Regional Water Strategy

Western

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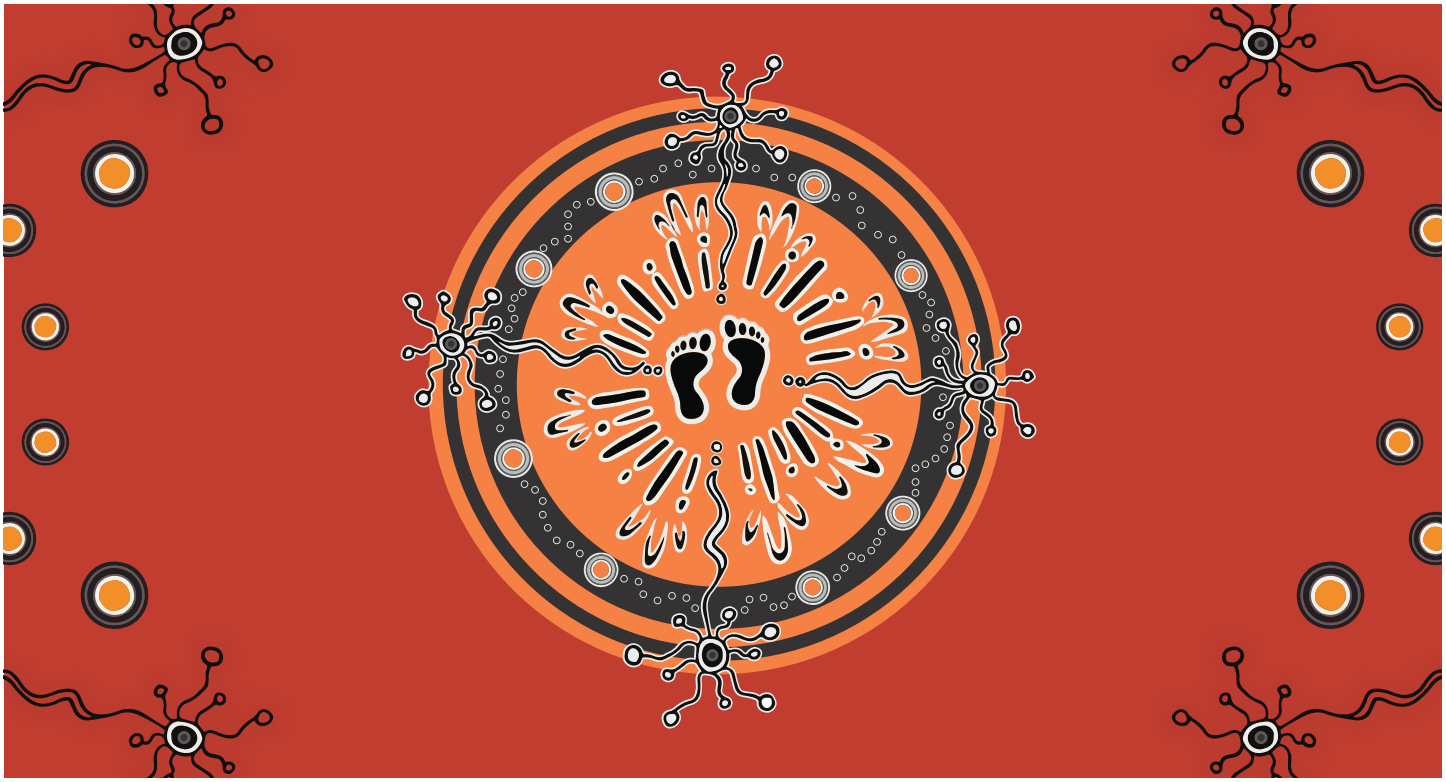

Acknowledging First Nations people

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 practise the oldest living culture on earth.

The NSW Government acknowledges the First Nations people/Traditional Owners from the Western region as having an intrinsic connection with the lands and waters of the Western Regional Water Strategy area. The landscape and its waters provide the First Nations people with essential links to their history and help them to maintain and practise 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 their communities.

Artwork courtesy of Nikita Ridgeway.

Minister's foreword

The Hon. Kevin John Anderson, MP
Minister for Lands and Water, and
Minister for Hospitality and Racing

We need healthy rivers, healthy farms and healthy communities. The way we manage water deeply affects the livelihoods of people in NSW.

Water is the most precious resource we have. Everyone and everything relies on water. It supports our towns, the rich cultural heritage of our Aboriginal communities, our industries and our natural environment. Water underpins the Western region's health and prosperity.

The Western region faces many water challenges. The way we manage these affects the lives and livelihoods of all people in the region. This has led the NSW Government to develop a long-term strategic vision for water. Our vision sets the direction and lays a path to improve water security, river health and cultural outcomes in NSW. Central to this vision is taking a holistic approach to water management. This will help us ensure that water is used sustainably and fairly, and it will help us prepare for a more variable and changing climate.

The Western region is located within the traditional lands of 17 First Nations. These traditional custodians have cared for the region's rivers and catchments for over 45,000 years.

The region is home to around 36,000 people and holds the important regional centres of Broken Hill, Cobar and Bourke. Agriculture and mining are the key drivers of the region's economy.

Developing the Western Regional Water Strategy required us to take a detailed look at what makes this region unique. We considered its relationship with water and its needs and challenges, and we developed innovative ways to deliver safe and secure water supplies that are sustainable and resilient, both now and into the future.

We developed the State's water strategies using the best and latest scientific evidence. This helped us to understand the risks to water users, even in the most extreme climatic conditions. We engaged leading academics to develop new methods to better understand the Western region's climate. These new methods and data supplement our historical climate records with new evidence from the field of paleoclimatology. Over 500 years of climate data helped us to better understand historic climate variability. We have also applied the NSW Government's climate change projections to this new data to understand the impacts of a worst-case 'dry' climate scenario.

The climate modelling showed that extreme dry and wet periods worse than we've seen since European settlement have occurred in the past. These events are likely to become more frequent and severe in the future. Understanding these possible climate risks lets us plan for these events and make sure we are prepared if they do arise.

The contribution of the Western community has been instrumental in developing and finalising the strategy. We consulted with Aboriginal communities, local governments, industry and environmental groups, water users and members of the public. We listened to the feedback we received to make sure we deliver a strong strategy for the whole region.

I would particularly like to thank the Aboriginal communities across the region who engaged with us and contributed their voices to this strategy. Water is an essential part of their culture and is critical in Caring for Country. I hope that this strategy will start to dismantle the major barriers to Aboriginal people's water rights and access. I look forward to working collaboratively with Aboriginal communities in the Western region to achieve better water outcomes.

I would also like to thank local councils for their significant contributions and for their engagement and support. We will continue to partner with them as we implement the strategy.

I am proud to launch the Western Regional Water Strategy. I hope it will contribute to a healthy environment, resilient community, and a vibrant regional economy.

Image courtesy of Destination NSW. Darling River, Bourke.

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Image courtesy of Michael Scotland. Barwon River, Collarenebri.

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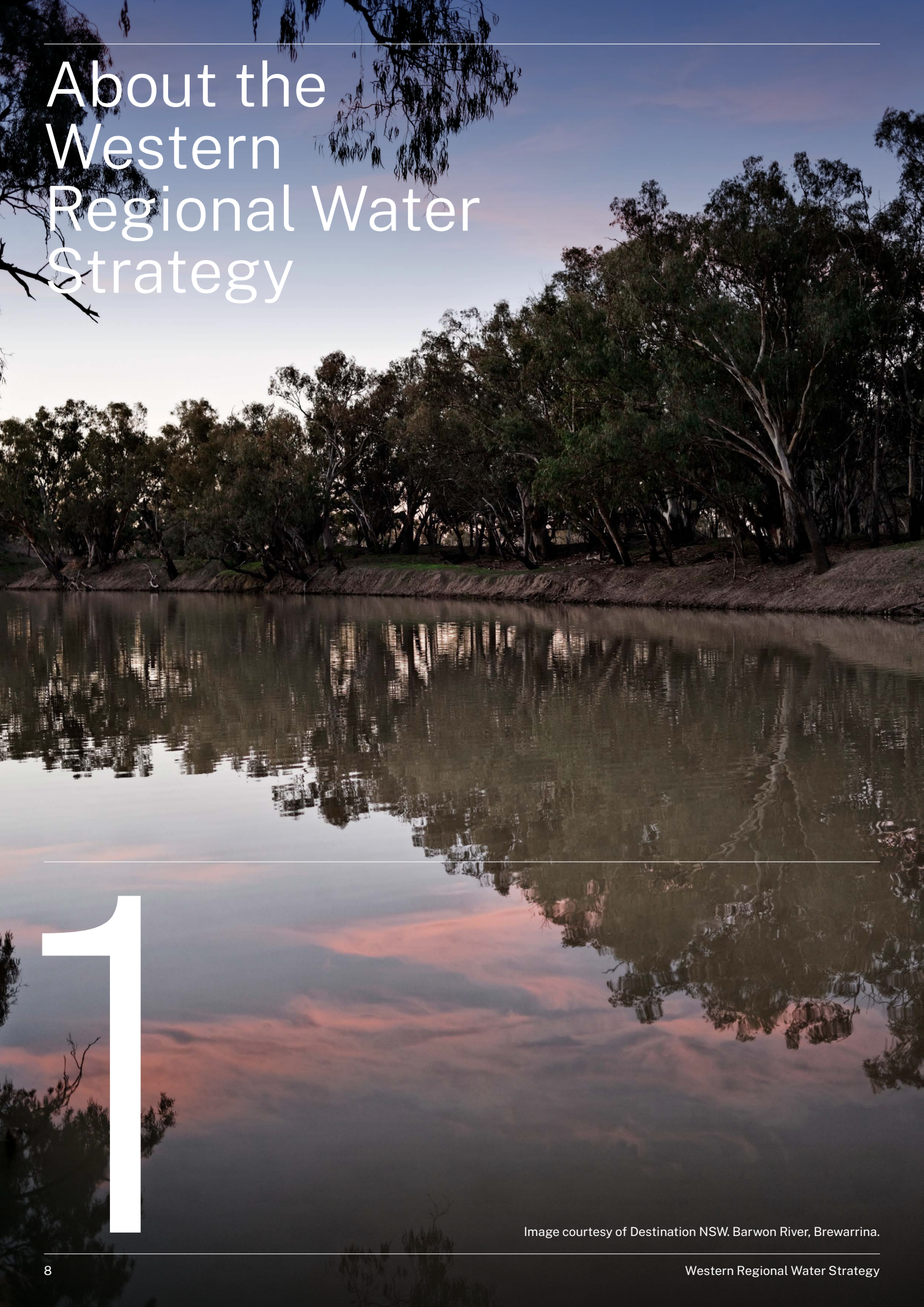


Image courtesy of Destination NSW. Barwon River, Brewarrina.

Secure, reliable and resilient water sources are critical to regional communities in NSW. They contribute to the appeal and prosperity of rural areas, regional towns and cities. They create cultural connections to Country and support community well-being. Water in the right places at the right times is also vital for healthy regional landscapes and sustainable ecosystems. Changing water demand, increased climate variability and shifting community expectations mean we need to plan and invest in improved long-term regional water security.

The Western Regional Water Strategy identifies the key regional challenges we need to tackle over the coming decades and outlines the actions we will undertake to respond to those challenges. The best and latest climate evidence, along with a wide range of tools and solutions, has been used to chart a progressive journey for water needs over the next 20 years.

Image courtesy of Michael Scotland. Barwon River, Mungindi.

The 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 Western Regional Water Strategy is one of a suite of catchment-based strategies across the state (Figure 1). The strategies identify critical challenges that we need to tackle over the coming decades and outline the priorities and actions that we will undertake to respond to those challenges.

Figure 1. Map of NSW regional water strategy regions

Objectives of regional water strategies

Regional water strategies will set out a long-term 'roadmap' of actions to deliver 5 key objectives (Figure 2). Each regional water strategy identifies the key challenges that impact on our ability to achieve these objectives and identifies priority actions that address the challenges and works towards meeting the relevant regional water strategy objectives.

Figure 2. Regional water strategy objectives

Deliver and manage water for local communities

Improve water security, water quality and flood management for regional towns and communities.

Enable economic prosperity

Improve water access reliability for regional industries.

Recognise and protect Aboriginal water rights, interests and access to water

Including Aboriginal heritage assets.

Protect and enhance the environment

Improve the health and integrity of environmental systems and assets, including by improving water quality.

Improve affordability

Identify most cost effective policy and infrastructure options.

Our aim is that each regional water strategy has a comprehensive, balanced package of options that delivers on all the regional water strategy objectives and aligns with the priority actions of the NSW Water Strategy.[1]

When formulating plans to share water, the NSW Government must take all reasonable steps to prioritise the protection of water sources and their dependent ecosystems.[2]

During extreme events, such as drought, our focus is on securing water for critical human needs. At these times, under section 60 of the *Water Management Act 2000,* critical human needs are the first priority and the environment is the second priority. Outside of these extreme events, the priority is providing water for the environment.

1. www.dpie.nsw.gov.au/water/plans-and-programs/nsw-water-strategy
2. Subsections 9(1)(b), 5(3)(a) and 5(3)(b) of the NSW *Water Management Act 2000.*

The regional water strategies cannot provide a comprehensive response to flooding

The role of the regional water strategies is to support the delivery of healthy, reliable and resilient water resources that sustain a liveable and prosperous region.

Improvements to flood risk mitigation are being considered through the 2022 NSW Flood Inquiry. The inquiry report and the NSW Government response can be found at: www.nsw.gov.au/nsw-government/projects-and-initiatives/floodinquiry

Although a comprehensive response to flooding is outside the scope of the regional water strategies, they can play a supporting role for local councils in the region to make targeted flood management improvements.

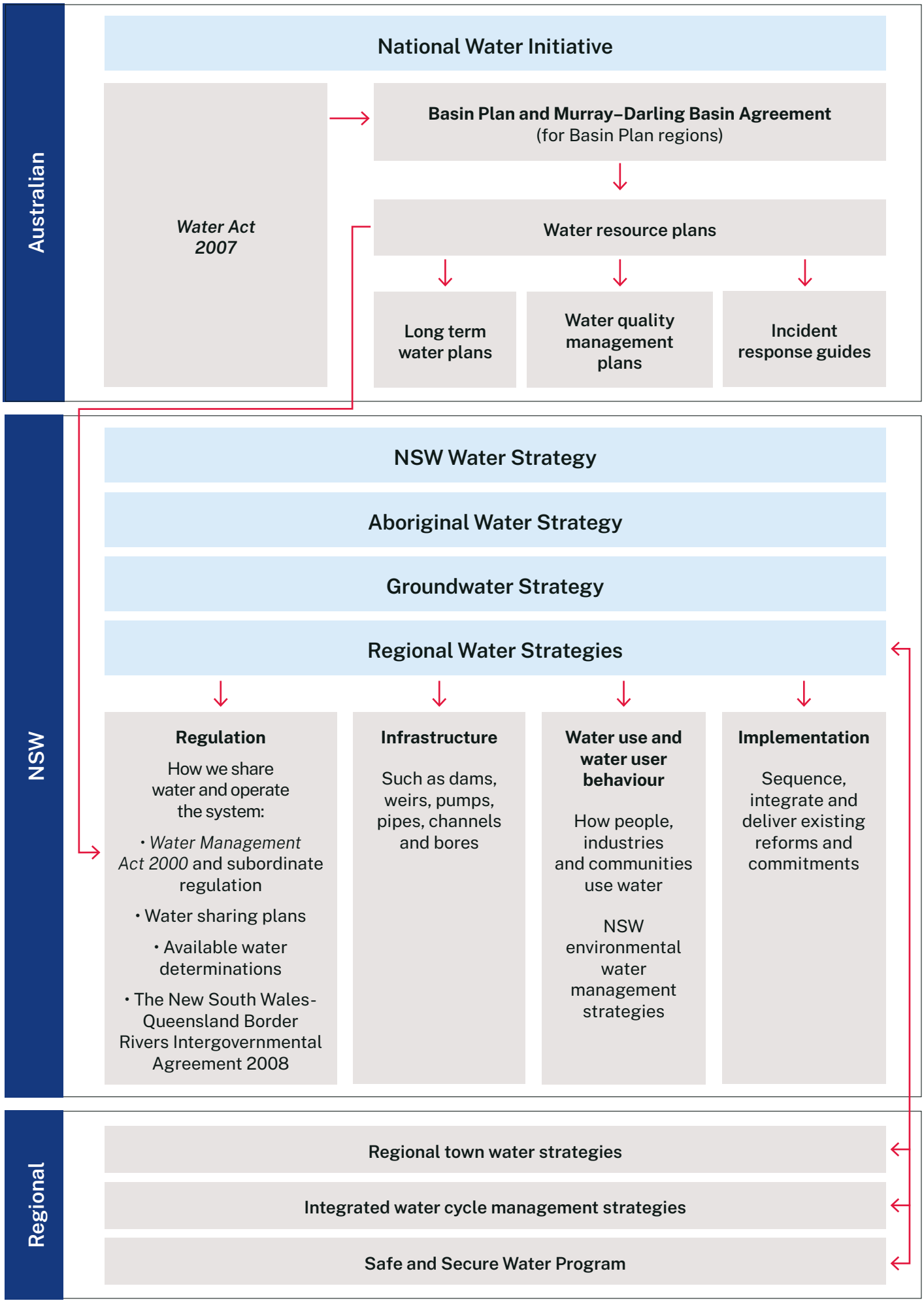
Image courtesy of Annette Corlis. Paroo River, Wilcannia.

Fitting regional water strategies with other water plans and policies

Each regional water strategy across the state sits within a broader policy and planning context, including a range of policies and plans that guide the management of water resources in NSW (Figure 3).

Image courtesy of Sally Anderson-Day. Barwon River, Brewarrina.

Figure 3. NSW water policy and planning context



The strategic planning framework for water management in NSW includes the NSW Water Strategy, which is underpinned by 14 regional and 2 metropolitan water strategies. The NSW Water Strategy was developed in parallel with these strategies and guides the strategic, state-level actions that we need to take. The regional water strategies prioritise how those state-wide actions, as well as other region specific, place-based solutions, are to be staged and implemented in each region.

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

- the Aboriginal Water Strategy – co-designed with Aboriginal people to identify a program of measures to deliver on First Nation's water rights and interests in water management
- the NSW Groundwater Strategy – to ensure 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 in regional towns in collaboration with local councils
- a new state-wide Water Efficiency Framework and Program – to reinvigorate water use efficiency programs in our cities, towns, and regional centres.

The NSW Water Strategy and the Western Regional Water Strategy also complement other whole-of-government strategies, including the 20-Year Economic Vision for Regional NSW,[3] the State Infrastructure Strategy,[4] and the New England North West Regional Plan 2041.[5]

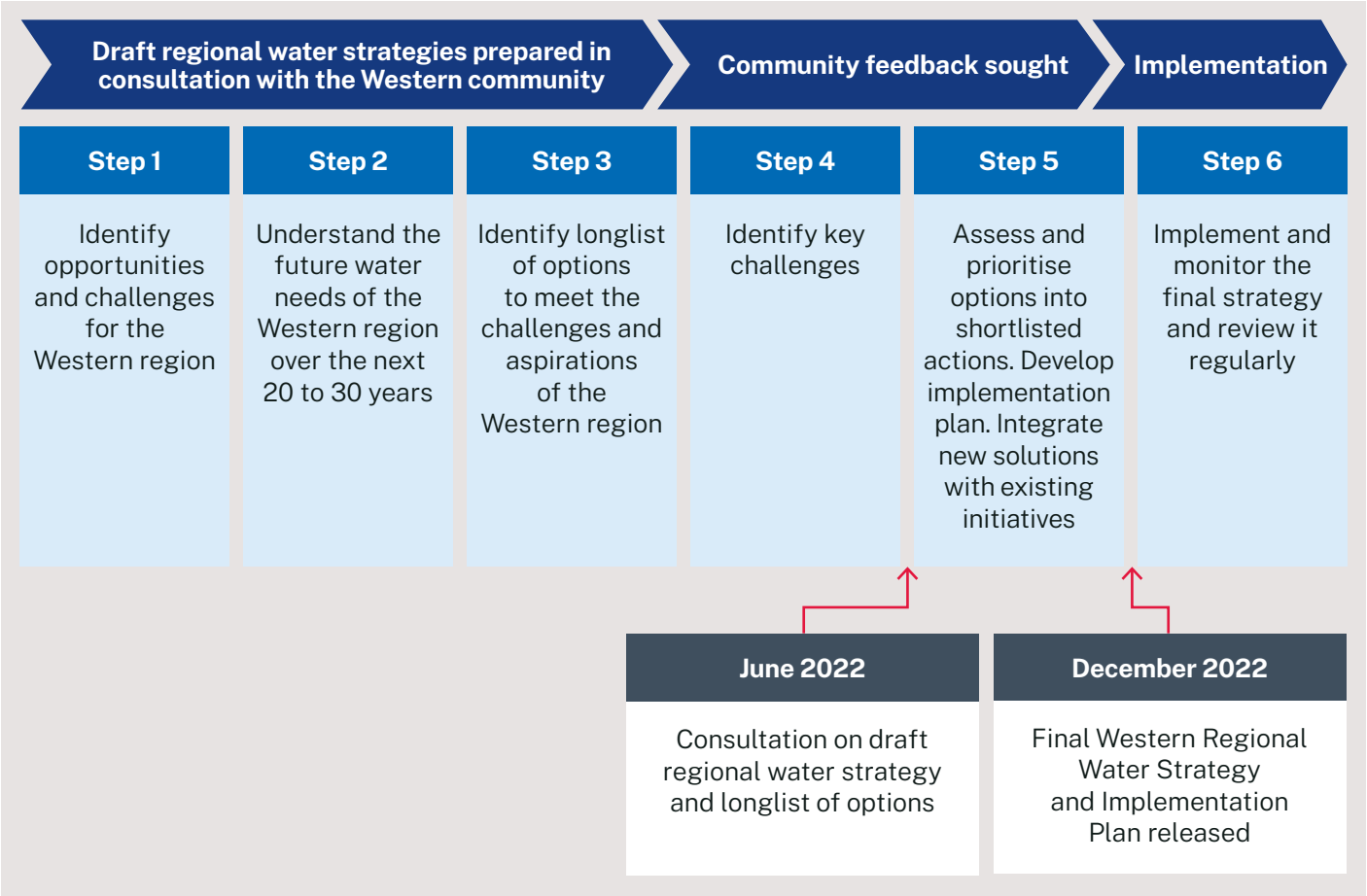
Image courtesy of Wentworth Shire Council. Lower Darling River at Wentworth.

3. www.nsw.gov.au/a-20-year-economic-vision-for-regional-nsw-refresh
4. www.infrastructure.nsw.gov.au/expert-advice/state-infrastructure-strategy/
5. www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/New-England-North-West-Regional-Plan-2041

Development of the Western Regional Water Strategy

The strategy has been developed using an evidence-based and risk-based approach informed by extensive community consultation at each step of the process. The NSW Government has taken a 6-step approach to preparing and implementing regional water strategies as shown in Figure 4.

Figure 4. Process for developing the Western Regional Water Strategy



What informed the Western Regional Water Strategy

We used feedback from the community, and the most recent data taken from a wide range of sources, to inform the regional water strategy and ensure it is based on a robust evidence base. This information has been used to help identify the challenges that need to be tackled first, and the measures that will best support the region over the next 20 years.

Information used to develop the strategy included:

- new climate data
- extensive community consultation across a broad range of interests
- economic, ecological and hydrological analyses
- a range of existing studies
- existing commitments and reforms.

Improved climate modelling and data

The regional water strategies are underpinned by ground-breaking new climate data and science. Until now, water management in NSW has been based on historical data and observations going back to the 1890s. This information has provided a limited understanding of extreme events.

Our new climate datasets and modelling give us a more sophisticated understanding of past and future climatic conditions. These improved datasets integrate recorded historical data with paleoclimate data[6] to give a modelling tool that generates 10,000 years of synthetic climate data. When combined with other sources of climate data, such as climate change projections, we can better understand natural climate variability – such as the likelihood of wetter and drier periods, and risks to future water availability in each region. The improved modelling means that we can move away from making decisions based heavily on single 'worst-case' scenarios drawn from a relatively short climatic record, to a more accurate understanding of the frequency and duration of past wet and dry periods.

This updated climate information is being used to develop the Western Regional Water Strategy. It will also support all water users to make more informed decisions and better plan and prepare for climate risks.[7]

The section on *Climate in the Western region* sets out the results from the analysis of the new climate data for the Western region. However, further work is required on the stochastic and longer term climate change modelling of the shortlisted actions. Due to the number of models required to be run concurrently for the Western region we are unable to finalise the climate model results until 2023, when we will publish the latest evidence about the future climate. This modelling will then be used to confirm the solutions to address the challenges associated with protecting and enhancing environmental assets, Aboriginal water interests, and towns and industries in a more variable climate and during extreme events.

Extensive community consultation

Developing an effective and lasting regional water strategy requires input from First Nations people, communities, towns, and industries across the Western region.

Over the last few years, the NSW Government has been consulting with stakeholders and communities on a range of water-related issues, including water resource plans, metering reforms, environmental water management, the Sustainable Diversion Limit Adjustment Mechanism program, the Better Baaka program, floodplain harvesting, connectivity, and drought. Through these engagements, we have heard many ideas about how to be better prepared for future droughts and floods, and for a more variable climate.

We have also heard that community members would like to act now rather than continuing to discuss options. We have taken this on board in the re-design of our approach to the Western Regional Water Strategy and have fast-tracked the analysis of certain options in this strategy so they can be implemented as soon as possible.

We sought feedback on the Draft Western Regional Water Strategy through a public exhibition period (Figure 5), as well as a range of targeted engagement sessions including meetings with councils and 3 meetings with the Connectivity Stakeholder Reference Group. Community feedback was critical in shaping the regional water strategy and implementation plan. A summary of this feedback can be found in the What We Heard report.[8]

6. Data reconstructed from before instrumental records began, using sources such as tree rings, cave deposits and coral growth.
7. More information about these new climate datasets and how they are being used in our river system models is in the *Regional Water Strategies Guide* available at, www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies
8. water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard

Figure 5. Stakeholder engagement during public exhibition and with the Connectivity Stakeholder Reference Group

150 total stakeholders engaged

29 formal submissions

6 email • 2 fillable form (PDF)

3 Aboriginal community sessions

24 attendees

3 Public information sessions

40 attendees

1 Live webinar

60 attendees

3 Connectivity stakeholder reference group meetings with representation from across the northern and southern basins

662 Unique website page visits

Image courtesy of Department of Planning and Environment – Environment and Heritage. Western Floodplain, Toorale.

The key insights from our most recent consultation with landholders, local councils, Aboriginal communities, stakeholders and the general public are shown in Figure 6 below.

Figure 6. Key insights from consultation on the Draft Western Regional Water Strategy

Feedback theme	Feedback summary
Connectivity	• Connectivity was consistently raised as an important issue, with widespread support for ensuring there are appropriate triggers to minimise or prevent cease-to-flow periods and protect connectivity flows throughout the catchment. • There was support for implementing and expanding the North-West Flow Plan objectives to achieve environmental water requirements and prevent salinity and blue-green algae issues, but there were also calls to ensure that only measures that could demonstratively achieve their intended objectives should be progressed. • A number of stakeholders expressed concern about the 195 GL trigger over all the Menindee Lakes proposed in the draft strategy. These stakeholders noted that a 195 GL trigger would provide less than 12 months of water during periods of high evaporation to support critical human and environmental needs in the Lower Darling. • Some stakeholders suggested that the trigger needs to ensure that the Lower Darling has accessible, manageable water for at least 2 summers or 18 months. These stakeholders suggested that there should be a minimum of 450 GL at Menindee Lakes and 30 GL flow at Wilcannia for 15 consecutive days before upstream access should be allowed. • Support for the proposed targets as long as they provide meaningful benefits and achieve their stated objectives, and are supported by the appropriate gauging, modelling, and forecasting capabilities.
Environment, ecosystem health and water quality	• Protecting and improving the catchment's environment and ecosystems was widely supported. • Initiatives to improve native fish health, fish passage and water quality were also supported. • Concerns were raised about the long-term impacts of infrastructure, erosion, over-extraction and contamination from agriculture. • There was concern about the possibility of environmental harm from the inclusion of 5-year accounting rules for floodplain harvesting in the water sharing plan rules. • Effective monitoring and management of floodplain harvesting volumes were viewed as essential.
Aboriginal knowledge and connection to Country	• There was widespread support for all options that improved the participation of Aboriginal people in water management. Ensuring that the needs and values of Aboriginal people are recognised and represented within the strategy was repeatedly endorsed. • Initiatives that support the involvement of Aboriginal people in the active management of rivers and water were also supported.
Water security for towns and small communities	• Managing water demand and improving water-use efficiency were identified as key priorities. • Further investigation of options for water recycling and managed aquifer recharge were also suggested. • The impacts of water scarcity on town water supply remains of widespread concern due to a range of issues, including impacts on mental health and potential loss of critical industries and skills. • While groundwater was recognised as important to address future climate-related water scarcity issues, there was also concern about potential impacts arising from over-reliance on, and lack of understanding about groundwater.

Figure 6. Key insights from consultation on the Draft Western Regional Water Strategy (continued)

Feedback theme	Feedback summary
Insecure water supplies affect the viability of businesses	• Water security was recognised as critical for economic growth, with support for providing greater certainty around the implementation and lifting of water restrictions by including triggers in water sharing plans. • Investigating water efficiency measures was commonly raised as a priority to help address climate change impacts.
New and existing infrastructure	• There were mixed views about the role of infrastructure. While there was some support for removing weirs to improve connectivity and help fish species and habitats recover, there was also concern about resulting impacts to water security, and stock and domestic users. • There was support for increasing water storage and supply by developing new infrastructure and upgrading existing infrastructure.
Water management	• Increasing the transparency of water management information was supported. There was also support for providing greater opportunities for inter-jurisdictional collaboration to manage water, environmental, social, and cultural needs. • Adapting water management to address climate change impacts and meet environmental needs was considered important.
Strategy development and implementation	• Providing transparency and accountability in the development, implementation, monitoring, and evaluation of the regional water strategy were considered important. • There was general support for better collaboration and relationship building between the Department of Planning and Environment, community and stakeholders to ensure successful implementation of the strategy. • Further consultation with community before the strategy is finalised, including stakeholders outside of the Western region, was seen as important, as was adequate consultation with Aboriginal stakeholders and communities.

Economic, environmental, and hydrological analyses

A range of robust assessments have been used to prioritise the actions in the regional water strategy, including:

- hydrologic analysis of options that had the potential to change the supply, demand, or allocation of water
- cost-benefit and cost-effectiveness economic analyses applying rapid assessment methods, with further detailed assessments to follow in 2023
- assessment of environmental impacts based on expert opinion, and detailed environmental watering requirement assessments based on hydrologic modelling
- an assessment of Aboriginal community feedback on actions aimed at improving Aboriginal water rights and access
- qualitative assessments based on feedback from the community.

More detail on the approach and results of these analyses is available on the department's website and in the attachments to this strategy.[9]

9. More detail on the assessments used to prioritise the actions in the regional water strategy are available at, water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/identifying-and-assessing

Existing studies

A significant amount of work has been undertaken to understand the risks affecting water resource management in regional NSW.[10] The Western Regional Water Strategy has been informed by a range of these studies, along with information provided by organisations and stakeholder groups across the region.

This work has included catchment studies, water security reports, and existing water allocation and drought planning, as well as regional development, infrastructure and environmental strategies prepared by NSW Government departments and agencies. We have also considered:

- specific studies undertaken for the Western Weirs and Wilcannia Weir business cases
- WaterNSW's 20-year Infrastructure Options Study for Rural Valleys
- reviews, assessments and studies relating to the Barwon–Darling River
- the Independent Assessment of Social and Economic Conditions in the Murray–Darling Basin, commissioned by the Australian Government
- stakeholder feedback on the Better Baaka proposals
- the Australian Competition and Consumer Commission's inquiry into markets for tradeable water rights in the Murray–Darling Basin.

We have also been guided by NSW's commitments under the Murray–Darling Basin Plan when developing the options to ensure that these commitments are met.

Building on existing commitments and reforms

Regional water strategies build on the foundation provided by existing NSW Government commitments, actions implemented by local governments and reforms to improve water security and reliability in our regions. The NSW Government has made significant commitments to address the risks associated with water in regional NSW and to prepare our regions for the future. Some of the state-wide water reforms include:

- improving water and sewage services for Aboriginal communities
- improving compliance and transparency around water use and access
- implementing robust metering laws to make sure that 95% of the potential water take in NSW is accurately measured and monitored.[11]

In 2020, the NSW Government also completed the delivery and commenced implementation of all of the environmental water reforms that arose from the Water Reform Taskforce, set up following the *Independent investigation into NSW water management and compliance report.*[12] These reforms include implementing:

- raising the commence to pump thresholds for A Class licences
- individual daily extraction components in the Barwon–Darling
- the resumption of flows rule in the Barwon–Darling
- active management to protect held environmental water in the Barwon–Darling, lower Macquarie, and lower Gwydir.

A number of projects are underway in the Western region to improve water management and environmental outcomes such as the Wilcannia Weir replacement, Toorale Water Infrastructure Project, Improving Floodplain Connections program, Lower Darling Recovery Reach and the Northern Basin Toolkit. The NSW Government also supported Western region councils to undertake emergency works to address water security issues during the 2017–2020 drought.

10. More information is in the *Regional Water Strategies Guide,* www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies
11. The NSW and Australian governments have committed $23.6 million and $12.5 million respectively to the metering program to ensure that meters are upgraded effectively. This commitment includes rebates for water users who switch to telemetry-based systems.
12. www.industry.nsw.gov.au/__data/assets/pdf_file/0019/131905/Matthews-final-report-NSW-water-management-and-compliance.pdf

The Western region

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Image courtesy of Destination NSW. Menindee Lake, Menindee.

