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Stocktake and options for improving connectivity in the northern Murray-Darling Basin

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Executive Summary

This report presents a stocktake and analysis of completed, current and proposed activities and initiatives which focus on improving longitudinal surface water connectivity across the northern Murray-Darling Basin (the northern Basin) 'to and through' Menindee Lakes.

Longitudinal connectivity along and between river reaches is critical for maintaining healthy ecosystems and supports a wide range of social, cultural and economic values.

There is evidence of significant changes to streamflow volumes, durations and frequencies in the northern Basin compared to pre-development levels.[1] This includes significant reductions in tributary inflows and an increase in cease-to-flow events and low flow conditions. The impacts of changes in the northern Basin also have significant consequences for the Lower Darling.

There is also evidence that, despite substantial actions to improve longitudinal connectivity, reduced connectivity in the northern Basin is having negative impacts on downstream ecosystems and communities.[2] Reduced flows and connectivity have, amongst other things, contributed to mass fish deaths and further mass fish deaths are considered likely.[3]

A stocktake of activities and initiatives that contribute to improved connectivity in the northern Basin was compiled based on discussions and engagement with federal and state water agencies.

This list of activities and initiatives was then assessed against a framework that set out seven fundamental requirements for achieving connectivity outcomes. Those requirements related to (i) defining objectives for connectivity, (ii) allocating water to support connectivity objectives, (iii) managing flows, (iv) the design of instream infrastructure, (v) water markets, (vi) governance and (vii) communication and engagement, including with First Nations Peoples.

The assessment considered the extent to which past, current and presently proposed initiatives address these requirements. The assessment was limited to consideration of the intended benefit of different activities and initiatives, and did not assess their actual effectiveness (for example, the assessment did not involve field work nor on-ground measurements). The analysis found that:

1. There has been and continues to be a major investment in initiatives that are designed to improve connectivity-outcomes in the northern Basin. This includes:
    a. Core water resources planning and management activities, such as establishing water plans/water sharing plans and management of water access entitlements
    b. Reviews or updates of water resources planning and management arrangements undertaken for the purpose of improving connectivity outcomes
    c. Government-funded programs or projects for directly or indirectly improving connectivity.
2. The scope of these activities demonstrates a collective and concerted commitment by state and commonwealth jurisdictions to maintaining or improving connectivity in the northern Basin. This finding is not based on the effectiveness of past and current initiatives, but rather the extent to which measures have been undertaken or are proposed that address the

[1] NSW Department of Planning and Environment (2022) Regional Water Strategy – Western. Available at: https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0003/548202/western-regional-water-strategy.pdf
[2] Connectivity Expert Panel Final Report, July 2024, available at: https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0003/616737/connectivity-expert-panel-final-report.pdf
[3] Office of the NSW Chief Scientist & Engineer (2023) Independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee, page 1, Finding #13.

fundamental requirements for maintaining or improving connectivity. In essence, the aims and objectives of these activities and initiatives are sound. An assessment of the effectiveness of current and proposed measures in improving connectivity outcomes was beyond the scope of the current report. Such an assessment should be undertaken as a priority to inform future water resources planning activities and investments.

3. Many of the initiatives that support connectivity outcomes are embedded within 'business as usual' management practices, such as through their incorporation within water sharing rules or infrastructure operating arrangements. Other actions, such as changes to infrastructure to remove barriers or improve fish passage, are expected to enhance and lock in ongoing connectivity benefits.

4. A number of critical initiatives remain in a pilot phase. Further action, and potentially investment, will be required to maintain the benefits associated with these initiatives including:
    a. The review of the Menindee Lakes operating rules
    b. The northern to southern Basin environmental flow protection trial
    c. Recommendations from the NSW Independent Expert Connectivity Panel[4] as part of the Northern Basin Connectivity Program
    d. Investments in improving water information and compliance systems, processes and tools initiated through the recently completed Hydrometric Networks and Remote Sensing (Improving Water Information in the Northern Basin) Program
    e. The adoption of event-based mechanisms to enhance outcomes associated with held environmental water management (HEW) such as has been piloted by the Commonwealth Environmental Water Office (CEWO) in the Lower Balonne.

5. There are opportunities to better coordinate and build on existing activities and efforts by:
    a. Improving the way connectivity objectives are defined and reported. This includes establishing regional and inter-catchment connectivity objectives, to ensure that catchment-level plans and management arrangements consider the need for flows to support environmental and connectivity outcomes in downstream catchments.
    b. Adopting a more strategic approach to coordinating, leveraging, and prioritizing activities across the northern Basin from a connectivity perspective. For example, a strategic planning process could be used to guide future investments in infrastructure modification or removal to improve fish passage in the northern Basin.
    c. Identifying opportunities to share approaches and learnings between catchments and across jurisdictions. There has been a major investment in better understanding approaches and measures for improving environmental water management and connectivity. There are likely to be lessons from these experiences that would benefit others. For example, there may be lessons for Queensland water managers (at least in more developed areas such as the Lower Balonne) arising from the active management of environmental water that is being implemented in northern NSW.

[4] The panel submitted its final report in July 2024. This completed the panel's work. Any response to the panel's recommendations is now a matter for the NSW Government.

6. The hydrology of the northern Basin and nature of water resources development – notably the fact that much of the river system is 'unregulated' by major on-river storages – means that 'event-based management' offers substantial scope for improving connectivity outcomes. This may involve, for example, 'active management' of individual flow events to protect environmental water (as is implemented in the Barwon Darling), 'flow event-management' (which applies in a number of the Queensland catchments) or the 'event-based mechanisms' (which have been piloted by the CEWO in the Lower Balonne). Any increased focus on event-based management is likely to require a range of changes to regulatory instruments, systems and processes, and greater engagement with stakeholders, including First Nations Peoples. The costs associated with these requirements will need to be weighed against the benefits from shifting towards event-based management.

7. A range of opportunities have been identified that relate to each of the fundamental requirements for improved connectivity (Table 1). Investments in further initiatives to improve connectivity should be considered in the context of other issues and related risks to the health of the northern Basin, and the Basin as a whole, to prioritise available resources in a way that achieves the greatest benefit for the Basin and its communities. This should include an assessment of:

    a. Risks associated with reduced connectivity on a catchment-by-catchment basis based on current and potential future climates

    b. The extent to which existing and planned interventions are expected to mitigate these risks

    c. The costs and benefits associated with potential interventions, including socio-economic, cultural, and ecological costs and benefits.

8. Further work is required to understand the extent to which past and current initiatives mitigate risks to achieving the desired connectivity outcomes. Regardless, maintaining and improving on the benefits associated with previous actions and investments will require a sustained commitment by governments to continue with implementation, including continuing to implement and strengthen the suite of water resources management plans and tools in place in a way that supports longitudinal connectivity across the northern Basin and into the southern Basin.

Table 1. Summary of opportunities for improving connectivity outcomes in the northern Basin

Requirement	Opportunities and considerations
Objectives are defined	• There are opportunities to improve connectivity outcomes by strengthening or expanding the way objectives related to connectivity are defined. Consideration should be given to: - including greater specificity where objectives simply refer to 'improving connectivity' - including regional or inter-catchment connectivity objectives at the basin and catchment scales, thus considering overall system-wide connectivity - defining connectivity objectives in a way that better aligns with and supports event-based management.
Water is allocated to support connectivity objectives	• Ongoing activities to better protect environmental flows, including those crossing the Queensland/NSW border, to reach and pass through the Menindee Lakes system provide a significant opportunity to improve connectivity outcomes through the northern Basin and into the lower Darling. • The management of First Nations water entitlements may contribute towards connectivity outcomes where objectives align.

Requirement	Opportunities and considerations
	• Consideration should be given to opportunities for focussing further on the measurement and regulation of overland flow/floodplain harvesting water – and the implications for in river flows and connectivity – on an event-by-event (rather than annual) basis.
Flows are managed to achieve connectivity objectives	• There are opportunities to expand approaches to accounting for and protecting HEW. This includes expanding the approach to active management to protect environmental flows that has been successfully applied, in the Barwon-Darling, the Lower Macquarie Bogan and the Gwydir, to other catchments and through Menindee Lakes. • There are also opportunities to expand the use of event-based mechanisms. Initial trials undertaken by the CEWO provide a good basis for expanding approaches to HEW. • Objectives related to planned environmental water management (PEW) are generally limited to the end of catchment. Consideration should be given to how catchment-level objectives and PEW requirements might be expanded to provide and protect PEW to support inter-catchment and system-wide connectivity outcomes. • An increased focus on event-based management will require a more sophisticated approach to managing water abstractions during flow events.
Infrastructure design supports connectivity objectives	• There are opportunities to be more strategic in how activities related to infrastructure and connectivity are prioritised. Consideration should be given to: - Developing a master plan for the basin to prioritise future interventions to remove barriers (e.g. fish ways) and the allocation of funding to maximise connectivity benefits. In the interim, the construction of fishways to maximise fish mobility above the Menindee weir pool has already been identified as a high priority.[5] - Undertaking a strategic assessment of the implications of new infrastructure for connectivity and hence where requirements (including potentially prohibitions) related to new infrastructure might be put in place.
Water markets	• Consideration be given to continuing the pursuit of opportunities for maintaining maximum flexibility in the trading of environmental water, provided it does not adversely impact on other users or uses.
Governance	• Consideration be given to whether objectives are currently defined in a way that allows for outcomes to be assessed against those objectives. • Any increased focus on event-based management will likely need to be supported by strengthened arrangements in gathering of data and intelligence, consultation and decision-making processes, reporting, assessment of actions, adaptive management, accounting, compliance, monitoring, measurement, modelling and forecasting.
Stakeholder engagement and communications (including First Nations)	• Any increased focus on event-based management will require an accompanying increase in effort to engage with stakeholders in planning, and before, during and after flow events. • Consideration be given to assessing the extent to which reporting arrangements are meeting the expectations of stakeholders and providing them with confidence in the effectiveness of existing approaches. • Increased engagement with First Nations is likely to require substantial investment and sustained support / capacity development, and meaningful engagement processes.

