategies will be a key tool in securing funding as future opportunities arise.

This consultation paper seeks your feedback on which actions should be prioritised for implementation over the next 3 to 5 years and which ones should be implemented in the medium and longer term. Figure 15 shows the NSW Murray Regional Water Strategy delivery timeline for your reference.



Image courtesy of Destination NSW. River of islands Mulwala.

Figure 15. NSW Murray Regional Water Strategy delivery timeline



Your voice is important. This consultation paper is on public exhibition from 22 May to 14 July 2024. Supporting information is available at dpie.nsw.gov.au/murray-regional-water-strategy

You can also have your say by providing written feedback to the NSW Department of Climate Change, Energy, the Environment and Water via:

Web: dpie.nsw.gov.au/murray-regional-water-strategy

Email: regionalwater.strategies@dpie.nsw.gov.au

Specific feedback is requested on:

- whether any of the actions in this consultation paper should not be shortlisted and why
- how actions should be staged and which actions should be implemented first

Please note that all submissions will be published on the NSW Department of Climate Change, Energy, the Environment and Water's website, unless you let us know in your submission that you do not wish the content to be released.

To support community engagement on this consultation paper, consultation sessions will be held to give participants additional context and a more thorough understanding of proposed priorities and actions. Details of these sessions can be found at the website listed above.



Image courtesy of Jason King. Barmah NSW Murray River at Broken Creek Junction.

Attachments

6

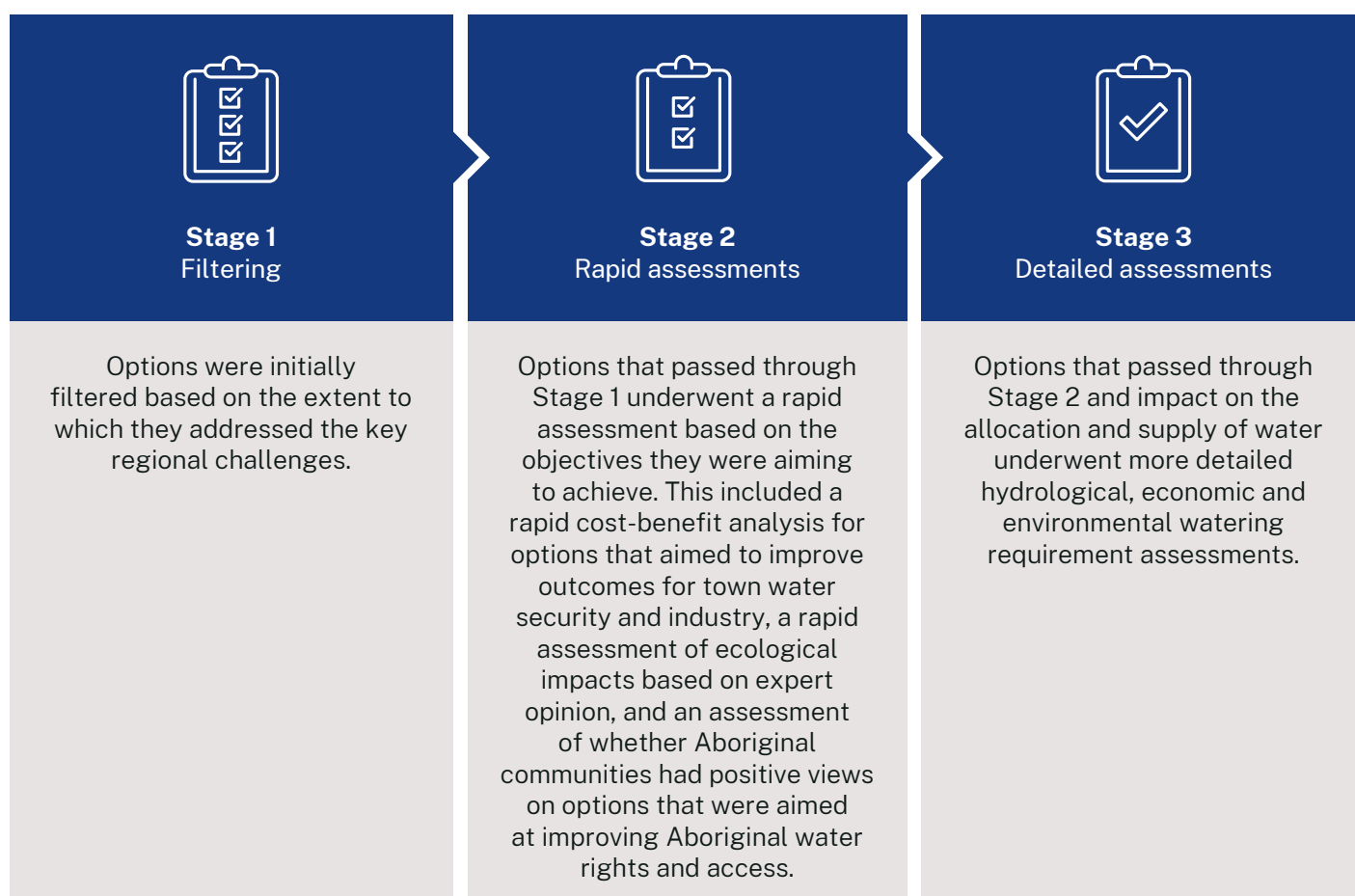
Image courtesy of Destination NSW. Murray River National Park.