Figure 7. Snapshot of the Western region

Aboriginal nations:
The Western region (as defined for the regional water strategies program) is located within the traditional lands of the following Aboriginal nations: Barkandji, Budjiti, Gomeroi/Kamilaroi, Guwamu (Kooma), Kunja, Malyangapa, Maraura, Murrawarri, Muthi Muthi, Ngemba, Ngiyampaa, Ualarai/Euahlayi, Wangaaypuwan, Wayilwan, Wilyakali, Wongaibon and Wongkumara

Water is deeply entwined with Aboriginal culture and Aboriginal people's connection to Country

36,671
population

275,556
km^2 area
about one-third of NSW

Key regional centres include:
Broken Hill and Cobar

Towns:
Bourke, Brewarrina, Collarenebri, Menindee, Pooncarie, Lightning Ridge, Tibooburra, Walgett and Wilcannia

Climate:
Semi-arid to arid with mild winters, hot summers and high evaporation rates

Main rivers:
Barwon, Darling-Baaka, Intersecting streams, Culgoa, Narran, Warrego and Paroo

Over 90% of water flowing in the Barwon–Darling comes from upstream catchments

Major water storages:
The main river systems are unregulated until the Menindee Lakes Scheme which has a storage capacity of 1,731 GL

Evaporation from Menindee Lakes is significant, due to the semi-arid climate, the shallow depth and the large surface area of the lakes

Water for the environment:
Approximately 66% of surface water licence shares in the region, or 372 GL of water entitlements, are managed by state and federal environmental water holders. Of these shares, 324 GL are held in the regulated Lower Darling and includes 250 GL of supplementary water entitlements

Groundwater sources:
There are many sources of groundwater, although fresh groundwater is limited, and many sources need to be treated to meet drinking water guidelines

Groundwater sources are significant for supporting a range of ecologically valuable ecosystems

Key environmental assets:
The Barwon–Darling is a critical ecological link between the northern and southern Murray–Darling Basin and is classified as an aquatic endangered ecological community

The region supports several endangered ecological communities and nationally significant wetlands: Narran Lakes, Paroo River Wetlands, Kinchega National Park, Toorale and Willandra Lakes and the Great Artesian Basin Mound Spring Clusters

Gross regional product: **$2.3 billion**

Dominant agriculture land use is rangeland grazing of sheep, goats or cattle. Some irrigated cotton production occurs in the upper catchments, concentrated on the alluvial floodplains near Collarenebri and Bourke

Industry in the region is diversifying, with renewable energy projects expanding, tourism increasing and ongoing exploration for mining and gas commodities

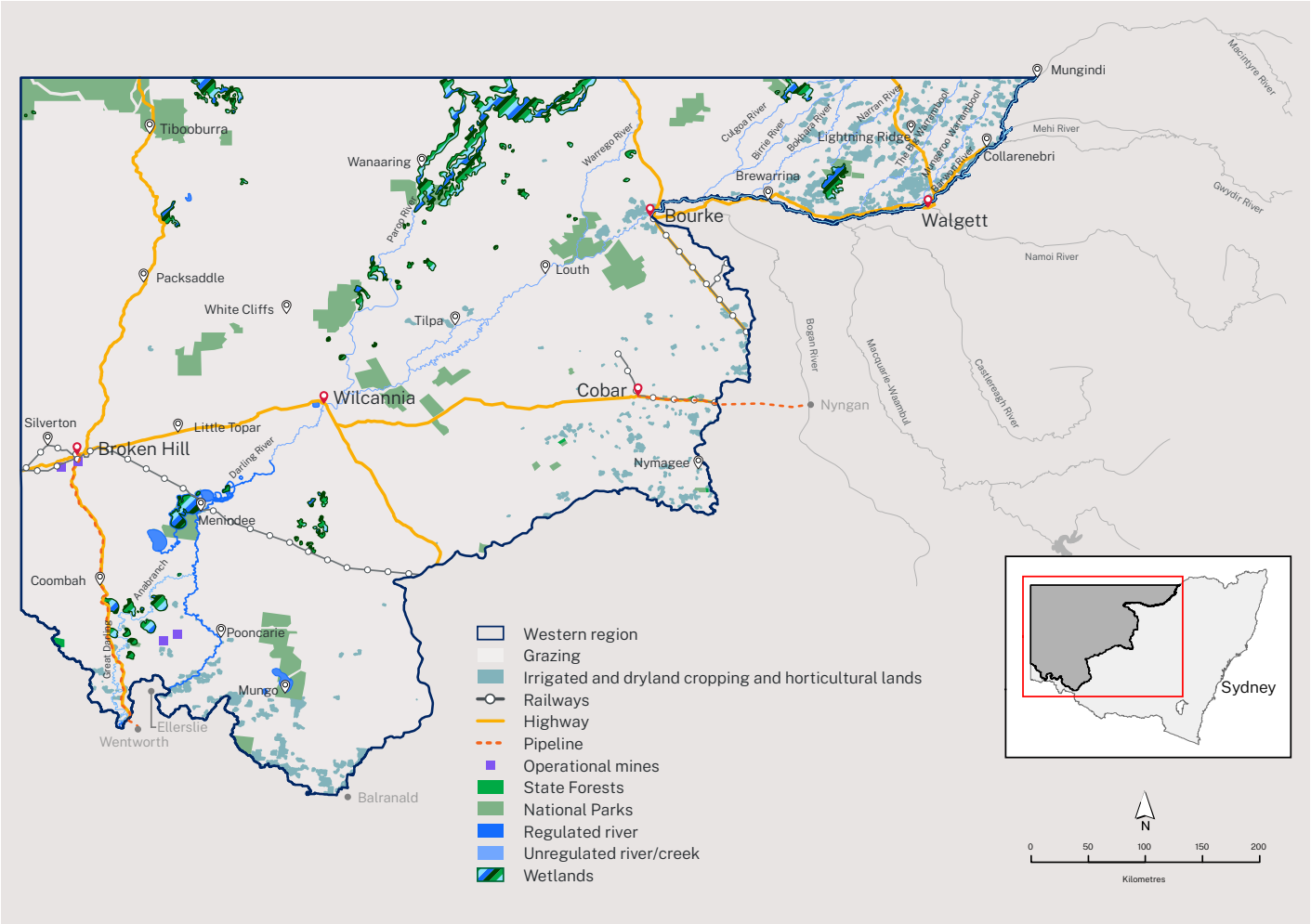
The Western region is vast, flat and low-lying, making up about one-third of the land mass of New South Wales. The region is bounded by the Queensland border to the north, Wentworth to the south, the South Australian border to the west and the Border Rivers, Gwydir, Namoi, Macquarie–Castlereagh, Lachlan, Murrumbidgee and Murray catchments to the east and south (Figure 8).

The Western region is located within the traditional lands of 17 First Nations who have remained caretakers of the region for over 60,000 years. The region is rich in Aboriginal culture and heritage and many significant Aboriginal cultural and heritage sites are also recognised as important water-dependent environmental assets, including Baiame's Ngunnhu (Brewarrina Fish Traps), Paroo River Wetlands, and Narran Lake Nature Reserve.

While covering such an extensive area, the region is home to a small and dispersed population of about 36,700 people – or 0.6% of the state's population. The region has an average population density of just 0.2 persons/km^2, the lowest of all the NSW water strategy regions.

Most people live in the regional centres of Broken Hill (population 17,600), Cobar (4,600), and Bourke (2,600). These regional centres – and other towns such as Mungindi, Walgett, Lightning Ridge, Brewarrina, Tibooburra, and Menindee – are important employment and service hubs for surrounding communities.

Figure 8. Map of the Western region



Water is a significant feature of the Western region's semi-arid environment, with multiple sources of interconnected rivers, creeks, lakes, groundwater aquifers and wetlands. Water is critical to the spiritual health of Aboriginal communities, the environment, the social fabric and liveability of the Western region, and its economic prosperity.

The region's towns, communities and industries use water from:

- the Barwon–Darling River
- Menindee Lakes and the Lower Darling
- the Intersecting Streams (which originate in Queensland)
- groundwater resources
- arid catchments in the north-west that do not form part of the Murray–Darling Basin.

The Barwon–Darling system is the main water source in the region and connects the northern and southern parts of the Murray–Darling Basin. It starts upstream of Mungindi and flows 1,900 km until it reaches the Murray River at Wentworth. The system has 3 sections:

1. Barwon River, which stretches from the confluence of the Weir and Macintyre rivers about 25 km upstream of Mungindi, south to the Culgoa River near Bourke
2. an unregulated portion of the Darling River, which flows from the confluence of Culgoa River near Bourke to the Menindee Lakes in the south
3. a regulated portion of the Darling River (known as the Lower Darling River), which continues from the Menindee Lakes to the Murray River in the south.[13]

The Barwon–Darling remains unregulated until it reaches Menindee Lakes and is one of the most significant unregulated river systems in NSW. The Menindee Lakes regulates the water flowing along the Lower Darling. Unlike most inland catchments in NSW, the Barwon–Darling River upstream of Menindee does not have a large headwater storage that regulates flows along the length of the river. Over 90% of the inflows in the region over the long term are generated in upstream catchments, most of which are regulated.

This means that towns, the environment, and other water users within the Western region rely on inflows from the north that are impacted by water extraction, the operation of headwater dams, and the climate, including its effect on soil moisture and flooding, in upstream tributaries.

Annual rainfall in the region is generally low, with mild winters, hot summers, high evaporation rates and long periods of low or no flows interspersed with small-to-medium and high-flow events. These conditions mean that agricultural industries, town weirs, and environmental assets along the unregulated rivers rely on the irregular small-to-medium and high-flow events to survive and prosper.

First Nations people in the region rely on water for their health, wellbeing and connection to Country. They value maintaining connectivity to land and water, and the region's rivers are considered 'classrooms' for maintaining the continuity of First Nations culture.

13. A major feature of the Lower Darling system is the Great Darling Anabranch, which extends for 460 km, leaving the Darling River about 40 km south of Menindee and entering the Murray River downstream of Wentworth. The Anabranch is part of the *Lower Murray Darling Unregulated Water Sharing Plan 2011.*

Water use in the Western region

The highest volume water use in the unregulated Barwon–Darling River in average years is for irrigated crops centred around Bourke and Mogil Mogil. In the Lower Darling, the water is predominately held by environmental water holders, with productive use centred around grazing. Local water utility licences in the Barwon–Darling River and Lower Darling hold around 3% of total water licences in the region (Table 1).

Table 1. Barwon–Darling and Lower Darling river licences (2021–2022)

Lower Darling Regulated River		Barwon–Darling Unregulated River		Lower Murray–Darling Unregulated River	
Entitlement	**Proportion of shares compared to total share pool (%)**	**Entitlement**	**Proportion of shares compared to total share pool (%)**	**Entitlement**	**Proportion of shares compared to total share pool (%)**
Supplementary	74	**Unregulated river – C Class**	23	**Local water utility**	65
General security	24	**Unregulated river – B Class**	68	**Domestic and stock**	<1
High security	2	**Unregulated river – A Class**	5	**Unregulated river**	35
Local water utility*	<1	**Local water utility**	3		
Domestic and stock	<1	**Domestic and stock**	<1		
Total	**100**	**Total**	**100**	**Total**	**100**

Source: Essential Water, the water utility for Broken Hill, mainly sources water from the Murray River through a pipeline and is not included in the total percentage. Nevertheless, Stephens Creek Reservoir remains an important source of unregulated supply for Essential Water.

The Barwon–Darling plays a critical role in the Murray–Darling Basin, providing the ecological link between the northern and southern basins, and is one of the most important ecological corridors across the Murray–Darling Basin. The majority of the river is classified as an aquatic endangered ecological community.[14] The river supports a range of threatened species such as Murray Cod and Silver Perch, key recreational fish species including Golden Perch, as well as internationally important wetlands.

Ensuring there is enough water in the Barwon–Darling system and the Lower Darling River for critical needs during summer can be a challenge. High evaporation and infiltration rates along the length of the river system mean that it can take from one to 4 months for water to flow from the northern valleys to Menindee Lakes.

14. Listing endangered ecological communities is a form of landscape or systems level protection. These communities provide vital wildlife corridors and habitat refuges for many plant and animal species, including threatened species and other Australian plants and animals that are in decline. Endangered ecological communities are those listed in 'Schedule I' of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.

The Menindee Lakes storage system consists of 4 main lakes: Wetherell, Pamamaroo, Menindee, and Cawndilla (Figure 9). The lakes are a critical ecological system for native fish breeding and bird life and also hold important cultural values and significance for Aboriginal people.

The Menindee Lakes system is the only large public water storage in the Western region with the infrastructure owned and operated by the NSW Government. The water can also be shared to meet Murray River demands when the volume rises above 640 GL, and until it drops below 480 GL in accordance with the Murray–Darling Basin Agreement.

Flows into the lakes often occur in large pulses, after flooding rain in the upper catchments. Large floods usually occur after late summer rains in Queensland or after late winter rains in NSW tributaries.

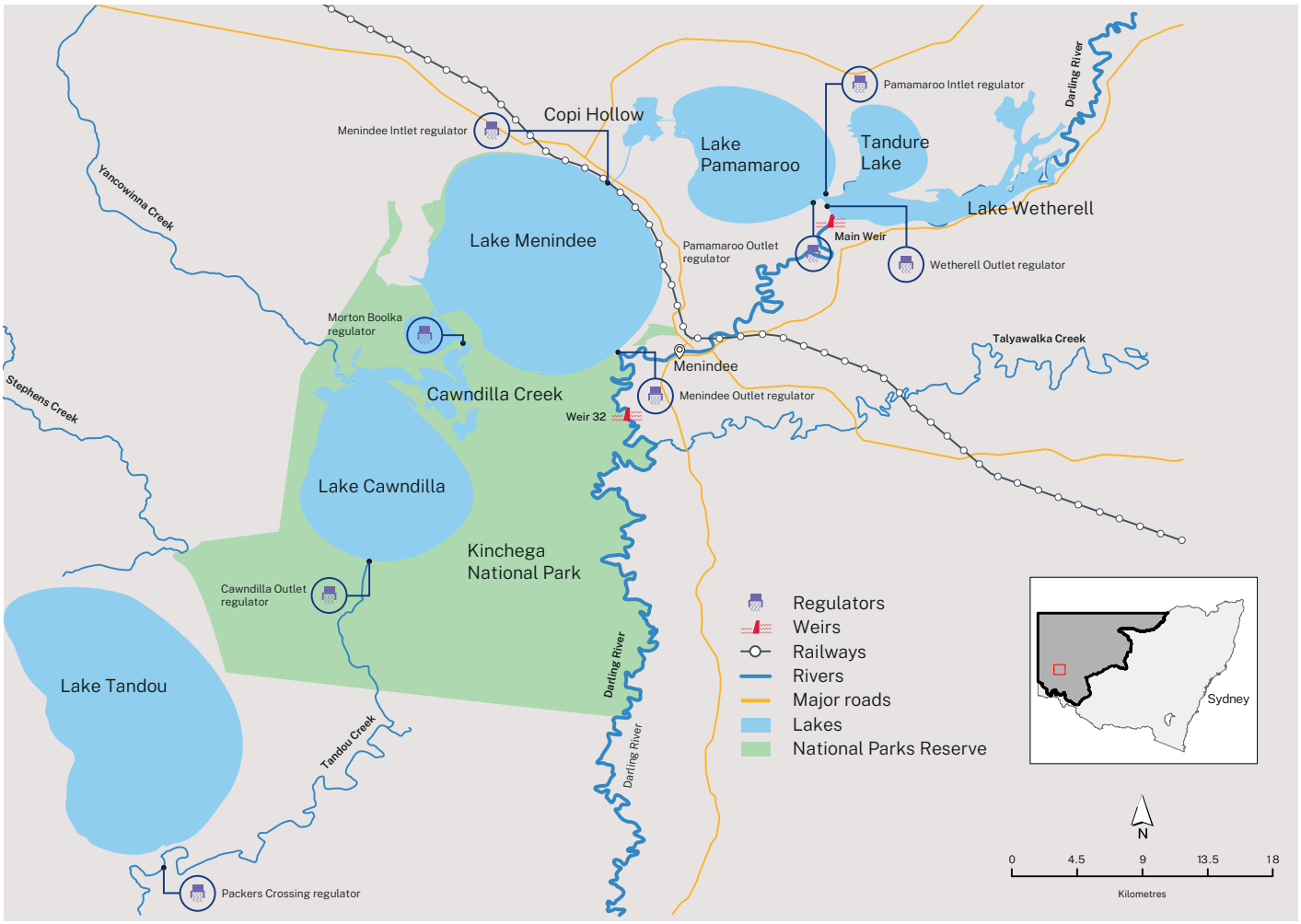
Evaporation from Menindee Lakes is significant, due to the semi-arid climate, the shallow depth (average 7 m) and the large surface area of the lakes.[15] Losses can be as high as 700 GL/year,[16] or about 40% of the storage capacity when the lakes are full.

The Intersecting Streams system includes the Narran, Bokhara, Culgoa, Warrego, and Paroo rivers, which flow south across the Queensland–NSW border and into the Barwon River. The system contains many tributaries, distributaries and anabranches and an extensive network of ephemeral wetlands and hypersaline lakes. The system is unique and has some of the largest natural free-flowing and high environmental value systems in the Murray–Darling Basin.

Stream flows are highly variable between seasons and across catchments, with sporadic flooding associated with cyclonic rain. Between wet periods, most streams become a series of unconnected waterholes, lakes and wetlands. With the exception of the Narran River, the Intersecting Streams connect to the Barwon–Darling River during wet periods and make an important flow contribution to that system.

Extraction of water in the Intersecting Streams is mainly for stock and domestic purposes and is a very small component of total water use in the region.

Figure 9. Map of the Menindee Lakes system



15. WaterNSW, *Menindee Lakes Facts and History,* www.waternsw.com.au/supply/visit/menindee-lakes
16. MDBA, *Managing Menindee Lakes: The Facts,* www.mdba.gov.au/river-murray-system/river-murray-operations/joint-management-river-murray/menindee-lakes-facts

What the future climate could look like in the Western region

3

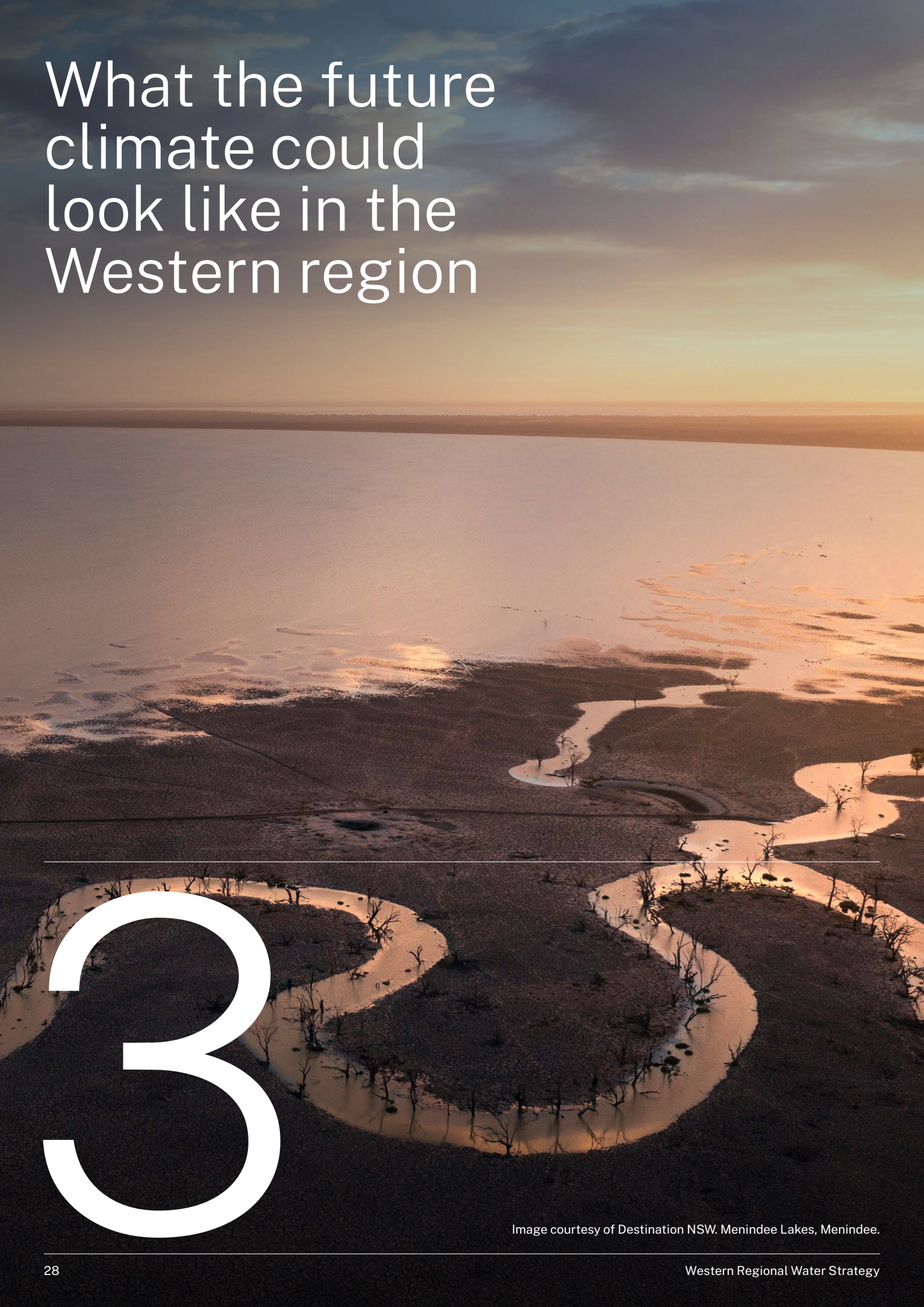


Image courtesy of Destination NSW. Menindee Lakes, Menindee.

Climate data and modelling being used to develop the strategy

In assessing the options and understanding the key challenges in this strategy we drew on 3 datasets:

- **Historical data:** data collected from rainfall and evaporation records collected by Australian Government meteorological records. This dataset was used in the final strategy.
- **Long-term historic climate projections (stochastic data):** 10,000 years of stochastic-generated climate data developed using paleo climatic information by The University of Adelaide, Australia. This dataset will be finalised in 2023.
- **Dry climate change scenario:** modified version of the long-term climate variability data, scaled up or down using the NSW and Australian Regional Climate Modelling (NARCliM) climate projections. These scaling factors compare the baseline period of 1990–2009 with climate projections for the periods 2020–2039 and 2060–2079. We apply these scaling factors to every climate timeseries used in the modelling. This dataset will be finalised in 2023.

Why we are using the dry 'worst-case' future climate scenario

The regional water strategies have planned for climate change by using a dry 'worst-case' climate change scenario. The dry future climate change scenario is the SRES A2,[17] which represents a high carbon emissions scenario and therefore results in higher projected climate change impacts on the region. 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 because many governments around the world are already taking action on climate change. However, using this 'worst-case' scenario helps us to plan strategically and to focus on the key challenges facing a region. It also helps us understand how different options might work in a very dry climate in the future.

Considering the worst-case climate scenario together with current climatic conditions is appropriate for this type of strategic-level assessment. It allows us to assess the full range of risks to the water system. We will need to complete more refined assessments of climate change risk when we implement many of the regional water strategy actions. These additional assessments will be based on both the action's planning horizon and the latest climate science.

This approach recognises that policy and operational decisions with short-term planning horizons should be based on shorter-term climate scenarios and risk management. When making long-term infrastructure and investment decisions, we will need to consider how the climate may change decades into the future. These longer-term climate scenarios may be more extreme than the shorter-term climate scenario.

Our climate science is continuously improving. The regional water strategies are an important first step to better understand each 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 our understanding of each region's climate and how it affects our vital water resources, including groundwater.

17. The SRES A2 assumes a 2°C warming over the regional water strategy planning horizon. The Special Report on Emissions Scenarios (SRES) is a report by the Intergovernmental Panel on Climate Change (IPCC) that was published in 2000. The greenhouse gas emissions scenarios described in the report have been used to make projections of possible future climate change. The A2 scenario is at the higher end of the SRES emissions.

Climate snapshot

The Western region **experiences arid, dry conditions and a highly variable climate, with low rainfall, very high evaporation rates and lengthy dry periods.**

- Droughts can be persistent, occurring on average once in every 8 to 10 years. The Barwon–Darling River often stops flowing during dry periods.
- Evaporation in the region is very high. Monthly evaporation rates can be more than 8 times the average rainfall and Menindee Lakes can lose up to 40% of its water in a year due to evaporation.
- The number of hot days (a maximum temperature higher than 35°C) ranges from 30 to 40 days/year in the south to over 70 days in the north-west of the region.

Flooding is **an important feature of the Western region.**

- Floods are a vital, natural process that support the region's ecological and agricultural productivity.
- Even under dry climate change scenarios, we may see more extreme floods with higher flows of water than we have experienced in the past.
- Significant increases in summer and autumn rainfall could lead to corresponding increases in the frequency and magnitude of flooding during these seasons.

Hydrological models updated with the **latest climate change data suggest that a future climate could be even more variable.**

- Our new modelling suggests that under a worst case, dry climate change scenario there could be:
  - seasonal shifts in inflow patterns, higher evaporation, more hot days and an increase in fire-weather conditions
  - more times when the northern NSW valleys do not connect with the Barwon–Darling, with up to 40% less inflows into the Barwon–Darling on average under a worst-case dry climate change scenario when compared to the long-term historical climate
  - increased probability of the 2017–2020 drought reoccurring. Under a worst-case climate change scenario, there could be no inflows into Menindee Lakes for 3 years or more.

While these impacts are not expected in the short term, and the likelihood of the worst-case scenario eventuating is small, these new projections show that just relying on observed historical records to make future water management decisions may no longer be the best course of action. We need to have plans in place to be prepared and resilient if there are future changes in the climate.

Image courtesy of Sally Anderson-Day. Barwon River, Brewarrina.

Figure 10. What the future climate could look like in the Western region

Worse droughts

Under the driest climate change scenario, **minimum inflows into the Barwon–Darling River** from the NSW and Queensland tributaries could be significantly less than what we experienced over the 2017–2020 drought.

Changing rainfall patterns

Average rainfall is **projected to decrease in most months except February to April**, leading to a change in inflows in the river under the driest climate change scenario.

The Barwon–Darling may receive larger late summer inflows followed by very low inflows for the rest of the year.

Higher evaporation

Evapotranspiration could increase by up to

5%

by 2070

compared to levels between 1990 and 2009, with the largest increases in winter and spring.

Higher flood peaks

There is potential for **flood peaks to be higher** than what we have seen in the observed historical record.

Higher minimum and maximum temperatures

Temperatures are expected to **increase by an average of 0.7°C** now (2020 to 2039) and 2.1°C in the future (2060 to 2079).

Fewer inflows into the Barwon–Darling River from NSW and Queensland tributaries

There could be **42% lower median annual inflows** into the Barwon–Darling River when compared to our long term historical climate projections under the driest climate change scenario, which may or may not occur.

The region has wet and dry periods that can last decades

Our observed historic climate records from the last 130 years indicate that the Western region has had lengthy dry and wet periods (Figure 13):

- the 1900s to 1940s was a comparatively dry period
- the 1950s to 1990s was a comparatively wet period
- the Millennium Drought (2001–2009), followed by the 2017–2020 drought saw a return to a mostly dry period for the first 2 decades of this century.

Most of the recorded short droughts (1–5 years) and decadal droughts (10 years) in the region have occurred during dry periods in the region's climate (Figure 11 and Figure 12). This pattern is the same for the Border Rivers, Gwydir, Namoi and Macquarie–Castlereagh catchments, which are key NSW contributors to water flowing into the Barwon–Darling River.

Figure 11. Lowest 5-year rainfall periods from the historical record in the Barwon–Darling River catchment (1889–2020)

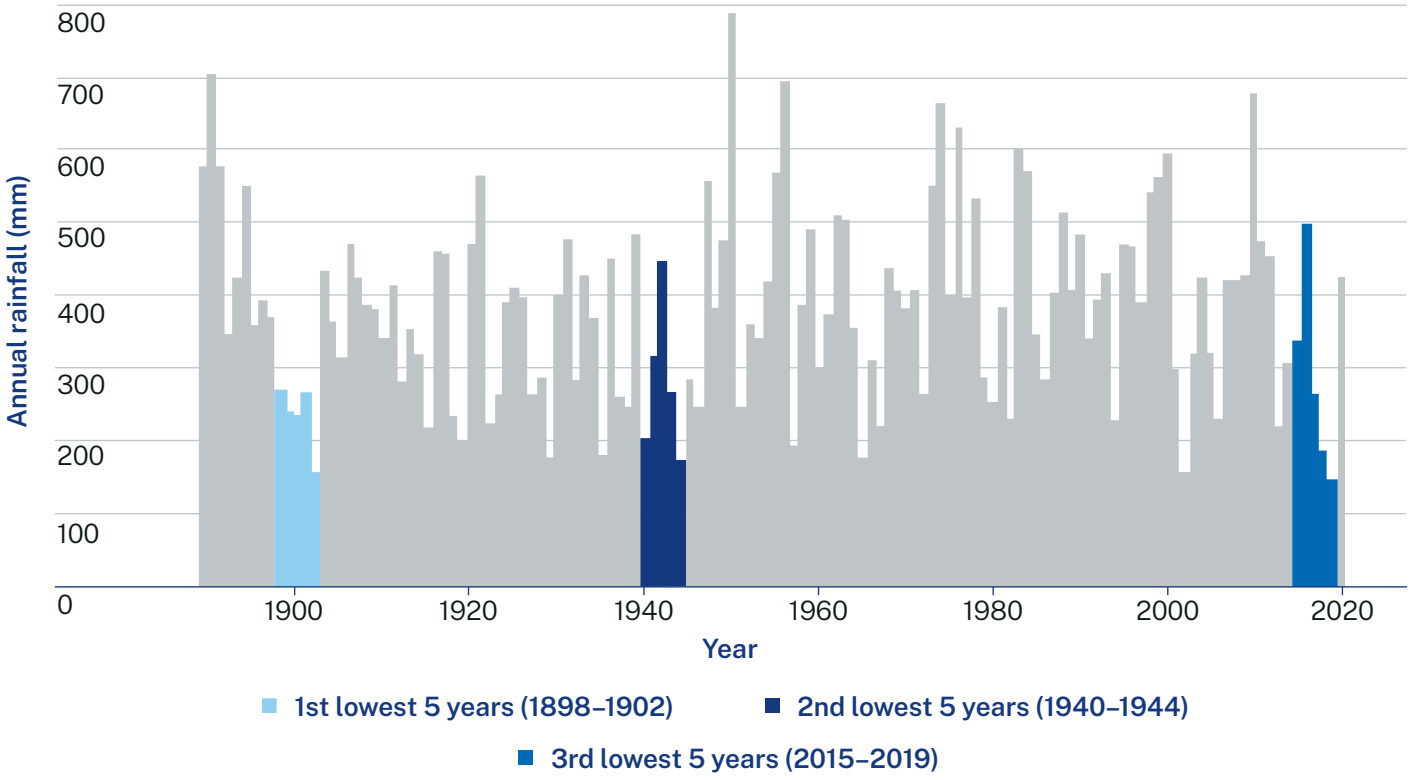
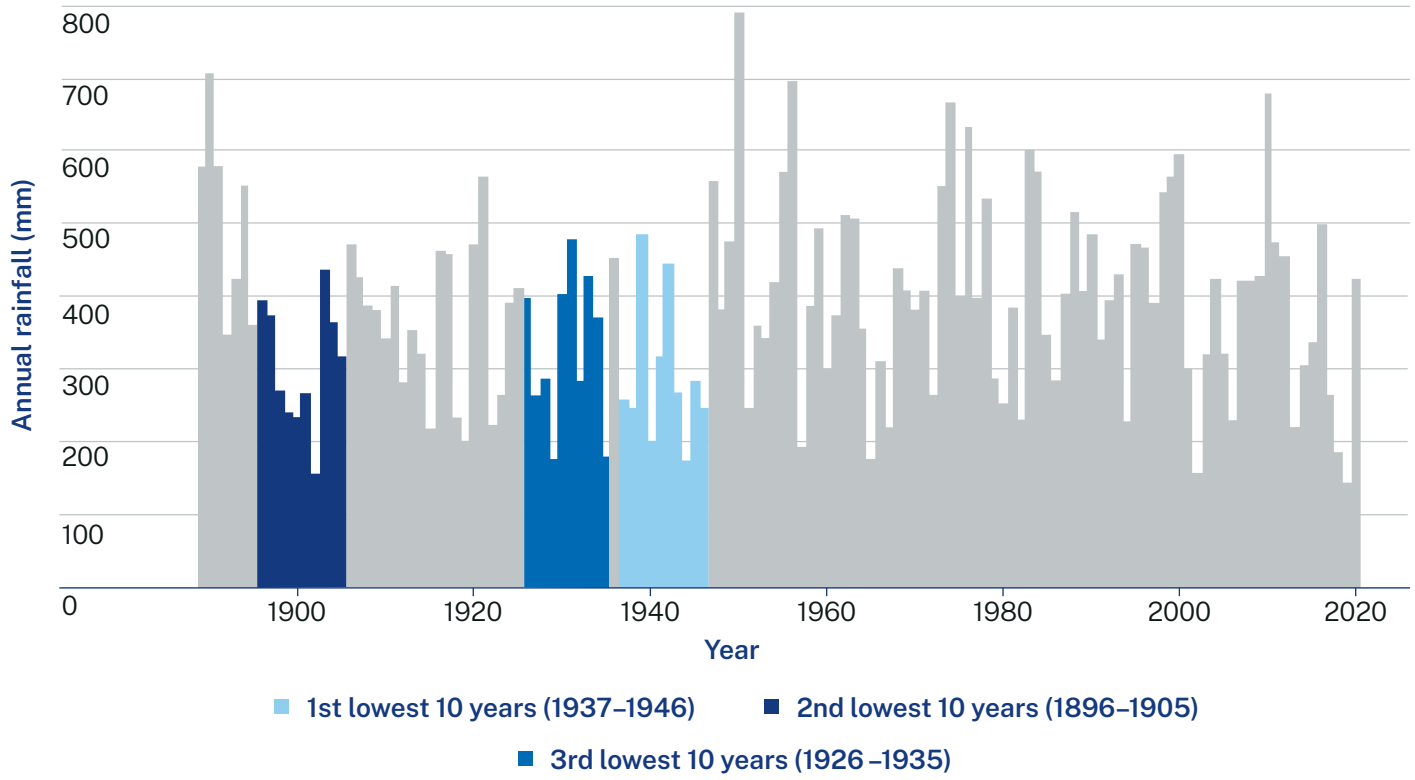


Figure 12. Lowest 10-year rainfall periods from the historical record in the Barwon–Darling River catchment (1889–2020)



The river has stopped flowing during dry periods

The Barwon–Darling naturally has periods of low flows or cease-to-flow events.

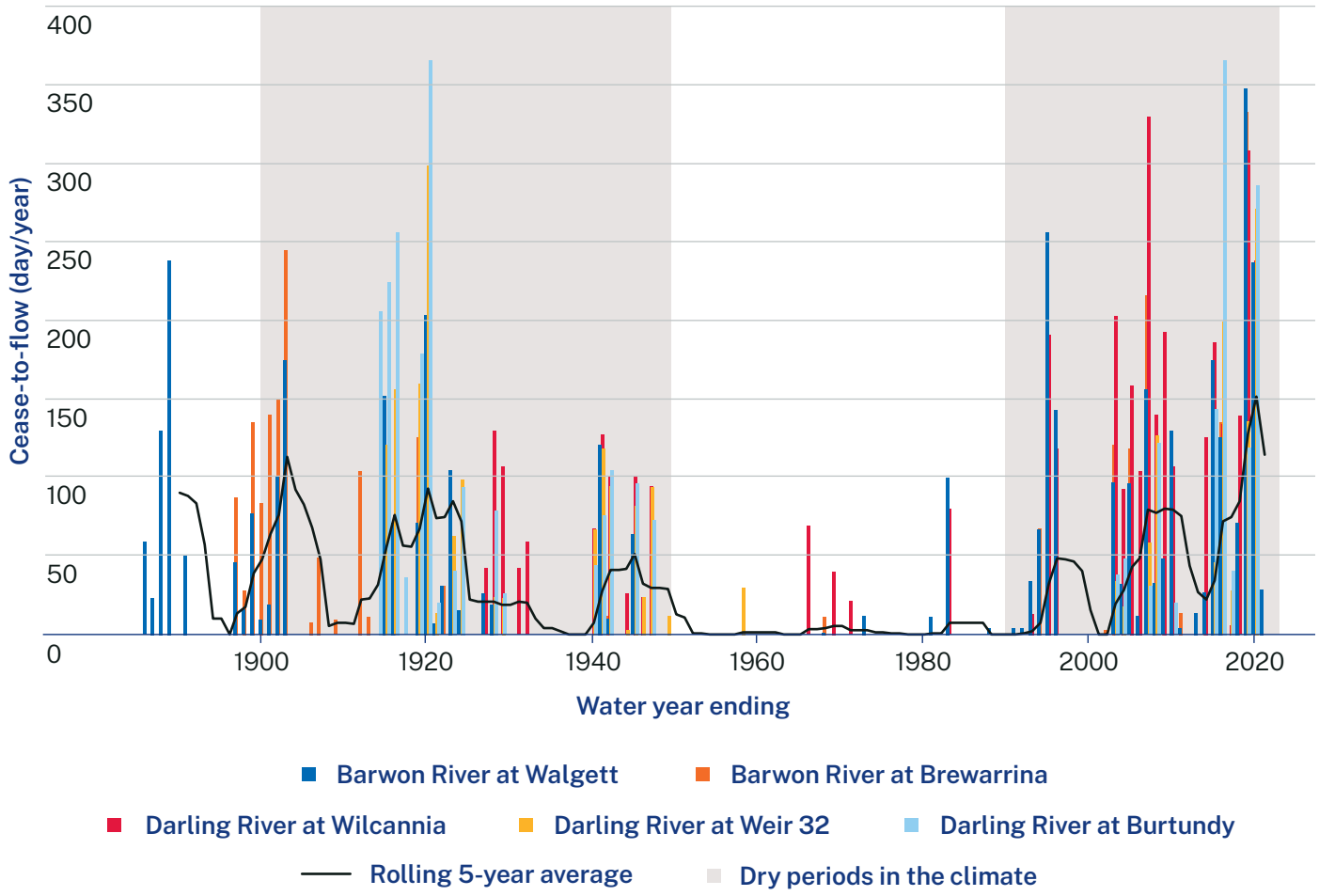
Historical data from the last 130 years shows that the Barwon–Darling River has stopped flowing a number of times, with extended cease-to-flow periods occurring more often during dry cycles. Figure 13 shows the number of days in each year since the early 1900s that the river has stopped flowing. This observed data shows that extended dry periods and cease-to-flow events have occurred at various times, including before 1940 when there was little water infrastructure and extraction in the northern Basin.

For example, before 1940, the longest periods the river stopped flowing were:

- Walgett: 270 days in 1902
- Brewarrina: 296 days in 1902
- Wilcannia: 130 days in 1927
- Weir 32/Menindee Town: 236 days in 1919–1920.

In comparison, the river stopped flowing for 364 days at Walgett and 555 days in the Lower Darling River in the last drought. Extended dry periods, particularly if the dry periods happen in close succession with minimal flows in between, can have significant impacts on communities, cultural needs and the environment, across the region.

Figure 13. Number of cease-to-flow days per year in the Barwon–Darling River



The 2017–2020 drought was the worst 3-year drought on record

Droughts occur, on average, once in 8–10 years in the Western region. However, due to its vast area, the impacts of any drought are not necessarily the same across the whole region. Droughts can span multiple years, and each drought differs in its severity, spatial extent and seasonality.

The most severe droughts have included:

- the most recent drought (2017-2020)
- Millennium Drought (2001–2009)
- World War II Drought (1937–1945)
- Federation Drought (1895–1903).