[5] Office of the NSW Chief Scientist & Engineer (2023) Independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee

Shortened forms

Short form	Full form
BOC	Basin Officials Committee
CEWO	Commonwealth Environmental Water Office
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Cth)
HEW	Held environmental water management
MDBA	Murray-Darling Basin Authority
Northern Basin	Northern Murray-Darling Basin
NSW	New South Wales
PEW	Planned environmental water management
SDL	Sustainable diversion limit

1 Introduction

1.1 Purpose and scope of works

Badu Advisory has been engaged by the Murray-Darling Basin Authority (MDBA) to:

- Undertake a stocktake of completed, current and proposed activities and initiatives which focus on improving longitudinal surface water connectivity across the northern Murray-Darling Basin (the northern Basin) 'to and through' Menindee Lakes
- Develop a framework to undertake an analysis of the activities identified through the stocktake, to identify synergies, gaps and opportunities for further connectivity improvement, and
- Identify no-regrets actions over the next 1-3 years and provide any value-add to better coordinate ongoing work.

The purpose of this work is to:

- Inform the Basin Officials Committee (BOC) in responding to a request from the Murray-Darling Basin Ministerial Council to develop actions to deliver existing and new commitments to improve connectivity, and
- Inform preparatory work being undertaken to support the 2026 review of the Murray-Darling Basin Plan (Basin Plan), particularly the potential for changes to the regulatory design to support improved connectivity outcomes.

1.2 Methodology

Preparation of this report has involved the following steps:

- Initial briefings with the MDBA and the BOC Alternates representatives.
- Provision by the Commonwealth, Queensland and New South Wales (NSW) government agencies of an initial list and description of connectivity-focussed activities and initiatives in the northern Basin.
- A desktop review of completed, current and proposed activities and initiatives which focus on improving longitudinal connectivity in the northern Basin.
- Development of a draft analytical framework to assess activities and identify potential gaps and opportunities.
- Presentations of the draft framework and an initial list and description of activities and initiatives to different government stakeholders, including the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW), the Commonwealth Environmental Water Office (CEWO), the MDBA, and NSW and Queensland water agencies.
- Written feedback provided by government stakeholders on the draft framework and stocktake.
- Finalise the framework and stocktake and undertake an analysis of the activities and initiatives against the framework to assess:
    - the extent to which existing activities and initiatives meet the requirements for maintaining or improving connectivity
    - any gaps and opportunities to expand or improve on current endeavours.
- Presentation of the draft findings to the BOC Alternates committee for feedback.
- Finalise the report and recommendations based on feedback.

1.3 Limitations

The preparation of this report has required a rapid, high-level review of a large amount of material. For this and related reasons we note the following limitations of the work:

- The report presents a description of activities and initiatives undertaken to improve connectivity in the northern Basin. The review sets out the scope of those activities and initiatives but does not describe or assess their actual effectiveness in achieving outcomes (for example, the assessment did not involve field work nor on-ground measurements). Rather, the report is limited to describing the intended benefit of different activities and initiatives.
- The review has relied primarily on inputs from relevant government agencies in identifying activities and initiatives and source material to inform the review. There has been no engagement with non-government stakeholders in undertaking the review, including no engagement with First Nations Peoples.
- The review has not involved an assessment of the costs or hydrologic connectivity benefits associated with different intervention options. Costs and benefits, including socio-economic, cultural and ecological, should be considered in detail prior to making a final decision on those future initiatives to be progressed.
- The review has not involved a detailed assessment of each individual activity and initiative considered in the stocktake. For example, there are multiple water plans/water sharing plans that apply across the northern Basin. The review captures the overall role and contribution of these plans in achieving connectivity outcomes and provides examples of specific approaches undertaken by plans to improve connectivity. However, an exhaustive review of each water plan/water sharing plan was out of scope.
- The review has not assessed the risk to achieving Basin Plan outcomes as a result of connectivity issues relative to other risks. As such, it does not consider or comment on the importance of addressing connectivity issues relative to other challenges in the northern Basin, nor the risks to the northern Basin relative to the southern Basin, and how interventions across the Basin should be prioritised.
- For the most part, the stocktake does not capture research programs related to connectivity in the northern Basin.

2 Background

2.1 Connectivity

In the context of water resources management, 'connectivity' is used to refer to:

- **Longitudinal connectivity**, which is when a river is connected along its length, or the river is flowing
- **Lateral connectivity**, which is when a river is connected to the wetlands and floodplains either side of the river, and
- **Vertical connectivity**, which is the connection between groundwater and surface water systems.

This report is focussed on longitudinal connectivity, given that this is a basin-scale issue – in terms of both impacts and responses – whereas lateral and vertical connectivity have a greater local dimension.

Longitudinal connectivity along and between river reaches is critical for maintaining healthy ecosystems and supports a wide range of social, cultural and economic values. Connectivity is important because:

- It allows for the movement of nutrients and sediment throughout the river
- It allows native fish and other organisms to move and disperse
- It contributes to improved water quality
- It supports the communities and industries that rely on rivers for water for drinking, irrigation, and other purposes, and for the social and cultural values that they provide.

Connectivity is important at all times:

- when rivers are flowing, connectivity builds the resilience of the system, providing opportunities for movement, spawning, and recruitment, and improving water quality and productivity in the system
- in wet periods connectivity supports large-scale productivity, replenishing wetlands and flushing rivers to prepare systems for dry conditions
- in extreme droughts connectivity helps to avoid irretrievable damage to species, ecological communities and ecosystems.[6]

It is important to note that, for present purposes, longitudinal connectivity relates to connectivity which occurs as a result of the natural variability in the flow regime that is typical for the watercourses of the northern Basin. It is not about maintaining constant flows along a watercourse which would only serve to further the spread of exotic pest species (such as European carp) and adversely impact native species.

The degree of natural variability in flows – and therefore longitudinal connectivity – differs from catchment to catchment. In some river systems (e.g. the Moonie and the Paroo), longitudinal connectivity only occurs intermittently during very large flood events. For most of the time such river systems remain a series of disconnected waterholes which are important refugia for native species during extended dry periods. In other river systems, longitudinal connectivity may prevail for longer periods but occurs to varying extents depending on climatic conditions. This has important implications for the management of access to water from river systems which is discussed in section 2.3.

[6] NSW Department of Planning and Environment (2022) Regional Water Strategy – Western. Available at: https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0003/548202/western-regional-water-strategy.pdf

2.2 The northern Basin

The northern Basin refers to the northern portion of the Murray-Darling Basin and includes all the catchments that contribute to the Barwon-Darling River upstream of Menindee Lakes. The northern Basin covers approximately 600,000 km^2 and includes catchments in NSW and Queensland (Figure 1). The Barwon-Darling River provides the primary connection between waters from the northern Basin into the southern Basin and the Murray River.

Figure 1. Map of the northern and southern sections of the Murray-Darling Basin. Source: MDBA

The northern Basin has a highly variable climate and much of the region experiences arid, dry conditions with low rainfall, very high evaporation rates and lengthy dry periods. Average annual rainfall ranges from 300 to 800 mm. Rainfall is highly seasonal, with the majority occurring during summer months, driven by tropical weather patterns. This variability leads to periodic droughts and floods, significantly impacting water availability.

The different climate and hydrology experienced by the northern and southern Basins, and particularly the higher natural system water evaporation in the northern Basin, mean that the long-term average outflow from the Darling River at its junction with the Murray River under pre-development conditions is only 2,400 GL/y (18% of inflows) compared with 11,800 GL/y (74% of inflows) from the Murray River. This is despite the northern Basin accounting for more than 50% of the total catchment area of the Murray-Darling Basin. The Darling River contributes, on average, about 13% to the total lower Murray River flow volume under current development conditions. The Darling River contributes more than 25% to the total lower Murray River flow in only 10% of years.[7] Figure 2 shows the relative contribution of different catchments to the total surface water availability in the basin.

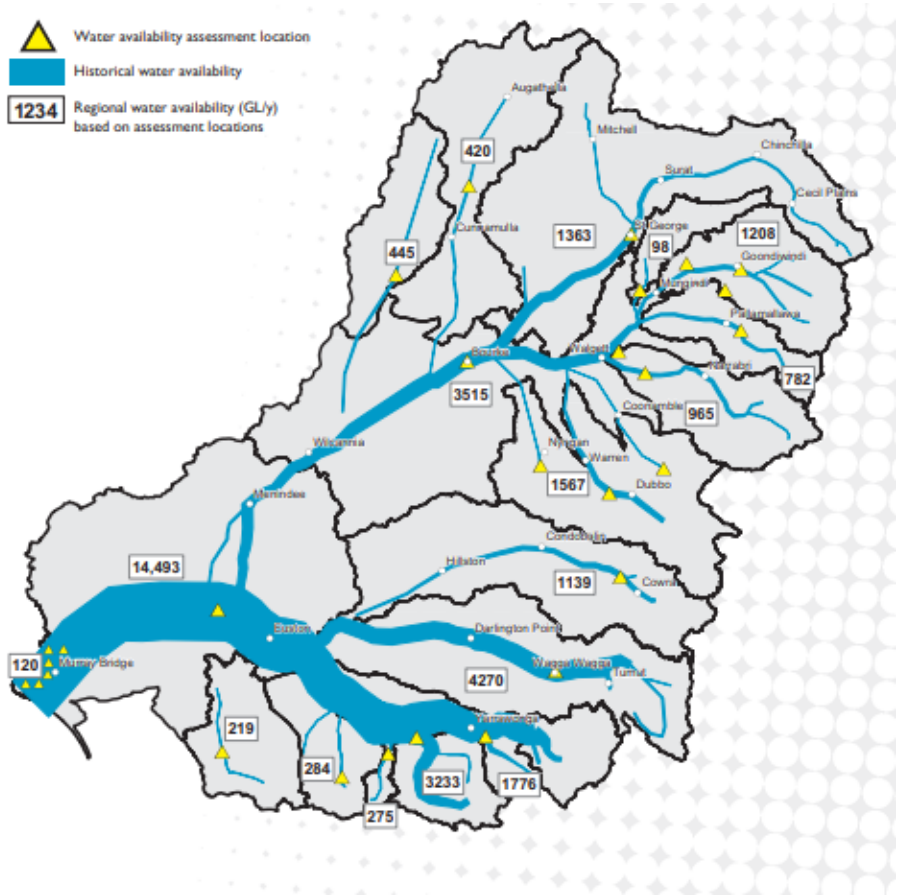

Figure 2. Surface water availability in the Murray-Darling Basin. Source: CSIRO (2008). Water availability in the Murray-Darling Basin. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia. 67pp.