Attachment A: Summary of the options assessment process

The original draft NSW Murray Regional Water Strategy presented 44 options to address regional challenges. In response to the public exhibition, these original options were updated and expanded. Additional options were also added to the list.

The process to move from the long list to the short list is summarised in Figure 16.

Figure 16. Going from long list of options to a short list



At each step of the assessment, the long list of options from the draft NSW Murray Regional Water Strategy were filtered and narrowed based on evidence, analysis and community feedback. Several options were consolidated, refined or not progressed and converted into proposed actions.

Attachment B summarises the overall outcomes of the options assessment (Table 7). Results from the economic and ecohydrological analyses are presented in Attachment C.

The analysis is a high-level assessment, appropriate for a strategic purposes, and it is not designed to

consider all possible impacts on the environment, water users or Aboriginal people. However, it does provide enough detail to determine if an option is likely to make a net positive contribution to the regional water strategy's objectives. More detailed environmental, economic and cultural assessments are required and will be undertaken in any subsequent business case development or planning process for actions that proceed to the implementation stage.

After community consultation, the recommended actions for the regional water strategy will be sequenced, meaning, they will not all be implemented at the same time.

Attachment B: Assessment results – Long list of options to proposed shortlist of actions

This section summarises the assessment outcomes for each of the options in the draft NSW Murray Regional Water Strategy.

Table 7. Assessment of long list of options



Options progressed to next step



To be considered in other NSW processes



Option not progressed

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
1. Improve access to culturally significant areas and waterways for Aboriginal people		not assessed	insufficient information to assess		The NSW State Water Strategy Action 2.6: <i>Work with Aboriginal people to maintain and preserve water-related cultural sites and landscapes</i> provides the overarching framework. This will be considered as part of the <i>NSW Aboriginal Water Strategy</i> .
					Incorporated into NSW Murray Regional Water Strategy proposed action 2.7.
2. Review Aboriginal Cultural Water Access Licence framework		not assessed	insufficient information to assess		This will be undertaken as part of the <i>NSW Aboriginal Water Strategy</i> .