The 2017–2020 drought resulted in 3 years of low inflows into the Barwon–Darling River and Menindee Lakes, which significantly stressed Western region communities and the environment. These low inflows were a major contributor to the 2018–2019 fish deaths in the Lower Darling.[18] Our new datasets and modelling suggest that the probability of low inflows like those experienced during 2017 to 2020 drought occurring again is:

- less than 1% if the future climate is similar to our long-term historic climate projections
- less than 4% of the time if the worst-case dry climate change scenario occurs.

Significantly, no towns ran out of water during the recent drought. This was due to concerted efforts by the community, local water utilities and government to reduce demand for water, conserve remaining river supplies for critical human needs and establish alternative back-up sources of groundwater.

Image courtesy of Water Infrastructure NSW. Copi Hollow, Menindee.

18. Vertessy, R., Barma, D., Baumgartner, L., Mitrovic, S., Sheldon, F., and Bond, N 2021, *Final report of the Independent Assessment of the 2018–19 fish deaths in the Lower Darling. La Trobe.* Report. The Vertessy report found that the main causal factors of the fish deaths were climatic conditions, hydrology and water management and Menindee Lakes operations.

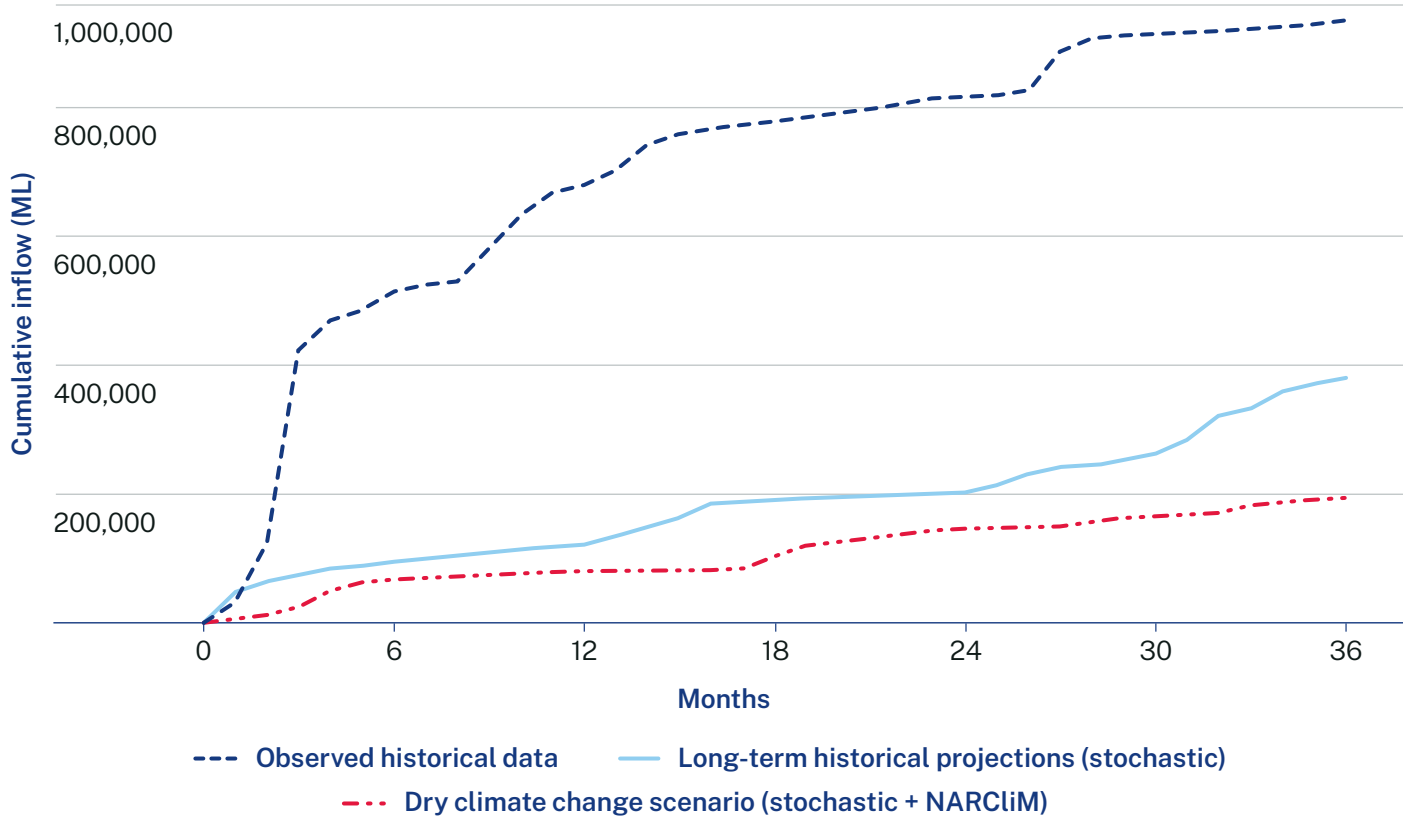
A future climate could be more variable, with shifts in rainfall seasonality and higher evaporation

The wet and dry cycles and the patterns of rainfall that we have seen in the last 130 years are not unusual when compared to our modelling of the long-term climate beyond the observed records. There have been more extreme dry and wet conditions in the long-term past than we have seen in the last 130 years. If the region's future climate is like its past climate – before observed records began – we could experience a climate that can have more variability in rainfall, particularly during summer and winter, more variability in inflows into Menindee Lakes and potentially more extreme droughts.

Our modelling also includes recognised climate change projections. We have analysed a dry 'worst-case' climate change scenario. While this scenario may not occur, if the worst-case dry climate change scenario eventuates, there may be an increase in extreme weather events with more severe droughts. The wet years could result in higher flows than we have seen in the past and in the dry years, there could be more extended droughts.

There is a small probability that we could see droughts even worse than the 2017–2020 drought. At the most extreme scenario, the minimum inflows into the Barwon–Darling from the NSW and Queensland tributaries over a 36-month period under a dry climate change scenario could be a fraction of what we have experienced over the 2017–2020 period (Figure 14) and there could be no inflows into Menindee Lakes for 3 years. Under this scenario, there is also a possibility there could be significant increases in the frequency of cease-to-flow events. Increases in cease-to-flow events may be most prevalent in the northern river sections, especially around Brewarrina.

Figure 14. 36-month minimum inflows into the Barwon–Darling River from the NSW and QLD tributaries



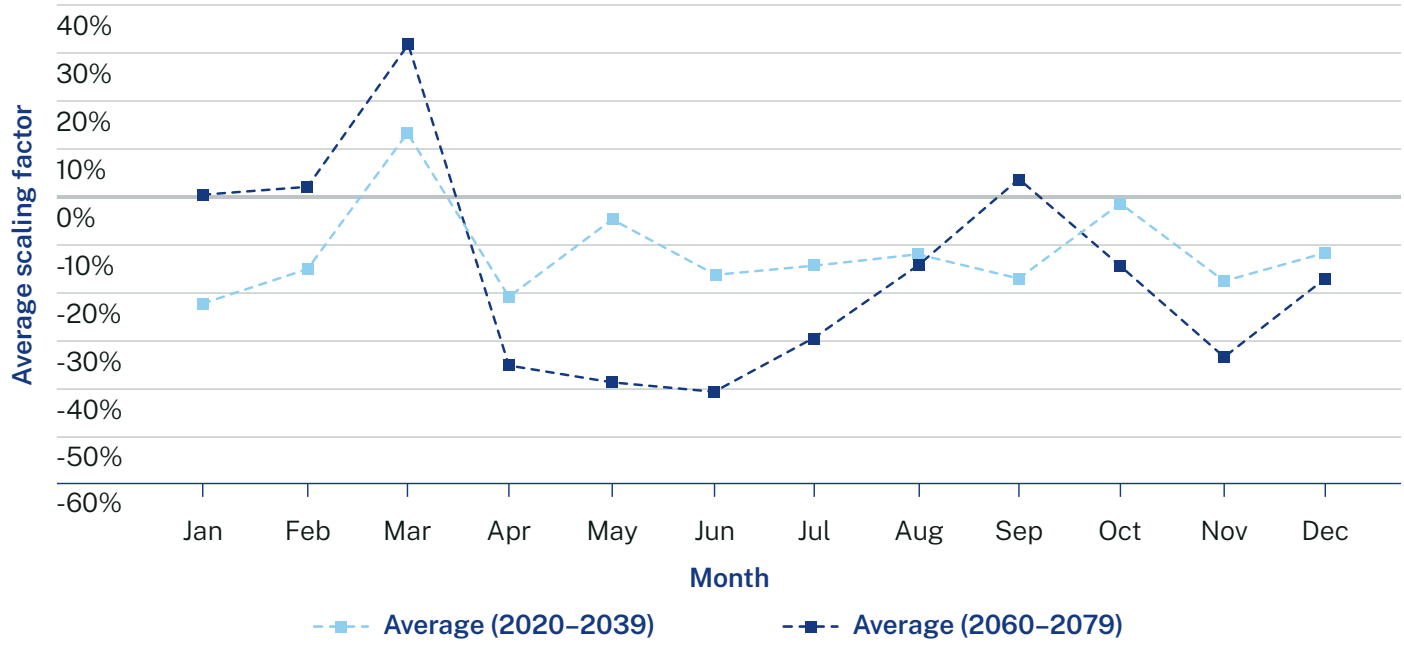
Our climate change model also shows potential changes to the seasonality of inflows into the Barwon–Darling River from both the NSW and Queensland tributaries (Figure 15). Historically, the Barwon–Darling receives inflows in autumn and again in late winter. However, under a dry climate change scenario, average rainfall is projected to decrease in most months except February to April, leading to a change in inflows in the river. The Barwon–Darling may receive larger late summer inflows followed by very low inflows, for the rest of the year.

Rainfall could be more sporadic with short, sharp and heavy rainfall events. Changes in rainfall patterns have implications for cropping practices and releases of environmental water in upstream catchments.

These changes in rainfall and inflow patterns would affect industries; town water supplies; and the plants, animals and ecosystems that rely on variable flows.

While these scenarios may not occur, the analysis helps us to understand what we may need to do to begin to prepare for a more variable or changing future climate.

Figure 15. Short and long-term climate change (NARCliM) projections for average monthly rainfall in the Western region, compared to the baseline period 1990–2009



Note: This figure is derived from NARCliM 1.0 future climate change projections and represents catchment average monthly changes for the short term (2020–2039) and long term (2060–2079), compared to the baseline period of 1990–2009. The baseline period is represented as 0% on the scaling factor.

The challenges facing the Western region

4

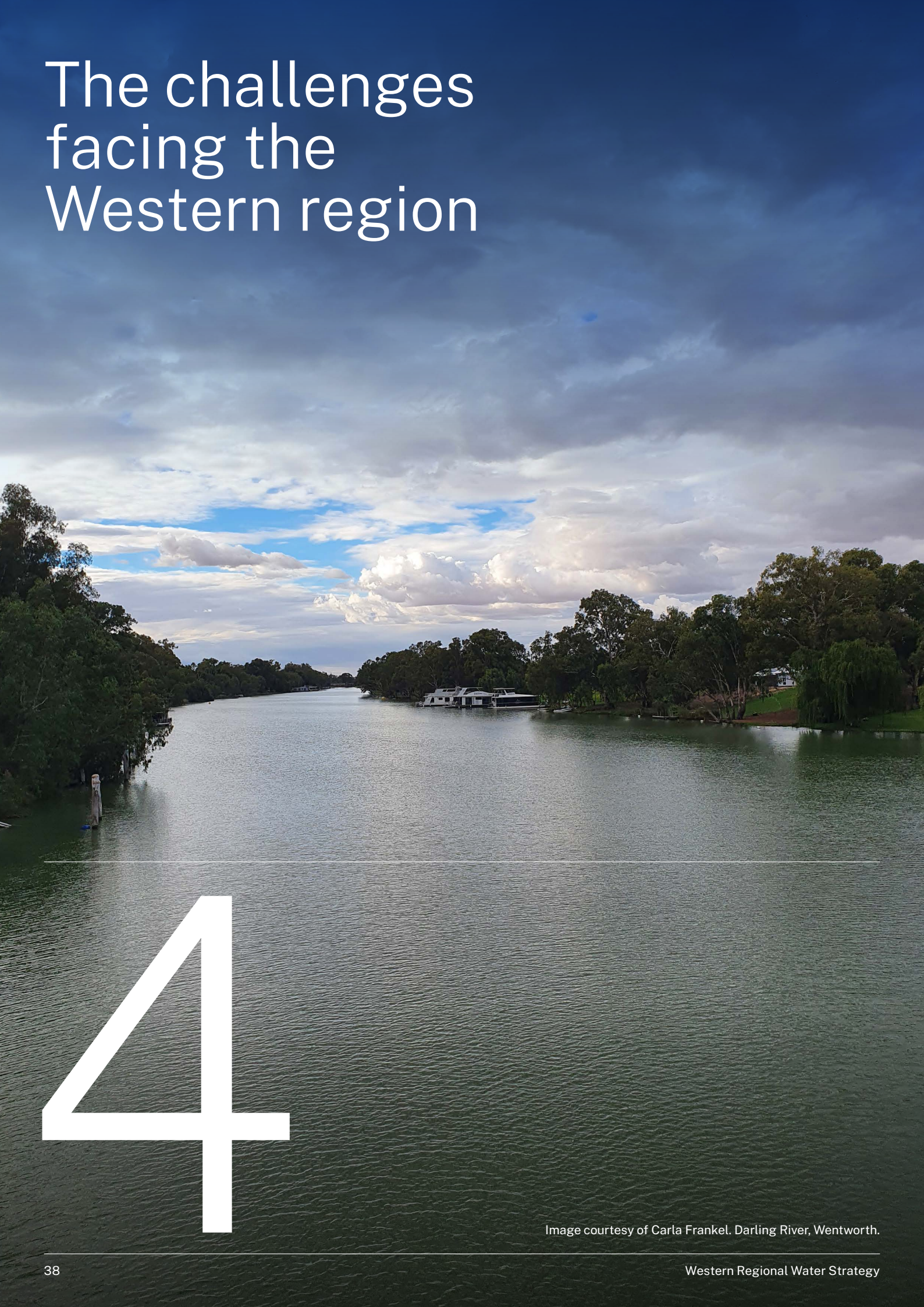


Image courtesy of Carla Frankel. Darling River, Wentworth.

The Western region is a productive agricultural and mineral rich region of NSW and home to a wide variety of aquatic ecosystems including internationally and culturally significant wetland complexes.

Like all regions across Australia, the Western region faces a warmer and more variable climate. We need to prepare now for the transition to a scenario where we do more with less water, make wise decisions about our water use and management armed with better knowledge and information, and protect our most critical water needs for both humans and the environment.

We have identified 6 key challenges that are the immediate priorities for the region. Addressing these challenges will help us meet the vision and objectives we have set for the Western Regional Water Strategy. The key challenges for the region are:

- Declining water security for towns and small communities
- Insecure water supplies affect the viability of businesses
- Addressing barriers to Aboriginal people's water rights
- Declining health of natural systems
- Reduced connectivity impacts critical needs
- Poor water quality.

Image courtesy of Destination NSW. Townscape, Bourke.

Challenge: Declining water security for towns and small communities

Extended droughts could increase water security risks for towns and landholders

Many towns along the Barwon–Darling and Lower Darling rivers rely on surface water from a series of small weirs, supplemented in some cases by groundwater of variable quality and quantity. Due to the small storage volumes, low average annual rainfall and high evaporation rates, these weirs rely on irregular inflows to replenish water supplies for local communities.

Town weir pools typically supply most towns for approximately 6–9 months. Extended no-flow periods and very high evaporation rates in summer can result in a rapid depletion of water in town weir pools, placing stress on town water supplies and affecting the quality of the water in the pools. For example, during the 2017–2020 drought, water levels in the Bourke Weir fell by approximately 2 m in 7 months (a 60% drop in weir capacity), placing water security for the town at risk.

Approximately 16% of people in the region source water for their own drinking and domestic use from roof water harvesting in rainwater tanks, harvesting runoff within their properties into farm dams and accessing unregulated rivers and groundwater aquifers. During droughts, these households need to rely on groundwater or water carted from nearby towns, placing an increased demand on town water supplies. Supplying water to the region's small and highly dispersed communities can be expensive and challenging.

Maintaining water security for towns is also crucial for maintaining the liveability of communities, attracting people to the region and supporting a growing tourism industry.

While recent investments in water supply and groundwater have helped improve water security for a number of towns in the region including Broken Hill, most towns do not have a secure water supply (Table 2).

Table 2. Summary of town water security assessment conducted as part of the Western Weirs Strategic Business Case

Town water supply – weir	Emergency/backup groundwater supply	Secure town water supply
Angledool	Yes	No
Bourke	Yes	No
Brewarrina	Yes	Yes
Collarenebri	Yes	No
Gongolgon	No	No
Goodooga	Yes	No
Louth	Yes	No
Menindee and Sunset Strip	Yes	Yes
Pooncarie	Yes	No
Tilpa	Yes	No
Walgett*	Yes	N/A
Wilcannia*	Yes	N/A

*Walgett Weir has already been raised and a new Wilcannia Weir is to be built, so these weirs were not further considered by the Western Weirs Project.

Note: This analysis was based on a secure yield assessment that compared the secure yield for each town water supply against the 30-year unrestricted dry year demand for the town. The 30-year unrestricted dry year demand was estimated in accordance with the Department of Planning and Environment – Water's February 2019 integrated water cycle management checklist. The dry year demand used is an estimate of the 2020 unrestricted dry year demand. It does not account for potential residential or non-residential growth or climate change.

Climate change was considered in the assessment. It was assumed that the secure yield under a historic climate would be reduced by 35% (being the average of 8 secure yield studies undertaken for inland supply systems, where the reduction in secure yield ranged from 20% to 50%).

Image courtesy of Destination NSW. The Paddle Vessel Jandra Cruises, North Bourke.

In addition, water demand per household is significantly higher in the Western region compared to other parts of the state (Table 3). While water demand per household in the region is expected to be higher than the average in NSW given the arid and hot conditions, there may be opportunities to implement water efficiency and demand management measures.

A more variable or drier future climate could result in extended dry periods with longer no flow periods, and poor water quality in town weirs, including elevated levels of salinity and blue-green algae. For towns and Aboriginal communities, the potential for more frequent and longer dry periods will mean less secure water supplies unless actions are taken to invest in diversified water sources – including climate-independent sources – and change how we manage major storages. This risk will be greatest for towns that rely on water from unregulated rivers.

Table 3. Potable water demand and average household demand for towns along the Barwon–Darling

Town	Town average potable demand (kL/year)	Town water demand per household (kL/year)
Mungindi	224,000	824
Collarenebri	200,000	913
Walgett	270,000	398
Brewarrina	200,000	543
Bourke	471,000	552
Louth	15,000	484
Tilpa	10,000	500
Wilcannia	132,500	594
Menindee	166,000	769
Pooncarie	62,000	886

Groundwater availability and quality varies

A more variable or drier future climate could result in a greater reliance on groundwater for towns with emergency or backup bores. Some councils have also indicated an interest in exploring opportunities for additional treatment of groundwater to support drinking water for towns where groundwater quality is poor. While groundwater may be a solution for some communities, its use comes with a number of challenges.

While there are many sources of groundwater across the region, its availability and quality varies according to location and geology. Potable groundwater is limited, and all shallow groundwater sources need to be treated to meet drinking water guidelines. The water from artesian bores is often at high temperatures, which can also make it challenging for towns to use this groundwater.

Groundwater salinity is a major challenge in the region and salt interception schemes are in place to help manage the risks of saline groundwater discharging into surface water ecosystems. Increased use of bores that access fresh water can result in saline water from deeper in the alluvium flowing into the bore. A better understanding of the size of these shallow pockets of fresh groundwater and how they change over time in response to surface water flows and floods will be needed to improve water security for towns and other users.

Towns and local water utilities have limited access to data on groundwater sources availability, quality and extraction and the potential effects of climate change on these sources. The data may not be accessible or available to water users in a format that is useful to their needs. This makes it difficult to make effective decisions based on an evidence-based assessment of risk, particularly during drought periods.

Image courtesy of Sally Anderson-Day. Barwon River, Brewarrina.

Challenge: Insecure water supplies affect the viability of businesses

Water underpins the regional economy

The Western region is home to a range of industries. The primary employment sector is the healthcare and social assistance, with employment mainly occurring in larger centres like Broken Hill and Cobar (Figure 16). Mining, agriculture and tourism are also important industries, with mining providing the largest economic output for the region (Figure 17).

The mining and agricultural sectors directly employ around 25% of all workers and underpin other town-based businesses. Tourism employed over 900 workers in 2016.

Due to the predominantly semi-arid climate, the main agriculture land use in the region is extensive grazing of rangelands by sheep, goats, and cattle. Crops tend to be annual or seasonal and irrigated cotton production occurs in the upper catchments, concentrated on the alluvial floodplains near Collarenebri and Bourke. Although irrigated agriculture accounts for a very small proportion of agricultural land use in the region, it provides a significant proportion of agricultural income. In 2017–18, the gross value of irrigated agricultural production in the Western natural resource management region was $298.8 million, which represented 46% of the gross value of agricultural production in the management region.

Mining operations include the:

- Ginkgo and Snapper mineral sands operations near Pooncarie
- CBH Rasp, Broken Hill Operations, Perilya, and Pinnacles Mines near Broken Hill
- CSA, CBH Endeavour, Peak Gold (Newgold) and Tritton Copper Operations at Cobar.

These sectors rely on access to water, which means that regional economic output can vary significantly in response to climate conditions and mining commodity fluctuations. Having a reliable water supply and making the most efficient use of available water will become even more important to the sustained success of these sectors under a more variable climate.

Similarly, tourism in the region is often linked to water availability. In 2021, record numbers of visitors went to the region to see Menindee Lakes full for the first time in years. Many small townships provide an important role supporting tourism in the Western region by providing rest and re-supply opportunities; however, very few towns in the Western region have adequate water security. For example, communities in the Unincorporated Area[19] have important visitor economies but do not have a reticulated water supply.

We know from history, and the 2017–2020 drought experience, that water availability influences employment and business growth in the Western region. For example, the Millennium Drought had an adverse impact on agribusiness across the region and we heard from people in the Unincorporated Area that tourism levels dropped during the 2017–2020 drought. Conversely high flows in the Barwon–Darling system and the filling of the Menindee Lakes brings in tourism to the region. Improving water security and reliability is crucial for attracting people and businesses to the region and supporting the growing tourism industry.

19. Unincorporated areas are parts of Australia not administered by incorporated bodies such as local government.

Importance of agriculture in the Western region

Agriculture is a significant part of regional NSW. It drives employment, regional economies and supports towns. NSW crops, fodder and livestock provide food and fibre to NSW, Australia and abroad.

The Western region with its hot dry climate and diverse soil types supports a range of agricultural industries including irrigated cotton in the north particularly in the Brewarrina and Bourke local government areas where there is access to surface water from the major rivers in the region. Extensive livestock grazing on predominantly native pastures is also an important industry in the region. Diversification into kangaroo or goat meat as a potential source of permanent income is being seen as important for many farmers.

Agriculture also supports downstream value-added industries in the region. It creates economic and employment opportunities in meat processing, agricultural tourism, farming supplies, technical support services as well as in transport industries and research facilities, such as the Fowlers Gap Research Station north of Broken Hill.

Agriculture in the Western region employs over 40% of the workforce in the Unincorporated Area and Central Darling local government area, 30% of the workforce in the Brewarrina local government area and 27% of the workforce in the Walgett local government area contributing to the region's $2.3 billion/year economy.

Agriculture will remain an essential industry in the region for years to come.

Image courtesy of Carla Frankel. Mundi Mundi Lookout, Silverton.

Figure 16. Employment in key industries in the Western region (2016)

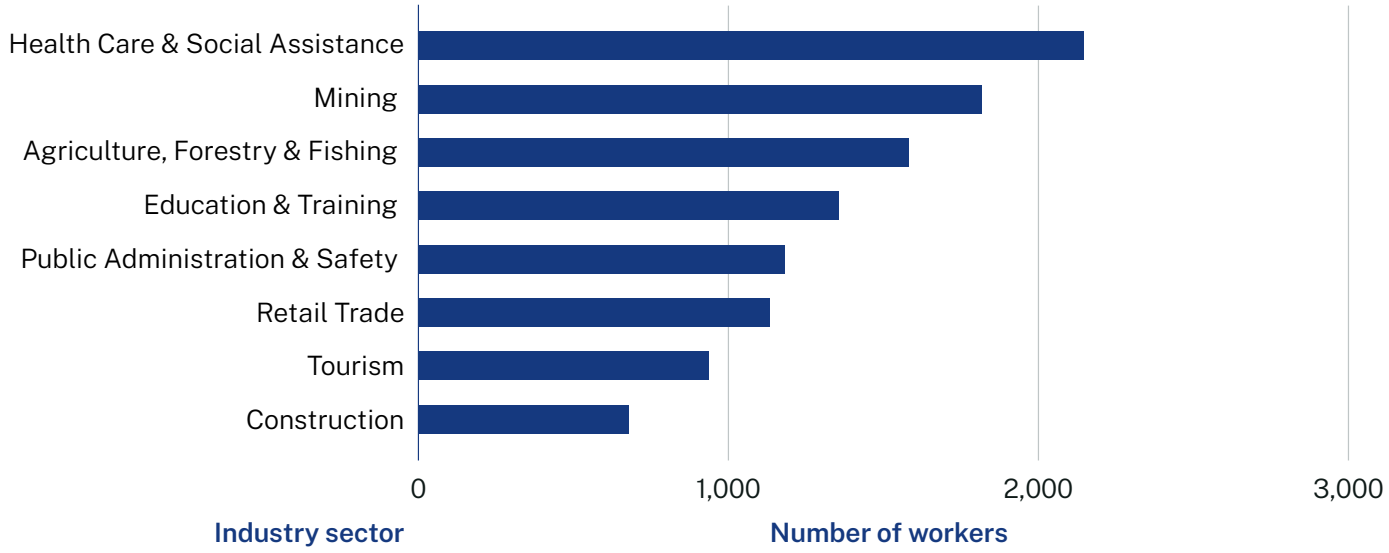
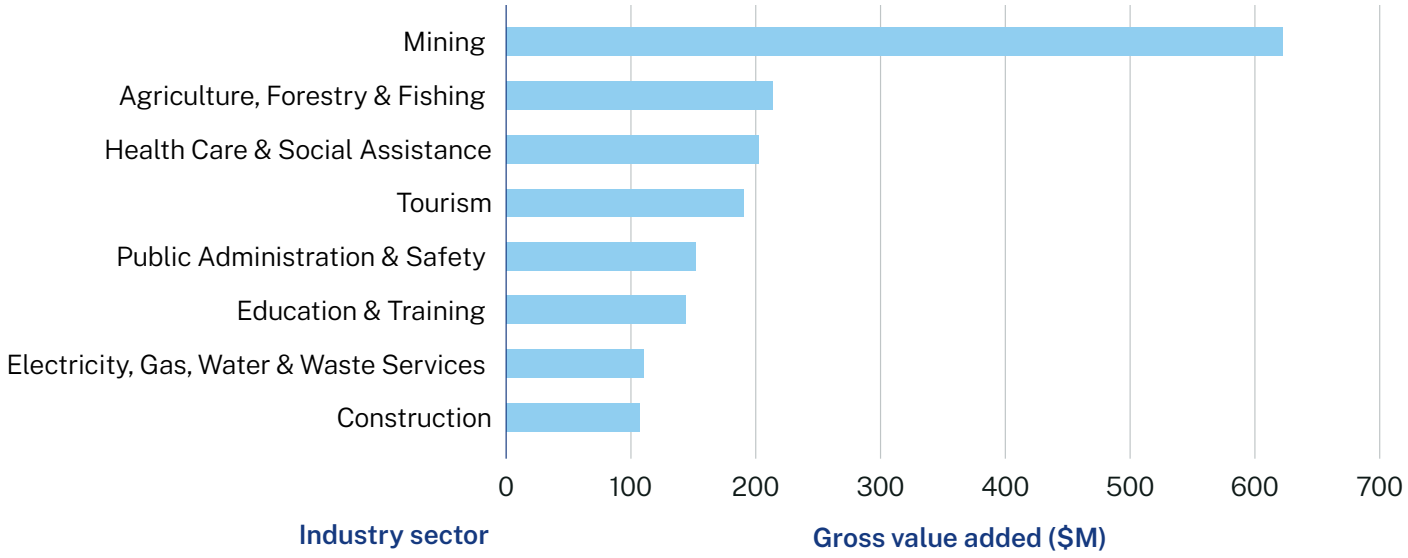


Figure 17. Economic outputs of key industries in the Western region (2018–2019)



Surface water is unreliable and groundwater use is limited by water quality

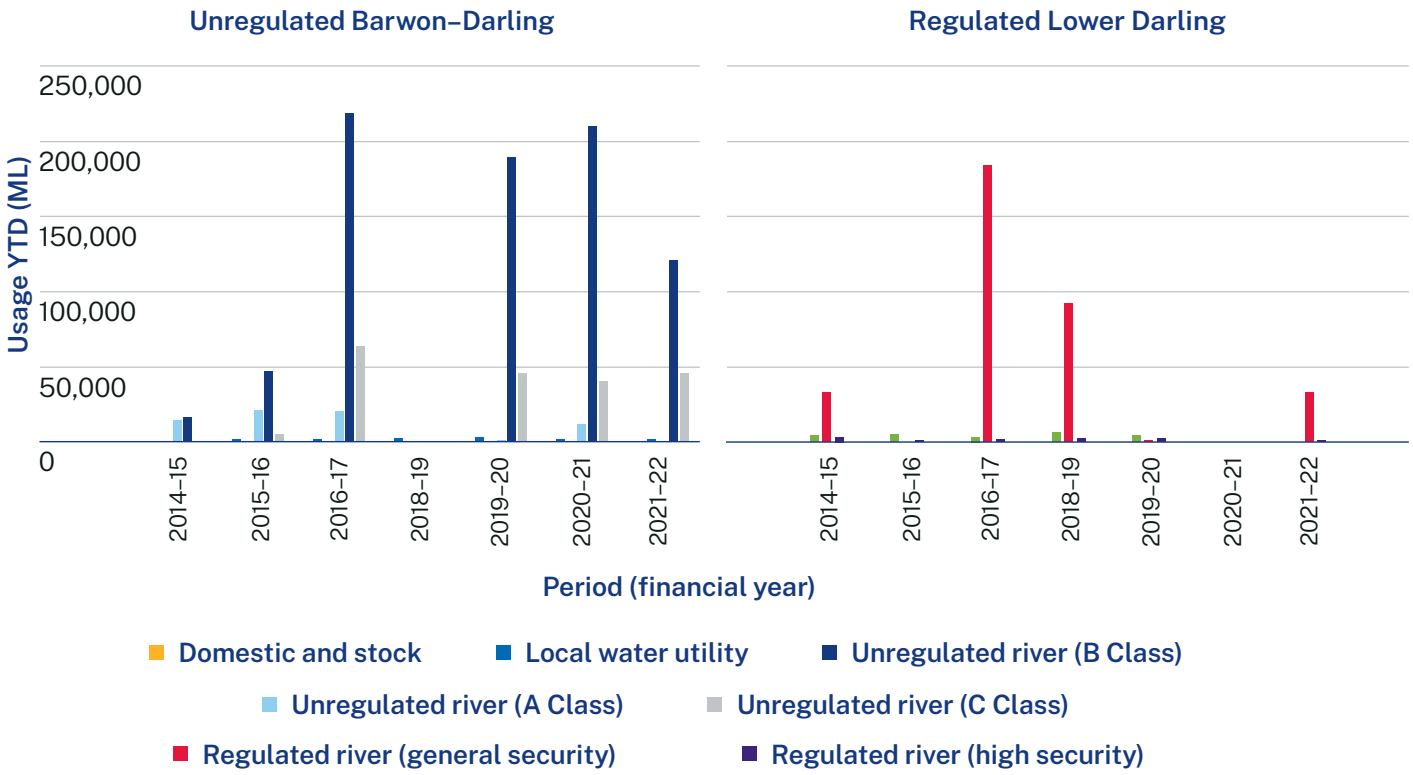
Most of the water taken in the Western region by industry is from the Barwon–Darling unregulated system and the Lower Darling regulated river (see Figure 18).

In the Barwon–Darling unregulated system, over 188 GL of entitlements are licensed for unregulated access (A, B and C Class) licences, the majority of which are held by cropping farmers concentrated around Bourke. Approximately 350 GL of licensed entitlement is held in the Lower Darling, predominantly by the NSW and Commonwealth environmental water holders.

The timing of when water can be taken depends on the amount of water flowing in the rivers and the storage level of Menindee Lakes. The actual amount of water used by these licence holders changes each year depends on available flows in the river.

Reliance on unregulated river flows and a regulated river in a highly variable climate makes industries vulnerable to drought and means industries rely on those few years of high-flow events to sustain their operations. Years of low flows and extended droughts can have a significant impact on industry and impose hardship on communities, with the impacts of reduced production extending to other parts of the economy. We heard from councils that access to reliable potable water supply is also important to increasing visitor numbers to the region.

Figure 18. Water taken under different categories of water licences in the unregulated Barwon–Darling and regulated Lower Darling Rivers between 2014–15 and 2021–22



Source: NSW Water Register waterregister.waternsw.com.au/water-register-frame

Groundwater use is low across the Western region compared to some other regions and is often constrained by water quality. Groundwater quality in the region naturally varies between and within groundwater sources. There are a number of water quality challenges:

- **Salinity is a key challenge in the Western region** and limits the use of groundwater in sources such as the Western Rock Porous groundwater. Shallow groundwater can cause land salinisation or saline groundwater flowing into rivers. Salt interception schemes are in place at Bourke and Wentworth to reduce the volume of saline groundwater flowing from the alluvium into the Darling and Murray rivers.
- Groundwater from the deep **Great Artesian Basin has high concentrations of sodium,** making it unsuitable for irrigation, and exceeds the *Australian Drinking Water Guidelines*[20] aesthetic values for sodium in most areas in the Surat, Warrego, and Central Groundwater Sources.
- The **temperature of bore water** from the Great Artesian Basin can exceed 50°C in the Central Groundwater Source. Water at these temperatures require cooling before being used for drinking water or for agricultural purposes.
- **Fluoride concentrations** of more than 6 times the Australian Drinking Water Guidelines can be found in groundwater along the boundary between the Warrego and Central Groundwater Sources.

Managing groundwater salinity and promoting groundwater desalination for industry and towns can help to address future water security challenges.

Given the expected continuing demands on groundwater, enhancing our understanding of the interaction between surface water and groundwater resources in the Western region will help to improve our management of connected water sources. We need to understand where a change in groundwater use can influence flows to rivers and vice versa. We also need to understand how a changing climate is impacting the replenishment of groundwater resources. More broadly, we need to ensure ongoing investment in the groundwater monitoring network, so we have the water quantity and quality information we need to manage the resource into the future.

Future climate change scenarios present challenges for industries

Mining and agricultural businesses in the Western region anticipate wet and dry cycles and plan for their businesses to withstand several years of low or no surface water flows. Many farm businesses have adapted to the region's highly variable climate through:

- producing annual or seasonal crops
- investing in new technologies that have helped drive on-farm water use efficiency and on-farm storage in irrigated agricultural businesses
- improved rangelands management, which allowed many farmers to become more sustainable
- mines holding multiple water sources accessing licences that may maximise use of local runoff and waste water. Mines are able to use water of a lower quality than many other industries.

Recent improvements in our understanding of the region's climate suggest that droughts may occur more often and last longer than under the observed historical climate. While the impacts of a changing climate are uncertain, there could be reductions in the amount of water flowing into rivers because of less overall rainfall and high evapotranspiration. While the impacts of climate change are uncertain, our new modelling shows that the future climate in the Western region could increase the water security risk for most surface water users, with:

- significantly less water available in dry periods, when compared to the last 130 years of data (Figure 19)
- a slight increase in water available during wet periods, when compared to the last 130 years of data (Figure 20)
- limited change in average years.