The contrast between the northern and southern Basins is highlighted by the differences between the NSW sections of the basin (Table 2).

[7] Chiew FHS, Weber TR, Aryal SK, Post DA, Vaze J, Zheng H, Peña-Arancibia JL and Robertson DE (2022) Evaluation of causes of reduced flow in the northern Murray–Darling Basin. CSIRO Technical report for the Murray–Darling Basin Authority.

Table 2. Contrast between NSW northern and southern Murray-Darling Basin. Source: NSW Government

	NSW Northern Basin	NSW Southern Basin
System type	Mix regulated & unregulated	Highly regulated
Nature of flows	Highly variable flows	Less variable
Environmental water holdings	391 GL	1,954 GL
Entitlements		
General security	1, 692 GL	4, 261 GL
Supplementary	467 GL	1,451 GL
Unregulated	649 GL	240 GL
Floodplain harvesting	371 GL	Nil
	All Northern Basin	**All Southern Basin**
Total storage	4, 708 GL	16, 296 GL
Contribution Basin flows	35%	65%

Again, due to the climate and hydrology, many of the river systems within the northern Basin contribute, under natural conditions only a relatively small portion of flow to downstream catchments.

For example, again under natural conditions, less than 10% of the inflows in the Paroo and Warrego and less than 30% in the Condamine Balonne and Macquarie-Castlereagh rivers leave their respective catchments, with the rest consumed by the environment or taken up through evaporation or groundwater. The relative, and potential, contribution of different catchments to connectivity and flows in downstream catchments is an important consideration in prioritising the location of, and type of investment, in measures to improve connectivity outcomes.

Even where the volumes are relatively small, connectivity remains critical. For example, 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, with most of these flow contributions occurring during high-flow periods.[8]

The different hydrology and topography of the northern Basin has resulted in water resources development that differs significantly from the southern Basin. Notably:

- There is limited public water storage infrastructure. Public water reservoirs in the northern Basin account for only 20% of the total reservoir storage capacity across the Murray-Darling Basin.

[8] NSW Department of Planning and Environment (2022) Regional Water Strategy – Western.

- Consequently, there is a relatively high portion of 'unregulated' or 'unsupplemented' water access entitlements, that is, water use that relies on the flow of the river, rather than water that has been stored in an instream dam or weir.
- There is a higher reliance on on-farm storages to collect water when it is available.
- A relatively large portion of surface water take is via floodplain harvesting (as it is termed in NSW) or the take of overland flows (as it is termed in Queensland). For example, in NSW floodplain harvesting accounts for 20-25% of total water take in the northern Basin. [9]

2.3 Water resources management and event-based management

Key instruments that support water resources management in the northern Basin include:

- The Basin Plan, which establishes long-term limits on the average annual volume of water that can be taken from different catchments ('sustainable diversion limits' or SDLs)
- Water sharing plans (NSW) or water plans (Queensland), which define catchment-level outcomes/objectives for the management of water resources, put in place measures to ensure that the SDLs are not exceeded, establish access rules, and are generally the primary instrument controlling the take of water, and
- Water access licences (NSW) or water entitlements (Queensland), which regulate the amount of water that can be abstracted by water users under different conditions and are subject to the requirements set by water sharing plans/water plans.

Managing water entitlement/licence holders' access to water within river systems during natural flow events is an important tool in achieving longitudinal connectivity in the watercourses of the northern Basin. Such 'event-based management' has been implemented in northern NSW and south-west Queensland catchments in the northern Basin in a range of different forms including:

- 'active management' of individual flow events (as implemented in the Barwon Darling for example) – this may involve restricting the take of water (e.g. by applying raised flow thresholds and/or implementing individual daily extraction components) during each flow event to protect 'active environmental water' and restore connectivity within and between water sources following an extended dry period, and/or reserving a portion of flows to maintain longitudinal connectivity within and between the water source and other connected water sources
- 'flow event-management' (as implemented within and downstream of the St George Water Supply Scheme for example) – this involves the release of water that has been temporarily stored in Beardmore Dam, to keep water in the distributary channels and achieve channel wetting and waterhole filling outcomes in advance of, or during, a natural flow event[10]
- 'event-based mechanisms' (as trialled in the Lower Balonne for example) – this may involve the use of instream and on-farm infrastructure to store and release water combined with the temporary purchase of entitlements to take water to alter the timing or rate of flows, direct flows to a different watercourse or off-stream ecological assets, and/or enhance overall flows[11].

2.4 Changes to climate, flow and connectivity in the northern Basin

There is a declining rainfall trend across the Murray-Darling Basin from 1940 onwards. Further, the temperature in the basin has risen by about 1.4°C over the past 100 years, resulting in increases in

[9] Chiew FHS, Weber TR, Aryal SK, Post DA, Vaze J, Zheng H, Peña-Arancibia JL and Robertson DE (2022) Evaluation of causes of reduced flow in the northern Murray–Darling Basin. CSIRO Technical report for the Murray–Darling Basin Authority.

[10] Lower Balonne Water Management Area: March to April 2021 flow event report, Department of Regional Development, Manufacturing and Water, 2021

[11] Commonwealth Environmental Water Portfolio Management Plan: Northern Intersecting Streams 2019–20, Commonwealth of Australia, 2019

potential evapotranspiration and accentuating the reduction in runoff.[12] In addition to changes in climate, water resources development has also contributed significantly to the reduction in streamflow across the northern Basin. There is evidence of significant changes to streamflow volumes, durations and frequencies in the northern Basin compared to pre-development levels. This is evident in the Barwon-Darling where:

- tributary inflows have reduced by 37 percent (average end of system flows)
- average streamflow volumes in the river have decreased by 40–50%
- natural variability of river flow has decreased due to large headwater impoundments
- higher flows and freshes have reduced
- cease-to-flow events (0-1 month) and low flow conditions have increased. [13]

The impacts of changes in the northern Basin also have significant consequences for the Lower Darling. Water resources development, and particularly the Menindee Lakes scheme, has significantly altered the natural flow regime of the Lower Darling through:

- substantial reductions in monthly and annual flow volumes
- changes to the seasonality of flows with greater flows during the mid-summer, and
- a reduction in the peak flow and more persistent low flows.[14]

Worst-case climate change scenarios suggest further significant reductions in flows, including a reduction in the number and duration of floods, high-flow events and freshes. Changes to flows and connectivity pose a significant risk to towns, landholders, and ecosystems. Reduced connectivity has, amongst other things:

- reduced the availability of water for town water supply,[15]
- contributed to major fish death events[16]
- generally resulting in a decline in ecological health.[17]

In the opinion of the NSW Connectivity Expert Panel, the evidence is unequivocal that reduced connectivity in the northern Basin is having negative impacts on downstream ecosystems and communities.[18]

Sources of further information related to connectivity in the NSW part of the northern Basin is shown in Appendix A.

[12] Chiew FHS, Weber TR, Aryal SK, Post DA, Vaze J, Zheng H, Peña-Arancibia JL and Robertson DE (2022) Evaluation of causes of reduced flow in the northern Murray–Darling Basin. CSIRO Technical report
[13] Ibid; NSW Government – DPIE (2020) Barwon–Darling Long Term Water Plan Part A
[14] NSW Department of Planning and Environment (2022) Regional Water Strategy – Western
[15] NSW Department of Planning and Environment (2023) Regional Water Strategy – Namoi
[16] Office of the NSW Chief Scientist & Engineer (2023) Independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee
[17] Ibid
[18] Connectivity Expert Panel Final Report, July 2024, available at: https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0003/616737/connectivity-expert-panel-final-report.pdf

3 Stocktake of activities for improving connectivity

3.1 Overview

The review has identified a large number of activities and initiatives that influence connectivity outcomes. This includes:

- Core water resources planning and management activities, such as establishing water plans/water sharing plans and management of water access entitlements. These activities, amongst other things, identify objectives related to watercourse flows (and connectivity) and put in place controls on the quantity of water that can be abstracted from a watercourse and the timing of those abstractions. These are typically ongoing, 'business as usual' functions implemented by water management agencies.
- Reviews or updates of water resources planning as part of the adaptive water planning frameworks and management arrangements undertaken for the purpose of improving connectivity outcomes. For example, reviews to inform potential changes to water sharing rules or infrastructure operating rules.
- Government-funded programs or projects that directly or indirectly impact on connectivity. These may be initiated in response to a particular incident (e.g. major fish deaths) and typically involve one-off investments that may support reviews, research, improved water resources management tools and capacity, new infrastructure or modifications to existing infrastructure, or other activities.