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
3. Support long-term participation of local Aboriginal people in water-related matters	✓	not assessed	insufficient information to assess	>	The NSW State Water Strategy Action 2.2: <i>Strengthen the role of First Nations in water planning and management</i> provides the overarching framework. This will be considered as part of the NSW Aboriginal Water Strategy.
				✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.4.
4. Fund water entitlements for Aboriginal communities	✓	not assessed	insufficient information to assess	>	The NSW State Water Strategy Action 2.4: <i>Provide Aboriginal ownership of and access to water for cultural and economic purposes</i> provides the overarching framework. This will also be considered as part of the NSW Aboriginal Water Strategy.
5. Secure flows for water dependent cultural sites	✓	not assessed	insufficient information to assess	>	The NSW State Water Strategy Action 2.2: <i>Strengthen the role of First Nations in water planning and management</i> provides the overarching framework. This will be considered as part of the NSW Aboriginal Water Strategy.
				✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 2.1 and 2.9.
6. Shared benefit Project (environment and cultural outcomes)	✓	not assessed	minor/moderate improvement (regarding environmental effects only)	>	The NSW State Water Strategy Action 2.2: <i>Strengthen the role of First Nations in water planning and management</i> provides the overarching framework. This will be considered as part of the NSW Aboriginal Water Strategy.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
7. Incorporate Aboriginal history of water and culture in the Southern Basin into water data	✓	not assessed	minor/moderate improvement (regarding environmental effects only)	⊗	The NSW State Water Strategy Action 2.5: <i>Work with First Nations to improve shared water knowledge</i> provides the overarching framework. This will also be considered as part of the <i>NSW Aboriginal Water Strategy</i> .
				✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.4.
8. Review drought rules for the NSW Murray region	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.2.
9. Review the allocation and accounting framework in the NSW Murray (Surface water)	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.2.
10. Investigate Murray River system water sharing, delivery and accounting arrangements under the Murray–Darling Basin Agreement	✓	only part of the option assessed: discontinuation of additional dilution flows to South Australia	insufficient information to assess	✓	Note that discontinuing additional dilution flows to South Australia, was shown to have very little benefit and also extreme environmental impacts in the ecohydrological assessments.
				⊗	Remainder of option is incorporated into NSW Murray Regional Water Strategy proposed action 1.6.
11. Review groundwater extraction limits	✓	not assessed	no/little change	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.1.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
12. Provide increased clarity about sustainable groundwater management	✓	not assessed	minor/moderate improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 1.1, 2.5 and 3.2.
13. Investigate Water Access Licence conversion	✓	Assessment of this option was split into 2 – see results for option 13a and 13b in Attachment C	minor/moderate impact	13a ✓	Option 13a incorporated into NSW Murray Regional Water Strategy proposed action 1.2.
				13b ✗	
14. Investigate land use change and population growth impacts on water resources	✓	not assessed	minor/moderate improvement	✓	This action will be progressed through the NSW Water Strategy Action 4.4: Better integrate land use planning and water management.
				>	Incorporated into NSW Murray Regional Water Strategy proposed action 1.5 and 2.6.
15. Develop climate risk evidence base to inform the next Snowy Water Licence Review	✓	not assessed	minor/moderate improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.3.
16. Enhance southern inland floodplain management plans	✓	not assessed	minor/moderate improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 2.4.
17. Investigate water quality improvement measures	✓	not assessed	major/extreme improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 1.1, 1.5, 2.1, 2.2, 2.3, 2.6, 2.9 and 2.10.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
18. Manage groundwater salinity	✓	not assessed	minor/moderate improvement	✓	The action is being addressed at a state level in the <i>NSW Groundwater Strategy</i> and supported through NSW Murray Regional Water Strategy proposed action 1.1.
				>	
19. Monitor sediment compaction over the long term	✗	not assessed	minor/moderate improvement	>	The action is being addressed at a state level in the <i>NSW Groundwater Strategy</i> .
20. Review impediments to water recycling projects	✓	not assessed	no/little change	✓	This would be investigated as part of town Integrated Water Cycle Management Plans through Safe and Secure Water Program.
				>	Incorporated into NSW Murray Regional Water Strategy proposed action 3.4.
21. Managed aquifer recharge investigations and policy	✓	not assessed	no/little change	>	The action is being addressed at a state level in the <i>NSW Groundwater Strategy</i> .
				✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.2.
22. Secure and reliable access to groundwater for towns	✓	not assessed	no/little change	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.1, 3.2 and 3.4.
23. Maintain water-related amenity in the NSW Murray region during droughts	✓	not assessed	no/little change	>	This would be investigated as part of town Integrated Water Cycle Management Plans through Safe and Secure Water Program.
24. Investigate inter-regional connections	✗	not assessed	no/little change	✗	Does not meet a regional challenge.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
25. Investigate groundwater desalination for industry and towns	✓	not assessed	no/little change	✓	The action is being addressed at a state level in the <i>NSW Groundwater Strategy</i> . Incorporated into NSW Murray Regional Water Strategy proposed action 3.4.
				>	
26. Improve protection of groundwater dependent ecosystems	✓	not assessed	minor/moderate improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 1.1 and 2.5.
27. Address cold water pollution in the Hume Dam	✓	not assessed	major/extreme improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 2.3.
28. Remediate fish passage (<i>NSW Fish Passage Strategy</i>)	✓	not assessed	major/extreme improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 2.3 and 4.2.
				>	
29. Implement fish-friendly water extraction	✓	not assessed	major/extreme improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 2.3 and 4.2.
				>	
30. Improve flows to important ecological sites	✓	not assessed	major/extreme improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 2.1 and 2.10.
31. Develop a river and catchment recovery program for the NSW Murray region	✓	not assessed	major/extreme improvement	✓	Incorporated into Regional Water Strategy proposed actions 1.4, 2.6, 2.7 and 2.9.
32. Review environmental water arrangements	✓	not assessed	minor/moderate improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 1.2, 2.1, 2.2 and 3.8.
33. Re-establish threatened fish species through habitat restoration and conservation restocking	✓	not assessed	major/extreme improvement	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 2.3 and 4.2.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
34. Better understand the economic value of ecosystem services of riverine environmental assets	✓	not assessed	no/little change	>	The action is being addressed at a state level in the NSW State Water Strategy. Action 5.2: Invest in research and development and new technologies to lift water productivity in NSW industries.
35. Better understand water use with data collection and analytics	✓	not assessed	no/little change	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.6.
36. Improve the understanding of groundwater sources and processes, risks and impacts	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 1.1, 2.5 and 3.2.
37. Undertake a water dependent industry resilience study	✓	not assessed	no/little change	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 1.5.
38. Develop targeted education and capacity building programs	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.6.
39. Investigate water availability in the NSW Murray region	✓	not assessed	insufficient information to assess	>	A working group of industry stakeholders, and NSW and Australian government agencies has been established to explore the issue of potential underuse.
40. Investigate non-residential water efficiency (towns and industries)	✓	not assessed	no/little change	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.4 and 3.5.

Original long list option	Options filtering	Assessments		Shortlisted	Comment
	Meets key regional challenge	Hydrological, economic and ecohydrological assessments	Rapid environment assessment		
41. Investigate the expansion of cloud seeding in key water supply catchments	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.3.
42. Undertake joint exploration for groundwater with the NSW Geological Survey	✓	not assessed	no/little change	>	The action is being addressed at a state level in the NSW Groundwater Strategy.
43. Review water markets and trade	✓	not assessed	no/little change	>	This option is being addressed through the current water market reforms in the Murray-Darling Basin.
44. Consider hydrological processes in bushfire management	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.3.
New option: Sharing of new Regional Water Strategy climate and modelling data with local water utilities to inform local strategic planning	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.4.
New option: Improve channel sharing arrangements for environmental water releases	✗	not assessed	insufficient information to assess	✗	Did not meet a regional challenge.
New option: Training and information products	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed action 3.6.
New option: Undertake a town water vulnerability study	✓	not assessed	insufficient information to assess	✓	Incorporated into NSW Murray Regional Water Strategy proposed actions 3.4 and 3.5.