20. www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Figure 19. Average annual water extraction for A, B and C Class licences in the driest 1-year, 5-year and 10-year climate sequences under historical, long-term historic (paleo-stochastic data) and long term climate change scenarios

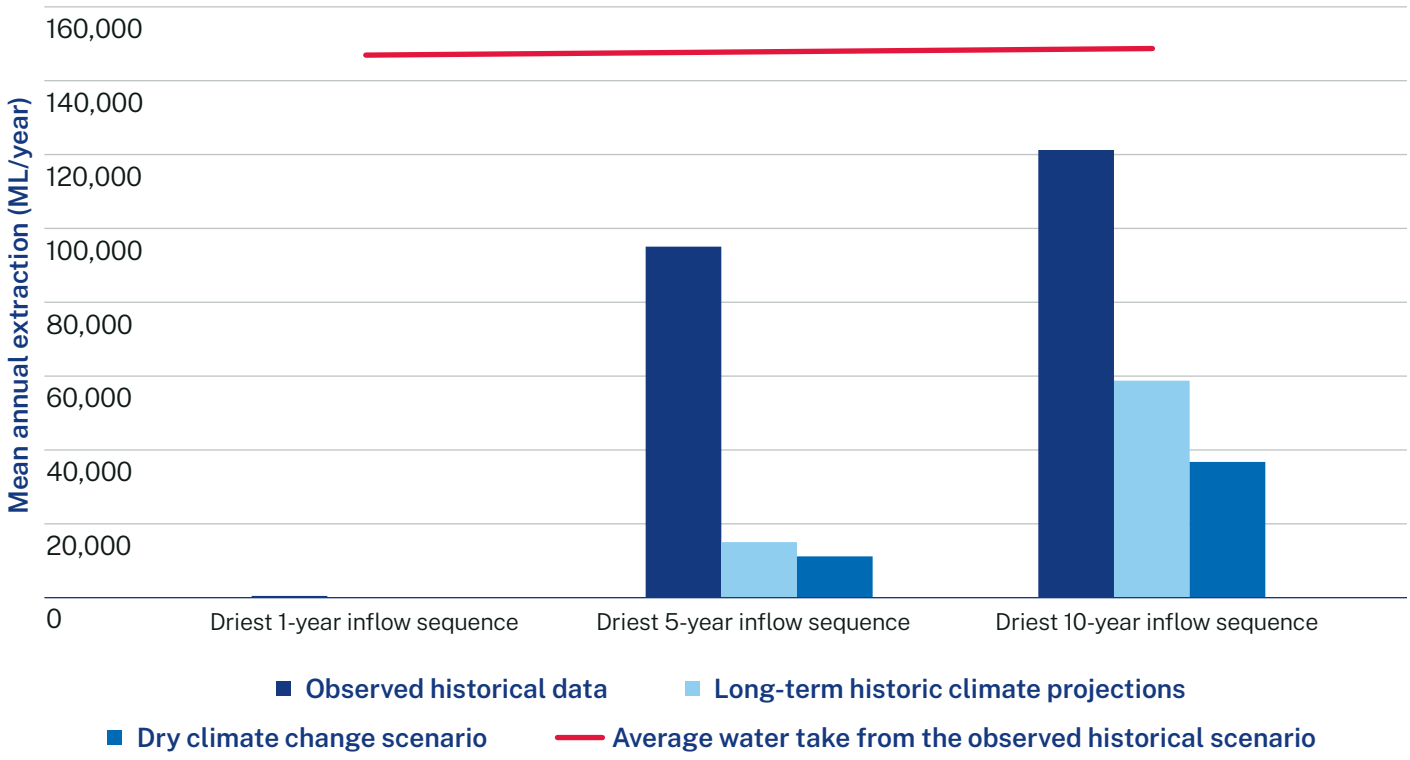
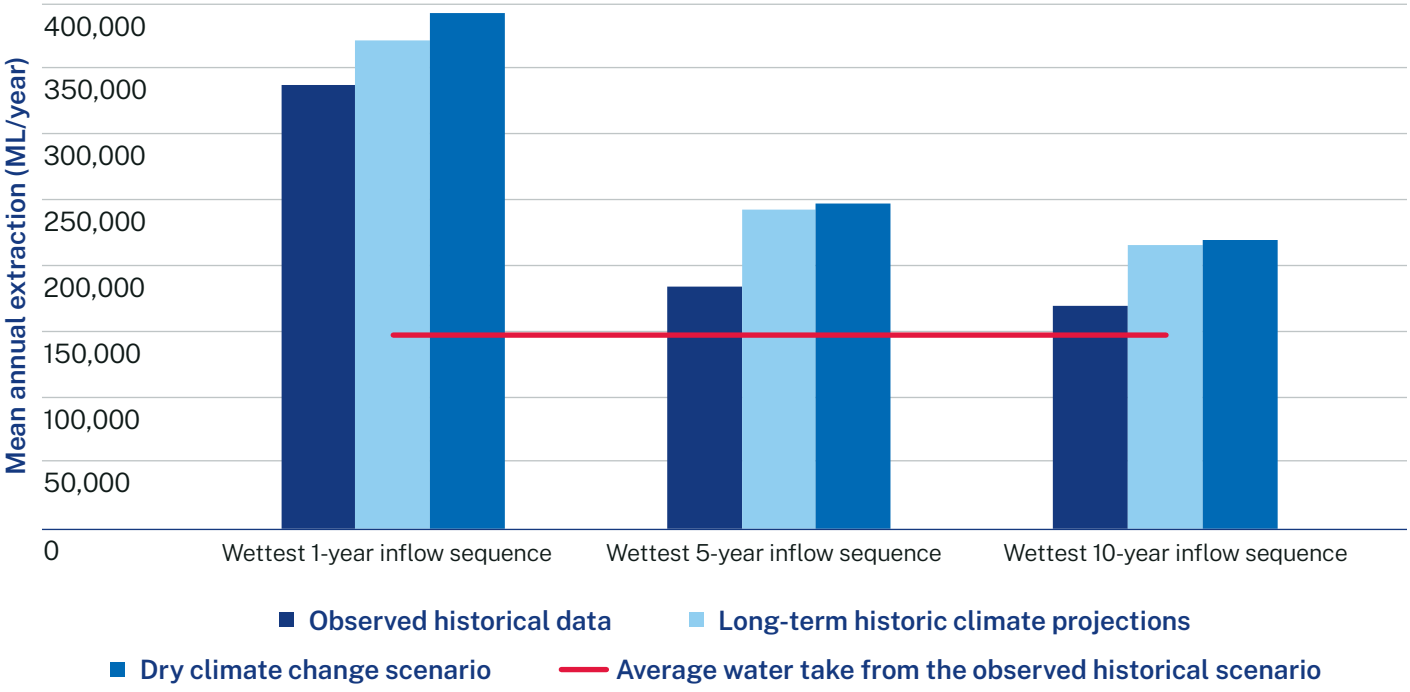


Figure 20. Average annual water extraction for A, B and C Class licences in the wettest 1-year, 5-year and 10-year climate sequences under historical, long-term historic projections (paleo-stochastic data) and long term climate change scenarios



Challenge: Addressing barriers to Aboriginal people's water rights

The Western region lies within the traditional lands of the following First Nations groups (Table 4).

Table 4. First Nations of the Western region

Barkandji	Budjiti	Gomeroi/Kamilaroi
Guwamu (Kooma)	Kunja	Malyangapa
Maraura	Murrawarri	Muthi Muthi
Ngemba	Ngiyampaa	Ualarai/Euahlayi
Wangaaypuwan	Wayilwan	Wilyakali
Wongaibon	Wongkumara	

First Nations people strongly identify with water and some, such as the Barkandji (people of the river), derive their names from their relationship with water bodies. The lands and water resources of the Western region contain places of deep significance to Aboriginal people and are central to their spiritual and religious belief system. They are celebrated in rituals, ceremony, stories, dance, and artworks. They also allow kinship, connection, stories, songlines, and healing through medicine and food.

Protecting waterways and water-dependent sites is important to Aboriginal people and supports them in their custodial roles. Under their law and customs, Aboriginal people have rights and a moral obligation to care for Country, which includes caring for rivers, creeks, and wetlands and ensuring that people and ecosystems downstream have access to healthy water supplies. For example, the Ngemba people have a strong connection to the Brewarrina Fish Traps or Baiame's Ngunnhu and feel responsible for maintaining and protecting them. The Ngunnhu are where many different nations came together to practice culture, to trade and to develop partnerships.

Access to healthy surface water and groundwater systems is critical for maintaining the health, wellbeing and culture of First Nations people. The region's rivers are considered 'classrooms' for maintaining the continuity of culture, providing a purpose and pathway for young people to connect to culture, and providing a space for teaching. Aquatic, riparian, and floodplain vegetation and healthy fauna species support Aboriginal cultural values and practices. Changes to flow regimes can directly or indirectly impact cultural sites and practices around rivers, wetlands or lakes.

Aboriginal people have lost access to water

The historical dispossession of land, including water licences allocated to land parcels, have continued to impact First Nation people's access to water. Fences and locked gates, including on public land, prevent First Nation people from accessing water, carrying out cultural practices and using traditional knowledge to care for and manage waterways. In addition, changes to the flows in the river and water quality have had impacts on Aboriginal people's ability to practice and teach culture and affected the natural environment of culturally important places.

The application process for cultural licences is not meeting Aboriginal people's needs

The NSW Government's water management framework has evolved over time, and there are legislative provisions to provide for cultural access licences. First Nation people's legal rights as they apply to water management have been recognised in international human rights treaties and conventions, in Australian and NSW Native Title and land rights laws, and in water plans. For the Western region, NSW water legislation provides for 3 types of licences for Aboriginal people:

1. **Aboriginal cultural access licences** – provide up to 10 ML/year per licence for cultural purposes such as cultural teaching or ceremonial purposes.[21]
2. **Aboriginal environmental water licences** – provide 500 ML/year (with a combined limit of 2,000 ML/year for the water source) for enhancing Aboriginal cultural value of important lagoons and billabongs.
3. **Aquifer community development access licences** – provide up to 50 ML/year for various purposes that relate to Aboriginal communities and can be traded temporarily.

Under Commonwealth legislation, anyone who holds native title with respect to water can take and use water for personal, domestic, and non-commercial communal purposes. Native title holders often have water-related aspirations, such as the right to fish, the protection of water-related places of cultural importance or participation in decisions about water allocations and water management practices within a native title determination area. Under NSW legislation, native title holders have the right to take and use water in the exercise of native title rights without the need for an access licence, water supply work approval or water use approval.

In groundwater water sharing plans, where groundwater-dependent, culturally significant areas are identified, rules are applied to ensure these are protected from any impacts associated with the construction or use of water supply works. Similarly, where flood-dependent cultural assets and values are identified in floodplain management plans, rules are applied to ensure they receive flood flows.

However, we heard from First Nations people in the Western region that the current provisions are not meeting their spiritual, cultural, social, and economic needs. The application process for licences is not well understood and those who had gone through the process found it difficult to navigate. As a result, the use of the cultural licences is virtually non-existent.

We have heard that access to water for cultural purposes is a basic human right and we need to ensure the assessment frameworks for issuing Aboriginal water licences is culturally appropriate and clearly communicated to First Nations people.

We also heard that licences or water entitlements owned by First Nations people should be allowed for economic benefit. While some Aboriginal businesses, groups and Aboriginal Land Councils own water access licences, which are available on the market for trading, often the cost prohibits First Nations people from buying these entitlements and allocations.

First Nations people in the region would also like to see more economic opportunities around the management of water and important cultural sites. For example, through water quality monitoring or riparian revegetation.

Aboriginal nations feel like they are not being heard

During our consultations with First Nations people in the Western region, we heard that communities feel like they constantly speak to government agencies but are not being heard.

First Nations people want to be more involved in water management decision making, including how the water source is protected.

There is increasing recognition that First Nations knowledge is an essential element of how natural resources are managed in Australia. We have heard that we need to incorporate First Nations knowledge or cultural science to support and supplement the data that has been collected by NSW Government agencies. The complexities of water management legislation and licensing, along with limited opportunities to participate in decision making, are significant barriers to making better use of First Nation people's knowledge and skills.

21. NSW water sharing plans accessed from, www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/status

Challenge: Declining health of natural systems

Changes in river flows have impacted the health of aquatic ecosystems

Regulation, water extraction, and land use change in the Barwon–Darling, Lower Darling, and upstream catchments have resulted in modifications to how water moves laterally and longitudinally through the region's landscape and connected systems.

The health of river systems depends on there being a range of flows, including bankfull flows, overbank flows, freshes and dry spells, as well as periodic low-flow and cease-to-flow periods. The extraction of water and the operation of water infrastructure changes the timing, magnitude, duration, and frequency of flows and, in turn, impacts river ecology. By the mid-1990s, it was generally acknowledged that habitats along the entire river had been degraded by hydrological changes. Controlling river flows has resulted in a reduction of moderate to high flows downstream, with the greatest impact on large fresh, bankfull, and overbank flows (Figure 21 and Figure 22). Alterations to frequency and the size of low flows and increased cease-to-flow durations have also been recorded.[22]

Image courtesy of Annette Corlis. Paroo River, Wilcannia.

22. Murray–Darling Basin Authority 2018, *Ecological needs of low flows in the Barwon–Darling*. Available at, www.mdba.gov.au/publications/mdba-reports/barwon–darling-ecological-needs-hydrology

Figure 21. Modelled change in total number of different flow events in the Barwon–Darling River at Wilcannia over the last 130 years, with and without current development

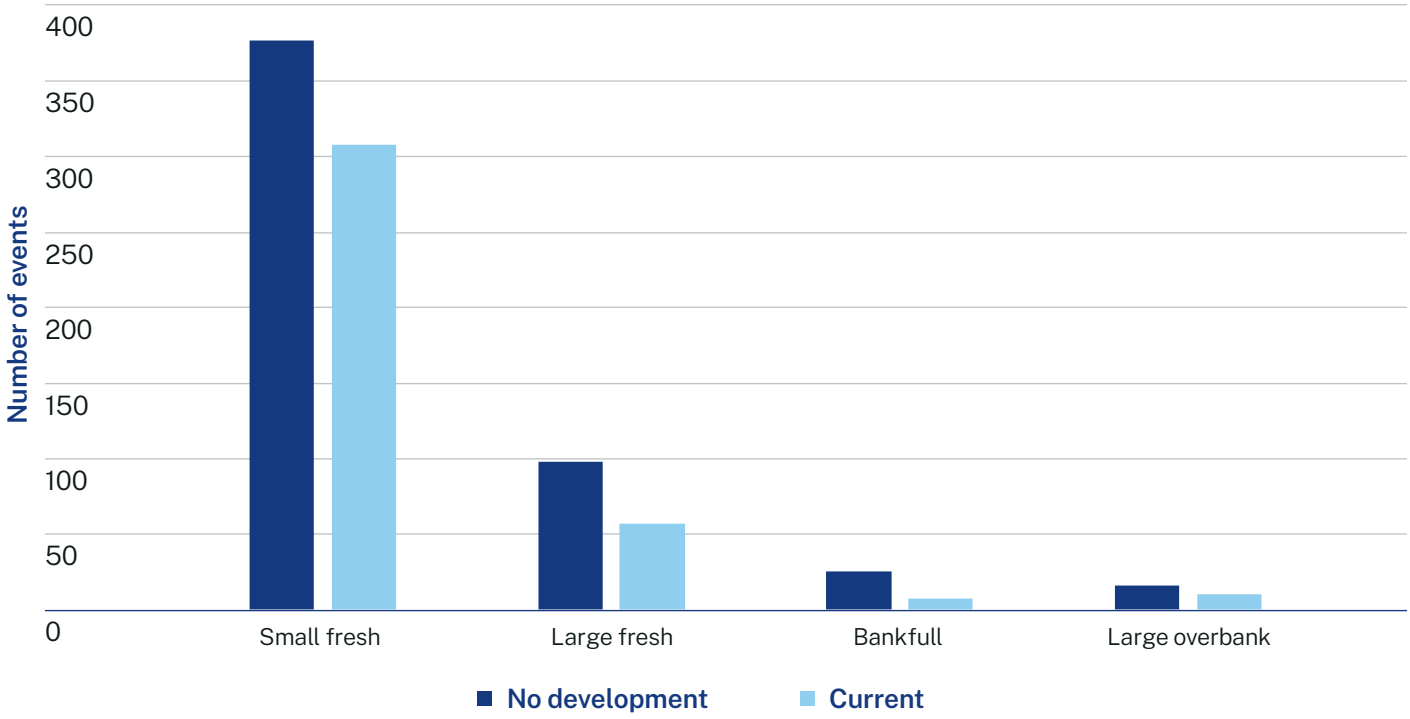
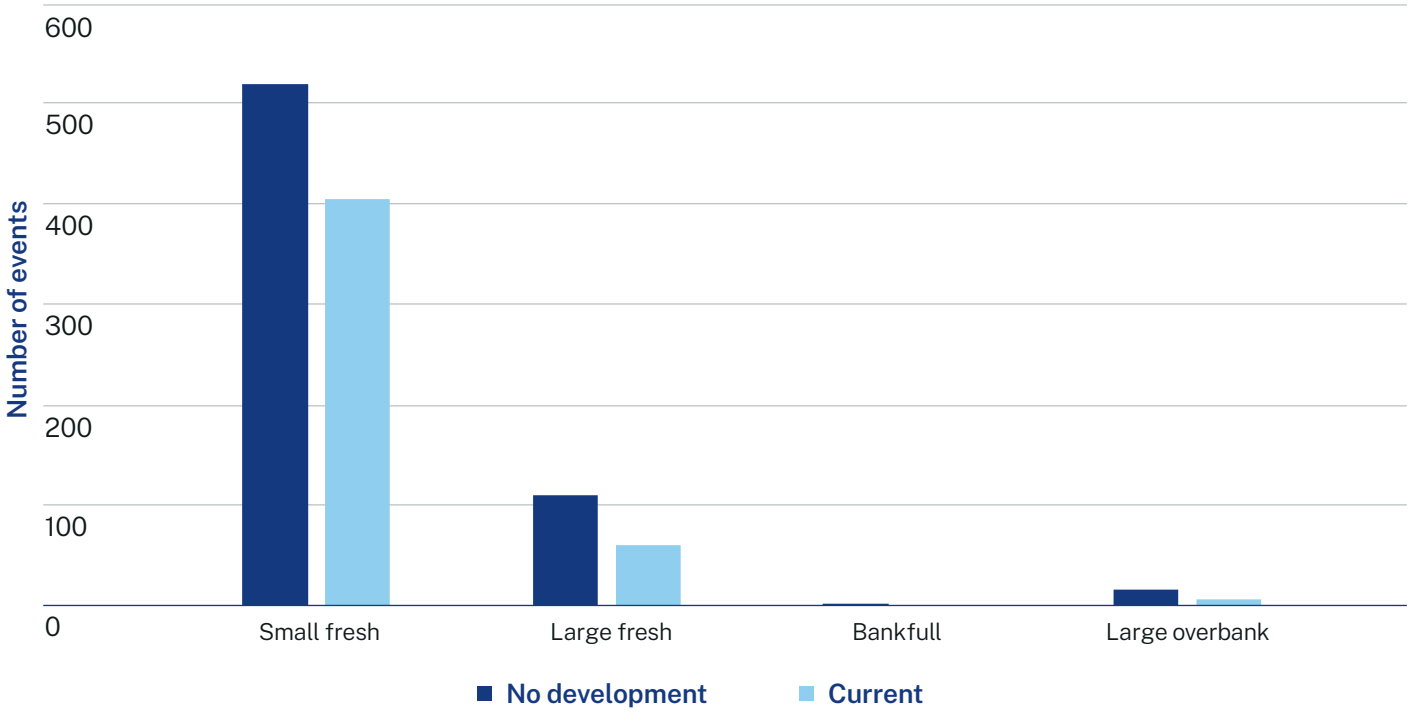


Figure 22. Modelled change in total number of different flow events in the Barwon–Darling River at Bourke over the last 130 years, with and without current development



Unconstrained floodplain harvesting, which is the capture of water that flows across floodplains by irrigators for later use, has reduced the volume, frequency, and duration of floods. Implementation of the NSW Floodplain Harvesting Policy[23] will help regulate and constrain growth in this form of water capture and bring it back within legal limits set by the Murray–Darling Basin Plan and NSW Water Sharing Plans. Implementing the policy will return more than 50 GL/year on average to floodplains, rivers and creeks in the northern Basin and support the needs of the environment.[24]

Prior to the completion of the Menindee Lakes scheme in 1960, the Lower Darling River was unregulated and subject to highly variable flow conditions. The Lakes scheme significantly altered the natural flow regime of the Lower Darling and Great Darling Anabranch, through:

- substantial reductions in monthly and annual flow volumes
- changes to the seasonality of flows with greater flows during mid-summer
- a reduction in the peak flow and more persistent low flows.[25]

Altered flow regimes in the region's river systems have contributed to loss of native vegetation and wetlands and a decline in species abundance, movement and diversity impacting the condition of fish communities and waterbird habitat. These effects are likely to be exacerbated under future climate change.

Research suggests that aquatic communities in the Barwon–Darling are under increased stress because of fewer opportunities to disperse to new habitats and increasing periods of still rather than flowing water.[26] Because the Barwon–Darling is a key movement corridor, flow alteration is also likely to have had a detrimental long-term effect on fish populations in other parts of the northern Basin.

There is an endangered ecological community stretching between Mungindi and the Menindee Lakes (the Darling River EEC). The EEC includes all native fish and aquatic invertebrates and the classification was based on decline in several species and communities. Modification of natural flow is listed as the primary threat, although other threats such as barriers to movement, land clearing, water quality, and pest species are also important factors.[27]

Poor water quality and extreme water quality events in parts of the region affect the ecology and survival of aquatic organisms, and the ability of the community to use the river. Water quality is impacted by both the flow characteristics of the waterway, as well as inputs from the land and river banks, including nutrients, sediment and organic matter. Temperature and light also play a role. While some water quality issues arise from the way that our waterways are managed, others such as temperature and light are not possible to influence.

Infrastructure and pest species impact the resilience of aquatic species

Physical structures such as weirs and floodplain infrastructure can restrict the ability of native fish to move to breed, and to find food and ideal habitat.

In addition, approximately 1.3 million adults, larvae and juvenile fish across the Murray–Darling Basin are lost each year due to pumping and diversion infrastructure. The Department of Primary Industries – Fisheries is leading a program to reduce this impact by installing fish protection screening throughout the basin.[28] In 2021 a screening program commenced in the Macquarie Valley. Plans to expand the program further, including the installation of new screens along the Barwon–Darling, form part of the Australian Government's 2022 commitments under the Northern Basin Toolkit.[29]

There are 16 high-priority barriers to fish passage on the Barwon–Darling, which are planned to be remediated through the Western Weirs/Better Baaka, Northern Basin Toolkit, Lower Darling Fish Passage, and Menindee Accelerated Fishways programs.

The Murray–Darling system has a high proportion of alien species: 12 out of 57 fish species are alien.[30] Carp is an abundant alien fish species that has been contributing to the degradation of the aquatic ecosystems of the Murray–Darling Basin since the 1960s. They now account for up to 90% of fish biomass in some parts of the basin.[31] Carp populations have expanded rapidly, partly due to regulation creating conditions that preference their biological needs over those of native fish.

23. www.industry.nsw.gov.au/water/plans-programs/healthy-floodplains-project/nsw-floodplain-harvesting-policy
24. Department of Planning, Industry and Environment, February 2021, *Modelled downstream effects of licensing floodplain harvesting Subtitle: NSW Border Rivers & Gwydir valleys,* www.industry.nsw.gov.au/__data/assets/pdf_file/0011/350201/modelled-downstream-effects-if-licensing-floodplain-harvesting-nsw-border-rivers-and-gwydir.pdf
25. Department of Primary Industries, April 2018, *NSW Murray and Lower Darling Water Resource Plan: Surface water resource description,* www.industry.nsw.gov.au/__data/assets/pdf_file/0008/145394/Murray-and-Lower-Darling.pdf
26. Mallen-Cooper M. Zampatti, B 2020, *Restoring the ecological integrity of a dryland river: Why low flows in the Barwon–Darling River must flow. Ecological Management & Restoration 21(3).*
27. Department of Primary Industries, *Darling River EEC,* www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-ecological-communities/darling-river-eec#:~:text=The%20Darling%20River%20endangered%20ecological,of%20New%20South%20Wales%2C%20and
28. Department of Primary Industries – Fisheries 2021, *Design specifications for fish-protection screens in Australia.* Available at, www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1373577/Design-specifications-for-fish-protection-screens_FINAL_WPA.pdf
29. For further information see: www.mdba.gov.au/basin-plan/northern-basin-projects/northern-basin-toolkit-measures
30. Lintermans, M 2007, *Fishes of the Murray–Darling Basin: An introductory guide*
31. Commonwealth Environmental Water Office 2016, *Carp in the Murray–Darling Basin and Commonwealth environmental water.* Accessed from, www.environment.gov.au/water/cewo/carp-murray–darling-basin

Environmental needs are under considerable strain during droughts

Droughts – like the most recent 2017–2020 drought – are particularly damaging to the region's river systems and to faunal species that require permanent water, such as native fish, mussels, aquatic animals and waterbirds.

Extended droughts lead to drying out of drought refuges and fish deaths. Events like the Menindee fish deaths in December 2018, and throughout 2019 were caused by a combination of drought, water extraction, poor water quality and the drying out of refuges or habitat.[32] In 2016, before 2017–2020 drought, the fish community of the Barwon–Darling's main channel was rated as being in fair condition. The long-term impacts of the 2017–2020 drought are not yet fully known.

As well as reducing inflows to streams, droughts lower groundwater levels. This can reduce groundwater discharge to connected streams that occurs during low flows at some locations on the Darling River[33] and reduces the ability for groundwater-dependent ecosystems to access water, resulting in poor ecosystem health and poor instream ecological values.

The NSW and Commonwealth environmental water holders own and manage a total of 324 GL of water entitlement in the Lower Darling – 93% of total regulated Lower Darling entitlement. Most of this water is held as supplementary licences (250 GL) and is only available during wet conditions when the lakes are spilling. The remaining environmental holdings are 4.7 GL of high security and 69.3 GL of general security licences (Table 5).

In the Barwon–Darling, environmental water managers hold approximately 30 GL of entitlement and in extraordinary circumstances such as the last drought, also rely on water holdings held in tributary valleys to support the Barwon–Darling environment.

Table 5. Western region environmental water holdings by type and entitlement

Barwon–Darling water holdings – type	Barwon–Darling water entitlements	Lower Darling water holdings – type	Lower Darling water entitlements
A, B, and C Class along with unregulated	30 GL	Supplementary	250 GL
		High security	4.7 GL
		General security	69.3 GL

The amount of licensed environmental water available varies year by year depending on supplementary flow events, water allocations, and how much water has been carried over, in the same way that it does for other users. This variability is considered as part of the annual planning process by environmental water managers. However, it can mean that during dry periods, there may be less water available to release for the environment and, in some instances, limited opportunities to maintain critical environmental needs such as refuge river pools, core wetland areas, and seed banks in the soil. Ongoing dry conditions also reduce the reliability and accessibility of these licences.

32. www.mdba.gov.au/sites/default/files/pubs/Final-Report-Independent-Panel-fish-deaths-lower%20Darling_4.pdf
33. Department of Planning, Industry and Environment 2019, *Groundwater Resource Description — Darling Alluvium Water Resource Plan.* Available at, www.industry.nsw.gov.au/__data/assets/pdf_file/0018/236061/draft-darling-alluvium-resource-description.pdf

Climate change scenarios could increase the long-term risks for natural systems

The worst-case climate change scenario identified in this strategy points to significant reductions in the volume of water flowing into the Barwon–Darling system each year. If these scenarios eventuate, there could be a reduction in the number and duration of floods, high-flow events and freshes. This reduction could have a detrimental impact on the health and resilience of water-dependent species and ecosystems, leading to a long-term decline in species and habitat.

In general, our modelling simulations estimate that under a dry climate change scenario:

- There could be less water flowing into the Barwon–Darling system from tributaries in NSW and Queensland. The median annual inflows could be 42% lower when compared to our long-term historical climate projections.
- There could be, on average, a 37% reduction in the number of high-flow events that fill the banks. These flows are identified in the Barwon–Darling Long-Term Water Plan[34] as an important environmental water requirement.
- The number of freshes occurring every year is predicted to decrease by 33% and the duration of these flows when they do occur is expected to decline by 19%. This is expected to impact on the ability of the native fish population to breed, recruit and move, leading to a long-term decline in numbers.
- There could be a 15% reduction in the frequency of average (1,000 ML/day) flow events in the Great Darling Anabranch.
- There could be around a 22% increase in the time that the Menindee Lakes are under NSW control (i.e. when the volume in the lakes falls below 480 GL) when compared to our long term historical climate projections.

There could also be a large increase in the number of years in which a cease-to-flow event occurs. This is most pronounced in the unregulated river systems. Cessation of flow in rivers and streams could result in drying of flowing water habitats, increased sedimentation, water quality deterioration (elevated water temperatures and low dissolved oxygen levels) and the loss of connectivity throughout the river system – all of which will have damaging effects on aquatic ecosystems.

Importantly, these climatic changes will not occur in isolation: there will also be increasing demands on our water resources along with land use and industry changes. The impacts on natural systems from these concurrent changes will be made worse due to the impacts occurring in upstream catchments, as well as within the Barwon–Darling catchment. This means that, as we face a more variable climate, we will need to direct concerted and coordinated efforts across the Barwon–Darling system and tributary valleys to support the region's vital environmental assets into the future.

Image courtesy of Michael Scotland. Barwon–Darling River, Walgett.

34. www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/long-term-water-plans/barwon-—darling

Challenge: Reduced connectivity impacts critical needs

An adequate level of connectivity, or water flowing between river valleys, is critical to sharing water fairly and supporting environmental health across NSW.

The Barwon–Darling system relies heavily on water from NSW and Queensland tributaries: over 90% of the flows in the Barwon–Darling system originate from the major upstream valleys (Condamine–Balonne, Warrego, Border Rivers, Gwydir, Namoi and Macquarie–Castlereagh). Most of these flow contributions occur during high-flow periods. This means that industries, communities and ecological needs across the region rely on water flowing from upstream catchments that are influenced by climate conditions, water management and extractions in those catchments.

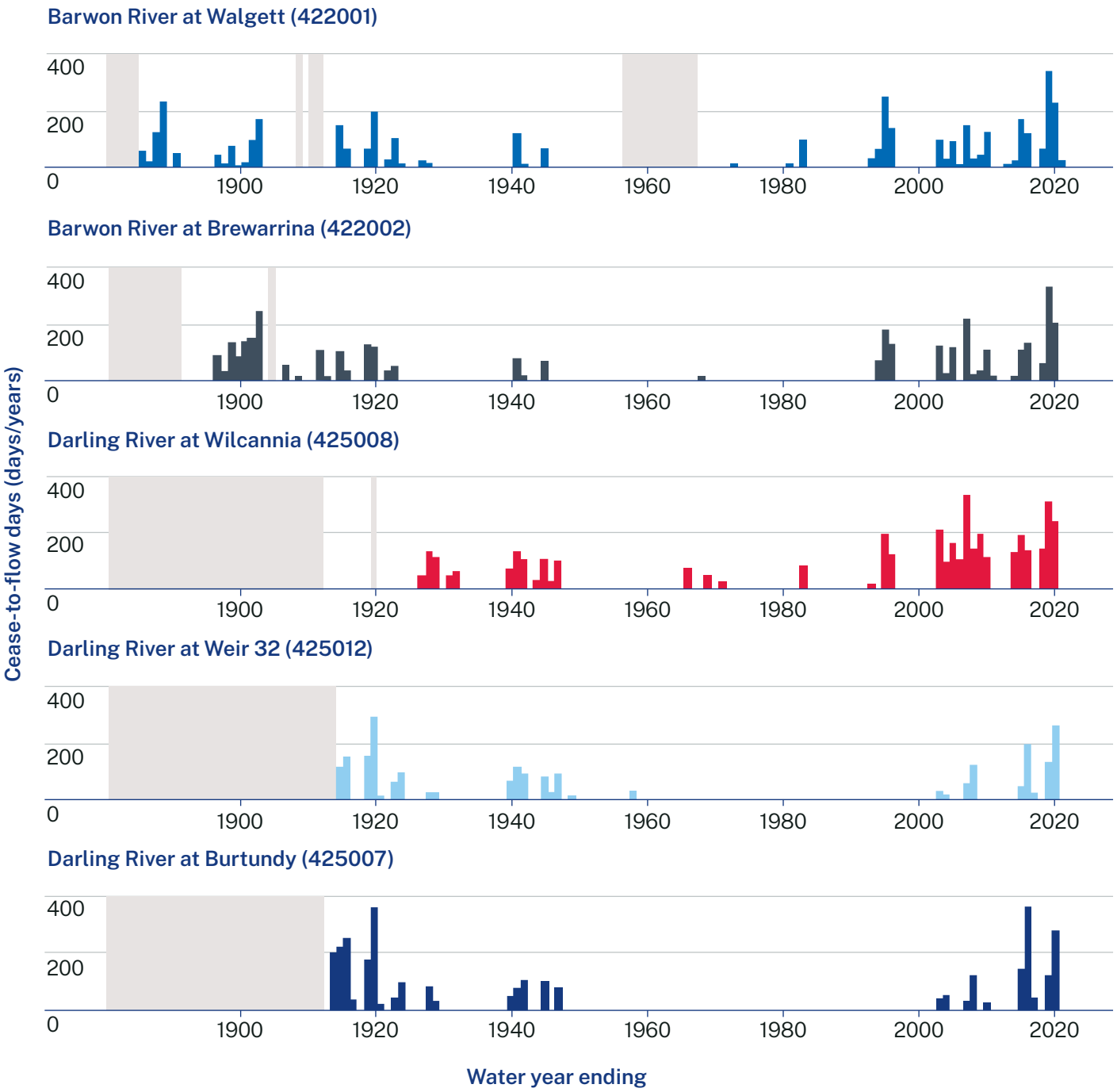
Connectivity supports communities and ecosystems at all times:

- connectivity during non-drought times builds the resilience of the system, providing opportunities for movement, spawning, and recruitment, and improving water quality and productivity in the system
- connectivity in wet periods supports large-scale productivity, replenishing wetlands and flushing rivers to prepare systems for dry conditions
- connectivity in extreme droughts helps to avoid irretrievable damage to species, ecological communities and ecosystems.

Maintaining connectivity during extended dry periods is most challenging

The Barwon–Darling and Lower Darling Rivers naturally go through wetting and drying cycles. It is not unusual for the Barwon–Darling to stop flowing for extended periods (Figure 23). Even at the turn of last century, when there was little agricultural development upstream, there were long periods when the river did not flow. The last 20 years has been a dry period in our climate, with frequent and extended cease-to-flow periods. Extended and frequent dry periods reduces the recovery time in between droughts, affecting critical human needs and environmental health. Extended dry periods also have cultural impacts across the region.

Figure 23. Number of cease-to-flow days per year at different locations on the Barwon–Darling



Note: The grey areas indicate no usable records.

Water legislation requires critical human and environmental needs to be protected across catchments, which can be challenging during extreme droughts. When most of the northern and western NSW catchments are experiencing a very dry period, it can be virtually impossible to maintain base flows and low flows along the length of the tributary and into the Barwon–Darling. For example, during the last drought the Namoi River at Gunnedah stopped flowing between January 2019 and February 2020, with Keepit Dam levels too low to make any releases.

The challenge is determining how to prepare and build drought resilience to support critical human and environmental needs during acute climatic conditions. Improving connectivity during non-drought times may help to build resilience to future extended dry periods.

Development has contributed to more short cease-to-flow events but extended dry periods are driven by the climate

Over the last 50 years, development has occurred across western NSW, with accompanying changes to land use and water extraction. We have heard from some communities that development and water extraction upstream has resulted in less connectivity, or less water flowing downstream, that has extended droughts or brought droughts forward.

Our analysis shows that development has likely increased the frequency of shorter cease-to-flow periods (0–1 month) and low-flow periods in the Barwon–Darling. In some instances, low flows have increased by up to 50%, with a measurable increase in the frequency of low flows since the early 1990s.

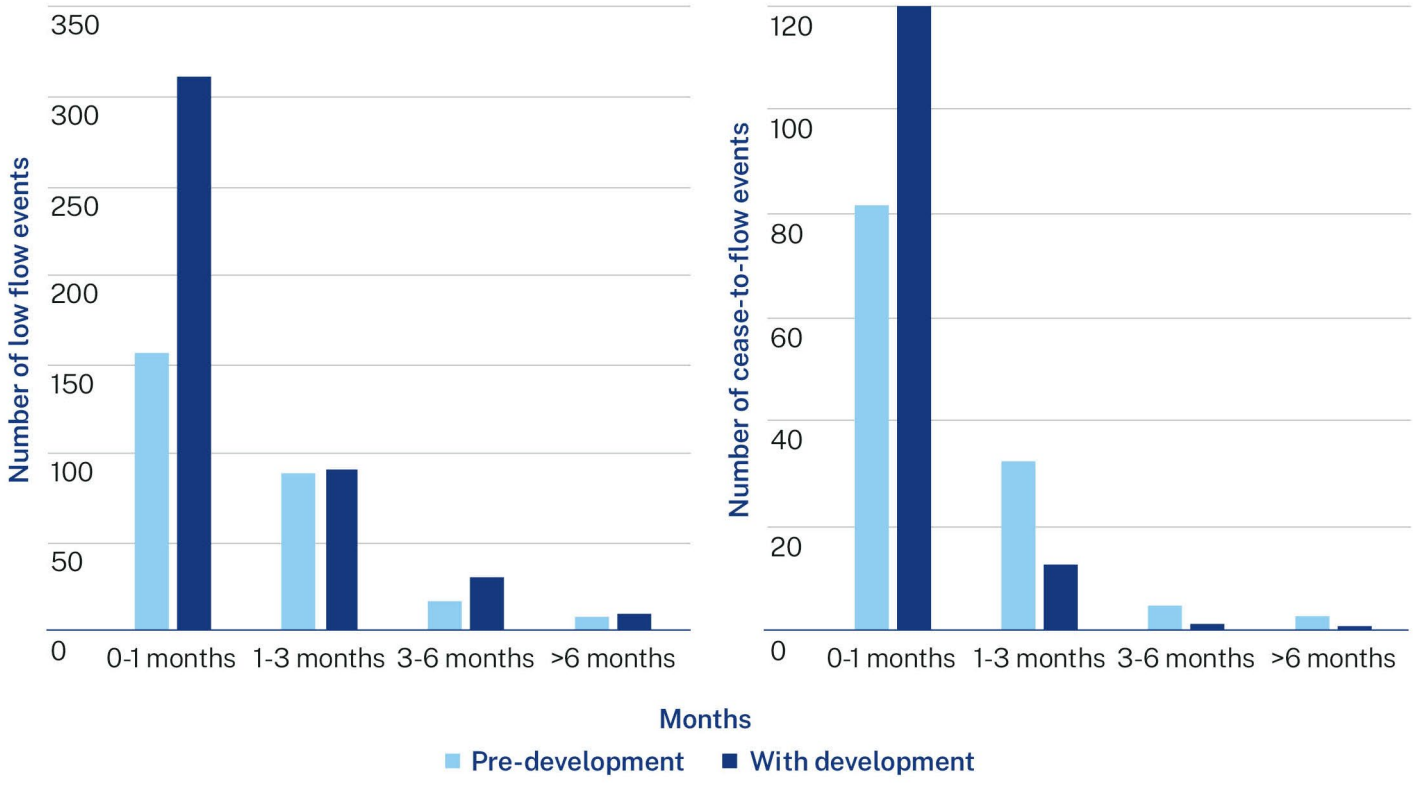
However, longer cease-to-flow events are more likely driven by the climate, rather than irrigation development because very little inflow occurs during these events (Figure 24).