3.2 Stocktake of initiatives

Table 3 sets out a list of completed, current and proposed activities and initiatives which focus on improving longitudinal surface water connectivity across the northern Basin that were identified by the review. The table includes links to key source material. The activities and initiatives are also shown in the map in Figure 3. Appendix B includes a description of each activity/initiative and its intended contribution to connectivity outcomes.

Note that:

- The table is not an exhaustive list of activities and initiatives, and in particular it does not capture all laws and regulatory instruments that impact on connectivity, only the primary or key ones of more direct relevance. The list also includes some activities and initiatives which have or will contribute towards connectivity outcomes, but where that is not the primary objective.
- In a number of instances there is overlap between the activities/initiatives listed. For example, the list includes both overarching 'programs' (e.g. Northern Basin Toolkit, Murray-Darling Basin Compliance Compact), and projects implemented under those programs. Projects funded under the Northern Basin Toolkit are noted as a 'NBTK project'.

Table 3. List of major initiatives to improve connectivity in the northern Basin

Activity/initiative	Location	Timescale
Commonwealth/Joint programs		
A1. Water Act 2007 (Cth)	Whole of basin	Ongoing
A2. Murray-Darling Basin Agreement	Whole of basin	Ongoing
A3. Murray-Darling Basin Plan 2012	Whole of basin	Ongoing, next review in 2026

Activity/initiative	Location	Timescale
A4. Water recovery programs	Condamine-Balonne and NSW Border rivers catchments	Targets recovery water for the environment (December 2027)
A5. Aboriginal Water Entitlements Program	Whole of basin	Purchasing FY24/25-25/26
A6. Cultural Flows Planning for Cultural Economies Program	Whole of basin	FY 24/25 – 26/27
A7. Basin-wide Environmental Watering Strategy	Whole of basin	Ongoing, reviewed every 5 years
A8. CEWH Annual Water Management Plan	Whole of basin	Annual plan, objectives updated annually
A9. Event-based mechanisms (NBTK project)	Lower Balonne	Ad hoc – no timetable for ongoing implementation or expansion
A10. Constraints Relaxation Implementation Roadmap	Gwydir	Roadmap due end 2024
A11. Implementation of Measures to Improve Environmental Outcomes in the Northern MDB and Northern Basin Toolkit	Northern basin	Projects to be completed by December 2026
A12. Macquarie Marshes Enhanced Watering project (NBTK project)	Macquarie River	Complete (NBTK project)
A13. NSW Fish for the Future: Reconnecting the Northern Basin project (NBTK project)	NSW Border Rivers, Barwon-Darling	Partly completed
A14. Toorale Water Infrastructure Project	Warrego River	Complete
A15. Gwydir Reconnecting Watercourse Country Program (NBTK project)	Gwydir River	Ongoing. Expected to be completed by December 2026
A16. Wilcannia weir replacement project	Darling River	Project paused pending independent review of environmental impacts
A17. CEWH Environmental Activities	Whole of basin	Ongoing
A18. Review of Menindee Lakes Operating Rules	Menindee Lakes (impacts downstream)	June 2024 to December 2025
A19. Northern to southern Basin environmental flow protection trial	Menindee Lakes and lower Darling	12-month trial from May 2024 to June 2025
A20. Australian Government response to the Independent Assessment of the 2018-19 Fish Deaths in the Lower Darling	Barwon-Darling	Complete
A21. Native Fish Recovery Strategy	Whole of basin	30-year horizon with 10-year implementation stages

Activity/initiative	Location	Timescale
A22. Governance to support environmental watering	Whole of basin	Ongoing
A23. Murray-Darling Basin Compliance Compact (including projects under the Hydrometric Networks and Remote Sensing Program)	Whole of basin	Complete
A24. Improved northern Basin gauge network	Northern basin	Complete
A25. Fencing Northern Riverbanks project (NSW and Queensland)	Northern basin	Complete
A26. Licensing of floodplain harvesting in NSW and floodplain harvesting measurement	NSW catchments	Licences to be in place for all northern valleys by early 2025
A27. Northern Murray-Darling Basin Metering Program	Northern basin	Complete
A28. Cold Water Pollution Mitigation at Pindari Dam	Pindari dam	Expected to be completed by December 2026
NSW		
A29. Regional Water Strategies	Regional (NSW)	Ongoing – intended to meet requirements over 20-40 years
A30. North-West Flow Plan	Northern Basin - NSW	Ongoing – implemented through water sharing plans
A31. Water sharing plans	Catchment based, but capturing entire basin in NSW	Ongoing, reviewed every 10 years
A32. Active management to protect environmental flows (NBTK project)	Barwon-Darling and the Gwydir and Macquarie unregulated water sources	Ongoing, method to be expanded in next 12 months to include cross-border e-water
A33. Review of minimum inflows in NSW regulated water sharing plans	NSW catchments	Review underway, report due March 2025
A34. NSW Northern Basin Connectivity Program	Northern Basin – NSW	Ongoing – implementation by mid-2026
A35. Long-term watering plans	Catchment based, but capturing entire basin in NSW	Ongoing, reviewed every 5 years
A36. NSW Government response to independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee	Barwon-Darling and Menindee Lakes	Various commitments over multiple years

Activity/initiative	Location	Timescale
A37. Compliance against the Longer Term Annual Average Extraction Limits (LTAAEL)	Northern Basin - NSW	Annual
A38. Northern Basin First Flush Assessment	Northern basin – NSW	Review complete, implementation of recommendations ongoing
A39. Critical dry condition triggers to reduce risk to environmental and human water needs	Barwon-Darling	Ongoing – revised modelling requested as a result of Connectivity Expert Panel recommendations
A40. Water quality governance roadmap	Northern basin - NSW	Roadmap released in June 2024, subject to ongoing implementation
A41. Fish friendly waterway crossings	Northern Basin – NSW	Ongoing
Queensland		
A42. Water plans and water management protocols	Catchment based, but capturing entire basin in Qld	Ongoing, reviewed every 10 years
A43. Lower Balonne Water Management Area Water harvesting announced period guide	Lower Balonne (Qld)	Ongoing
A44. Performance and Assessment Reports	Northern Basin - Qld	Ongoing, reports on water plans every 5 years
A45. Accounting for held environmental water passing the Qld/NSW border (NBTK project)	Northern Basin - Qld (but not all entitlements)	Ongoing
A46. Environmental Flows Assessment Program (EFAP) and other research programs	Northern Basin - Qld	Ongoing
A47. Long-term watering plans (LTWPs) and Annual environmental watering priorities (AEWPs)	Norther Basin – QLD	Ongoing
A48. Collaborations with and advice to the Commonwealth Environmental Water Office (NBTK project)	Northern basin – Qld (high risk areas)	Licensing for overland flow being expanded to Border Rivers and Moonie
A49. Overland flow water licencing and measurement	Qld MDB	Metering completed by end of 2026
A50. Strengthened water measurement	Northern Basin – Qld	Ongoing
A51. Requirements for constructing or raising waterway barrier works	Whole of basin in Qld	Ongoing