Attachment C: Assessment of options that impact supply, demand or allocation of water

This attachment summarises the results of the hydrologic, economic and environmental assessment of options in the draft NSW Murray Regional Water Strategy that were able to be hydrologically assessed as they potentially impact the supply, demand or allocation of water in the regulated river system.

Assessment was done by first introducing adding the option into the Department's river system models and observing the changes that occurred to extraction of water and flows compared to the base case of current situation. Importantly, the modelling assumed that the diversion limit set by the Basin Plan is not exceeded. This was done by reducing the amount of water for lower priority licences if an option would have resulted in the diversion limits being exceeded.

In the past, water infrastructure and policy changes have been assessed against approximately 130 years of data – the historical set of instrumental data. Using the long-term paleoclimatic analysis developed for the regional water strategies, together with projections of future climate change gives us a much better understanding of the water risks that the region could face and how well different options could perform under different climate scenarios that we haven't seen in our observed past. The rapid cost-benefit analysis (CBA) was carried out using the historical data, while the detailed CBA and environmental assessments were carried out using the new long-term climate datasets.

The long-term climate data sets comprise:

- the long-term historical climate scenario, which is a 10,000-year synthetic data set based on paleoclimatic analysis
- the dry future climate change scenario, which is essentially the long-term historical climate scenario, adjusted by a set of scaling factors derived from the NARCLiM project (SRES A2 climate scenario).

For the purposes of the economic and environmental assessments, these datasets were broken down into 1,000 periods (termed realisations for the purposes of this assessment) of 40-year duration. This allows us to understand the economic and environmental impacts over the 40-year outlook of the regional water strategies. It also allows us to better plan for uncertainty by considering 1,000 different possibilities of what the climate may look like over the next 40 years, given the assumed climate scenario.

Ecological assessment methods

The ecological effects of the options portfolios were modelled and assessed at selected flow gauge sites on the regulated rivers of the NSW Murray region. The sites were selected based on their proximity to the anticipated impacts of the option and their relationship to the likely or potential ecological requirements of aquatic flora and fauna.

Following on from the rapid ecological assessment which involved a high-level assessment based on expert opinion, flow metrics used for the detailed assessment included the frequency and duration of cease-to-flow events and base flows; the frequency of freshes, large and infrequent bank-full and overbank flows, and low flows (90th and 95th percentile flows); and the annual volume of flows.

These metrics were assessed for the long-term historical past climate and dry future climate scenarios. The results were then categorised as having an impact from extreme improvement to extreme detrimental impact to rate the potential impacts or benefits to the environment. The rapid environmental assessment uses a 5-category ranking and the detailed assessment uses an expanded 11-category ranking. The effect on these metrics was calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios using the categories in Table 8.

Table 8. Explanation of categories used in ecological assessment

Stage 1 category	Stage 2 category	Estimated percentage change in hydrology/ecology
Major/Extreme impact	Extreme impact	More than 30% change in a negative direction (i.e. < -30%)
	Major impact	More than 20% change in a negative direction (i.e. < -20%)
Minor/Moderate impact	Moderate impact	More than 10% change in a negative direction (i.e. < -10%)
	Minor impact	More than 3% change in negative direction (i.e. < -3%)
No/Little change	Little impact	Less than 3 % change in a negative direction (i.e.< 0%)
	No change	0%, rounded to the nearest whole percentage point
	Little improvement	Less than 3% change in a positive direction (>0% and <3%)
Minor/Moderate improvement	Minor improvement	More than 3% change in a positive direction (i.e. >3%)
	Moderate improvement	More than 10% change in a positive direction (i.e. >10%)
Major/Extreme improvement	Major improvement	More than 20% change in a positive direction (i.e. >20%)
	Extreme improvement	More than 30% change in a positive direction (i.e. >30%)

All environmental changes against options should be considered against the effects of the long-term climate and under a dry future climate as these option effects will add to these impacts. In particular, Table 9 indicates that under a dry future climate many measures of environmental requirement will be impacted, with total volumes, no flow events and the size (ML/day) of fresh and large flows all showing extreme impacts. The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios. Cells are shaded following categories in Table 8. It should also be noted that these are compounding effects. That is, the dry future climate is compared to the long-term climate scenario and so there is an additional 30% or more increase in the number of no flow events per 130 years above the 30% or more effect of the long-term climate.

The changes effected by the proposed options would, in the scenarios shown, be changes in addition to the other changes due to climate. Some metrics will be under considerable stress already because of climate change effects. In particular, Table 9 indicates that under the long-term historical and the dry future climate scenarios many measures of environmental requirement will be impacted by climate influences alone. These results⁹⁹ generally indicate a moderately more stressed flow regime under long-term historical conditions but, not surprisingly, much more stressed ecological conditions under a future dry climate.