The changes in flow patterns are most likely due to the following:

- In extended dry periods, there is little to no water that can be taken by upstream commercial water users and often town water restrictions are in place.
- Peaks of higher flows and freshes are extracted by water users in both NSW and Queensland, resulting in longer or more frequent low-flow events.
- Dams in the tributaries have been operated in recent years to avoid in-valley cease-to-flow periods for as long as possible, prolonging low flows and reducing no flows.
- Dams impact and capture low-base flows and small and large freshes. Depending on the volume and timing of water released and the river conditions at the time, dam releases may or may not contribute to end-of-system flows and subsequent inflows to the Barwon–Darling.

This suggests that changing the rules can help to manage short cease-to-flow events and low-flow events but cannot address extended dry periods or maintain a constantly flowing river. Changes to address long cease-to-flow and low-flow periods would require significant reform to how we share water or to the infrastructure within the system.

Figure 24. Modelled number and duration of low-flow (left graph) and no-flow (right graph) events with and without development, averaged across gauges at Bourke, Brewarrina and Wilcannia for the period 1895–2020



Climate change could result in less connectivity

New climate modelling for the regional water strategies suggests that extreme events could become more extreme – wet periods are likely to become wetter, and dry periods could become more acute. The future climate is uncertain. It may be similar to what has been experienced in the past; it could be wetter in some years; and in other years it might be drier than previously seen. Our analysis suggests that under a dry climate change scenario, there could be less water flowing into the Barwon–Darling from tributaries in NSW and Queensland. The median annual inflows could be 42% lower when compared to our long-term historical climate projections.[35]

Over the last 130 years, the Namoi and Border Rivers have contributed more flows to the Barwon–Darling than other tributaries – particularly during average or wet years – and are the most efficient at contributing flows to downstream reaches.

Other rivers, such as the Paroo, Macquarie–Wambuul and Gwydir, are less efficient at contributing flows at Menindee, as they contain large floodplain and wetland systems that absorb significant volumes of water before the flows can reach the Barwon–Darling. Within these systems, there are channels for water to flow around some wetlands and provide flows into the Barwon–Darling. These channels include the Mehi River or Carole/Gil Gil Creek in the Gwydir Valley and the Bogan River or via the Bulgerega and Northern Bypass Channel in the Macquarie Marshes.

The impact of a dry climate change scenario varies across the basin. Under a dry climate change scenario, there may be changes to the relative contributions that different systems make to inflows into the Barwon–Darling (Table 6). There could be:

- reductions in the relative inflow contributions of the Border Rivers, Namoi, Condamine–Balonne, Macquarie–Castlereagh valleys and Bogan River
- increases in the relative contributions of the Warrego and Moonie rivers.

These future climate changes may make it more difficult to achieve connectivity objectives, particularly during dry periods as the contributions decrease from important tributaries such as the Namoi and the Border Rivers.

Table 6. Major tributary contributions to long-term average flow in the Barwon–Darling

River system	Major tributary flow contribution[36]	Projected change in the proportion of inflows (volume) from Barwon–Darling tributaries under a dry climate change scenario compared to long-term climate data
Border Rivers	18.1%	-2.6%
Macquarie–Castlereagh and Bogan systems	17.3%	-0.5%
Condamine and Balonne rivers	12.9%	-0.8%
Gwydir River	8.3%	1.1%
Namoi River	18.8%	-1.5%
Warrego River	1.6%	2.29%
Moonie River	2.2%	2.92%

35. We have looked at a 10,000-year dataset. Within that 10,000-year dataset there are a range of 130-year subsets that have different average inflows sequences that range for 43% less on average compared to our long-term historical climate projections, to double the average annual inflows when compared to the historical climate projections.
36. Murray–Darling Basin Authority 2011, *Water resource assessments for without-development and baseline conditions,* Supporting information for the preparation of proposed Basin Plan Technical report 2010/20 Version 2 November 2011, Table 10, page 25. The modelled flow contribution figures are based on the without development figures in Table 10, accessed from, www.mdba.gov.au/sites/default/files/pubs/1111-BPKId-water-resource-assessments-development-baseline.pdf

Improving connectivity will have benefits and trade-offs

Improving connectivity has the potential to provide benefits to a range of people, ecosystems, and industries. However, sharing water across connected systems means that any water management or infrastructure action will involve trade-offs. An action to improve connectivity may result in additional water being provided for one type of water use, or to communities in one part of the region, and water access being reduced for other users. Similarly, focusing actions on one part of the flow regime may not necessarily achieve all connectivity objectives. These challenges and trade-offs are likely to become more acute under a drier climate.

To achieve the right balance, we need to acknowledge these limits and trade-offs and understand the impacts a changing climate will have on water users, water resources and the natural environment. The key will be in continuing to strive for a balanced approach that protects the fundamental health of the environment while supporting the wellbeing of communities and sustaining the jobs and industries that drive regional economies.

Image courtesy of Destination NSW. Menindee Lakes, Menindee.

Challenge: Poor water quality

Surface water and groundwater quality throughout the Western region varies and monitoring and responding to water quality issues has been a long-term concern. There are gaps in our understanding of how water quality varies over time.

Water quality issues are often caused by a combination of factors, including alteration to natural flow regimes, loss and degradation of riparian vegetation, poor land management practices and the impacts of severe weather and drought. Low flows in the Darling River in late 1991 led to an extremely large algal bloom. It stretched approximately 1,000 km from Mungindi to the Wilcannia weir pool. At the time, environmental factors such as stratification, increased nutrient levels, warm water temperature and low turbidity contributed to ideal bloom conditions.[37]

Recent extreme water quality events, including the large fish-death events around Menindee during 2018–2019 to 2019–2020, have highlighted the urgency to manage this issue, particularly in light of the potential impacts of climate change on the region.

Water quality is generally poor during periods of low or no flow in the Barwon–Darling and Lower Darling.[38] Poor water quality also occurs after droughts when flows return and begin to accumulate debris and dissolved material from previously dry river channels and floodplains.

The water is often murky (high turbidity), contains pathogens, nutrients, and possibly pesticides, causing the water to smell and become less clear further down the catchment. These water quality issues are caused by a combination of factors including:

- land management practices such as the widespread conversion of land to cropping and irrigation uses, grazing practices, feral pigs, stock trampling and degraded bank and riparian condition
- high flow from rainfall and run-off, which can result in more soil and nutrients being washed into waterways, making the water less clear and prone to excessive algal growth when flows reduce
- the high clay content of alluvial soils in the Western region, which means these soils are more likely to remain suspended in the water during both high and low flows.

In addition to high turbidity, prolonged periods of low flow and high temperatures result in weirs and refuge pools in the Western region often having algal bloom events and rivers having low levels of dissolved oxygen.

Poor surface water and groundwater quality affects the ecology and survival of aquatic organisms, is a risk to human health and stock, and impacts the social and recreational amenity of waterways. It consistently affects Aboriginal people's ability to practice culture on or near waterways. Poor water quality also presents significant water quality treatment issues for local water utilities and affects agricultural and other industrial processes that rely on water.

The Barwon–Darling Water Resource Plan identifies the middle and lower Barwon–Darling as a priority area to develop appropriate local water quality targets.[39]

37. 38. 39. Department of Planning, Industry and Environment 2019, *Barwon–Darling Water Course Water Resource Plan — Water quality management plan (SW12) Schedule H.* Available at, www.industry.nsw.gov.au/__data/assets/pdf_file/0010/273754/schedule-h-barwon–darling-wqmp.pdf

Image courtesy of John Spencer, Department of Planning and Environment. Darling River, Kinchega National Park.

A plan to secure water for the Western region

5

Image courtesy of Michael Scotland. Barwon–Darling River, Bourke.

Our vision is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous region. To achieve this, we need to position the region so there is the right amount of water of the right quality delivered in the right way for people, Aboriginal communities, towns, industries and the environment (Figure 25).

To address the 6 challenges in the Western region, we have prioritised a range of actions:

- Priority 1: Improving water security for towns, industries and communities
- Priority 2: Improving the resilience of natural systems
- Priority 3: Improving connectivity across the northern Basin.

Together, the actions can improve the Western region's readiness to adapt to a more variable climate and support the difficult decisions we need to make to deliver healthy, reliable and resilient water resources for the region's future.

The regional priorities do not override the priorities around water sharing set out in the *Water Management Act 2000.* The priorities help identify the range of actions that need to be progressed in the region over the coming decades. Each priority contributes to all of the objectives of the regional water strategies and multiple water needs. The actions are not listed in any priority order.

Image courtesy of Destination NSW. Murray and Darling Junction, Wentworth.

Figure 25. Water security challenges and priorities for the Western region

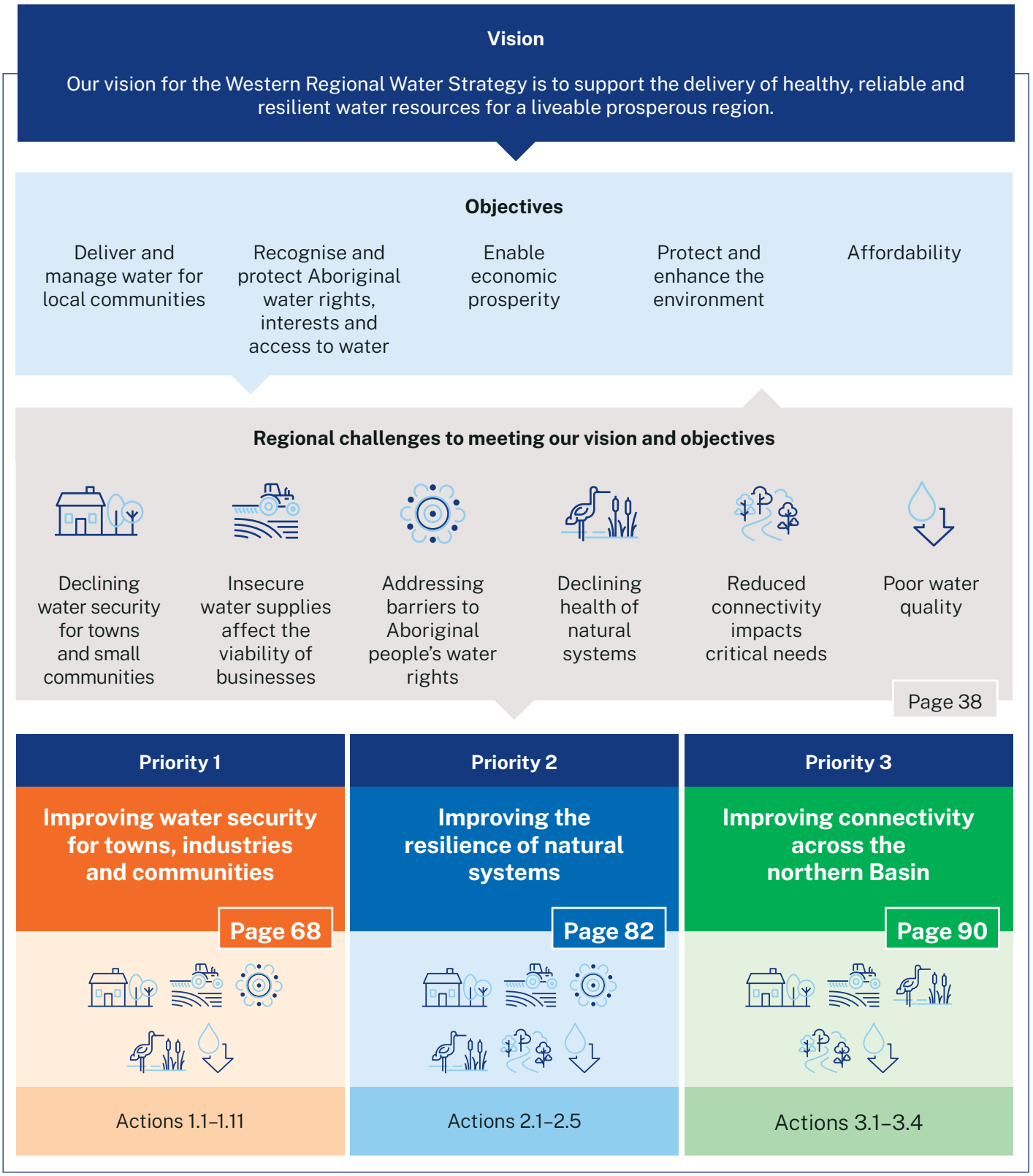
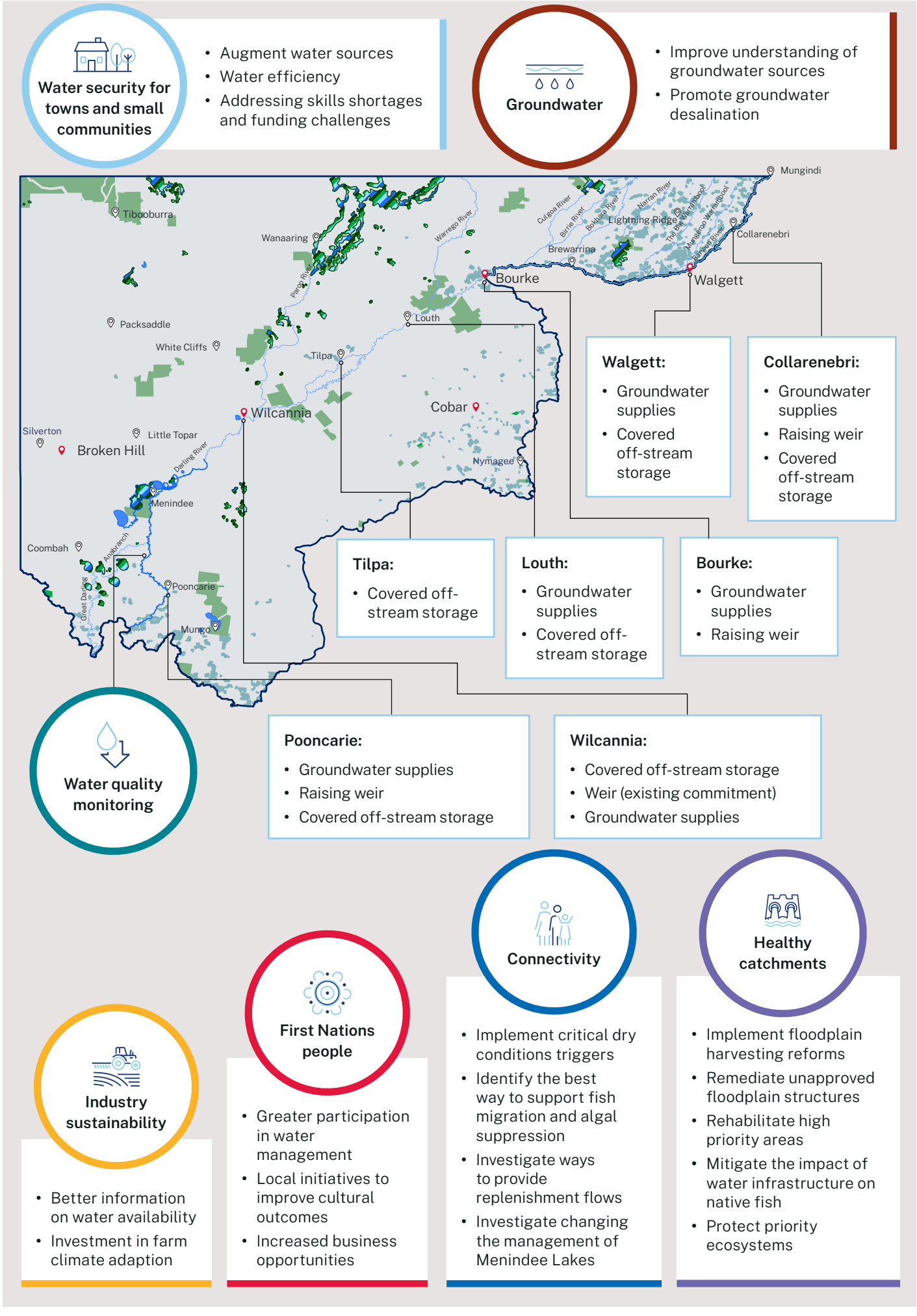


Figure 26. Summary of the Western Regional Water Strategy actions



Priority 1

Improving water security for towns, industries and communities

High evaporation rates and extended dry periods present significant risks to the small communities dispersed over large areas across the Western region.

The strategy focuses on building the resilience of towns and industries to future droughts and climate risks.

Improved water security for towns, communities and industries will help to attract and retain people, businesses and jobs in the region and support the growing tourism industry.

Our starting point

Investments have been made in recent years to help secure water supplies for towns in the Western region and prepare the region's economy for a more variable or drier climate.

Every local water utility faces unique challenges and risks. In the Western region, the costs associated with implementing water security infrastructure solutions across a small and dispersed ratepayer base, attracting and retaining skilled staff, and working through regulatory requirements can make it challenging for local water utilities to operate.

The NSW Government's Town Water Risk Reduction Program is working in partnership with councils, local water utilities, government agencies and the broader water sector to address these issues and improve management of town water risks. In addition, around $589 million has been invested in water security upgrades in the region through the Safe and Secure Water Program:

- Bourke Shire Council – $23.3 million, including new bores and a new water treatment plant
- Brewarrina Shire Council – $1.1 million for bore installation and pumping station modifications
- Central Darling Shire Council – $12.5 million for bores and treatment plants
- Cobar Shire Council – $32.5 million, including a new water treatment plant and pipeline replacements
- Wentworth Shire Council – $2.4 million, including Pooncarie emergency works and water treatment plant upgrades
- Walgett Shire Council – $17.9 million, including raising Walgett Weir and installing a fishway, new bores, tanks, and a water supply upgrade
- Replacing Wilcannia Weir – this project is fully funded and is planned to commence in 2023. The raised weir will have a fishway and operational gates
- Broken Hill City Council – $500 million to secure Broken Hill's water supplies, including construction of the $467 million pipeline from the River Murray to Broken Hill, temporary bores to provide back-up supply during the drought for Broken Hill and Menindee and a reverse osmosis plant
- $11.5 million in funding to Central Darling Shire Council for new or upgraded water treatment plants at Wilcannia, White Cliffs and Ivanhoe.

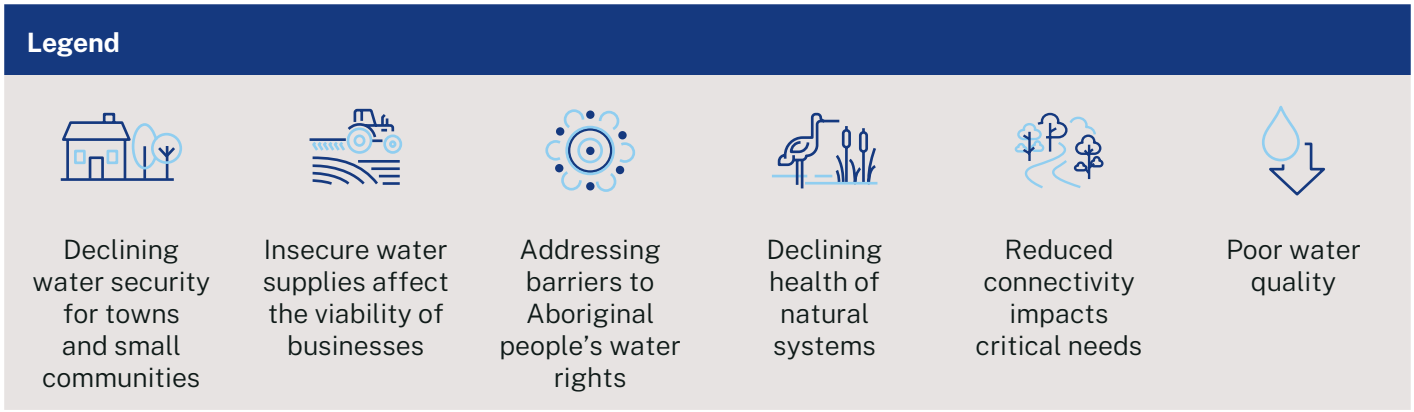
Other work that is also underway includes:

- Reducing Local Water Utilities network leakage and water losses through the **Regional Leakage Reduction Program.** The 3-year program aims to reduce reported non-revenue water, and to increase the ability of councils to maintain a reduction in network leakage through improved leakage management assets, capacity and data quality. Bourke Shire Council, Central Darling Shire Council, Walgett Shire Council, Essential Energy servicing Broken Hill and Cobar Water Board have all been ranked as priorities for the program. As most of these councils have reported non-revenue water totalling over 20% and will benefit from improved network leakage reduction resourcing.
- **Assessing the vulnerability of agricultural industries to climate change** – the Department of Primary Industries – Agriculture is assessing how vulnerable cotton and livestock production systems are to climate change and how climate change scenarios could result in changes to yield and the occurrence of pests and diseases. The project is identifying adaptation options such as crop substitution, new management systems and including carbon farming as part of livestock enterprises or an increased focus on goat production.
- **Exploring for groundwater in the region** – Geoscience Australia are undertaking a program of work to identify deep groundwater aquifers and sites with potential for future underground storage and to help to better understand groundwater systems in the Upper Darling River floodplain.
- **Providing enabling infrastructure to support industry development and diversification,** including upgrades to the Silver City Highway and the Pooncarie–Menindee Road, the Broken Hill and Wentworth airport upgrades, Bourke's central business district revitalisation and improvements to digital connectivity.
- **Activating and grow the critical minerals sector** – there are a number of important critical mineral deposits in the Western region. The NSW Government's Critical Minerals and High-Tech Metals Strategy[40] aims to position NSW as a major global supplier and processor of these minerals and secure new long-term opportunities for the state's mining industry.
- **Supporting on-farm connectivity and encouraging farmers to adopt agtech** to boost productivity, including water efficiency and drought preparedness through the NSW Government's $48 million expanded Farms of the Future program. A grants program will be delivered to help farmers purchase agtech devices and applications.
- The **Future Ready Regions Strategy** 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.
- The **20-Year Economic Vision for Regional NSW** is the NSW Government's plan to drive sustainable, long-term economic growth in regional NSW. It is the roadmap to unlock significant economic potential in regional NSW. It guides transformative, once-in-a-generation investment in our regions through the $4.2 billion Snowy Hydro Legacy Fund, to create jobs now and into the future.
- The Department of Planning and Environment has developed a suite of **Regional Plans,** so the whole of NSW is covered by strategic land-use plans. The regional plans set a 20-year framework, vision and direction for strategic planning and land use to ensure regions have the housing, jobs, infrastructure, a healthy environment, access to green spaces and connected communities to continue to be vibrant places for people to live, work and visit. The department has undertaken the first 5-year review of all regional plans to reset priorities and to extend the plans' reach from 2036 to 2041.
- The NSW Government has assisted local councils to develop **Regional Economic Development Strategies** (REDS) based on the concept of a Functional Economic Region. The REDS provide a clear economic development strategy for the region and are currently under review.
- Expand the **Town Water Risk Reduction Program and the Water Utilities Program.** The program's focus is on working together with the water sector to identify the most fundamental barriers within state and local government that prevent effective and strategic risk management, and to develop and implement long-term solutions to these barriers.

These actions will help to set the region's existing and emerging industries up for the future, and to further identify specific water needs, water management options, and availability issues that will need to be resolved to support them.

40. www.nsw.gov.au/criticalminerals

Figure 27. Priority 1: Improving water security for towns, industries and communities



Action number	Action name	Challenges addressed
Action 1.1:	Augment water supply systems for towns and small communities	
Action 1.2:	Adopt a stronger focus on water efficiency and demand management for towns	
Action 1.3:	Addressing water related skills shortages and funding challenges in small councils	
Action 1.4:	Use groundwater more efficiently, innovatively and sustainably	
Action 1.5:	Improve the collection, analysis and public access to data	
Action 1.6:	Collect water quality data in the Lower Darling River	
Action 1.7:	Develop ongoing arrangements for participation of local Aboriginal people in water management	
Action 1.8:	Support place-based initiatives to deliver cultural outcomes for Aboriginal people	
Action 1.9:	Improve cross-border collaboration and information sharing	
Action 1.10:	Support Aboriginal business opportunities in the Western region	
Action 1.11	Support adoption of farm climate adaptation and water efficiency measures	

Action 1.1: Augment water supply systems for towns and small communities

Augment town water supply systems

Many towns in the Western region do not have a secure water supply. Access to secure water can be challenging due to the dry climate, high evaporation rates and the location of many small towns and communities away from surface water or groundwater sources.

While recent investments in water supply and groundwater have helped improve water security for a number of towns in the region, including Broken Hill, a more variable future climate will mean that surface water is likely to become less reliable, increasing the probability of surface water supplies failing. Many of these towns may therefore need to rely more heavily on groundwater sources in the future. More needs to be done to ensure secure town water supplies.

This action will progress shortlisted actions to secure town water supplies in the Western region. This will include further investigating:

- **Raising town water supply weirs** at Collarenebri, Bourke and Pooncarie and installing gates and fishways to meet the water supply demands of these towns. While surface water will not always be available to meet town water supply needs, upgrading the weirs in these towns will provide greater water security.
- **Additional groundwater supplies for Collarenebri , Walgett, Bourke, Louth, Wilcannia, and Pooncarie.** Groundwater quality varies across the region and salinity, odour and temperature can inhibit the ability to use groundwater for drinking. We have heard from residents that there is a preference for drinking surface water over groundwater. Additional groundwater supplies for communities in western NSW will need to be supplemented with water quality treatment processes required to make groundwater suitable for use as drinking water. Community engagement and education programs will also be required on a future where groundwater will need to become a greater proportion of drinking water.
- **Covered off-stream storages** at Collarenebri, Walgett, Louth, Tilpa, Wilcannia and Pooncarie. Off-stream storages may give these towns an additional surface water source to draw on during dry times.

These actions were shortlisted through the Western Weirs Strategic Business Case. The next step for these proposals is a final business case. Funding for the final business case and beyond will be subject to government review and recommendation.

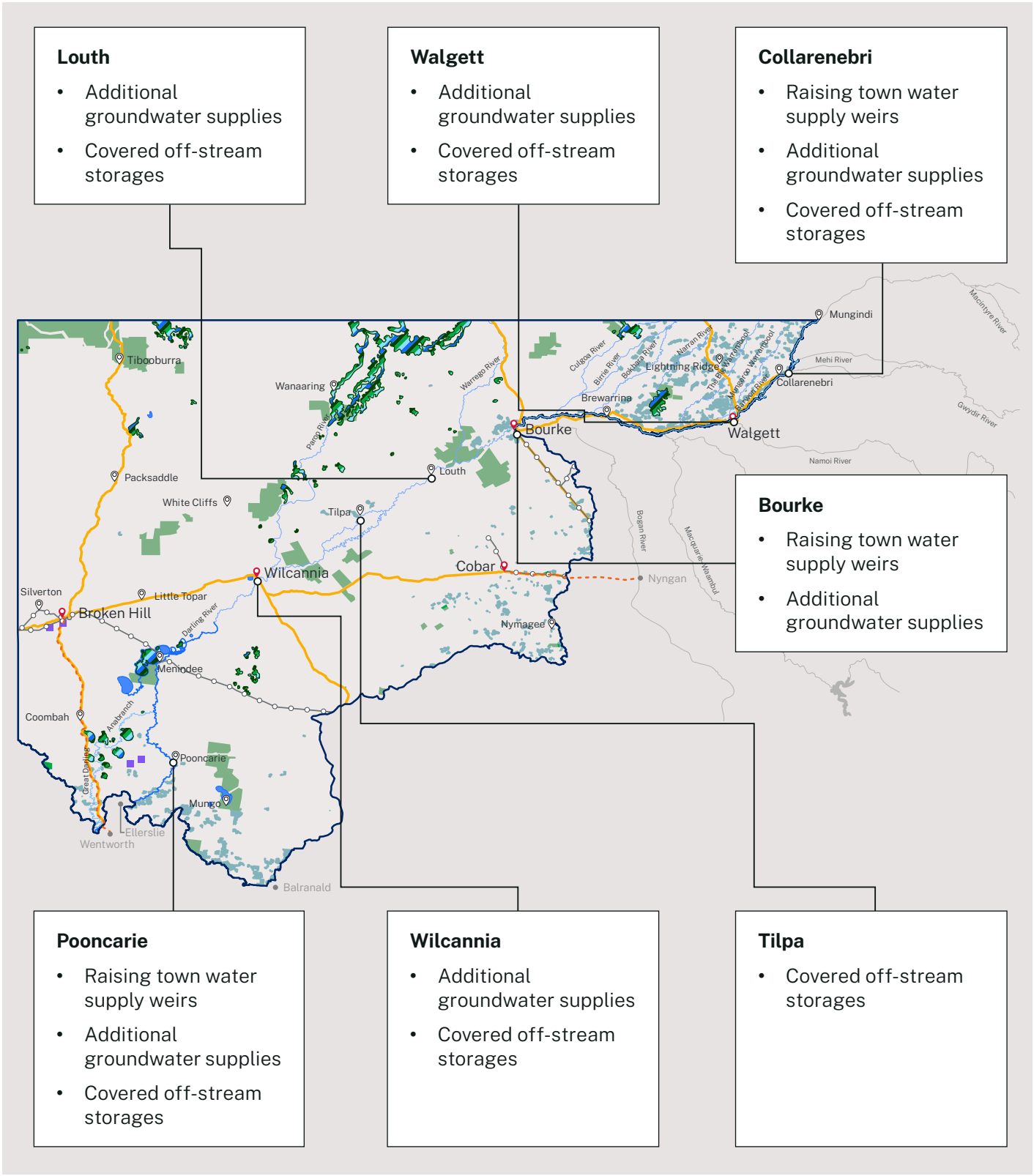
During discussions with Western region communities, it was clear that improvements to water security for towns and communities is widely supported.

Western Weirs Strategic Business Case

A strategic business case provides an understanding of the potential options that may be developed and analysed in greater depth, and if the project is funded to progress to a more detailed study, known as a final business case.

The Western Weirs Strategic Business Case assessed the feasibility of changing the operation of the existing river infrastructure by replacing existing fixed-crest weirs with regulated weirs, altering the height of some weirs and possibly removing other weirs. The strategic business case also assessed alternative non-weir options that could have similar benefits for improving town water security.

Figure 28. Shortlisted actions to augment town water supplies in the Western region



Water re-use and recycling

Reuse of wastewater and stormwater can play an important role in reducing demands on potable water supplies. Reuse projects are being successfully implemented at different scales and with various end uses across Australia and internationally. Across the region, some reuse projects have been implemented for commercial, industrial, agricultural, environmental and municipal purposes – for example, by Cobar Shire Council and by Essential Water in Broken Hill. However, existing barriers such as dispersed smaller towns and communities and cost are limiting more widespread use.

Over the next 5 years the NSW Water Strategy commits to progressing regulatory reform, guidelines and community acceptance campaigns to make the development and use of advanced water treatment facilities easier. This includes the development of a draft Recycled Water Roadmap for consultation. There are no plans to include purified recycled water in drinking supplies. Any decision on purified recycled water will be taken with extensive community consultation and stringent government approvals.

Over the longer term, this action will assess the viability of water recycling projects in the Western region within the terms set out in the Recycled Water Roadmap.

Small community water security assessment

Making significant water security investments at strategic points in the system can also help to improve water security for smaller surrounding towns during times of scarcity through either in-river deliveries or carting. Some small communities in the Western region may benefit from smaller scale water supply measures, particularly if they have been assessed as high risk under the Safe and Secure Water Program risk categorisation program. The Department of Planning and Environment – Water will work with and support councils to progress water security measures as part of the Safe and Secure Water Program. These smaller scale water supply measures may include:

- investigating ways to improve and streamline current water carting processes, such as through connecting tanks to the reticulated supply
- large rainwater tanks or reserve tanks that could be filled with town water as a back-up supply before heading into dry periods, or filled with carted water
- the potential for new and emerging technologies such as hydropanels or off-grid containerised water filtration units.

Image courtesy of iStock. Barwon River, Brewarrina.

Action 1.2: Adopt a stronger focus on water efficiency and demand management for towns

The efficient use of water contributes to the sustainability of long-term supplies, builds resilience to drought, and supports readiness to respond to future extremes in weather.

Using water more efficiently means making the best use of all available water. Household water demand for some towns in the Western region is relatively high when compared to towns in other parts of NSW. While water demand per household in the region is expected to be higher than average in NSW, given the arid and hot conditions, there may be opportunities to implement water efficiency and demand management measures.

Water efficiency should be considered in water demand and supply planning. All potential water efficiency options to achieve water security should be identified and evaluated on an equal basis with other supply and demand management measures.

There is a NSW Government expectation that water efficiency should be implemented where it is cost effective, considering the broad range of cost and benefits to customers. The NSW Water Efficiency Program has recently established some key initiatives, including the NSW Water Efficiency Framework and the Regional Leak Reduction Program.

Local water utilities play an important role in managing water demand and improving water efficiency. Some councils in the region have invested in demand management measures that have helped to improve the resilience of water for towns facing increased pressures from growth and recent droughts. For example, Bourke Shire Council has begun implementing a smart meter program, including telemetry. This program will help customers and council to identify water leaks early at individual properties so they can be repaired in a timely manner.

This action involves finalising the NSW Water Efficiency Program outline and encouraging councils and utilities to use the Water Efficiency Framework to plan and deliver water efficiency programs and initiatives.

NSW Water Efficiency Program

The NSW Water Efficiency Program seeks new ways and approaches to working with the community to ensure secure, reliable water sources and to build future resilience to climate change and droughts. It includes commitments for the Department of Planning and Environment to provide a clear statement of government policy; collaborate with government and across the water sector; to focus on building water efficiency capacity, gaining a greater understanding of water use, improving the evaluation of water efficiency initiatives and increasing private sector involvement. Key aspects of the NSW Water Efficiency Program to date have been:

- developing the NSW Water Efficiency Framework – a best practice guide for water efficiency planning
- establishing the Regional Leakage Reduction Program to address network leakage and water loss
- rolling out a washing machine replacement trial
- partnering with The Water Conservancy to support local water utilities and councils with Smart Water Advice resources
- partnering with the National Australian Built Environment Rating System to support buildings to achieve a first-time water rating.

Action 1.3: Addressing water related skills shortages and funding challenges in small councils

Attracting and retaining skilled staff to operate water treatment plants is a significant challenge for many small local water utilities across the Western region and NSW more broadly. During consultation with councils in the Western region we have heard that this is an ongoing and widespread issue that can impact council's ability to maintain water and sewerage treatment operations and maintenance. Some of this infrastructure, such as reverse osmosis plants, can be very challenging to operate and require a high degree of skill and training. This issue is compounded in the Western region by a low ratepayer base and high maintenance and operations costs associated with a high proportion of smaller, isolated communities.

Over the next 4 years there is an expected deficit of 1,476 water operators' qualifications in NSW and a shortfall of up to 21 trainers and assessors to deliver training in regional NSW. This limits the capability of local water utilities to operate and maintain water infrastructure.

This is a state-wide priority and work has already begun to help address this issue through the Department of Planning and Environment's Town Water Risk Reduction Program. Working with Training Services NSW, 200 fully funded training places for new trainees each year were made available from December 2021, with 153 places filled between December 2021 and October 2022. Under this action, the NSW Government will continue to work across the training and water sector to help address the skills and training gaps. The NSW Government is investing $32.8 million into a suite of new initiatives to provide greater support and improved skills and training for Local Water Utilities including funding for phase 2 of the Town Water Risk Reduction Program.