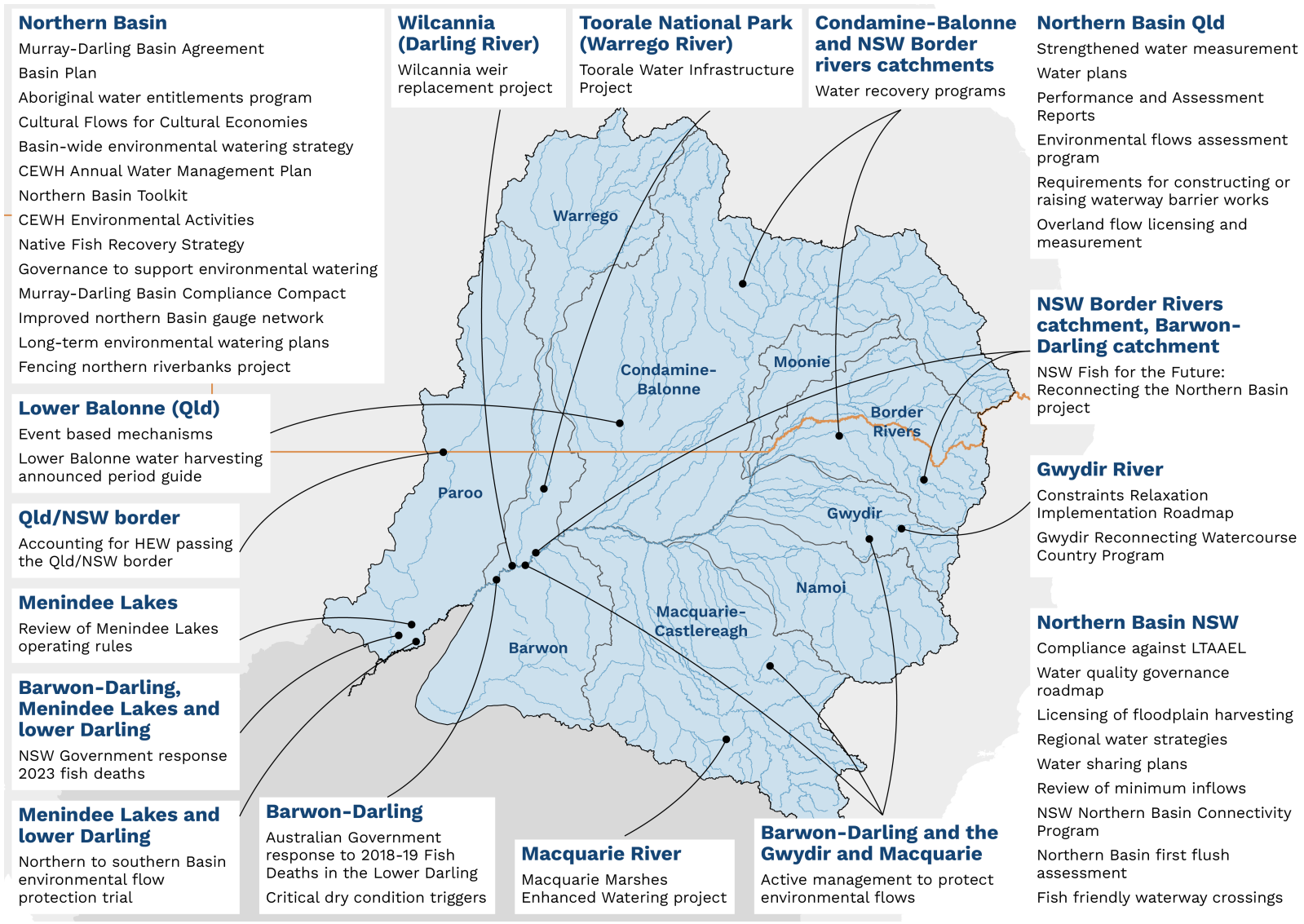

Figure 3. Connectivity-related activities and initiatives in the northern Basin

4 Assessment of current activities and gap analysis

4.1 Assessment framework

An assessment framework was developed to identify gaps in the current initiatives and opportunities to build on or expand previous or current endeavours.

The framework is based around a set of requirements (and components that make up those requirements) that are necessary to provide for longitudinal surface water connectivity.

Seven requirements and 20 components have been identified. The requirements and components, together with a description and explanation of their significance, are set out in Table 4.

Table 4. Requirements to support connectivity outcomes

Requirement	Component	Description
R1. Objectives are defined	Identify values and services (economic, ecological, cultural, social) that are dependent on longitudinal connectivity	Clearly define the values and services that are provided by the river system, and the extent to which maintaining those values and services relies on a level of connectivity being maintained/achieved. Specific objectives for connectivity – for example, in terms of the timing, volume, location, and duration of flows. This is necessary to ensure that interventions that aim to support connectivity outcomes align with and contribute towards the overall objectives.
	Define objectives for longitudinal connectivity	
R2. Water is allocated to support connectivity objectives	Limit on total water taken (long-term) from watercourses and connected groundwater systems	Measures to limit the extraction of water for consumptive purposes, to ensure that there is sufficient water remaining in the system to achieve connectivity objectives. This may include controls established through water plans/water sharing plans, and water licensing arrangements. This may require the recovery of water (e.g. buyback of entitlements or other investments to reduce total water abstractions) where a system has been overallocated.
	Recovery of water for the environment	
	Water sharing arrangements	Arrangements for sharing the bulk volumes of water between different user groups, particularly as between consumptive users and the environment. This is also necessary to ensure that sufficient water remaining in the system to achieve connectivity objectives.
	Regulation of overland flow/ floodplain harvesting take/interception activities	Measures to control or limit the amount of overland flow water that is captured. For example, this may involve prohibitions on storages that intercept overland flow or the taking of water from the floodplain (i.e. from outside of a watercourse). Necessary to ensure that water continues to enter the watercourse so that it can contribute to achieving connectivity objectives.

Requirement	Component	Description
R3. Flows are managed to achieve connectivity objectives, including during emergency events	Water infrastructure operations	Rules and operating procedures regarding how instream water infrastructure is operated, such as requirements to store, release, or pass-through flows under particular conditions.
	Abstraction management	Rules and regulations that limit the extent to which water access entitlement holders can take water during particular flow events. For example, licence conditions or water plan requirements that prohibit the take of water during low flow periods or during the first flow event following an extended dry period.
	Held environmental water (HEW) management	Arrangements for managing and releasing water entitlements held for the environment, such as the Commonwealth environmental water holdings managed by the CEWO.
	Planned environmental water (PEW) management	Rules and regulations related to planned environmental water, such as requirements set out in water plans/water sharing plans related to the amount of water that must be retained within the system, including protections relating to particular flow events.
R4. Infrastructure (including green infrastructure) is designed to support connectivity objectives (including non-water infrastructure, e.g. roads, bridges)	Understanding extent to which design of existing infrastructure supports connectivity	Information on current structures within watercourses and the extent to which those structures are impacting on connectivity. This information is necessary to support prioritisation of actions to remove/modify instream barriers.
	Modifications to existing infrastructure to improve connectivity	Changes to existing structures within watercourses to allow for improved flow of water and passage of biota, such as the removal of an old weir or retrofitting a fishway, to improve fish passage.
	Regulatory requirements for new infrastructure to support connectivity objectives	Regulations that prohibit construction of infrastructure that will have adverse impacts on connectivity, or design requirements for any new infrastructure to avoid or minimise any connectivity impacts, such as ensuring culverts or weirs have the ability to pass flows and allow for fish passage.
R5. Water markets	Markets allow for trading of water entitlements to support connectivity	Mechanisms that allow for water access entitlements to be acquired, managed and used to support connectivity. For example, to allow for the CEWO to purchase water access entitlements and release water available under those entitlements in a way that maximises environmental and connectivity outcomes.
	Trading water entitlements doesn't have negative impacts on connectivity	Protections to ensure that the relocation of water access entitlements through the trading of entitlements does not have negative impacts on environmental flows and connectivity, e.g. by materially increasing the amount of water taken from particular river reaches and reducing flows below acceptable levels at critical times.
R6. Governance	Monitoring, measuring, accounting and compliance	Systems, tools, and measures for understanding the amount of water that is being taken from the system over time, including those used to support decision-making and conformance with decisions made. Necessary to provide confidence to stakeholders and to ensure that the measures that have been

Requirement	Component	Description
		established to deliver environmental flows and connectivity outcomes are implemented as intended.
	Reporting on outcomes, understanding effectiveness of existing actions and responding to new information	Systems and mechanisms for evaluating whether existing approaches are being effective in contributing towards connectivity objectives (e.g. whether planning and operational requirements are resulting in the targeted flows, or whether the flows are achieving the environmental outcomes sought), reporting on the effectiveness of existing approaches, and adaptive management to adjust and improve approaches where evidence indicates that is appropriate.
	Modelling and forecasting (operational)	Systems and process to support operational decisions related to management of watercourses, such as modelling and forecasting tools to assess the likelihood of particular flow conditions and support decisions related to, for example, the release of flows or introducing water restrictions.
	Coordination and decision-making	Mechanisms for coordinating actions by different government agencies (e.g. state water agencies and the CEWO), for example to optimise connectivity benefits from management decisions such as water releases.
R7. Communication and engagement	Stakeholder awareness and engagement (including First Nations)	Measures to inform, increase understanding and awareness, engage with, obtain input from and report the views of the diverse range of stakeholders with interests relating to connectivity.

4.2 Assessment and gap analysis

The activities and initiatives identified through the stocktake process (Table 3) have been assessed against the framework (Table 4). This involved identifying, for each of the requirements and components set out in the framework:

- A cross-index of which of the activities and initiatives contributed to meeting each of the requirements. The result of this mapping exercise is shown in Appendix C.
- The extent to which each requirement was collectively met by the range of activities/initiatives. This involved considering for each activity/initiative:
    - Its geographic extent
    - Institutional responsibilities for implementation
    - The timescale, including whether it relates to a one-off project or is an ongoing initiative (e.g. embedded within core water resources management functions)
    - The sustainability of the activity/initiative – e.g. what if any ongoing support or funding might be required
- Any gaps, opportunities for new activities or building on/expanding existing activities, or other observations.

In reviewing whether a requirement is met, the assessment considered whether there are measures in place that are intended to address that requirement. The assessment did not consider the adequacy or effectiveness of those measures. For example, for requirement 2 (water is allocated to support connectivity outcomes), the assessment identified the measures in place to allocate water for the environment (e.g. basin plan requirements related to sustainable diversion limits). The

assessment did not consider whether the water set aside for the environment was sufficient to meet connectivity objectives.

Table 5 sets out the summary of the assessment, including, for each requirement, the extent to which the requirement is met, gaps, opportunities, and other considerations. Appendix D provides the full assessment of each requirement against the framework.

Table 5. Assessment and gap analysis of connectivity-related activities

Requirement	Component	Extent to which requirement is met, gaps, opportunities, and other considerations
R1. Objectives are defined	Identify values and services (economic, ecological, cultural, social) that are dependent on longitudinal connectivity and Define objectives for longitudinal connectivity	**Extent to which requirement is met** Requirement is well satisfied. Objectives related to longitudinal connectivity are included in plans and strategies at multiple levels, and hence embedded in 'business as usual' practices. Values are well defined at basin and catchment scales, including detailed ecological values. **Gaps, opportunities and other considerations** Some objectives are aspirational and/or do not lend themselves to reporting, notably flow objectives that are defined as long-term average (modelled) values. Consideration should be given to: - how objectives could be defined to better align with and support event-based management - scope for including regional or inter-catchment connectivity objectives, thus considering system-wide connectivity - including greater specificity where objectives simply refer to 'improving connectivity', without defining the type or level of connectivity targeted.
R2. Water is allocated to support connectivity objectives	Limit on total water taken (long-term) from watercourses and connected groundwater systems Recovery of water for the environment	**Extent to which requirement is met** Requirement is well satisfied. Sustainable diversion limits (SDLs), given effect through the basin plan and state water resource plans, establish a robust limit on the total water taken over the long term. Establishing SDLs, and recovering water to meet the SDLs, has been the major focus under the basin plan. These requirements are embedded in the water resource management framework through water resource plans and given effect through water access entitlement regimes. State processes have or are considering the implications of climate change for water availability, water access entitlements and/or allocations. In NSW there is a further plan limit (the long-term average annual extraction limit) set at the water sharing plan scale. This rule has already been used to reduce allocations to control growth in the Namoi, Gwydir, and NSW Border Rivers. Given the relatively short period that the SDLs have been in place, it is difficult to assess their adequacy in, or specific contribution to, achieving on-ground outcomes. **Gaps, opportunities and other considerations** A number of the NSW water resource plans for the Northern Basin are yet to be accredited. The basin plan review presents an opportunity to assess whether the approach is appropriate under climate change scenarios.