Table 9. Predicted environment effects under a long-term historical past climate and dry future climate using standard environmental metrics

	Long-term historical climate	Dry future climate
Metric	Average effect	
Median annual flow (ML)	moderate impact	extreme impact
Mean annual flow (ML)	moderate impact	extreme impact
Duration of no flow spells (days)	minor improv	moderate impact
Number of no flow events per 130 years	extreme impact	extreme impact
Number of years with a no flow event	major impact	extreme impact
Very low flow discharge (95%ile, ML/day)	no effect	moderate impact
Days below the very low flow rate	minor impact	no effect
Low flow discharge (90%ile, ML/day)	minor impact	moderate impact
Days below the low flow rate	no effect	minor improv
Low flow standard deviation	no effect	minor impact
Base flow threshold (ML/day)	minor impact	major impact
Fresh (20th percentile) flows (ML/day)	no effect	extreme impact
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	moderate improv	major impact

99. It should also be noted that these are compounding effects. That is, the results for the long-term historical climate scenario compares to the changes from the historical scenario. Whilst the dry future climate is compared to the long-term historical climate scenario.

Time between freshes (days)	moderate impact	major improv
High flows with a 1-year recurrence (ML/day)	minor impact	extreme impact
High flows with a 1.5-year recurrence (ML/day)	minor impact	extreme impact
High flows with a 2-year recurrence (ML/day)	moderate impact	extreme impact
High flows with a 5-year recurrence (ML/day)	no effect	extreme impact
High flows with a 10-year recurrence (ML/day)	no effect	extreme impact

Options assessment results

Results of the hydrological, cost-benefit and environmental assessments of these options are presented below:

Option 10: Investigate Murray River system water sharing, delivery and accounting arrangements under the Murray–Darling Basin Agreement

Purpose	This option would review current water management arrangements under the Murray–Darling Basin Agreement in the context of a changing climate and reduced water availability.
Description	The subcomponent of this option that was assessed focussed only on determining the benefit/impact to NSW interests from the removal of provisions in the MDB Agreement concerning the release of additional dilution flows (ADF). As such, the results of this assessment are only applicable to this sub-component, and not Option 10 as a whole.
Results	The assessments conducted here indicate that total removal of the ADF is not viable due to limited benefits and extreme environmental impacts. This does not imply that how the ADF is operationalised could not be optimised. In terms of hydrological impacts, only minimal changes in average effective allocation are exhibited across different climate datasets. Moreover, the alterations in average water diversions vary, with some climate scenarios showing minimal changes for HS and GS, which are likely within the model error bounds. Results show modest increases in supplementary water diversions (3% to 6%) and to local water utility diversions (11%–12%). Notably, there are expected to be decreases in average annual flow at Burtundy on the Darling River for all modelled climate scenarios ranging from -3% to -4%. With only limited material change in hydrologic outcomes, the cost-benefit analysis reveals minimal benefits associated with the option. There are minor improvements in economic outcomes under the different climate scenarios with changes ranging from -5.1% to 1.1% in town, annual and permanent crops results. Consequently, given the mixed hydrological impacts and resultant modest economic outcomes, Option 10 emerges as less optimal compared to alternative solutions for addressing water management challenges in the region. The environmental assessment indicated extreme differences between the options and the baseline (current water sharing plan) scenario for the frequency of no flow events under both the long-term historical climate and dry future climate. Under a dry future climate there was also an extreme effect on the frequency of days below the very low flow rate. The future dry climate effects are compared to the long-term historical climate data, and so the future climate effects have a compounding impact on the long-term historical climate impacts. This suggests a high level of stress on the health and survival of flow-dependent organisms under this option, especially under the dry future climate option. Only part of the option assessed – the total removal of ADF to South Australia. Note that the total removal of ADF to South Australia, was shown to have very little benefit and also extreme environmental impacts in the ecohydrological assessments. Remainder of option is incorporated into proposed action 1.6, including optimising ADF.

Limitations

These first environmental results are based on standard statistics only, and not statistics from the Long-Term Watering Plan (LTWP).¹⁰⁰ Results based on LTWP metrics, as advised by environmental water users will be presented in later reports. With both standard and LTWP metrics the results do not discriminate between the metrics being met by operational or environmental flows, and in some cases, these might occur in locations or times where there is minimal benefit. Results are time averaged at each site, and so the effects of some very high or low flow sequences might be masked. These limitations apply to all the environmental assessments in this section.

In the Murray model (not other valleys) the behaviour of the Held Environmental Water (HEW) is modelled as behaving the same way as General Security water. This applies to both the Victorian and NSW components of the model.^{101, 102} This does not apply to Planned Environmental Water (PEW). This means that some of the environmental benefits in both the base and options models are likely to be under-represented.

100. DPIE (2020). Murray–Lower Darling Long Term Water Plan. NSW Department of Planning, Industry & Environment. Part A.

101. MDBA (2019). Source Murray Model – Method for determining permitted take in the Victorian Murray, Kiewa and Ovens SDL resource units, Murray Darling Basin Authority Canberra, 2019.

102. DPIE (2022). Draft NSW Murray and Murrumbidgee Regional Water Strategies Climate and hydrological modelling, Department of Planning and Environment, December 2022.