Image courtesy of Destination NSW. Barwon River, Brewarrina.

Action 1.4: Use groundwater more efficiently, innovatively and sustainably

Given the expected continuing demands on groundwater, improving our understanding of groundwater sources can help support the long-term viability of groundwater as an alternate supply source in the Western region.

Groundwater availability and quality vary across the catchment. For example, areas in the northern part of the catchment overlie the Great Artesian Basin can supply long-term high yielding bores but water quality can vary and must be managed on a case-by-case basis.

Common issues with groundwater can include taste, odour, salinity and temperature. As a result, overall groundwater use in the Western region is low, but it remains a vital supplementary water supply in the region for towns and industry.

Salinity in particular limits the use of groundwater in sources such as the Western Rock Porous groundwater. Shallow groundwater can cause land salinisation or saline groundwater flowing into rivers. Fresh groundwater is limited and all shallow groundwater sources need to be treated to meet drinking water guidelines. Quality can also change over time; for example, due to declining groundwater levels that can draw in saline groundwater from surrounding aquifers.

Groundwater quality information in the region is generally out of date and has many gaps. Improving groundwater quality monitoring through auditing the current bore network, implementing regular sampling programs and collating groundwater quality data from industry and government sources into one database can help to identify groundwater quality risks early.

Improving our monitoring of low use groundwater sources, such as the Western Murray Porous Rock Groundwater Source, will also be important in developing a better understanding of water quality in these sources and determining how best to support any growth in their use.

Geoscience Australia are undertaking a program of work to help to better understand groundwater systems in the Upper Darling River floodplain.

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

This action will progress work to enhance our understanding of groundwater by:

- better understanding the interaction between surface water and groundwater resources, to help improve our understanding of where a change in groundwater use can influence flows to rivers and vice versa
- understanding how a changing climate is affecting the replenishment of groundwater resources
- ongoing investment in the groundwater monitoring network and sampling programs (including groundwater quality)
- obtaining and publishing more information about the groundwater systems in the Upper Darling River floodplain to possibly improve town water supply security and optimise the operation of the Upper Darling Salt Interception Scheme[41]
- investing in technology and research to understand how treated groundwater can support towns, landholders and industries to secure water supplies for communities in the face of a drier climate with less water in rivers. This includes promoting groundwater desalination and making sure groundwater of suitable quality is available for different purposes.

41. For more information see: www.industry.nsw.gov.au/water/science/groundwater-archive/interception-schemes-archive/upper-darling

Action 1.5: Improve the collection, analysis and public access to data

The NSW Government uses river system models to inform many decisions in regional water management. These models can produce detailed information on how changes to policy, water sharing rules, or infrastructure would impact the amount of water that flows in the river at different times and locations, and the water available to different users including the environment.

The incorporation of new climate datasets gives us a better understanding of how climate variability and climate change could impact catchment inflows and water availability in the region.

This action will continue to enhance the capability of the western models to support analysis of future operation, policy and planning decisions and their impacts on all water users, including the environment. This analysis, combined with improved communication and engagement approaches, will give stakeholders and the broader community greater confidence that water sharing and management decisions are made using the latest scientific knowledge and a strong and credible evidence base.

Siltation of the Menindee Lakes leads to a poor understanding of drought resilience for the towns of Menindee and Pooncarie. This issue can be addressed by a routine bathymetric survey program being included in the ongoing operations and maintenance program for Menindee Lakes.

This action will:

- continue to invest in science and modelling methods that enable us to better understand the movement of water across the floodplain, including:
  - floodplain inundation extent, duration and consequent environmental outcomes
  - the return of floodwater from the floodplain back to the river
  - developing within flood event forecasting capabilities.
- improve how our models represent river operations when the system is approaching and recovering from drought, including better representing low flows by moving the river models to the SOURCE modelling platform
- improved ability to simulate drought contingency measures and better representation of evaporation and groundwater seepage can improve our assessment of the impacts and benefits of different actions during droughts
- collaborate across different disciplines to explore how hydrologic models could be linked or combined with other models, such as economic and ecological models, to better understand ecological vulnerability to future conditions including climatic variation
- seek funding for a routine bathymetric survey program to be included in the ongoing operations and maintenance program for the Menindee Lakes
- developing the Drought Flood Risk Index with the aim of providing early warning to water users on whether the Lower Darling regulated valley is at a higher risk of heading into drought or floods.

Action 1.6: Collect water quality data in the Lower Darling River

The NSW Government has reviewed its network of stream and storage gauges, and groundwater and water quality monitoring in the Murray–Darling Basin. The primary purpose of the review was to ensure the network is fit for purpose. The current network is comprehensive, with over 500 sites predominately located in the major regulated river catchments. The sites collect data on stream and storage flow and volume, groundwater level, water quality and meteorological information such as rainfall.

The review found the stream gauging station, storage, water quality and rainfall monitoring network is effective given the need for prudence and efficiency in operation. Although the network is fit for purpose, the review identified some potential improvements. The upgrade and operation of sites and equipment depends on extra funding and justifying the expected benefits against the additional cost.

Water quality is important for ecological processes, recreation, amenity and industry use. Changes in water quality are due to a combination of factors, including changes in river flows and land use. For example, high flows from rainfall and runoff often result in higher turbidity, whereas low-flow and cease-to-flow events increase the risk of algal blooms in reservoirs and weirs. Rainfall following extended dry periods can also increase the risk of blackwater events, which can result in fish deaths.

An existing network of dissolved oxygen and electrical conductivity sensors has been installed at selected gauging stations on the Barwon–Darling and Lower Darling system. These sensors give a good indication of dissolved oxygen and conductivity levels when the rivers are flowing and the water column is well mixed. The network of permanent dissolved oxygen and electrical conductivity sensors on the Lower Darling, Menindee Lakes and the Great Darling Anabranch is currently limited. Additional dissolved oxygen and conductivity sensors could improve our ability to manage hypoxic blackwater events and improve the decision making around releases from the Menindee Lakes.

The Department of Planning and Environment – Water has reviewed the current hydrometric monitoring network to understand the water quality network gaps.[42] The review identified:

- **5 monitoring sites in the Lower Darling for water quality and rainfall improvement:** Darling River at Pooncarie, Burtundy, Wilcannia Main Channel, Menindee upstream of Weir 32 and the Great Darling Anabranch Offtake
- **7 sites along the Darling River for telemetry:** Darling River at Lakes Wetherell and Tandure Total Storage, Lake Pamamaroo and Copi Hollow Total Storage; Tulney, upstream of Tulney; upstream of Weir 32; Menincourt; and upstream of Menincourt
- **2 new sites for flow monitoring:** Darling River between Tilpa and Wilcannia and the Darling River upstream of Lake Wetherell.

This action will seek funding to invest in technologies and monitoring that can provide real time information about water quality and water flows at priority locations to inform planning and management for these systems. This action may also include installing new water quality monitors alongside flow gauges in the Lower Darling, Menindee Lakes and the Great Darling Anabranch.

42. Department of Planning and Environment – Water 2021, *Hydrometric Network Review.* Available at, water.dpie.nsw.gov.au/science-data-and-modelling/data/hydrometric-network-review

Action 1.7: Develop ongoing arrangements for participation of local Aboriginal people in water management

An effective governance, engagement and knowledge sharing process is the first step in fundamentally improving Aboriginal people's involvement in water management and supporting cultural, environmental, social, and economic outcomes. For it to be successful, the makeup and function of groups need to be led by local communities. Experience has shown that government-dictated governance models for Aboriginal communities do not work.

The NSW Government is setting up an Aboriginal Water Program led by an all Aboriginal team of staff. The team will develop an Aboriginal Water Strategy. The program will work with and fund existing or new Aboriginal groups that have developed a governance approach for involvement in water management processes. The success of this action will be driven by the extent to which it enables self-determination and provides an adequate level of support for these groups.

This action supports Priority Reform 1 in the Closing the Gap National Agreement[43] – to enter formal partnerships and decision-making arrangements and develop place-based partnerships to respond to local priorities.

Local Aboriginal groups in the Western region could be involved in:

- developing programs and initiatives to improve cultural competency within the water sector
- developing culturally appropriate water knowledge programs
- outlining a process that the NSW Government can follow to ensure water decisions have appropriately been considered by the community
- progressing on-ground initiatives
- integrating Aboriginal knowledge and science into water related decision making.

Action 1.8: Support place-based initiatives to deliver cultural outcomes for Aboriginal people

This action will fund and support Aboriginal organisations and communities to develop tailored projects for their communities. It would aim to move away from central decision making and develop a flexible program that can be adapted and is driven by the principle of self-determination – local communities speaking with their voice to make decisions about the programs needed for their community and their region.

This action could include Aboriginal communities and organisations:

- developing a cultural watering program that identifies the specific sites or locations where water should be delivered at certain times. This could involve working with the Department of Planning and Environment – Water, Environment and Heritage Group, WaterNSW and environmental water holders to identify whether co-benefits could arise from water for the environment. Examples of sites identified through consultation include Lake Woytchugga near Wilcannia and Fletchers Lake near Dareton
- working with the NSW Government to improve access to Country, including identifying locations that have local significance, by opening up local parcels of land that access waterways that are otherwise gated or locked
- establishing a restoration reach that would use cultural knowledge and science to rehabilitate riparian land, planting native species and caring for Country
- identifying projects that could be implemented by River Ranger programs such as the Barkindji Maraura Elders Environment Team and the Barkandji or Dhariwaa Elders river rangers
- developing and delivering programs that engage Aboriginal youth in water and landscape management, with an objective to build cultural awareness and give a sense of ownership and cultural connectivity.

To receive government funding or support, these initiatives would need to have local champions, effective local governance arrangements and a strong capacity-building component, such as activities that focus on water legislation and literacy, licensing of water structures, landscape management or knowledge activities for schools and youth programs.

43. For further information see: www.closingthegap.gov.au/national-agreement

Action 1.9: Improve cross-border collaboration and information sharing

This action involves a continued focus on improving collaboration and information sharing across NSW and Queensland.

Towns, water users and communities often access water from both sides of the border. Cross-border water management arrangements can be challenging due to the differences in legislation and rules between NSW and Queensland making arrangements complex to navigate and at times results in gaps in strategic planning or operational decision-making. Each state is responsible for managing water on its own side of the border, through its own legislation but alongside agreed guidelines under the NSW–Queensland Border Rivers Intergovernmental Agreement 2008.[44] It also means that towns relying on shared infrastructure to provide water supplies may not have control over when water is released.

This action will continue to improve and implement effective governance frameworks and collaboration forums to improve cross-border water planning and cooperation between NSW and Queensland.

The Department of Planning and Environment – Water worked with the Queensland Government and the Commonwealth Environmental Water Holder to develop an accounting method for determining the volume of held environmental water crossing the Queensland–NSW border into the Intersecting Streams. This action will further progress work on recognition of held environmental water from Queensland in the Intersecting Streams.

Action 1.10: Support Aboriginal business opportunities in the Western region

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.

This action will support Aboriginal business development opportunities in the Western region. The action will be led by the Department of Planning and Environment with support from the Department of Regional NSW. Through the Aboriginal Partnership Program, a dedicated Partnership Manager will work with Aboriginal organisations, businesses, and individuals to:

- identify and develop new business opportunities
- better manage existing business
- access support or grant funding.

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

44. For further information see: www.industry.nsw.gov.au/water/what-we-do/legislation-policies/intergovernmental-agreements

Action 1.11: Support adoption of farm climate adaptation and water efficiency measures

Many Australian farm businesses are early adopters of best practice management and new technology.[45] For example the cotton industry has significantly improved whole farm irrigation efficiency and producers now harvest twice as much cotton from the same amount of water as 20 years ago.[46]

Industry associations, research institutions and governments have worked together for decades to improve traditional crop and livestock production systems, including their water use efficiency and productivity. Grower-led irrigation research has been underway in the region for more than a decade.

Continuing critical research and development will set industry up for the future and may go a significant way to mitigating future climate risks and adapting to climate change. There are opportunities to fast-track research and development into new practices and enterprises that are best suited to the warmer and drier conditions projected for regional NSW. This research would build on the Climate Vulnerability Assessment being undertaken by the Department of Primary Industries and help agricultural businesses to diversify their incomes and ensure their long-term sustainability.

This work could be progressed through:

- the NSW Government's $48 million expanded Farms of the Future program, which will support on-farm connectivity and encourage farmers to adopt agricultural technology (agtech) to boost productivity
- completion of stages 1 and 2 of the Department of Primary Industries Climate Vulnerability Assessment, which includes publishing summaries of the assessments of climate risk and opportunities for western agricultural commodities, integrating water data from the regional water strategies into the assessment and investigating adaptation responses for cotton
- measuring water productivity and water sustainability indices for cotton production systems and identifying potential changes to water use, productivity and sustainability
- productivity including water efficiency and drought preparedness in 2022, a grants program will be delivered to help farmers purchase agtech devices and applications
- research programs of the Department of Primary Industries – Agriculture, which will lead efforts to translate world-leading research into practical improvements, including drawing on research to develop and coordinate local pilots, and information and training programs
- the One Basin Cooperative Research Centre program, a collaboration between governments, research institutions and industry that will develop policy, technical and financial solutions to support and reduce exposure to climate, water and environmental threats in the Murray–Darling Basin.

45. Roth, G., Harris, G., Gillies, M., Montgomery, J. and Wigginton, D 2013, *Water-use efficiency and productivity trends in Australian irrigated cotton: a review, Crop and Pasture Science,* 64(12), pp.1033-1048
46. Cotton Australia 2019, *Australian Cotton Sustainability Report 2019.* Available at, cottonaustralia.com.au/assets/general/Publications/Sustainability-Reports/2019-Australian-Cotton-Sustainability-Report-Full-Report-2.pdf

Priority 2

Improving the resilience of natural systems

Environmental water entitlements in the Barwon–Darling and Lower Darling system are used to help maintain natural river flows, provide drought refuge and habitat, support native fish populations and vegetation and build ecosystem resilience. Despite this, water for the environment is not always available when it is needed, nor can it always be delivered to its best effect during dry and wet periods because of operational constraints.

Future droughts and long-term dry climate change scenarios will increase the stresses on ecosystems and native species. The actions in this strategy focus on improving the health and resilience of natural systems to withstand future extreme events and protect aquatic species and habitats.

Our starting point

Improving native fish habitats and movement

Programs funded by the Australian Government and NSW Government are underway to improve the health and resilience of native fish in the Western region:

- **Establishing native fish recovery reaches** – the Australian Government has committed to implementing the Native Fish Recovery Strategy[47] to guide investment in native fish and river health actions that will help rebuild healthy and resilient native fish populations. The Australian Government and NSW Government are collaborating to deliver the strategy, including implementing management actions in the Lower Darling–Baaka Recovery Reach.
- **Funding the Fencing Northern Basin Riverbanks Program** – this program supports landholders to protect valuable ecological sites and improve water quality and native fish habitat across the northern Basin. This program includes off-stream stock watering points, control of exotic woody weeds, minor erosion control works, revegetation and river re-snagging to protect native fish, and stock-proof fencing along riverbanks.

Toorale National Park

Toorale National Park is located about 65 km south-west of Bourke in north-western NSW. Toorale Station was purchased jointly by the Australian Government and NSW Government and added to the NSW reserve system to protect its outstanding environmental and cultural values. At the same time, the Toorale water access licences were purchased by the Australian Government to deliver environmental benefits in the Warrego and Darling rivers.

Toorale Station has extensive infrastructure dating back to the nineteenth century that was built to regulate water across the property for agricultural purposes. The Toorale Water Infrastructure Project is modifying, decommissioning and removing this water infrastructure to improve flow management. The project aims to maintain and enhance the important values of Toorale while passing more water to the Darling River.

The new structures will enable more water to flow to the Darling River when downstream needs are a priority and provide for ongoing watering of important habitats at Toorale when needed. New fishways will increase connectivity and support healthier fish populations in the Warrego and Darling rivers.

47. For further information see: www.mdba.gov.au/publications/governance/native-fish-recovery-strategy

Maintaining environmental flows

Water sharing plans in the Western region include rules and tools to maintain and improve the flows of rivers and support environmental outcomes in the Western region. A summary of these rules is:

- Protections for low flows – There are limits on the portion of flows that may be extracted, with the remainder left in the river for environmental purposes. In 2020, amendments were made to the *Water Sharing Plan for the Barwon–Darling Unregulated River Water Source 2012* to increase this protection by raising the thresholds at most locations for when A Class licence holders can access water.
- Individual daily extraction components set a daily extraction limit for water licence holders along the Barwon–Darling to manage the amount of water that can be taken out of the river each day during peak irrigation periods.
- Protections for licensed environmental water from extraction in unregulated river systems (active management) – Licensed environmental water is protected from extraction as it moves through the Macquarie, Gwydir and Barwon–Darling unregulated systems. These provisions ensure that this water can remain in the rivers to provide its intended environmental outcomes and that water users are advised of these flows and know when they cannot access water.
- Protections for the 'resumption of flow' of water in the Barwon–Darling following extended low flows. These protections recognise that these first flows of water are critical to replenishing refuges and town weir pools by allowing larvae and juvenile fish to flow down the system reach key nursery habitats such as Menindee Lakes.
- There is a 30 GL environmental water allowance in the Lower Darling for managing water quality issues (triggered by a high alert for blue-green algae).
- There are 121 GL[48] of held environmental water in the Western region. This includes:
  - 30,359 ML in the Barwon–Darling[49]
  - 72,879 ML in the Lower Darling[50] (this is about 75% of the available 98,781 ML of regulated river entitlement (excluding supplementary entitlements)
  - 17,826 ML in the Intersecting Streams (Warrego River).
- Recommended minimum flow releases from Weir 32 at Menindee Lakes to the Lower Darling River to mitigate blue-green algae and maintain river health. This is prescribed by the Murray–Darling Basin Agreement.
- End-of-system flow rules in the Namoi tributary require a flow to be retained at the end of the river system. This ensures that flow is maintained below the areas of major extraction. Current end-of-system flow targets in some tributary valleys such as Namoi and Border Rivers do not address no-to low-flow conditions, as they are not triggered during dry conditions.

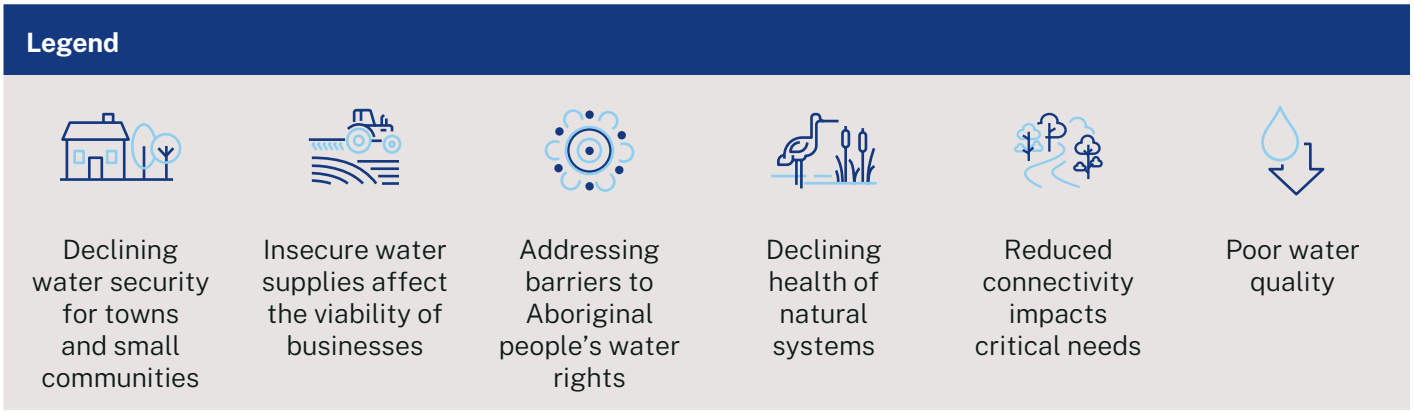
Natural capital

The NSW Government recognises there are growing demands on and from within the primary industries sector to implement sustainable production processes and land management techniques. In response, the NSW Government is running a suite of voluntary programs to assist the primary industries sector to undertake sustainable actions to enable improved productivity, drought and climatic resilience, regenerate local landscapes, and facilitate new/diversified income streams. These programs are designed to provide participants with options to support their business goals and deliver environmental benefits. These programs include:

- Sustainable Farming Program – $206 million over 10 years to 2032
- Primary Industries Productivity and Abatement Program – $125 million over 8 years to 2030
- Private Land Conservation Program – $70 million annually
- Biodiversity Credit Supply Program – $106 million over 3 years to 2025.[51]

48. Excludes 250,000 ML in supplementary entitlement, and unregulated entitlements in Queensland tributaries
49. Department of Planning, Industry and Environment – Water 2020, *Draft Barwon–Darling Watercourse Water Resource Plan*. Currently in review.
50. Department of Planning, Industry and Environment – Water 2020, *Draft NSW Murray and Lower Darling Surface Water Resource Plan*. Currently in review.
51. Department of Planning, Industry and Environment – Water 2020, *Draft Intersecting Streams Surface Water Resource Plan*. Currently in review. This excludes held environmental water in Queensland tributaries.

Figure 29. Priority 2: Improving the resilience of natural systems



Action number	Action name	Challenges addressed
Action 2.1:	Fully implement the NSW Floodplain Harvesting Policy	
Action 2.2:	Remediate unapproved floodwork structures or constraints	
Action 2.3:	Protect priority aquatic and groundwater dependent ecosystems	
Action 2.4:	Undertaking broadscale, long-term catchment management and better integrating land use and water management	
Action 2.5:	Mitigate the impact of water infrastructure on native fish	

Action 2.1: Fully implement the NSW Floodplain Harvesting Policy

Floodplain harvesting happens when water is collected from floodplains during a flood or after a major or significant rain event (overland flows). It is a form of water take that has not been fully transitioned into the licensing framework provided by the *Water Management Act 2000.*

Floodplain harvesting is accounted for in the legal limits on water extractions as set out in the Murray–Darling Basin Agreement (the Cap), NSW water sharing plans (long-term average annual extraction limits) and the Murray–Darling Basin Plan (sustainable diversion limits).

Floodplain harvesting in the Western region occurs within the Barwon–Darling valley floodplain and accounts for an estimated 10–15% of the total amount of water taken from surface water resources on a long-term average in the region. The region's agricultural industries rely on water from floodplain harvesting take during wet periods to support existing and emerging industries. Similarly, the floodplains across the region rely on large flows to maintain floodplains and their dependent ecosystems.

There has been growth in floodplain harvesting across the northern Basin over the last 20 years, with the amount of water being taken across all categories of water take now estimated to be greater than the limits set through some water sharing plans in a number of valleys. This growth in floodplain harvesting is largely historic, with 80% of growth in on-farm storages across the northern Basin occurring prior to 2008.

The NSW Government is implementing the NSW Floodplain Harvesting Policy in the northern Basin. Under the policy, floodplain harvesting will be licensed and managed within legal limits, providing business security and certainty while improving environmental and cultural outcomes. Floodplain harvesting is highly variable in nature and relies on wet conditions to create overland flows. In drier years, very little to no floodplain harvesting takes place. This means that connectivity benefits from floodplain harvesting reforms will occur during times where there are medium to high flows rather than during periods where there is low to no flow in the river. The reforms may provide both longitudinal and lateral connectivity benefits in the region.

Additional modelling has been undertaken to understand the combined impact of floodplain harvesting policy implementation on Barwon–Darling flows from upstream catchments. Introducing the combination of entitlements and account management rules will reduce floodplain harvesting enough to bring the long-term average annual diversion for the water source within the plan limit. Compliance with the plan limit will require a 1.2 GL restriction on floodplain harvesting in the Barwon–Darling. This is primarily due to the exclusion of a small number of ineligible works in the process of determining floodplain harvesting entitlements.[52]

This action will implement floodplain harvesting water access licences and works approvals in the Barwon–Darling by June 2023.

Action 2.2: Remediate unapproved floodwork structures or constraints

Floodplain structures in the Western region, including levee banks, earthworks, on-farm storages, raised roads and water supply channels can block or significantly alter the natural flow of water across the floodplain. Disconnection of these natural flow paths within and between valleys impacts on ecological and cultural assets.

Some ecological assets in the Western region rely on floodplain flows for their maintenance and survival.

This action, through the Improving Floodplain Connections program, will remediate or remove unapproved works in one priority area in the Barwon–Darling floodplain that are altering the flow of floodwaters in the region and potentially impeding the delivery of water to ecological assets and floodplain areas. Wetland and floodplain ecosystems in the Western region would benefit from this proposed action.

The program also has the potential to enhance cultural sites and values held by local Aboriginal people. This action will also explore how Aboriginal cultural heritage values and ecological balance can be restored in partnership with Aboriginal communities.

52. Department of Planning and Environment 2022, *Floodplain harvesting entitlements for the Barwon–Darling unregulated river system Model scenarios May,* www.industry.nsw.gov.au/__data/assets/pdf_file/0013/512500/model-scenarios-report.pdf

Action 2.3: Protect priority aquatic and groundwater dependent ecosystems

Improve the health of ecosystems that depend on groundwater

A critical but often overlooked element of the water cycle is groundwater and groundwater dependent ecosystems. These ecosystems support a range of species and provide important ecosystem services, such as habitat refuges and removal of nutrients from water. They also have inherent environmental value. Groundwater dependent ecosystems are classified broadly as terrestrial (vegetation communities), aquatic (wetlands and springs) or subterranean (aquifers).

In the Western region, these ecosystems support a variety of fauna and flora communities, including canegrass swamp, river Coolabah and river red gum in the Darling Riverine Plains and the Lower Darling. Important groundwater fed ecosystems in the region include the Narran Lakes east of Brewarrina and the systems of artesian springs in the Great Artesian Basin.

These communities are characterised by having endangered ecological communities, Ramsar wetlands (Paroo wetlands and associated Menindee wetlands), extensive connected riparian corridors and important vegetation species of black box, lignum and river red gums.[53]

The Great Artesian Basin Springs Project[54] is collecting hydrogeological and ecological data about springs fed by deep groundwater sources to develop a baseline dataset that will allow scientists to monitor changes over time and better manage the Great Artesian Basin. This data will contribute to our knowledge of groundwater and dependent ecosystems in the basin; however more data and information is needed on groundwater sources, processes, risks and impacts.

A number of submissions received during the public exhibition of the draft strategy indicated support for a better understanding of how flows, interconnectedness and recharge impact groundwater dependent ecosystems before increasing reliance on groundwater sources. This action will focus on advancing our knowledge and management of these ecosystems in the Western region's groundwater sources by reviewing our monitoring and evaluation of groundwater dependent ecosystems, developing educational materials for water users and the wider community, establishing watering requirements for each type of groundwater dependent ecosystem and updating relevant policies and guidelines around managing, assessing and protecting these vital and sensitive ecosystems.

Assess the impacts of climate change on the flow regime and identify cooperative actions to improve ecological outcomes

Ongoing increases in temperatures and reduced rainfall combined with additional regulation and storage in upstream tributaries and the Barwon–Darling could lead to longer and more frequent cease-to-flow periods, lower average flows and longer dry periods.

A more detailed assessment of current and possible future flow regimes in the Barwon–Darling is needed to identify how changes in the climate could lead to changes of different flow types and what adaptive strategies are required to maintain and protect important ecological assets and functions in the catchment.

Progressing this action will require:

- a review of the flow regime in the Barwon–Darling to identify what environmental water requirements are currently being met, or are absent, from the current flow regime (the relevant environmental water requirements are documented in the Barwon–Darling and Murray–Lower Darling long term water plans)
- an assessment of the impact of future climate change scenarios (being generated through the Western Regional Water Strategy) on the achievement of environmental water requirements of the Barwon–Darling
- identify whether cooperative and basin wide actions are needed to address any of the identified at-risk flows in achieving environmental outcomes under a changing climate.

The new climate data from the Western Regional Water Strategy is the first step in progressing this action. The actions in Priority 3 may go a significant way to addressing the needs of the environment and communities.

Address riverbank erosion below Weir 32

With the large volume of flows moving through Weir 32 on the Lower Darling River near the Menindee Lakes since 2021 there has been significant localised erosion downstream of the weir. This erosion has cased riverbank vegetation to fall into the river contributing to water quality issues. This action is to seek funding to undertake riverbank rehabilitation works at the site to prevent further erosion.

53. Department of Planning and Environment – Water 2019, *Groundwater Resource Description; Darling Alluvium Water Resource Plan.* Available at, www.industry.nsw.gov.au/water/plans-programs/water-resource-plans/drafts/darling-alluvium/components
54. Department of Planning and Environment – Water, *Groundwater Dependent Ecosystems – The Great Artesian Basin Springs Project.* Available at, water.dpie.nsw.gov.au/science-data-and-modelling/groundwater-management-and-science/groundwater-and-the-environment

Action 2.4: Undertaking broadscale, long-term catchment management and better integrating land use and water management

Land use changes and land clearing have had detrimental impacts on the health of the rivers throughout the region. Water now moves more quickly and with more energy through the catchment, eroding land and waterways, reducing water quality, and leading to less water being stored in the landscape. The degradation of native riparian vegetation along water courses is recognised as a key threatening process under the *Fisheries Management Act 1994*. A region-wide approach is likely to be the most effective long-term solution to improving water quality in the catchment.

Detailed aquatic (in channel) and riparian habitat mapping has been undertaken for the majority of the Barwon–Darling River, as well as reaches of the Lower Darling River. This work has documented the riparian features of the region, focusing on native vegetation, weed infestation and existing management activities. The data can be analysed to inform targeted and priority on-ground actions to protect and improve aquatic and riparian habitat as part of future investment and programs.

This includes the Healthy Rivers Program and the Fencing Northern Riverbanks Program which are being implemented by Western Local Land Services and the Lower Darling-Baaka Recovery Reach led by the Commonwealth Environmental Water Office, Department of Primary Industries – Fisheries and the Murray–Darling Basin Authority. Future investment can also be used to complete detailed mapping at the identified remaining reaches.

Additionally, floodplain habitat and connectivity are critical for ecosystem processes, including providing nursery grounds for native fish species. The Menindee Lakes System is a significant recruitment habitat for native fish and there is potential to identify and improve related management actions for similar floodplain habitats in the Western region. Action and investment are needed to progress a floodplain mapping project in the Western region focusing on potential native fish and ecosystem processes to determine and progress water management actions that ensure improved connectivity and functioning of these critical habitats.

This action will build on existing land management programs and other local initiatives to support a whole-of-catchment program of works to improve river health, water quality, connectivity, ecosystem resilience and land use practices. We will build skills and share knowledge around catchment and landscape management.

This will be achieved by riparian restoration activities such as fencing, works to remediate gully and watercourse erosion, stewardships and improved agronomic practices. Along with re-establishing threatened fish species, there is a focus on engaging local landholders and building the skills and sharing the knowledge of landholders, community groups and First Nations people. Particularly for the Barwon–Darling, Lower Darling and the Intersecting Streams.

Implementation of this action will involve:

- mapping existing programs and potential gaps and overlaps
- further developing the identification of priority areas to protect or rehabilitate – based on, detailed habitat mapping data, native fish conditions, threatened species distribution or the River Styles framework, severity of land degradation and environmental management outcomes
- understanding and including local Aboriginal knowledge and expertise in delivering river improvement works – for example, through a River Ranger Program and the Pathways to Country project
- developing a local Natural Resource Management Plan for the Western region to assist in planning for healthy and resilient soils, flora, fauna, rivers, wetlands and aquifers for future generations to thrive
- funding the Fencing Basin Program to support local landholders and protect important ecological values
- continuation of the Healthy Rivers Program to improve habitat, re-establish and protect remnant native vegetation which will improve water quality and river health
- further integration of wetland farm management and primary production to minimise negative impacts on wetland function.

Action 2.5: Mitigate the impact of water infrastructure on native fish

The Barwon–Darling and Lower Darling rivers and the Great Darling Anabranch are critical native fish corridors, especially for species such as Golden Perch, connecting the northern Murray–Darling Basin to the southern Basin. Protecting the habitats of these native fish species and enabling them to freely move within the Western region will help the resilience of fish species in a changing climate and will help to maintain and replenish native fish stocks across the northern and southern basins.

Improve fish passage at priority sites

Physical barriers to fish passage such as weirs and dams can limit fish movement, leading to a decline in the health and viability of native fish populations. Currently native fish can only move through the Barwon–Darling and Lower Darling system during high-flow conditions when water overflows weirs and other instream barriers.

The NSW Government and the Australian Government have made commitments to address barriers to fish passage through a range of initiatives, including the Reconnecting the Northern Basin project as part of the Northern Basin Toolkit, the Wilcannia Weir Replacement Project, the Lower Darling Fish Passage Program, the Accelerated Fish Passage project and Better Baaka program.

These programs of works will target fish passage actions at priority sites on the Barwon–Darling and Lower Darling, with the potential to reinstate connectivity to thousands of kilometers in the Western region and reconnect the southern and northern basins.

Priority sites include Mungindi Weir, Camilaroy Weir, Presburys Weir, Banarway Weir (No 4), Collarenebri Weir (No. 5), Calmundy Weir (No. 8), Bourke Weir, Darling River Weir (No. 19A), Darling River Weir (No. 20A), Louth Weir (No. 21), Tilpa Weir (No. 24), an Unlicensed weir on the Darling River, Wilcannia Weir, Burtundy Weir, Pooncarie Weir, Weir 32, and Lake Wetherell Levee and Lake Victoria Inlet Regulator.

Various stages of works have commenced at the majority of sites, including feasibility, business case and design activities, with on-ground implementation expected to commence over the next few years. Additional investment may be required pending the roll out of an implementation program to ensure system scale connectivity is achieved and ecological, social, cultural and economic outcomes are maximised. Investment at these sites will complement previous fish passage works in the Western region, including at Brewarrina Weir and Walgett Weir on the Barwon River.

Implement diversion screens at priority pump sites to protect native fish

Every year, large numbers of native fish are extracted by pumps and diverted into irrigation channels, never to return to the Barwon–Darling River. There are around 523 water pumps in the Western region that operate for an average of 3 months a year. This equates to a potential loss of up to 59 million native fish from the region per year.

Installation of screens at pump sites and diversion regulators can reduce fish losses by over 90% at these sites, helping more fish survive to maturity and boosting fish numbers. The protection extends to other aquatic species such as crayfish and turtles. Screening infrastructure also improves pump operation, water delivery and extraction efficiency for asset owners through fewer blockages caused by debris.

The Australian Government has funded the first phase of works to implement screening activities under the Northern Basin Toolkit – Fish Friendly Water Extraction project, which will install fish diversion screens at priority sites in the Barwon–Darling and Gwydir valleys in NSW and the Condamine–Balonne and Queensland component of the Border Rivers. The sites selected will complement other fish passage works and diversion screening activities being undertaken in NSW and Queensland.

The Fish-Friendly Water Extraction project involves the collaboration of government agencies, water users, irrigation engineers, local screen manufacturers and anglers to design, manufacture and install modern diversion screens at priority sites. Implementation of this project has commenced via targeted expressions of interest, manufacture procurement processes and on-ground works out to 2024.

The project also complements the Fish-Friendly Screens for Efficient Use of Water project led by Local Land Services, which provides funding support to landholders in a targeted area of the Western region, including the Lower Darling for the installation of a fish-friendly diversion screen on their pump intakes.

This action will build on existing government commitments and continue the rollout of diversion screens at other priority sites in the Western region over time to maximise environmental and water user benefits, with additional investment needed to achieve this in the future.

Develop and implement extreme event management for native fish

Cumulative impacts from extreme events including drought, floods and bushfires across NSW present significant risks to native fish populations and river health. The widespread fish deaths during the 2018–19 summer in western NSW, and subsequent bushfires and major flood events across inland catchments demonstrate the significant impacts on native fish, water quality and river health and the need to be prepared with appropriate actions and protocols to minimise impacts where possible.

Increases in long climate driven cease-to-flow conditions coupled with increasingly frequent dry and hot conditions, particularly during summer in the Western region may mean that the conditions that contributed to the 2018–19 fish deaths in the Lower Darling River may become more common. This means that preventing fish death events is going to be an ongoing challenge.

In response to the extensive drought across the NSW Murray–Darling Basin during 2019–2021, the NSW Government developed a response framework to mitigate the likely impacts on native fish populations. The NSW Native Fish Drought Response program was established to develop a strategic framework that outlined relevant policies, procedures, roles and responsibilities for the emergency management stages of mitigation, preparedness, response and recovery during the drought. The program complemented similar response actions from other Murray–Darling Basin governments, including the Commonwealth, to ensure efforts were consistent, coordinated, efficient and effective. This included assessing all potential response options, such as policy, on-ground, research, compliance, and communication to guide extreme event response and native fish recovery.