Requirement	Component	Extent to which requirement is met, gaps, opportunities, and other considerations
		There are limits on the extent to which managing the average, long-term take of water can deliver connectivity outcomes in a highly variable and mostly unregulated system like the northern Basin. In the future it may be appropriate to shift the focus in the northern Basin to improving management of individual flow events to improve connectivity outcomes (i.e. event-based management). The management of First Nations water entitlements may contribute towards connectivity outcomes in some instances and there is an opportunity to coordinate the management of this water and environmental water where objectives align.
	Water sharing arrangements	**Extent to which requirement is met** Requirement is well satisfied but remains a significant work in progress. Water sharing arrangements across the basin are well established and provide certainty to State agencies, environmental water holders and water users regarding how water will be made available under different conditions. **Gaps, opportunities and other considerations** Ongoing activities to better protect environmental flows, including those crossing the Qld/NSW border, to reach and pass through the Menindee Lakes system provide a significant opportunity to improve connectivity outcomes through the northern Basin and into the lower Darling.
	Regulation of overland flow/floodplain harvesting take/interception activities	**Extent to which requirement is met** Requirement is broadly satisfied, noting that it remains a work in progress. Controls are in place that aim to limit any further growth in interception activities and the take of overland flow/floodplain harvesting water. Approximately 76% (NSW) and 46% (QLD) of floodplain take is licensed. Approximately 32% of floodplain take in Queensland is metered. The percentage in NSW is unknown.[19] **Gaps, opportunities and other considerations** While the total amount of overland flow/floodplain harvesting water taken remains capped at a point in time (e.g. early 2000s in the case of Queensland), the measurement, regulation, management and modelling of overland flow/floodplain harvesting water has proven to be particularly complex and challenging. Consider opportunities for focussing more on the measurement and regulation of overland flow/floodplain harvesting water – and the implications for in river flows and connectivity – on an event-by-event (rather than an average annual) basis.

[19] https://www.igwc.gov.au/sites/default/files/2024-04/murray-darling-basin-metering-report-card-2023.pdf

Requirement	Component	Extent to which requirement is met, gaps, opportunities, and other considerations
R3. Flows are managed to achieve connectivity objectives, including during emergency events	Water infrastructure operations	**Extent to which requirement is met** Requirement is satisfied, noting that there is significant work in progress. Infrastructure operating arrangements include provisions related to flow releases to maintain connectivity. Rules are subject to an ongoing process of continuous improvement, as evidenced by a range of reviews. **Gaps, opportunities and other considerations** Consider opportunities to adapt the findings from reviews of previous events to other locations in the northern Basin.
	Abstraction management	**Extent to which requirement is met** Requirement is satisfied, noting that there is significant work in progress. Approaches to abstraction management have focussed primarily on meeting requirements related to the SDLs and long-term average levels of take. There have also been considerable efforts to improve compliance and enforcement, including in agency establishment and reform and development of improved water data capture, information and analytics (also see R6). There have been significant advances in abstraction management to adjust levels of take during different flow events, to support environmental and connectivity-related outcomes. **Gaps, opportunities and other considerations** An increased focus on event-based management will require a more sophisticated approach to managing water abstractions during flow events. The close linkages between water sharing plans/water plans and requirements related to abstraction management will likely require periodic changes to plans to meet new management requirements, including in response to various ongoing reviews. Consider opportunities to adapt the findings from reviews of previous events to other locations in the northern Basin.
	HEW management	**Extent to which requirement is met** Requirement is well satisfied. Management of HEW has been a high priority over the last decade. Comprehensive planning arrangements are now in place and HEW is managed to achieve connectivity outcomes as part of business as usual. There is a process of continuous improvement in place. **Gaps, opportunities and other considerations**

Requirement	Component	Extent to which requirement is met, gaps, opportunities, and other considerations
		There are opportunities to expand approaches to accounting for and protecting HEW. This includes expanding the approach to active management to protect environmental flows that has been successfully applied, in the Barwon-Darling, the Lower Macquarie Bogan and the Gwydir, to other catchments and through Menindee Lakes. There are also opportunities to expand the use of event-based mechanisms. There is likely to be a need for more innovative approaches to accessing and utilising water in the northern Basin, given the limited extent of instream, public water infrastructure. Initial trials undertaken by the CEWO provide a good basis for expanding approaches to HEW management.
	PEW management	**Extent to which requirement is met** Requirement is well satisfied. There are extensive provisions in place as part of existing plans and supporting measures to provide and manage PEW to achieve connectivity outcomes. **Gaps, opportunities and other considerations** Objectives related to PEW are generally limited to the end of catchment. Consideration should be given to how catchment-level objectives and PEW requirements might be expanded to provide and protect PEW to support inter-catchment and "whole of system" connectivity outcomes. This could include consideration of the role of the basin plan in this regard.
R4. Infrastructure (including green infrastructure) is designed to support connectivity objectives (including non-water infrastructur	Understanding extent to which design of existing infrastructure supports connectivity	**Extent to which requirement is met** Requirement is satisfied. There has been substantial investment in modifying existing water infrastructure to improve connectivity outcomes, particularly related to fish passage. Most of the investment in infrastructure modifications has been for one-off projects. The review has not been able to assess the extent to which the improved connectivity associated with modifications to infrastructure requires ongoing maintenance/investment. Research projects provide some baseline information on barriers in Qld watercourses in the northern Basin and associated risks.[20]
	Modifications to existing infrastructure to improve connectivity	

[20] Barriers database - Detailed information on the size, shape and drownout thresholds for all instream barriers in the QMDB based on 3d drone imagery;

Requirement	Component	Extent to which requirement is met, gaps, opportunities, and other considerations
e, e.g. roads, bridges)		**Gaps, opportunities and other considerations** The review has not been able to determine whether there has been a systematic process for identifying barriers that are impacting on connectivity and for prioritising investment in removing or mitigating the impacts of those barriers. Consideration should be given to developing a master plan for the basin to prioritise future interventions and the allocation of funding to maximise connectivity benefits.
	Regulatory requirements for new infrastructure to support connectivity objectives	**Extent to which requirement is met** Requirement is satisfied. New works in a waterway are generally required to accommodate fish passage. **Gaps, opportunities and other considerations** Both NSW water sharing plans and Qld water plans place restrictions on where/who can construct instream storages. Consideration should be given to whether there has been a strategic assessment of the implications of new infrastructure for connectivity and hence whether these restrictions might be expanded/adjusted.
R5. Water markets	Markets allow for trading of water entitlements to support connectivity and Trading water entitlements doesn't have negative impacts on connectivity	**Extent to which requirement is met** Requirement is satisfied. The water market arrangements have broadly supported the recovery of water and water trading rules are in place to prevent or minimise impacts on environmental flows (including connectivity) as a result of water trading. **Gaps, opportunities and other considerations** We understand that there are concerns in some quarters that there is an actual or perceived inequity of trade opportunities for water entitlements for environmental purposes (i.e. differential treatment of e-water entitlements), and that consideration is being given to ensuring all water entitlements are treated the same. There is a risk that such changes to trading rules could limit options for managing environmental water. Consideration should be given to maintaining/maximising opportunities for trading environmental water, provided it does not adversely impact on other users or uses. This recommendation is consistent with ongoing work as part of the Water market reform: final roadmap report.
R6. Governance	Monitoring, measuring,	**Extent to which requirement is met** Requirement is well satisfied.

Assessment of the combined risk to migratory fish from flow regime change and barriers to dispersal (Marshall JC, Lobegeiger JS and Starkey A (2021) Risks to Fish Populations in Dryland Rivers From the Combined Threats of Drought and Instream Barriers. Front. Environ. Sci. 9:671556.)