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 10. Option 10: Investigate Murray River system water sharing, delivery and accounting arrangements under the Murray–Darling Basin Agreement

Climate dataset	Change in Murray average (30 Sept.) allocation (%)		Change in Murray average (30 June) allocation (%)		Change in Murray average consumptive water diversions (GL/year)				Change in lower Darling River average annual flow at Burtundy
	High security	General security*	High security	General security*	High security	General security	Supp.	LWU	
Historical climate	-1%	2%	1%	0%	1%	0%	6%	12%	-4%
Long-term historical climate	0%	0%	0%	0%	0%	0%	3%	12%	-3%
Dry future climate	-2%	1%	0%	0%	-1%	0%	5%	11%	-4%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

Table 11. Cost benefit analysis results Option 10: Investigate Murray River system water sharing, delivery and accounting arrangements under the Murray–Darling Basin Agreement

Climate dataset	Average Change in Economic Outcomes (\$ million, over 40 years)			Net Present Cost (\$, million)	Average Net Present Value (\$, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	1.7 (0.2%)	26.1 (0.4%)	4.5 (0.1%)	0.0	32.2	NA
Long-term historical climate	0.4 (0%)	35 (0.5%)	4.9 (0.1%)	0.0	40.3	NA
Dry future climate	2.9 (0.3%)	0.5 (0%)	25.9 (0.7%)	0.0	29.4	NA

Note: values in the parenthesis are the % change values to the baseline values; NA represents BCR could not be calculated as this option has not been costed.

Ecological assessment

The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios.

An average extreme impact on the frequency of no flow periods was modelled for both climate scenarios. There was also an average extreme increase in the frequency of days below the very low flow threshold under the long-term historical climate. This suggests a flow regime where low flows that are required for the persistence of aquatic organisms are poorly maintained, thereby increasing the risk of population decline and local extinctions.¹⁰³

Table 12. Predicted environment effects for one component of Option 10 (removal of ADF) using long-term historical climate and dry future climate modelling and standard environmental statistics

	Long-term historical climate	Dry future climate
Metric	Mean or median site effect	
Mean annual flow (ML)	minor improv	no effect
Duration of no flow spells (days)	minor improv	minor impact
Number of no flow events per 130 years	extreme impact	extreme impact
Number of years with a no flow event	extreme impact	extreme impact
Very low flow discharge (95%ile, ML/day)	no effect	no effect
Days below the very low flow rate	extreme impact	no effect
Low flow discharge (90%ile, ML/day)	no effect	no effect
Days below the low flow rate	minor impact	no effect
Low flow standard deviation	minor impact	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	minor improv	no effect
High flows with a 10-year recurrence (ML/day)	no effect	minor improv

103. E.g., see Rolls, R. J., Growns, I. O., Khan, T. A., Wilson, G. G., Ellison, T. L., Prior, A., & Waring, C. C. (2013). Fish recruitment in rivers with modified discharge depends on the interacting effects of flow and thermal regimes. *Freshwater Biology*, 58(9), 1804–1819.

Option 13a: Investigate water access licence conversion of 10% of General Security (GS) entitlement to High Security (HS) entitlement

Purpose	To give regulated river water users the ability to improve the security of their entitlements.
Description	This option involves the voluntary conversion of 10% of consumptive general security (GS) entitlements to high security (HS) entitlements. To ensure SDL compliance, we derived a conversion factor for the converted entitlements and increased the storage reserve by the additional HS entitlements. The conversion factor for this option was found to be 0.79.
Results	Option 13a is viable for shortlisting. The hydrological modelling results and in particular, the economic assessment results showed that the benefits outweighed potential impacts. In addition, impacts on environmental metrics were minor to moderate. There were minor to moderate increases in HS allocations, particularly under a dry future climate scenario. There were minor increases in GS effective allocations for 30 September (1%–3%) and minimal to small increases in GS effective allocations for 30 June (1%–2%), which are likely within the model error bounds. Supplementary (Supp.) diversions decrease by (1%–6%) and local water utilities (LWU) water diversions were not materially affected. There are only minor impacts on the average flow at Yarrawonga. As expected, the model indicates a substantial increase to HS (~89%–97%) diversions and a decrease in GS (~7%–10%) diversions for all climate scenarios due to the changed portion of entitlement shares. Note that this option is expected to help transfer the use of inflows from wet years (when typically demands are lower) to more moderate or dry years. In terms of cost benefits results, there are negligible changes for towns in all modelled climate scenarios. While annual crops results show a decrease in economic outcome (~5% to 8%) for all modelled climate scenario, permanent crops indicate a positive impact for all modelled climate scenarios with increases in the range of 63% to 77%. The main effect of the ecological results was a minor increase in ‘no flow’ event frequency under the long-term historical climate and a moderate increase in the days below the very low flow threshold under both climate scenarios. It is noted that this option also drew concerns from water user stakeholders, highlighting the potential for 3rd party impacts on the reliability of the remaining GS water entitlements. As such, implementation of this action would need to be done with close engagement of stakeholders to understand and where possible, address concerns.
Limitations	The assumptions used in the modelling assessment were conservative in that they were specifically designed to not overstate benefits or underestimate impacts. The identification of a conversion factor, locations for conversions and proportion of sleeper licences, etc were all heavily considered in multiple modelling run iterations and reflect this conservative approach. Further details on the modelled approach for this option can be found in the supporting document – <i>Hydrologic analysis of options for the NSW Murray Regional Water Strategy</i> .