The activities covered all the emergency management stages, and included:

- identifying and prioritising sites across the NSW Murray–Darling Basin that are key to the long-term maintenance of fish populations both locally, regionally and across the entire basin, and their associated risks of fish deaths
- developing agreed policy statements, identifying the range of technological interventions available to reduce the risk of fish deaths, monitoring at key sites to inform any response actions and early warnings, and developing a communication strategy
- internal review of the NSW Native Fish Drought Response program undertaken at the conclusion of the main response activities
- on-ground activities, continued monitoring, and implementation of the communication strategy
- activities such as assessment of the impacts of the drought and responses at priority sites, monitoring at key sites, and continued development and implementation of appropriate native fish recovery actions to support depleted populations.

To better inform future management of native fish during extreme events, the NSW Government is currently reviewing and updating the Native Fish Drought Response program with expected completion to be by the end of 2022. This will improve emergency preparedness and response actions, including related policy, research and development, habitat rehabilitation, and capacity building with local communities. The NSW Native Fish Drought Response program will then be able to guide the future adaptation of extreme event management for native fish, particularly through undertaking detailed identification and mapping of critical drought refugia in the Western region and identifying critical dry watering requirements for these refugia.

This action would be complemented by other actions in this strategy that are designed to minimise the extent and frequency of cease-to-flow events in the Barwon–Darling and Lower Darling.

Upgrading or removing non-town weirs

Through the Better Baaka program there are a number of town water supply weirs the government is considering upgrading to improve fish passage, as well as considering whether to remove 11 non-town weirs. If some or all of the non-town weirs are removed, it may help water flow throughout the Barwon–Darling river system and support fish movement up and down the river. Removing or modifying these weirs would need to be accompanied by additional measures to help provide water for the landholders who rely on these weirs. These additional measures could include access to groundwater.

Through the consultation on the draft strategy we heard that some stakeholders were concerned that removal of some non-town weirs, such as weirs 19A and 20A downstream of Bourke could result in significant impacts to current users of the weir including the local community, tourists and landholders. For this reason extensive consultation with affected communities will be critical before any weirs are identified for upgrade or removal.

Priority 3

Improving connectivity across the northern Basin

Water flowing across connected catchments supports essential human and ecological needs in the Barwon–Darling River and Lower Darling system. The Barwon–Darling system relies on flows from 5 NSW valleys (Border Rivers, Gwydir, Namoi, Macquarie-Waambul and the Intersecting Streams), as well as a number of Queensland rivers.

Actions that seek to improve flows need to be targeted and realistic. Our data tells us that there have always been extreme dry conditions and periods of no flow in the Barwon–Darling. Through management, it is not possible to maintain a constantly flowing river and we have limited ability to break up drought induced extended cease-to-flow periods. The actions in this strategy focus on enabling water to flow across connected river valleys and downstream at important times for the following outcomes:

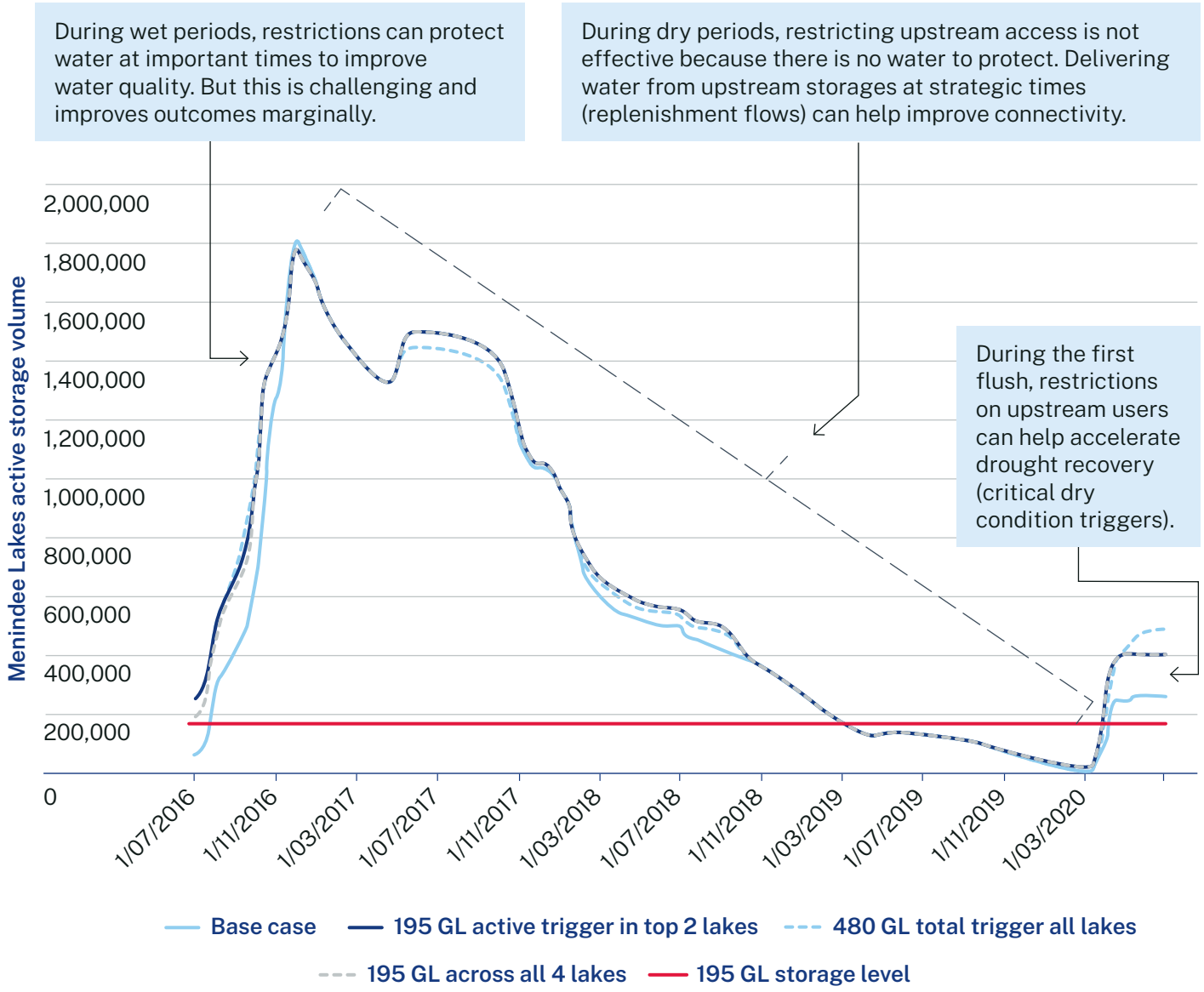
- **Protect the first flush of water after an extended drought** to protect critical human and environmental needs and support recovery post droughts.
- **Reduce the impact of cease-to-flow periods** and improve low-flow connectivity. While addressing this impact will be challenging, this is an area of great importance to communities and the environment, and can support social, mental health and environmental benefits.
- **Suppress algal blooms,** which continue to be a persistent and major challenge for towns, the environment and industry in the region.
- **Support fish migration,** as the Barwon–Darling, Lower Darling and Menindee Lakes system is the most ecologically important fish movement corridor in the basin.

Importantly, actions to improve connectivity are not intended to maintain a constantly flowing river, reduce the overall amount of water being taken out of rivers (consistent with the sustainable diversion limits set by the Basin Plan) or move productive use of water from one valley to another.

The right tools are needed to effectively meet these objectives. The significant analysis underpinning this strategy has demonstrated that placing restrictions on low priority licences such as supplementary, floodplain harvesting, B Class and C Class licences is unlikely to result in significant changes in flows downstream or at the end of the system during droughts. This is because these licences rely on large natural flows which often do not occur during droughts when there is often no water downstream, and there is no water upstream to restrict.

However, protecting water across connected systems at important times is critical to the fair sharing of water, including water for the environment. It is possible to intervene during critically dry periods to break up acute cease-to-flow periods primarily through accessing water from storages but this is a significant reform that requires more analysis and community consultation (Figure 30).

Figure 30. Modelled Menindee Lakes storage volume during the 2017–2020 drought



Our starting point

Since the introduction of the Murray–Darling Basin Plan in 2012, over 2,000 GL/year of surface water has been recovered for the environment across the Murray–Darling Basin, with over 460 GL of this recovery coming from the northern Basin in Queensland and NSW.[55] This recovered water is managed in partnership between the NSW and Commonwealth environmental water holders to achieve environmental outcomes. At times this water is managed to improve connectivity within and between systems.

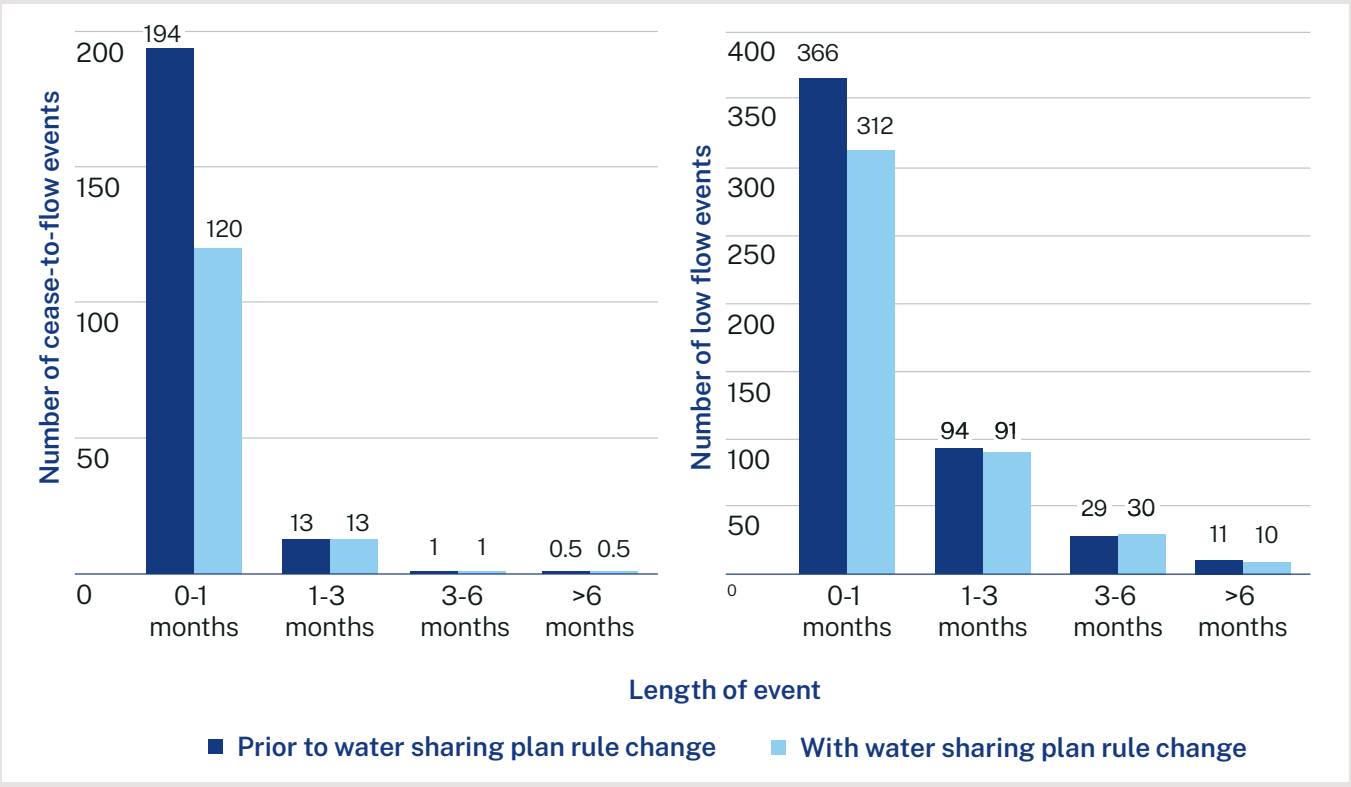
The NSW Government has undertaken other reforms to improve flows along the Barwon–Darling system (Figure 31). In 2020, the NSW Government made a range of changes to the Barwon–Darling Water Sharing Plan to improve connectivity. These changes included:

- **raising the threshold at which A Class licence holders in the Barwon–Darling can access water** – to help protect low flows which supports the water needs of basic landholder rights and may result in more water being left in the river to flow downstream
- **implementing individual daily extraction component** – establishes a daily extraction limit for water licence holders, to manage the amount of water that can be taken out of the river during peak irrigation periods
- a **'resumption of flows'** rule – this protects flows in the Barwon–Darling River after an extended dry period for cultural and local community outcomes
- **protecting licensed environmental water from extraction as it moves though the Barwon–Darling (active management)** – when held environmental water is in the river, commence-to-pump heights are raised to allow the held environmental water to remain instream to deliver its intended environmental outcome.

These changes will reduce the frequency of short (less than one-month) low-flow events by 11% and the frequency of short (less than one-month) no-flow events by 36% on average across Bourke, Brewarrina and Wilcannia gauges over the long term.

In addition, in 2022 the NSW Government implemented unprecedented statutory protections to prohibit floodplain harvesting take in the Border Rivers and Gwydir when there is less than 195 GL being stored in Menindee Lakes, until rivers are again running close to their full capacity, ensuring downstream critical needs are considered before water is taken by lower priority licences upstream.

Figure 31. Improvements in the number of cease-to-flow events (left) and low flow events (right) (modelled) with and without the 2020 water sharing plan changes in a repeat of the 1895–2020 climate – averaged across Bourke, Brewarrina and Wilcannia gauges



55. More information is available at, www.mdba.gov.au/progress-water-recovery

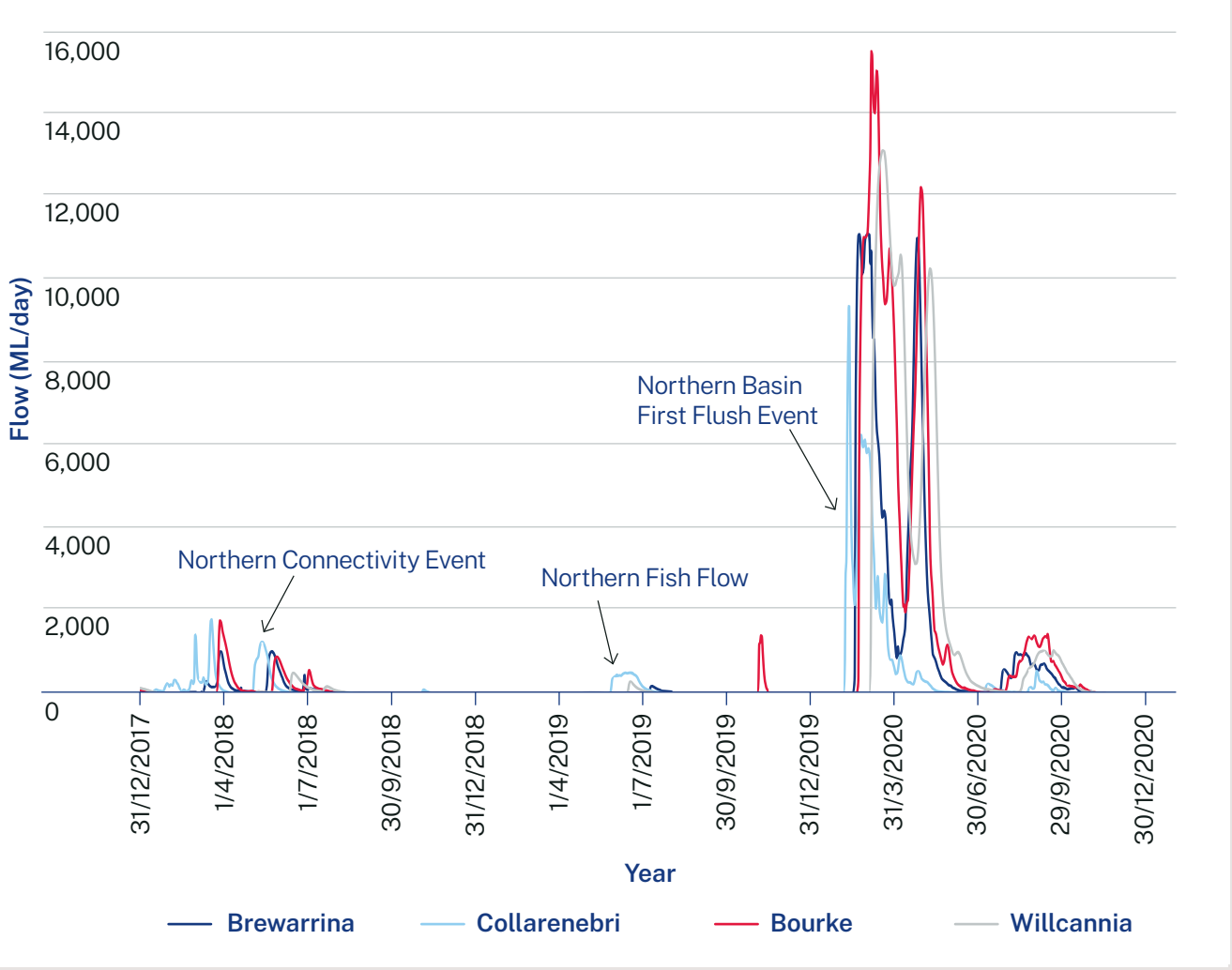
In addition to the 2020 rules, existing rules in water sharing plans support connectivity with varying levels of effectiveness:[56]

- B Class and C Class licence pumping thresholds along the Barwon–Darling
- end-of-system flow rules in the Namoi and Border Rivers catchments, which require a flow to be retained at the end of the river system below the areas of major extraction under various conditions
- rules around sharing supplementary flows in the northern regulated river catchments.

Dams and infrastructure have also been operated in recent years to avoid cease-to-flow periods for as long as possible, prolonging low flows periods by keeping the river running and reducing no flows.

Four managed connectivity events in the Barwon–Darling were delivered between 2018 and 2021 using water held for the environment combined with temporary restrictions on water users in the northern Basin (under section 324 of the *Water Management Act 2000*). These measures were exceptional events, being the only time the rivers connected between 2017 and early 2020, and demonstrating the significant outcomes that can be achieved through event-based management during an extreme drought (Figure 32).

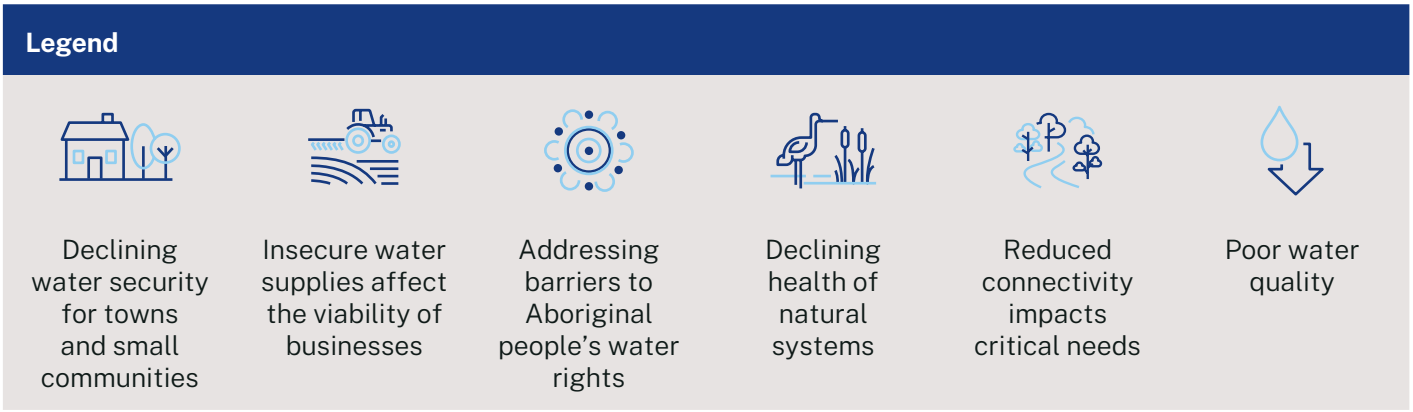
Figure 32. Recent connectivity events in the Barwon–Darling River



The largest of these events was in early 2020 following the first major rainfall and inflows after the 2017–2020 drought. First flush flows were protected by imposing temporary water restrictions across the NSW northern Basin on commercial access, including floodplain harvesting. Protecting the first flush provided significant flows along connected rivers and allowed town weirs and refuge pools to be topped up along the northern river systems, the Barwon–Darling and into Menindee Lakes providing important social, cultural, and ecological outcomes.

56. See Department of Planning and Environment, *Stocktake of northern basin connectivity rules — analysis of implementation and effectiveness.* Available at, www.industry.nsw.gov.au/water/environmental-water-hub/outcomes

Figure 33. Priority 3: Improving connectivity across the northern Basin



Action number	Action name	Challenges addressed
Action 3.1:	Publish critical dry condition triggers and seek to implement them in water sharing plans	
Action 3.2:	Finalise the review of the North-West Flow Plan to identify the best way to support algal suppression and fish migration	
Action 3.3:	Further investigate ways to provide replenishment flows from the northern tributaries during dry periods	
Action 3.4:	Progress investigations into changing the management of Menindee Lakes	

Action 3.1: Publish critical dry condition triggers and seek to implement them in water sharing plans

Protecting the first flow of water after an extended drought and allowing the water to remain within the river is essential supporting drought recovery and supporting critical human and environmental needs. This action will deliver on the main recommendation of the independent panel's review[57] of the first flush by publishing critical dry condition triggers.

Critical dry condition triggers can protect the first flush of water by restricting supplementary, floodplain harvesting, B Class and C Class licences during an extended dry period until there has been enough water flowing across connected systems.

In 2022, the NSW Government amended the Border Rivers and Gwydir water sharing plans to prohibit floodplain harvesting take in the Border Rivers and Gwydir valleys when there is less than 195 GL being stored in Menindee Lakes, until rivers are again running close to their full capacity. This ensures downstream critical needs are considered before water is taken by lower priority licences upstream.

What we heard

The Draft Western Regional Water Strategy proposed restricting lower priority licences when the total storage of Menindee Lakes was below 195 GL. During public consultation we heard:

- support for triggers that are effective at achieving their objectives
- the Menindee Lakes trigger should be higher than the 195 GL total storage trigger proposed in the draft strategy, and not include inactive storage, citing that a total 195 GL trigger would not adequately provide 12 months of critical needs in the Lower Darling
- some stakeholders suggested that the trigger should be 450–480 GL excluding inactive storage to provide sufficient flows to the Lower Darling for 12 to 18 months
- there was general support for rules based triggers rather than relying on temporary water restrictions that are subject to Ministerial discretion and do not give businesses and the community certainty.

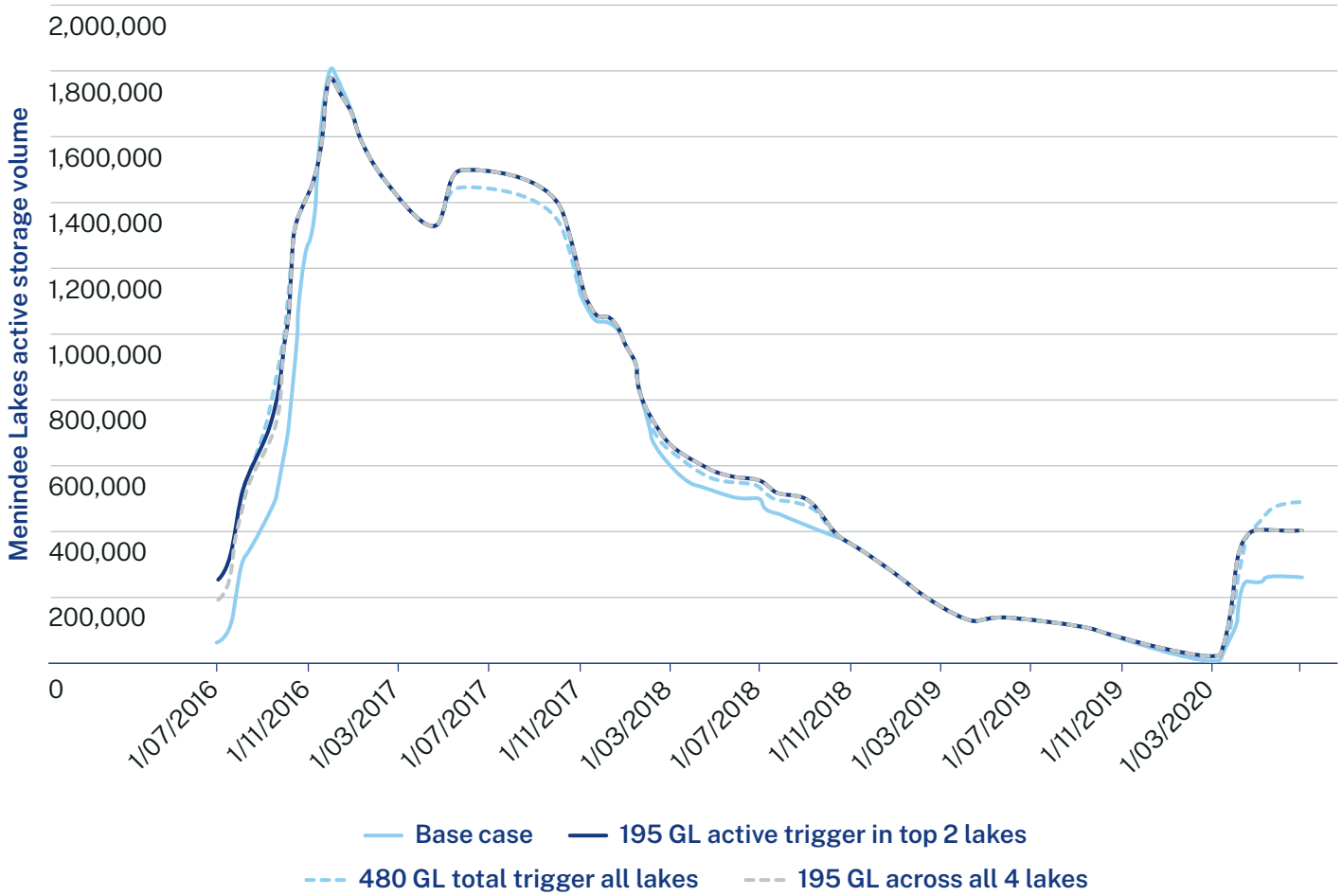
As a result of the comments received during the draft strategy consultation, 2 new targets were analysed; a 195 GL storage target in the top lakes excluding inactive storage and a 480 GL target. The results of this analysis are in Attachment 3.

Our analysis found that the main benefit of restricting upstream access when Menindee Lakes are at low levels and other critical dry condition triggers have been met is to accelerate drought recovery. Placing restrictions on supplementary, floodplain harvesting, B Class and C Class licences during droughts is unlikely to help improve connectivity during extreme dry periods and prevent Menindee Lakes or weir pools from depleting.

This is because during dry periods, when it is dry in downstream catchments, it is often also dry in upstream catchments and there no flows that can be protected. Large flows are needed for supplementary, floodplain harvesting or B Class and C Class licences water take. A trigger would not have stopped or slowed the depletion of Menindee Lakes in the 2017–2020 drought (see Figure 34 and Attachment 3 for further detail).

57. Independent Panel Assessment of the Management of the 2020 Northern Basin First Flush Event and the NSW Government response to this review is available at, www.industry.nsw.gov.au/water/allocations-availability/northern-basin-first-flush-assessment

Figure 34. Modelled Menindee Lakes storage volume during the 2017–2020 drought with and without 195 GL all lakes, 195 GL (active) and 480 GL triggers



The critical dry conditions triggers would however play an important role in accelerating drought recovery for the Menindee Lakes, weir pools and the river systems. This will become increasingly important to support the resilience of the region if a drier climate results in more frequent droughts.

Applying this action will restrict water being taken by supplementary, floodplain harvesting, B Class and C Class licences when:

- there is approximately 12 months of water remaining for critical human and environmental needs in the Lower Darling. This will depend on where the water is located and whether infrastructure changes have been made to the lakes. The trigger will be imposed when there is:
  - approximately 250 GL of active water with current infrastructure. The current inlet regulator in Pamamaroo is in need of repair and requires additional water to be held in the Lakes until the inlet regulator has been repaired, 250 GL may be required to provide 12 months of critical needs in the Lower Darling. Upgrading the inlet regulator will commence once water levels in the lakes drop to manageable levels
  - 195 GL or less of active water the upper lakes of the Menindee Lakes storage (primarily Wetherell and Tandure lakes)[58] to provide approximately 12 months of water for critical needs in the Lower Darling.
- extended cease-to-flow periods are forecast in the Barwon–Darling, Border Rivers, Gwydir, Namoi and Macquarie catchments.

Restrictions will be lifted when there is enough water to restart the Lower Darling. Table 7 sets out these triggers in more detail.

58. Active water refers to the volume of water in the Menindee Lakes that can be accessed using gravity alone. Note that the Murray–Darling Basin Authority uses alternative active storage figures that assume that most of the water in the lakes (aside from 36 GL) can be accessed using pumps.

Table 7. Proposed critical dry conditions triggers

Proposed trigger for implementing temporary water restriction	Proposed trigger for lifting temporary water restriction
Wilcannia When there is a high confidence forecast cease-to-flow period of 120 days at Wilcannia (20 ML/day at Darling River at Wilcannia 425008).	Forecast 400 ML/day for 10 days (or 4,000 ML) at Wilcannia.
Bourke When there is a high confidence forecast cease-to-flow for 60 days at Bourke (0 ML/day at Darling River at Bourke 425003).	Forecast 972 ML/day for 10 days (or 9,720 ML) at Bourke.
Menindee Lakes When the active storage in the upper lakes of the Menindee Lakes storage (primarily Wetherell and Tandure lakes) is forecast to fall below 195 GL capacity. Once this trigger is reached there would be no releases beyond the minimum flow requirements from Wetherell, Pamamaroo and Tandure lakes. Note: If the Pamamaroo inlet regulator has not been upgraded then the trigger would be 250 GL active storage in Wetherell, Pamamaroo and Tandure lakes to provide 12 months supply to the Lower Darling River.	If the active storage in the upper Menindee lakes storage is less than 195 GL and the Lower Darling has ceased to flow then restrictions would be lifted when the lakes are forecast to have enough water to restart the river. This is likely to be approximately 255 GL: 195 GL (active) + 60 GL to restart the river. If the Lower Darling has not ceased to flow then the restrictions can be lifted earlier (when there is 195–255 GL of water in Menindee Lakes). Restrictions can be lifted upstream once the peak of the flow has passed as long as the Menindee Lakes are forecast to have the required volume. If the upper Menindee Lakes active storage is greater than 195 GL but the critical dry conditions triggers (defined above) have been reached at other locations, then restrictions will be lifted once the lifting triggers at each location are reached.
Northern valleys All or most of the northern valleys and/or Barwon–Darling River system are classified as Drought Stage 4 criticality under the Department of Planning and Environment's NSW Extreme Events Policy. And/or Cease-to-flow for 30 days or more extended periods for any of the following locations: • Border Rivers – Macintyre at Goondiwindi (416201A) • Gwydir River – Mehi at Moree (418002) • Macquarie – below Warren Weir (421004) • Namoi – below Mollee Weir (419039).	Resumption of flow targets for the northern tributaries such as: • Border Rivers – Macintyre at Goondiwindi – 3,600 ML over 7 days • Gwydir River – Mehi at Moree – 3,600 ML over 7 days • Macquarie – below Warren Weir – 21,000 ML over 7 days • Namoi – below Mollee Weir – 8,000 ML over 7 days.

How much water is needed in Menindee Lakes to provide 12 months of water for critical needs?

The regulated storage system of Menindee Lakes includes 4 main interconnected lakes (Figure 35). Not all of the water in Menindee Lakes can be accessed or delivered down the Lower Darling during dry periods. The amount of water needed to have at 12 months of accessible water to deliver for critical human and environmental needs in the Lower Darling depends on infrastructure upgrades and where the water is stored. For example:

- The Menindee Lakes are operated in a way that water is generally stored in all 4 lakes during periods of high storage volume and mostly in the upper lakes of Wetherell and Pamamaroo during dry periods. As storage levels decline in Lake Cawndilla it separates from Lake Menindee. Approximately 200 GL of water can become isolated when this occurs and cannot be used to support critical human and environmental needs in the Lower Darling.
- The Pamamaroo inlet regulator, located between Pamamaroo and Wetherell lakes, requires upgrading. Currently, the silty soils around the regulator means that water is required on both sides of the regulator to minimise the risk of the structure moving. By upgrading the regulator, more water can be stored in Lake Wetherell reducing the amount of water that is lost to evaporation from Lake Pamamaroo, which is larger and shallower than Lake Wetherell. If the inlet regulator is not repaired, more water would need to be stored in Lake Pamamaroo, meaning the trigger would need to be set at 250 GL active storage to provide 12 months of water for the Lower Darling. A key action in the Western Regional Water Strategy Implementation Plan is to upgrade the Pamamaroo Inlet Regulator. WaterNSW has funding to undertake this work and will commence the work once water levels in the lakes drop to manageable levels.
- Approximately 195 GL of accessible water in the upper lakes could help to provide approximately 12 months of water for critical needs in the Lower Darling. NSW inactive storage figures for the Menindee Lakes are included in Table 8 below. These figures do not take into account the volume of water that can be removed by pumps as this is an additional operational action that may or may not occur depending on the environmental conditions. If pumps are used then the inactive storage levels can be much lower than those shown in Table 8.
- Operational experience of the Menindee Lakes has shown that siltation can change the inactive volumes over time – particularly after large and prolonged floods such as the 2022 events. A routine bathymetric survey program, or other method with equivalent outcomes, as part of the ongoing operations and maintenance program for Menindee Lakes can help manage this.

Table 8. NSW inaccessible storage figures for the Menindee Lakes

Lake	Inactive storage (ML)
Tandure	6,188
Wetherell	490
Pamamaroo	31,710
Copi Hollow	0
Menindee	51,440
Cawndilla	8,950

Figure 35. Configuration of Menindee Lakes System

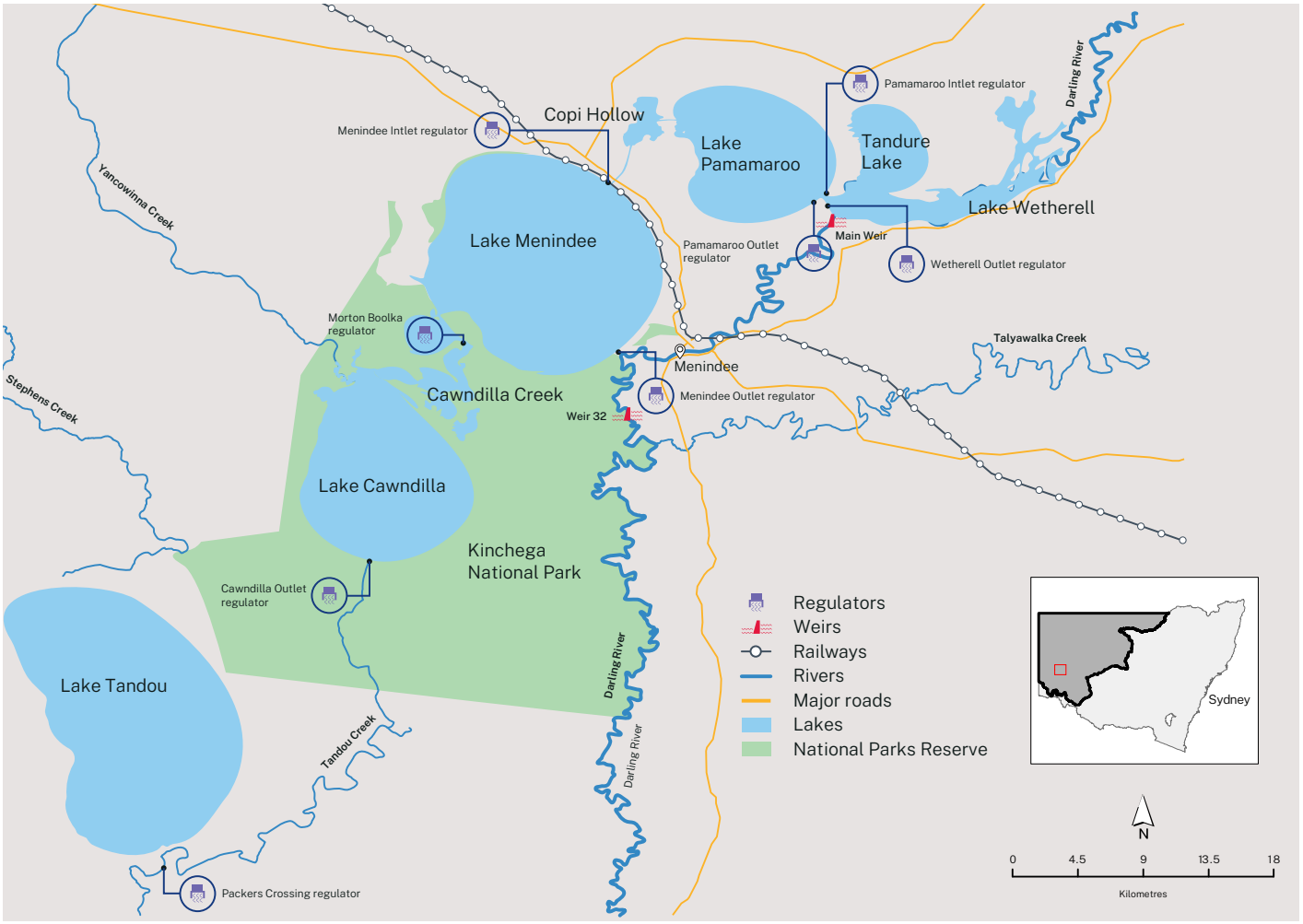


Image courtesy of Carla Frankel. Menindee Lakes system, NSW.