Requirement	Component	Extent to which requirement is met, gaps, opportunities, and other considerations
	accounting and compliance	There has been significant investment and resultant improvement in governance mechanisms, including compliance, monitoring and reporting. A number of recent improvements have been delivered through one-off investments. It is not clear the extent to which ongoing funding is required or available to maintain assets and benefits. **Gaps, opportunities and other considerations** There will continue to be opportunities to improve and expand existing compliance, accounting and measurement. Notably, any increased focus on event-based management will likely need to be supported by strengthened arrangements in gathering of data and intelligence, consultation and decision-making processes, accounting, compliance, monitoring and measurement.
	Reporting on outcomes, understanding effectiveness of existing actions and responding to new information	**Extent to which requirement is met** Requirement is broadly satisfied. Reporting on outcomes is via a mixture of periodic and one-off reporting. **Gaps, opportunities and other considerations** Consideration should be given to the extent to which existing reporting arrangements are meeting the expectations of stakeholders and providing them with confidence in the effectiveness of existing approaches to improving connectivity. As noted above with respect to objectives (R1), consideration should be given to whether objectives are currently defined in a way that allows for outcomes to be assessed against those objectives. Consideration should be given to how reporting, assessment of actions, and adaptive management might need to be adjusted in circumstances where and when there is a greater focus on event-based management.
	Modelling and forecasting (operational)	**Extent to which requirement is met** Requirement is broadly satisfied although remains a work in progress. There is substantial ongoing investment in improved modelling and forecasting, particularly to support planning initiatives, notably the basin plan review and for state water resources planning. **Gaps, opportunities and other considerations**

Requirement	Component	Extent to which requirement is met, gaps, opportunities, and other considerations
		Consideration should be given to the adequacy of existing modelling and forecasting systems to support event-based management in the northern Basin.
	Coordination and decision-making	**Extent to which requirement is met** Requirement is broadly satisfied. There appear to be good, established mechanisms in place to support collaborative decision-making and coordinated actions. The 2023 Implementation review of the Basin Plan identifies weak governance as contributing to delays in progress towards water recovery targets.[21] **Gaps, opportunities and other considerations** Consider if there are additional opportunities to share the considerable experience that has been developed across agencies in managing water for connectivity outcomes, both through BAU operations as well as specific reviews.
R7. Communication and engagement	Stakeholder awareness and engagement (including First Nations)	**Extent to which requirement is met** Requirement is broadly satisfied. There are a range of measures in place to support communication and engagement with the stakeholder base. **Gaps, opportunities and other considerations** Improving stakeholder understanding of the role and importance of connectivity is implicit in delivering on many of the objectives for the northern Basin. The review has not considered the wide range of ways that agencies communicate with stakeholders on water resources management issues. Any increased focus on event-based management will require an accompanying increase in effort to engage with stakeholders in planning, and before, during and after flow events. Increased engagement with First Nations is likely to require a substantial investment, including to ensure capacity within First Nations peoples to engage in a meaningful way.

[21] Productivity Commission 2023, Murray-Darling Basin Plan Implementation review 2023, Inquiry report no. 103, Canberra. Available at: https://www.pc.gov.au/inquiries/completed/basin-plan-2023/report/basin-plan-2023-overview.pdf

5 Conclusions and recommendations

Based on our analysis of the connectivity-related activities and initiatives being undertaken in the northern Basin, we make the following conclusions and recommendations:

1. There has been and continues to be a major investment in initiatives that are designed to improve connectivity-outcomes in the northern Basin. This includes:
    a. Core water resources planning and management activities, such as establishing water plans/water sharing plans and management of water access entitlements
    b. Reviews or updates of water resources planning and management arrangements undertaken for the purpose of improving connectivity outcomes
    c. Government-funded programs or projects for directly or indirectly improving connectivity.
2. The scope of these activities demonstrates a collective and concerted commitment by state and commonwealth jurisdictions to maintaining or improving connectivity in the northern Basin. This finding is not based on the effectiveness of past and current initiatives, but rather the extent to which measures have been undertaken or are proposed that address the fundamental requirements for maintaining or improving connectivity. In essence, the aims and objectives of these activities and initiatives are sound. An assessment of the effectiveness of current and proposed measures in improving connectivity outcomes was beyond the scope of the current report. Such an assessment should be undertaken as a priority to inform future water resources planning activities and investments.
3. Many of the initiatives that support connectivity outcomes are embedded within 'business as usual' management practices, such as through their incorporation within water sharing rules or infrastructure operating arrangements. Other actions, such as changes to infrastructure to remove barriers or improve fish passage, are expected to enhance and lock in ongoing connectivity benefits.
4. A number of critical initiatives remain in a pilot phase. Further action, and potentially investment, will be required to maintain the benefits associated with these initiatives including:
    a. The review of the Menindee Lakes operating rules
    b. The northern to southern Basin environmental flow protection trial
    c. Recommendations from the NSW Independent Expert Connectivity Panel[22] as part of the Northern Basin Connectivity Program
    d. Investments in improving water information and compliance systems, processes and tools initiated through the recently completed Hydrometric Networks and Remote Sensing (Improving Water Information in the Northern Basin) Program
    e. The adoption of event-based mechanisms to enhance outcomes associated with held environmental water management (HEW) such as has been piloted by the Commonwealth Environmental Water Office (CEWO) in the Lower Balonne.

[22] The panel submitted its final report in July 2024. This completed the panel's work. Any response to the panel's recommendations is now a matter for the NSW Government.

5. There are opportunities to better coordinate and build on existing activities and efforts by:
    a. Improving the way connectivity objectives are defined and reported. This includes establishing regional and inter-catchment connectivity objectives, to ensure that catchment-level plans and management arrangements consider the need for flows to support environmental and connectivity outcomes in downstream catchments.
    b. Adopting a more strategic approach to coordinating, leveraging, and prioritizing activities across the northern Basin from a connectivity perspective. For example, a strategic planning process could be used to guide future investments in infrastructure modification or removal to improve fish passage in the northern Basin.
    c. Identifying opportunities to share approaches and learnings between catchments and across jurisdictions. There has been a major investment in better understanding approaches and measures for improving environmental water management and connectivity. There are likely to be lessons from these experiences that would benefit others. For example, there may be lessons for Queensland water managers (at least in more developed areas such as the Lower Balonne) arising from the active management of environmental water that is being implemented in northern NSW.

6. The hydrology of the northern Basin and nature of water resources development – notably the fact that much of the river system is 'unregulated' by major on-river storages – means that 'event-based management' offers substantial scope for improving connectivity outcomes. This may involve, for example, 'active management' of individual flow events to protect environmental water (as is implemented in the Barwon Darling), 'flow event-management' (which applies in a number of the Queensland catchments) or the 'event-based mechanisms' (which have been piloted by the CEWO in the Lower Balonne). Any increased focus on event-based management is likely to require a range of changes to regulatory instruments, systems and processes, and greater engagement with stakeholders, including First Nations Peoples. The costs associated with these requirements will need to be weighed against the benefits from shifting towards event-based management.

7. A range of opportunities have been identified that relate to each of the fundamental requirements for improved connectivity (Table 6). Investments in further initiatives to improve connectivity should be considered in the context of other issues and related risks to the health of the northern Basin, and the Basin as a whole, to prioritise available resources in a way that achieves the greatest benefit for the Basin and its communities. This should include an assessment of:
    a. Risks associated with reduced connectivity on a catchment-by-catchment basis based on current and potential future climates
    b. The extent to which existing and planned interventions are expected to mitigate these risks
    c. The costs and benefits associated with potential interventions, including socio-economic, cultural, and ecological costs and benefits.
8. Further work is required to understand the extent to which past and current initiatives mitigate risks to achieving the desired connectivity outcomes. Regardless, maintaining and improving on the benefits associated with previous actions and investments will require a sustained commitment by governments to continue with implementation, including continuing to implement and strengthen the suite of water resources management plans

and tools in place in a way that supports longitudinal connectivity across the northern Basin and into the southern Basin.

Table 6. Summary of opportunities for improving connectivity outcomes in the northern Basin

Requirement	Opportunities and considerations
Objectives are defined	• There are opportunities to improve connectivity outcomes by strengthening or expanding the way objectives related to connectivity are defined. Consideration should be given to: - including greater specificity where objectives simply refer to 'improving connectivity' - including regional or inter-catchment connectivity objectives at the basin and catchment scales, thus considering overall system-wide connectivity - defining connectivity objectives in a way that better aligns with and supports event-based management.
Water is allocated to support connectivity objectives	• Ongoing activities to better protect environmental flows, including those crossing the Queensland/NSW border, to reach and pass through the Menindee Lakes system provide a significant opportunity to improve connectivity outcomes through the northern Basin and into the lower Darling. • The management of First Nations water entitlements may contribute towards connectivity outcomes where objectives align. • Consideration should be given to opportunities for focussing further on the measurement and regulation of overland flow/floodplain harvesting water – and the implications for in river flows and connectivity – on an event-by-event (rather than annual) basis.
Flows are managed to achieve connectivity objectives	• There are opportunities to expand approaches to accounting for and protecting HEW. This includes expanding the approach to active management to protect environmental flows that has been successfully applied, in the Barwon-Darling, the Lower Macquarie Bogan and the Gwydir, to other catchments and through Menindee Lakes. • There are also opportunities to expand the use of event-based mechanisms. Initial trials undertaken by the CEWO provide a good basis for expanding approaches to HEW. • Objectives related to planned environmental water management (PEW) are generally limited to the end of catchment. Consideration should be given to how catchment-level objectives and PEW requirements might be expanded to provide and protect PEW to support inter-catchment and system-wide connectivity outcomes. • An increased focus on event-based management will require a more sophisticated approach to managing water abstractions during flow events.
Infrastructure design supports connectivity objectives	• There are opportunities to be more strategic in how activities related to infrastructure and connectivity are prioritised. Consideration should be given to: - Developing a master plan for the basin to prioritise future interventions to remove barriers (e.g. fish ways) and the allocation of funding to maximise connectivity benefits. In the interim, the construction of fishways to maximise fish mobility above the Menindee weir pool has already been identified as a high priority.[23] - Undertaking a strategic assessment of the implications of new infrastructure for connectivity and hence where requirements (including potentially prohibitions) related to new infrastructure might be put in place.

[23] Office of the NSW Chief Scientist & Engineer (2023) Independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee

Requirement	Opportunities and considerations
Water markets	• Consideration be given to continuing the pursuit of opportunities for maintaining maximum flexibility in the trading of environmental water, provided it does not adversely impact on other users or uses.
Governance	• Consideration be given to whether objectives are currently defined in a way that allows for outcomes to be assessed against those objectives. • Any increased focus on event-based management will likely need to be supported by strengthened arrangements in gathering of data and intelligence, consultation and decision-making processes, reporting, assessment of actions, adaptive management, accounting, compliance, monitoring, measurement, modelling and forecasting.
Stakeholder engagement and communications (including First Nations)	• Any increased focus on event-based management will require an accompanying increase in effort to engage with stakeholders in planning, and before, during and after flow events. • Consideration be given to assessing the extent to which reporting arrangements are meeting the expectations of stakeholders and providing them with confidence in the effectiveness of existing approaches. • Increased engagement with First Nations is likely to require substantial investment and sustained support / capacity development, and meaningful engagement processes.