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 13. Hydrological modelling results Option 13a: Investigate water access licence conversion of 10% of General Security (GS) entitlement converted to High Security (HS) entitlement

Climate dataset	Change in Murray average (30 Sept.) allocation (%)		Change in Murray average (30 June) allocation (%)		Change in Murray average consumptive water diversions (GL/year)				Change in average Murray River annual flow at Yarrawonga
	High security	General security*	High security	General security*	High security	General security	Supp.	LWU	Gauge
Historical climate	1%	3%	0%	1%	90%	-9%	-1%	0%	2%
Long-term historical climate	0%	2%	0%	2%	89%	-10%	-2%	0%	2%
Dry future climate	6%	1%	1%	1%	97%	-7%	-6%	1%	1%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

Table 14. Cost-benefit analysis results Option 13a: Investigate water access licence conversion of 10% of General Security (GS) entitlement converted to High Security (HS) entitlement

Climate dataset	Average Change in Economic Outcomes (\$ million, over 40 years)			Net Present Cost (\$, million)	Average Net Present Value (\$, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	3.1 (0.3%)	-525 (-7.4%)	2,925.3 (64.1%)	0.0	2,403.4	NA
Long-term historical climate	1.3 (0.1%)	-557 (-7.9%)	2,946 (63.2%)	0.0	2,390.3	NA
Dry future climate	36.8 (3.2%)	-244.3 (-5.3%)	2,756.8 (69.6%)	0.0	2,549.3	NA

Note: values in the parenthesis are the % change values to the baseline values; NA represents BCR could not be calculated as this option has not been costed.

Environmental assessment

The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios.

The impacts are primarily a minor increase in the frequency of no flow periods under the long-term historical climate, and a moderate increase in days below the very low flow rate under both climate scenarios. While the impacts are not as extreme as observed for Option 10 (No Additional Dilution Flow) there were extreme impacts observed at some individual sites for the frequency of no flow events, and the frequency of days under the low and very low flow thresholds. Such results also suggest occasional protracted no or very low flow events. Infrequent extreme events such as extended drought often have major ecological consequences for river ecosystems.¹⁰⁴

Table 15. Predicted environment effects for Option 13a (10% conversion of General to High Security Water) using long-term historical climate and dry future climate modelling and standard environmental statistics

	Long-term historical climate	Dry future climate
Metric	Mean or median site effect	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	no effect
Number of no flow events per 130 years	minor impact	minor improv
Number of years with a no flow event	minor impact	no effect
Very low flow discharge (95%ile, ML/day)	no effect	no effect
Days below the very low flow rate	moderate impact	moderate impact
Low flow discharge (90%ile, ML/day)	no effect	no effect
Days below the low flow rate	minor impact	no effect
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	no effect	no effect
Time between freshes (days)	no effect	no effect
High flows with a 2-year recurrence (ML/day)	no effect	no effect
High flows with a 5-year recurrence (ML/day)	no effect	no effect
High flows with a 10-year recurrence (ML/day)	no effect	no effect

104. Tonkin, J. D. (2022). Climate change and extreme events in shaping river ecosystems. *Encyclopedia of Inland Waters*, 2, 653–664.

Option 13b: Investigate water access licence conversion of 20% of General Security (GS) entitlement to High Security (HS) entitlement

Purpose	To give regulated river water users the ability to improve the security of their entitlements.
Description	This option involves the voluntary conversion of 20% of consumptive general security (GS) entitlements to high security (HS) entitlements. To ensure SDL compliance, we derived a conversion factor for the converted entitlements and increased the storage reserve by the additional HS entitlements. The conversion factor for this option was found to be 0.84.
Results	Option 13b is not viable for shortlisting. This assessment highlights that whilst there are economic benefits associated with this option, there is also the potential for unacceptable impacts on the environment. The modelling results show in the historical and long-term historical climate scenarios that HS allocation remains unchanged, while GS effective allocation increases by approximately 8% and 6%, respectively. However, in the dry future climate scenario, HS allocation increases by around 8%, and GS effective allocation increases by around 4%. Additionally, there is a small increase in average annual flow at Yarrawonga. The modelling also shows substantial changes in average water diversions. There is a significant increase in water diversions for HS entitlements across all scenarios, ranging from around 189% to 205%, and a corresponding decrease in diversions for GS entitlements, ranging from around 16% to 21% (as expected). The cost-benefit analysis shows that, annual crop economic outcomes experience substantial declines across all climate scenarios, ranging from approximately 12% to 17%. Inversely, permanent crops show positive impacts, with increases ranging from 135% to 152%. The main ecohydrology results for this option were major and extreme increases in the number of days below the very low flow threshold under the long term historical and dry future climate scenario respectively. This would likely stress in-stream biota and groundwater-dependent plants such as river red gums, especially under a dry future climate. This option also drew significant concern from water user stakeholders, highlighting the potential for third party impacts on the reliability of the remaining GS water entitlements.
Limitations	The assumptions used in the modelling assessment were conservative in that they were specifically designed to not overstate benefits or underestimate impacts. The identification of a conversion factor, locations for conversions and proportion of sleeper licences, etc were all heavily considered in multiple modelling run iterations and reflect this conservative approach. Further details on the modelled approach for this option can be found in the supporting document – <i>Hydrologic analysis of options for the NSW Murray Regional Water Strategy</i> .