These triggers are proposed to be applied together to achieve the intended outcomes. This includes protections for access to water for towns, domestic and stock, and basic landholder rights, and preventing deterioration in refuge pool conditions to reduce the risk of unacceptable damage to environmental assets. These triggers will be supported by additional actions to:

- **Seek to implement the triggers through water sharing plan rules** as part of the remake of the Barwon–Darling Water Sharing Plan in 2024[59] and the northern tributary water sharing plans, to provide certainty and clarity for all communities.
- **Review potential offsetting actions to allow water users to take water during non-critical times** to make up for the water not taken during the first flush. Without any offsetting actions, the Menindee 195 GL active trigger is likely to result in a 24 GL/year average reduction in diversions across the northern Basin over the long-term, which is expected to result in $175 million economic impact over a 40-year period.
- Work with licence holders in the Lower Darling to **reduce risk of large water orders drawing the lakes down to critical levels –** this may need to be progressed through the Extreme Events Policy.
- **Progress actions to allow for more 'accessible water' to be stored in Menindee Lakes including:**
  - repairing Pamamaroo inlet regulator. Until this work is complete, 250 GL may be required to provide 12 months of critical needs in the Lower Darling
  - changes to Menindee Lakes management to recognise operational water released down the Darling Anabranch, which requires agreement with the Murray–Darling Basin Authority and basin states. This will help prioritise releases of water from less efficient lakes and allow for more accessible water to remain in Menindee Lakes when the lakes return to NSW control. Combining an active 195 GL trigger with releasing operational water down the Darling Anabranch could reduce the time Menindee Lakes are below critical levels
  - investigating efficiency changes to the Menindee Lakes to reduce inactive storage
  - developing other ways to identify critical thresholds including active monitoring of refuge pools once flows have ceased. If viable, locations other than Bourke and Wilcannia could be identified where critical conditions will be monitored to inform future management options.

For critical human needs we have considered the water needs for towns, domestic and stock and basic landholder rights. For critical dry environment needs we have looked at the thresholds at which a deterioration in refuge pool conditions leads to an increased risk of unacceptable damage to environmental assets. These thresholds are the points when timely intervention may prevent damage altogether.

It is not proposed to implement a 480 GL trigger at the Menindee Lakes. While this scenario may provide benefits to mean and median storage volumes a 480 GL trigger goes beyond the critical needs objective as this trigger sets aside more water than is required to meet 12 months supply in the Lower Darling River and does not provide significant additional benefits during critical dry periods. For example, restricting upstream access when Menindee Lakes were below 480 GL during the 2017–2020 drought would not have slowed the depletion of the Lakes. However, it would have helped deliver more water into Menindee Lakes faster during the first flush.

Lower Darling general security allocations are often announced when the lakes are around 300 GL so restricting upstream users to bring forward access to general security allocations for downstream users is not considered to be equitable. Attachment 3 includes further analysis and detail on the rationale behind the triggers. Additional consultation on the triggers will occur as part of any water sharing plan changes.

59. Note that amendments have been made to the Water Sharing Plan for the Barwon–Darling Unregulated River Water Source 2012 to apply existing 'resumption of flow' rules to floodplain harvesting access licences and to restrict floodplain harvesting access when there is less than 195 GL being stored in Menindee Lakes. The amendments proposed to the water sharing plan in the Western Regional Water Strategy will update the existing provisions.

Action 3.2: Finalise the review of the North-West Flow Plan to identify the best way to support algal suppression and fish migration

The ability for communities, ecosystems and industries to make use of water is closely linked to the quality of that water. We have heard from a range of stakeholders that improving water quality is just as important as making sure there is water in the river. Improving water quality and suppressing algal blooms continues to be an important objective for connectivity actions.

In addition, the Barwon–Darling and Lower Darling rivers are significant movement corridors for fish and the main ecological corridor connecting the northern Murray–Darling Basin to the southern Basin. Successful fish spawning and dispersal in the Barwon–Darling results in benefits to fish communities across the basin. Supporting fish migration continues to be a long-term objective.

This action will finalise a review on the best way to support algal suppression and fish migration, and confirm if restricting supplementary licences, B Class and C Class licences at important times should be progressed to suppress algal blooms and support fish migration.

The review will inform the remake of the Barwon–Darling Water Sharing Plan in 2024 and be informed by independent advice from an expert panel, additional technical analysis and stakeholder feedback.

Currently, access to water under supplementary licences is limited to times defined by water sharing plan rules. Some of these rules aim to restrict supplementary licence take in upstream valleys when specific downstream targets have not been met to support critical human needs, improve water quality and support fish passage. These rules were based on the North-West Flow Plan and have been in water sharing plan rules since 2004. However, they have not been implemented due to challenges in forecasting flows and operationally implementing the triggers.

The Department of Planning and Environment's analysis to date has found that restrictions on water access for supplementary and Barwon–Darling B Class and C Class licences which are modelled assuming perfect hindsight are:

- unlikely to reduce extended cease-to-flow periods because flows sufficient to provide supplementary access do not usually occur during cease-to-flow periods
- likely to increase the number of times when there are flows downstream to help suppress algal blooms at Wilcannia – with approximately 9 additional years over a 125-year period with at least one algal suppression event at Wilcannia
- unlikely to help improve the times there are sufficient flows to support fish migration, because the restrictions have only a minor effect and natural rain and inflow events are needed to create the larger flows needed for fish migration
- unlikely to significantly increase end of system flows in the northern valleys – a less than 1% increase in end of system flows in the northern tributaries over the long-term
- producing mixed results when using held environmental water versus restrictions on productive licences. Held environmental water licences could be better at meeting lower flow targets but is limited by its volume.

Our ability to forecast flows remains a significant impediment to implementing the algal suppression targets. Significant work will be required to develop flow forecasting alternatives such as a rules-based approach with simple, blunt triggers that provide direction about when to restrict water users upstream and allow flows downstream; or a decision support system to guide operational decision-making about when to restrict water users to meet the proposed targets.

Further detail on the analysis can be found in Attachment 4 of the Final Western Regional Water Strategy.

This action will:

- investigate opportunities to progress actions to support algal suppression flows (Table 9)
- investigate opportunities to remove physical barriers to improve fish migration (Table 9)
- seek advice from an expert panel on the full spectrum of options to improve fish migration in light of the modelling undertaken to date. This could include:
  - whether to remove the fish migration targets from water sharing plans and rely on lower flows and infrastructure changes to remediate fish barriers
  - update and implement new targets, including by investigating ways to have fish targets in the northern tributaries rather than the Barwon–Darling.

Any action will need to be supported by:

- options to offset any impacts on licence holders and allow water to be taken at non-critical times
- collaborative arrangements with environmental water holders to deliver on algal suppression and fish migration actions through watering strategies
- working with the Murray–Darling Basin Authority to recognise any connectivity amendments in the review of the Murray–Darling Basin Plan scheduled for 2026
- development of a rules-based approach or a decision support system to guide operational decision-making as an alternative to flow forecasting.

What we heard

Some stakeholders opposed the proposed target of 195 GL in Menindee Lakes as a replacement for the riparian targets in the existing Interim North-West Flow Plan. These stakeholders suggested that the flow rates in each reach of the river must be considered for the benefit of both basic landholder rights and the environment. There was also a number of comments indicating that the North-West Flow Plan targets must meet the Environmental Watering Requirements under long-term water plans.

Other stakeholders indicated that preference should be given to held environmental water to be used to achieve North-West Flow Plan outcomes. These stakeholders supported targets that were effective and met their objectives and did not support those restrictions that potentially provided little additional benefit at significant cost to water users. Additionally, these stakeholders indicated that the proposed targets must be accompanied by programs including provision of infrastructure to assist in addressing some of the critical water supply challenges.

On the basis of this feedback and the additional modelling undertaken, the actions to be progressed are summarised in Table 9.

Table 9. Draft options to investigate further as part of the review of the North-West Flow Plan

Objective	Trigger for restrictions
Algal suppression Preserve a flushing flow event in dry years to break up and disperse algal blooms.	Aim to achieve a flow of 3,000 ML/day for 7 days at Wilcannia if flows are below the following triggers during the spring/ summer period: • Walgett – 250 ML/day • Brewarrina – 510 ML/day • Bourke – 450 ML/day • Wilcannia – 350 ML/day.
Fish migration Preserve events needed for fish dispersal, spawning, and migration at appropriate times of the year.	The objectives of the fish migration targets cannot be effectively achieved using either restrictions or general security/ held environmental water. An independent expert panel will review the analysis and make a recommendation about how to proceed with the targets including the full spectrum of options to improve fish migration. This will include considering options from removing the targets and relying on infrastructure changes to fish barriers through to considering fish migration targets in the northern tributaries. Progress with the development of fishways will continue and consider the removal of non-town weirs to assist in improving fish migration.

Note: As indicated in the Draft Western Regional Water Strategy, it is not proposed to maintain the riparian rights targets in the North-West Flow Plan as the original riparian targets are now surpassed by water sharing plan rules. Instead, we will rely on the critical dry conditions targets to meet critical human and environmental needs.

Action 3.3: Further investigate ways to provide replenishment flows from the northern tributaries during dry periods

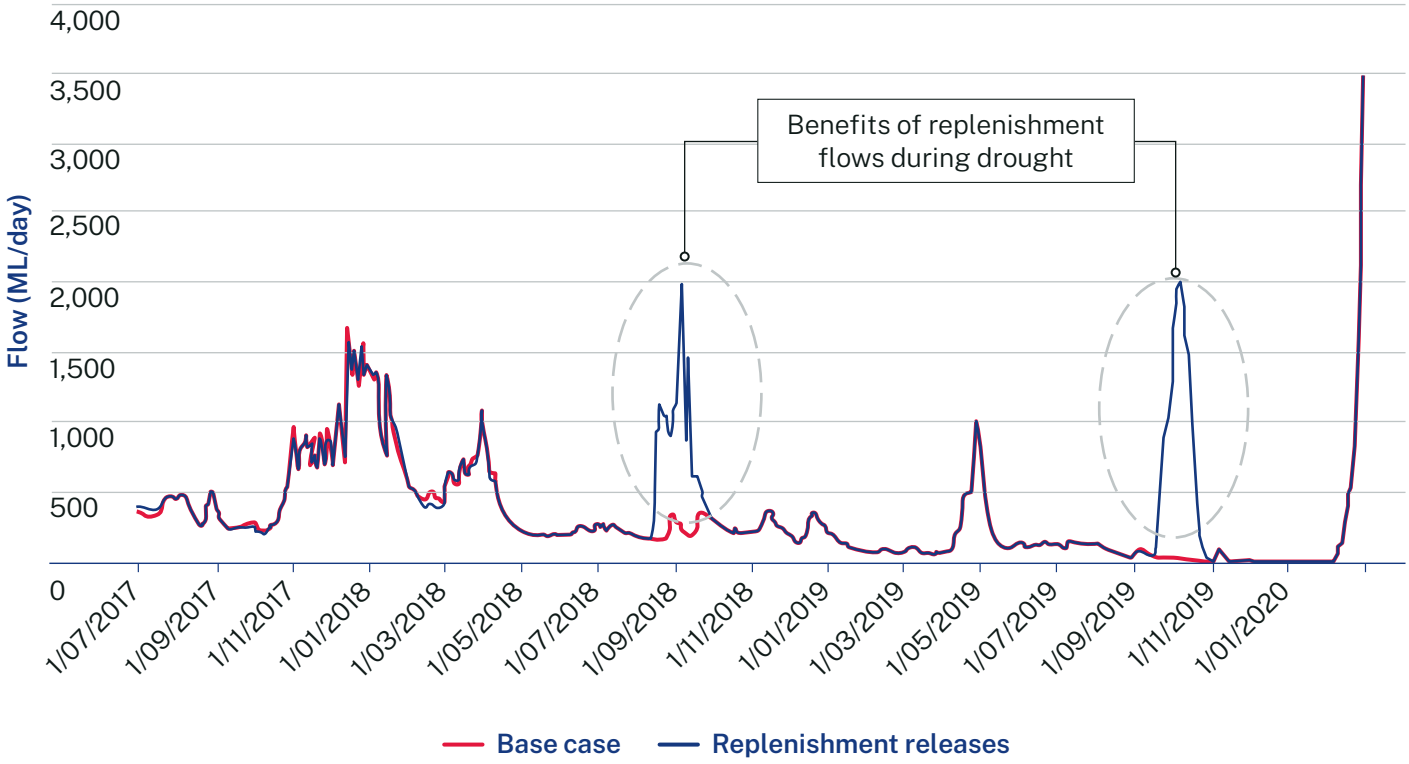
This action seeks to further investigate ways to reduce the impact of cease-to-flow periods across connected systems by delivering water from dams in the northern valleys to help provide flows at critical times in the Barwon–Darling (replenishment flows).

We have heard that extended cease-to-flow periods place significant social, mental health and environmental stress on communities across the northern Basin.

The premise of replenishment flows is to provide water from storages in the tributaries to break up extended cease-to-flow and low flows in the Barwon–Darling. Initial analysis suggests that replenishment flows can be an effective way to help reduce the impact of extended low-flow and cease-to-flow events and improve end-of-system flows during dry periods in the northern valleys.

Figure 36 shows that delivering replenishment flows at strategic times could have been used to provide much needed flows to break up an extended cease-to-flow period at Bourke during the 2017–2020 drought. However, the use of replenishment flows would need to be carefully considered as there were times during the last drought when replenishment flows did not significantly change the flows in the river.

Figure 36. Modelled flows at Bourke with and without replenishment flows during the 2017–2020 drought



Note: This analysis aimed to provide replenishment flows whenever the resumption of flow rule in the Barwon–Darling was triggered at Bourke. The modelling target was at least a week of flows at Bourke with peak flows above 972 ML/day (for up to 10 days) and at least 30 GL total event volume (as per the Resumption of Flow rule).

Replenishment flows could be used to provide flows to top up town water supplies, provide stock and domestic access and provide or top-up drought refuges for fish and other animals during extended droughts. Similar connectivity events were undertaken by environmental water holders in the 2017–2020 drought and resulted in being the only flows in the Barwon–Darling during this time.

There are a number of different ways that replenishment flows could be delivered including by using held environmental water, temporary purchase or trade of licences at certain times for critical needs, or by setting aside more water in upstream dams for connectivity purposes. Each implementation option has benefits, impacts and costs and will need to be thoroughly investigated.

Progressing this action will require significant analysis and consultation with the community and various levels of governments.

Action 3.4: Progress investigations into changing the management of Menindee Lakes

The Menindee Lakes storage is owned and operated by NSW in accordance with the Murray–Darling Basin Agreement. This agreement allows the Murray–Darling Basin Authority to use the water held within the lakes to be shared between NSW, Victoria and South Australia as part of the River Murray System when the volume is above 640 GL, until it next falls below 480 GL. Once the volume of water in Menindee Lakes falls below 480 GL, the remaining water is used and controlled by NSW alone.

Delivering operational water from down the Great Darling Anabranch from Lake Cawndilla

The location of water within the Menindee Lakes when they return to NSW control has a significant impact on the ability of NSW to access water for critical human and environmental needs. The Menindee Lakes is made up of 4 lakes and when the lakes fall to low levels, some of the water is considered 'inactive storage'[60] and cannot be accessed for release downstream.

For example, as storage levels decline in the lakes, Lake Cawndilla separates from Lake Menindee (when Lake Cawndilla holds approximately 200 GL). Some, or all, of the remaining water may be lost to evaporation depending on whether there are any releases from the lake.

This action will seek to formalise arrangements to deliver operational water from Lake Cawndilla to the Murray River via the Great Darling Anabranch. This would likely occur when storage levels in the lower lakes are dropping and the Menindee Lakes storage are forecast to return to NSW control.

This action could also deliver environmental benefits by providing an avenue for fish to move out of the drying Lake Cawndilla and subsequently enhance fish populations across the southern Basin. For example, the 2017 environmental flow to the Great Darling Anabranch provided the only dispersal opportunity for juvenile golden perch to move from the nursery habitat of Lake Cawndilla to the Murray River via the Great Darling Anabranch, providing a recruitment opportunity for the receiving Murray River and southern Basin-connected populations.

NSW is interested in formalising arrangements that would enable this remaining water to be delivered down the Great Darling Anabranch to the River Murray. While this arrangement may involve considerable losses from seepage and evaporation, up to 100 GL of water could still potentially be available for productive use downstream. Combining this action with actions to restrict lower priority licences upstream when Menindee Lakes is below 195 GL of accessible storage could reduce the time that Menindee Lakes are at critically low levels. For example, it could reduce the time Menindee Lakes (Wetherell, Pamamaroo and Tandure) are below 5% of active storage from 0.7% of the time to 0.5% of the time.

Delivery of environmental and other water orders from Lake Cawndilla via the Great Darling Anabranch has been negotiated in the past as a one-off arrangement without altering NSW or Commonwealth legislation.

This action will seek to change to the management of the Menindee Lakes by recognising releases of operational water from Lake Cawndilla to the Murray River via the Great Darling Anabranch.

Progressing this action will require:

- confirming any potential third party impacts on Victoria and South Australia, as well as on NSW Murray water users. Some water users and jurisdictions may have concerns that these changes impact on their water availability. Our initial analysis suggests the action could result in minor increases in average general security supply in the Lower Darling and NSW Murray rivers, and negligible difference in flows to South Australia (further analysis is available in Attachment 2)
- consultation and negotiation with other basin states and with the environmental water holders
- development of an operating procedure to clarify how releases would be managed in an event
- agreement to the operating procedure by the Murray–Darling Basin Authority, Victoria and South Australia
- funding to repair a regulator at the confluence of the Great Darling Anabranch and the Lower Darling River.

60. Inactive or 'dead' storage is the volume of water in a storage that cannot be accessed under normal operating conditions (for example, the volume of water below a low-level outlet).

Changing the operations of Menindee Lakes

The Menindee Lakes is managed to supply water to the Lower Darling River, the Murray River and ultimately to South Australia. How the lakes are managed is subject to negotiation with the Murray–Darling Basin Authority and other basin states. We have heard from some NSW stakeholders that the operation of Menindee Lakes needs to change to reflect the reduction in inflows to the lakes during droughts, and the potential for a changing climate to result in more frequent periods of low or no inflows into the lakes. In particular, we have heard that inactive storage in Menindee Lakes should be considered when managing water in the lakes. This will ensure a better reserve of water to meet critical needs in the Lower Darling and would increase the time that Menindee Lakes are in NSW control.

However, some water users and jurisdictions have concerns that changes to the operating arrangements of Menindee Lakes will impact on water users in the NSW Murray River as well as in Victoria and South Australia. Our analysis suggests that while there may be some years where water availability downstream might change, on average there are negligible changes to water allocations for NSW Murray licence holders or flows into South Australia (see Attachment 2 for further detail).

In the long term, this action could involve looking at ways to recognise inactive storage in the Menindee Lakes to provide more water for critical human and environmental needs as part of the review of the Murray–Darling Basin Plan in 2026. There may be additional options identified around changing the management of Menindee Lakes in a way that has community support. Any changes to recognising inactive storage in the lakes needs to be negotiated with Basin jurisdictions and will require an amendment of the Murray–Darling Basin Agreement.

Image courtesy of Destination NSW. Menindee Lakes, NSW.

Implementing the strategy

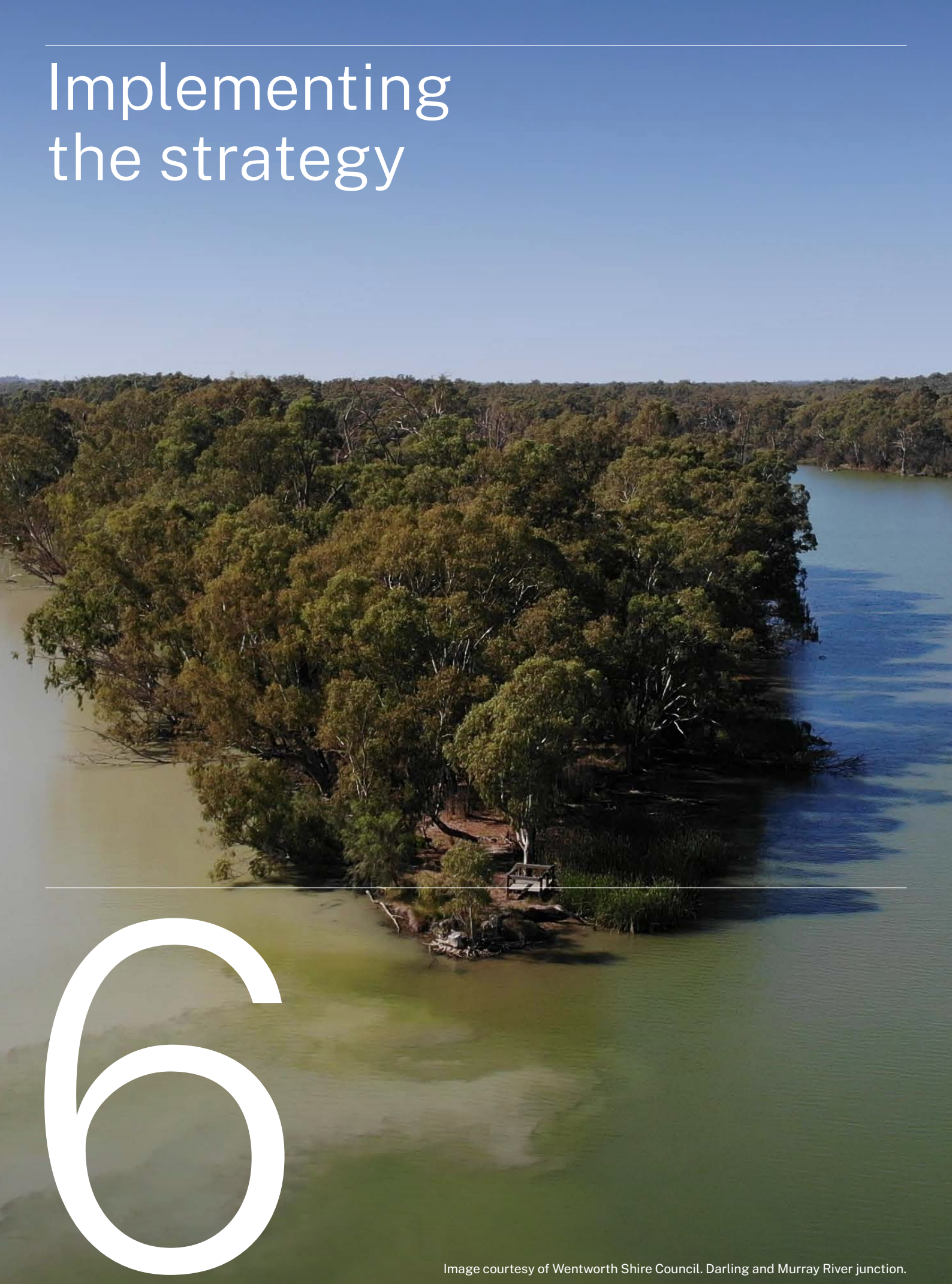


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Image courtesy of Wentworth Shire Council. Darling and Murray River junction.

Timing of the implementation

The strategy has a separate implementation plan that prioritises the delivery of actions throughout the life of the strategy. The implementation plan also outlines responsibilities and timeframes for delivery, so that we can monitor the progress of the actions, assess the effectiveness of the strategy, and identify areas where we need to adapt.

Further work is required on analysing how the shortlisted actions perform against the paleo-informed and climate change adjusted datasets. This will be the first stage of the implementation of the strategy and will inform how the actions will be implemented.

A critical feature of developing the Western Regional Water Strategy has been deciding which actions and investments are needed now, and which ones will be needed further into the future. The strategy has a 40-year timeframe and will be progressively implemented between now and 2060. The timing of various actions is aimed at meeting existing challenges, identifying and preparing for foreseeable challenges, and laying the groundwork for adapting to future uncertainties and changed circumstances.

The water security actions in this strategy have a strong focus on drought security following the experience of the 2017–2020 drought. However, this drought has been closely followed by major flood events from 2020–2023.

Some of the proposed actions may have the capability to mitigate low to moderate flooding events. Analysing the flood benefits of many of the proposed actions in this strategy will require enhanced investment by governments in flood modelling and mitigation works.

Progressing the shortlisted actions from the strategy to on-ground implementation can be supported by more detailed assessment of the flood mitigation benefits of some of the water security actions presented in this strategy and whole of government input.

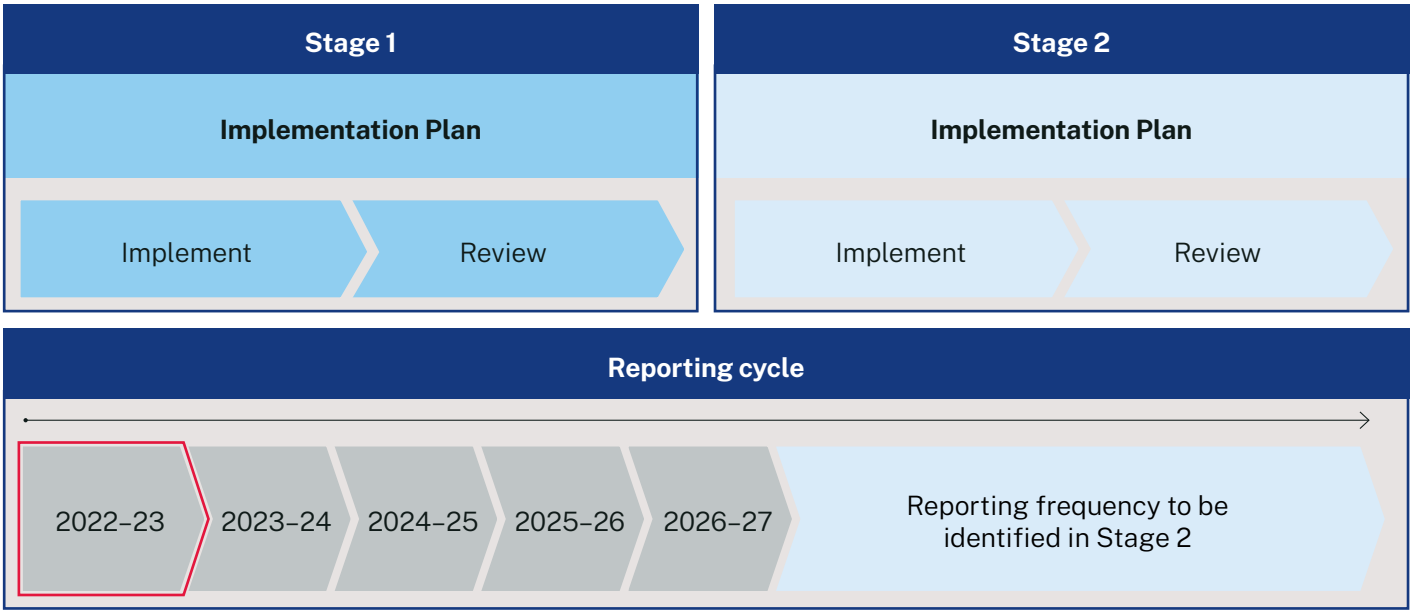
The floodplain management plans being developed for northern NSW valleys are the cornerstone for whole of catchment floodplain management in western NSW and will be extended into the southern NSW valleys over the coming years. Local councils, the Office of Local Government and the Department of Planning and Environment – Environment and Heritage also lead flood risk management for towns and regional centres across the state.

Not all actions will be commenced at once, and funding 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 seeking funding as future opportunities arise. The Western Regional Water Strategy has a separate implementation plan that prioritises the delivery of actions over the life of the strategy. The implementation plan also outlines responsibilities and timeframes for delivery, so that we can monitor the progress of the actions, assess the effectiveness of the strategy and identify areas where we need to adapt.

The implementation plan sets out priorities over the next 3 years and is located at www.dpie.nsw.gov.au/western-regional-water-strategy

We will report every year against actions in the implementation plan (Figure 37), so that the community can track our progress and we can demonstrate which actions have been delivered, or continue to be delivered, in that year.

Figure 37. Western Regional Water Strategy implementation timeline

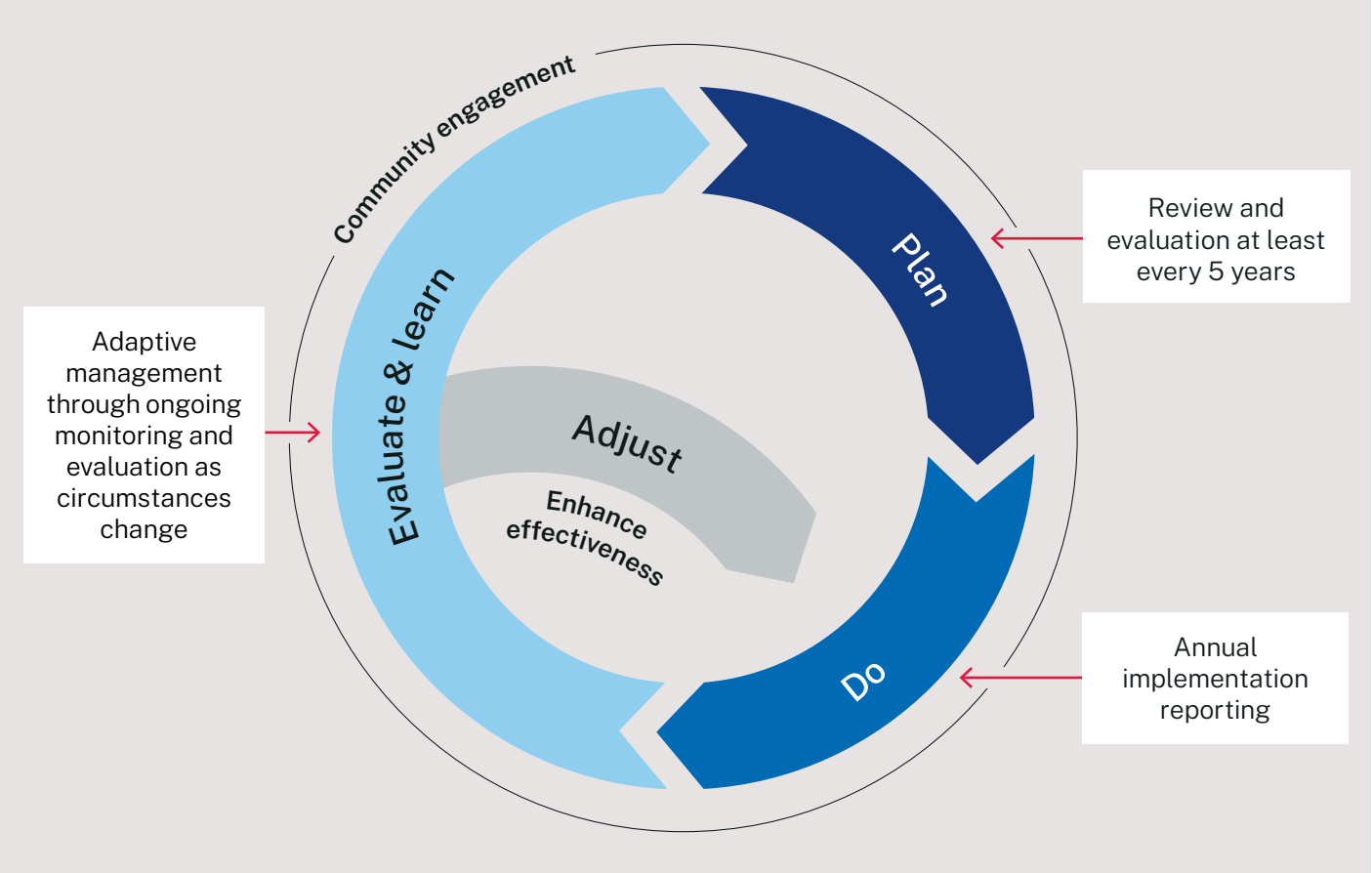


Ongoing monitoring, adaptation, and reporting

The Western Regional Water Strategy is designed to respond to changing circumstances (Figure 38). We will undertake a formal review of the strategy at least every 5 years, or in response to changing circumstances. The formal review will ensure that the key assumptions, such as population and demographics, have not significantly changed.

Amendments may be made in response to key changes in water demand, social preferences, climate, science and technology, economic conditions, or other events. These amendments may result in a shift in priorities, and the implementation plan will be updated to reflect this.

Figure 38. Regional water strategy process



Attachments to the strategy

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Image courtesy of Destination NSW. Menindee Lakes, Menindee.

Attachment 1: Summary of the options assessment

Attachment 2: Assessment of modelled options

Attachment 3: Additional analysis on the Menindee trigger options

Attachment 4: Analysis of restricting upstream licences to meet algal suppression and fish migration targets in the Barwon–Darling River

Attachment 5: Analysis on replenishments flows

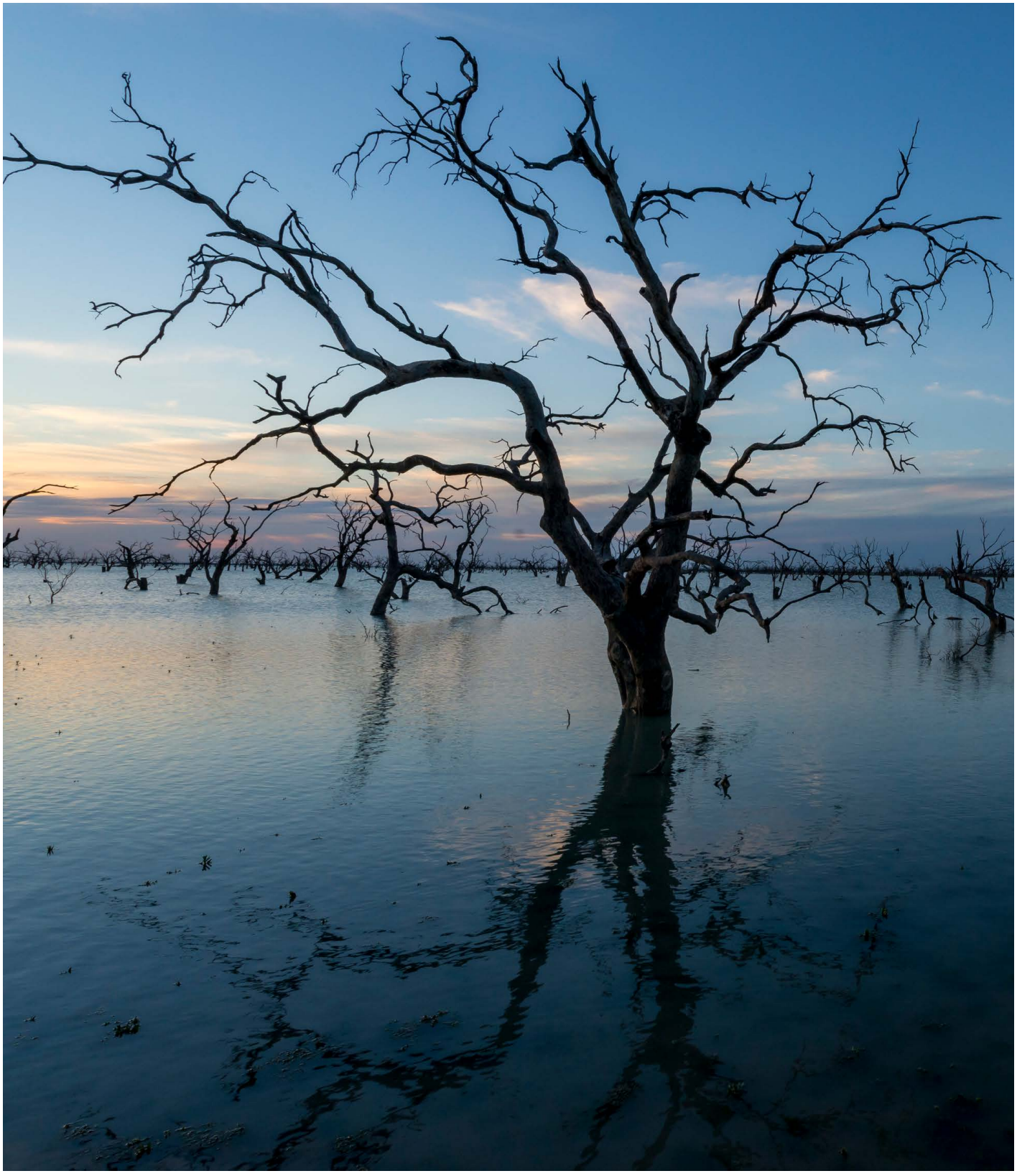

Image courtesy of John Spencer, Department of Planning and Environment. Lake Pamamaroo, Menindee Lakes.

Department of Planning and Environment