Hydrological and cost-benefit analyses results

Summaries of the hydrological and rapid cost benefit assessment results are shown below. These changes are compared to the base case (i.e. without the option).

Table 16. Hydrological modelling results Option 13b: Investigate water access licence conversion of 20% of General Security (GS) entitlement converted to High Security (HS) entitlement

Climate dataset	Change in Murray average (30 Sept.) allocation (%)		Change in Murray average (30 June) allocation (%)		Change in Murray average consumptive water diversions (GL/year)				Change in Murray River average annual flow at Yarrowonga
	High security	General security*	High security	General security*	High security	General security	Supp.	LWU	
Historical climate	1%	5%	1%	1%	192%	-19%	-2%	1%	4%
Long-term historical climate	0%	4%	0%	3%	189%	-21%	-3%	0%	4%
Dry future climate	6%	1%	1%	0%	205%	-16%	-12%	2%	3%

Note: High Security (HS) and General Security (GS) entitlements, Supplementary (Supp.), Local Water Utilities (LWU).

*GS allocations are the 'effective allocation', which totals the announced Available Water Determination + carryover.

Table 17. Cost-benefit analysis results Option 13b: Investigate water access licence conversion of 20% of General Security (GS) entitlement converted to High Security (HS) entitlement

Climate dataset	Average Change in Economic Outcomes (\$ million, over 40 years)			Net Present Cost (\$, million)	Average Net Present Value (\$, million)	Average benefit cost ratio
	Towns	Annual Crops	Permanent Crops			
Historical climate	3.8 (0.4%)	-1,109.5 (-15.7%)	6,243 (136.8%)	0.0	5,137.3	NA
Long-term historical climate	2.6 (0.3%)	-1,176.3 (-16.8%)	6,304.4 (135.2%)	0.0	5,130.7	NA
Dry future climate	61.8 (5.4%)	-568.8 (-12.3%)	6,022.3 (152.1%)	0.0	5,515.3	NA

Note: values in the parenthesis are the % change values to the baseline values; NA represents BCR could not be calculated as this option has not been costed.

Environmental assessment

The environmental effect is calculated as the percentage change against the base case for long-term historical past climate and dry future climate scenarios.

This greater rate of conversion, from 10% to 20% of GS seems to have resulted in greater protection against no flow events, perhaps because of more reliable base flow maintenance for delivery of consumptive flows. When these no flow events occur under a dry future climate these events are moderately more prolonged. There is, however, no such protection for preventing

against an increased frequency of days below the very low flow rate, and if the extreme dry future climate effects are added to the major effects of the long-term historical climate this scenario would likely lead to stressed in-stream biota and also to groundwater-dependent plants such as river red gums that often rely on the preservation of a groundwater mound maintained by river base flows.¹⁰⁵ There were, however, small percentage effects on high flow events such as freshes and 2 to 10 years recurrence high flows under the long-term climate, often with minor improvements in recurrence which could provide some small benefit to floodplain biota including river red gums.^{106, 107}



Image courtesy of Destination NSW. Bethanga Bridge, Bellbridge.

105. Barbour, E., Driver, P. D., Kuczera, G. A., Blakers, R., & Croke, B. (2011). Optimizing environmental flow rules-a conceptual model. 19th International Congress on Modelling and Simulation, Perth, Australia, 12–16 December 2011.

106. Doody, T. M., Colloff, M. J., Davies, M., Koul, V., Benyon, R. G., & Nagler, P. L. (2015). Quantifying water requirements of riparian river red gum (*Eucalyptus camaldulensis*) in the Murray–Darling Basin, Australia—implications for the management of environmental flows. *Ecohydrology*, 8(8), 1471-1487.

107. DPIE (2020). Murray–Lower Darling Long Term Water Plan. NSW Department of Planning, Industry & Environment. Part A.

Table 18. Predicted environment effects for Option 13b (20% conversion of General to High Security Water) using long-term historical climate and dry future climate modelling and standard environmental statistics

	Long-term historical climate	Dry future climate
Metric	Mean or median site effect	
Mean annual flow (ML)	no effect	no effect
Duration of no flow spells (days)	no effect	moderate impact
Number of no flow events per 130 years	no effect	no effect
Number of years with a no flow event	no effect	no effect
Very low flow discharge (95%ile, ML/day)	no effect	no effect
Days below the very low flow rate	major impact	extreme impact
Low flow discharge (90%ile, ML/day)	no effect	no effect
Days below the low flow rate	minor impact	minor impact
Low flow standard deviation	no effect	no effect
Base flow threshold (ML/day)	no effect	no effect
Fresh (20th percentile) flows (ML/day)	no effect	no effect
Number of freshes (events/year)	no effect	no effect
Duration of freshes (days)	minor improv	no effect
Time between freshes (days)	minor impact	no effect
High flows with a 2-year recurrence (ML/day)	minor improv	no effect
High flows with a 5-year recurrence (ML/day)	minor improv	no effect
High flows with a 10-year recurrence (ML/day)	no effect	minor improv