Appendix A –Sources of information on connectivity in the NSW northern Basin

Report	Connectivity information
Western Regional Water Strategy	• 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 (p. 53) • 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 (p.53) • Figure 23. Number of cease-to-flow days per year at different locations on the Barwon–Darling (p.57) • 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 (p.59) • 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 (p.92) • 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 Figure 32. Modelled Menindee Lakes storage volume during the 2017–2020 drought with and without the 195 GL (all lakes), 195 GL (active) and 480 GL triggers (p.96)
Modelled downstream effects of licensing floodplain harvesting – NSW Border Rivers, Gwydir, Macquarie, Namoi and Barwon-Darling valleys	• Table 6 Total annual diversions and annual end-of-system flow without and with implementation of the Policy in the NSW Border Rivers valley (p.20) • Table 7 Total annual diversions and annual end-of-system flow without and with implementation of the Policy in the Gwydir valley (p.25) • Table 8 Total annual diversions and annual end-of-system flow without and with implementation of the Policy in the Macquarie valley (p.29) • Table 9 Total annual diversions and annual end-of-system flow without and with implementation of the Policy in the Namoi valley (p.32) • Table 10 Total annual diversions and annual end-of-system flow without and with implementation of the Policy in the Barwon-Darling valley (p.36) • Table 11 Potential changes in annual mean flow at three key locations [in the Barwon-Darling] without and with the Policy implemented in the NSW Border Rivers valley. (p.40) • Table 12 Potential changes in annual mean flow at four key locations [in the Barwon-Darling] without and with the Policy implemented in the Gwydir valley (p.41) • Table 13 Potential changes in annual mean flow at three key locations [in the Barwon-Darling] without and with the Policy implemented in the Macquarie valley (p.42) • Table 14 Potential changes in annual mean flow at three key locations [in the Barwon-Darling] without and with the Policy implemented in the Namoi valley. (p.43) • Table 15 Potential changes in annual mean flow at two key locations without and with the Policy implemented in the Barwon-Darling valley (p.45)

	• Table 16 Potential changes in annual mean flow without and with the Policy implemented in the NSW Border Rivers, Gwydir, Macquarie, Namoi and Barwon-Darling at key locations in the Barwon-Darling (p.46) • Table 18 Potential changes in annual metrics in the Lower Darling without and with the Policy implemented in the NSW Border Rivers, Gwydir, Macquarie, Namoi and Barwon-Darling valleys (p.49) • Table 19 Potential changes in annual metrics in the Murray without and with the Policy implemented in the NSW Border Rivers, Gwydir, Macquarie, Namoi and Barwon-Darling valleys (p.51)
Building the pathway to improved northern Basin Connectivity	• Outlines what the department will do to consider the Panel's findings and recommendations and determine next steps. • Also contains a high-level project timeline

Appendix B – Summary of key activities and initiatives to improve connectivity in the Northern Basin

Activity/initiative	Description	Intended contribution to connectivity outcomes
Commonwealth/Joint programs		
A1. Water Act 2007 (Cth)	Establishes framework for sustainable management of the Murray-Darling Basin and requirement for the Basin Plan. The Restoring Our Rivers Act 2023 amended the *Water Act 2007* and Basin Plan to provide more time, more options, more funding and more accountability to deliver the Basin Plan and remaining water recovery targets. The amendments also made changes to the *Water Act 2007* to improve the functioning and governance of Basin water markets. Commitments related to the amendments and water recovery are captured in the Agreement of Murray-Darling Basin Ministers to Deliver the Basin Plan in Full. (This agreement is not included as a separate activity in this table as activities under it are captured by other items listed, including this item (A1) and Water recovery programs (A4)	Requires the Basin Plan to include information about: (a) the size, extent, **connectivity**, variability and condition of the Basin water resources (Section 22, Item 1). Otherwise, does not explicitly mention connectivity. Requirements for protecting and restoring the environment of the Basin implicitly require connectivity to be maintained. Improve capacity for Government to recovery water for environmental purposes to meet Bridging the Gap SDL targets and 450 GL objectives under Part 2AA of the Water Act and Schedule 5 of the Basin Plan, with benefits to include improved connectivity.
A2. Murray-Darling Basin Agreement	Establishes sharing arrangements for River Murray System, which includes the Menindee Lakes storage and the Darling River downstream of the lakes.	Ensure sufficient conveyance water to deliver critical human needs downstream.
A3. Murray-Darling Basin Plan 2012, including amendments from the Restoring Our	Plan for the sustainable management of the Basin, including • limits on the amount of water that can be taken identifying risks to the Basin's water resources and strategies to manage those risks • requirements for state water resource plans • an environmental watering plan to optimise environmental outcomes for the Basin.	Objectives include (Basin Plan, Clause 8.06): • to protect and restore connectivity within and between water-dependent ecosystems, including by ensuring that: (b) ecological processes dependent on hydrologic [longitudinal, lateral and vertical] connectivity

Activity/initiative	Description	Intended contribution to connectivity outcomes
River Act 2023 (Cth)	The plan aims to improve longitudinal connectivity across the northern Basin through placing limits on total water abstractions, water recovery, reducing consumptive water use and increasing river flows. Requirements for water resource plans and an environmental watering plan provide mechanisms for improving flows and maintaining/improving connectivity. Requires that the Authority prepare a Constraints Relaxation Implementation Roadmap (see action A10).	… are protected and restored; and (c) the Murray Mouth remains open … • to protect and restore ecosystem functions … including by ensuring that… habitat diversity, extent, condition and connectivity that supports the life cycles of biota of water-dependent ecosystems… is maintained. Targets to measure progress towards objectives include (Basin Plan, Schedule 7): • There are improvements in the following: • (a) flow regimes which include relevant flow components … [including cease-to-flow events, low-flow-season base flows, high-flow-season base flows] • (b) hydrologic connectivity between the river and floodplain and between hydrologically connected valleys
A4. Water recovery programs	Recovery of water to meet the SDLs stated in the Basin Plan via • infrastructure investments • water purchases • efficiency measures • northern Basin Toolkit measures (see action A11) • constraint relaxation projects (see actions A10 and A15). Includes the 'Bridging the gap' target and the '450 GL for enhanced environmental outcomes'. In September 2024 a tender was opened for purchasing water in the Condamine Balonne and the NSW Border rivers to bridge the remaining SDL gap. Water recovery under the Bridging the Gap includes: • a local recovery target: water required to meet the local environmental needs of a catchment, and	Provide sufficient water to support connectivity outcomes. Projects related to constraints relaxation are primarily located in the southern Basin, with the exception of work in the Gwydir (see action A15). (Noting that in unregulated systems such as the majority of the northern Basin the capacity of (recovered) HEW to contribute towards connectivity outcomes is limited.)

Activity/initiative	Description	Intended contribution to connectivity outcomes
	• a shared recovery target: water required in addition to the local recovery in each catchment to meet environmental needs across the Basin. This 'shared' component recognises the connectivity requirements of upstream catchments to contribute to downstream environmental needs.	
A5. Aboriginal Water Entitlements Program	$100 million program to purchase water entitlements for First Nations Peoples in the Murray–Darling Basin. Purchases are guided by the Strategic Purchasing Framework. It details the purchasing objectives and core principles designed with Basin First Nations. Principles include: • Connectivity, through targeting entitlements that provide the ability to transfer the annual right to take between zones and catchments (excluding those requiring land purchases) • wealth generation through targeting entitlements with high historic capital growth and returns • equal fund allocation between the north and south of the Basin • the catchments where water entitlements will be purchased.	Connectivity to allow for environmental and Cultural outcomes on Country.
A6. Cultural Planning Flows for Cultural Economies Program	$20 million grants program to support Basin First Nations Peoples to prepare Cultural flows plans which could assist in owning and managing water in ways that address their Nation's spiritual, Cultural, environmental, social, and economic needs. The program will run for 3 years with applications for funding expected to open in early 2025.	While primary focus relates to First Nations and cultural outcomes, can also be expected to result in connectivity outcomes.
A7. Basin-wide Environmental Watering Strategy	Establishes basis for managing environmental water holdings (i.e. HEW). Guides state-level long-term watering plans and state obligations to identify local environmental water requirements, many of which are associated with connectivity. Strategy is designed to: • guide the planning and delivery of water for the environment at the Basin scale over the long term • set out the expected environmental outcomes to be achieved by environmental water management at Basin scale	(Long-term) to improve connectivity by: • keeping base flows at least 60% of the natural level • achieving a 10% overall increase in flows in the Barwon Darling • improving connectivity of the river to its estuary.

Activity/initiative	Description	Intended contribution to connectivity outcomes
	• maximise environmental outcomes through effective and efficient environmental water management and consideration of all water • explain the context within which Basin annual environmental watering priorities will be set • guide the development complementary long-term environmental watering plans.	(However, while these are the aspirational targets, current management arrangements are not explicitly set to achieve these outcomes).
A8. CEWH Annual Water Management Plan	Informs how the CEWO make decisions on where and when to deliver HEW in the Murray–Darling Basin to benefit the environment. Plan includes information on: • First Nations advice • water availability and delivery • plans for carryover, transfers and trade • recent conditions • water supply and demand • environmental priorities.	Objectives (2022-23 Water Management Plan) include supporting longitudinal connectivity, including along the Bardon-Darling River and the lower Darling/Baaka and with the River Murray.
A9. Event-based mechanisms (NBTK project)	An event-based mechanism (EBM) is mechanism for providing additional water to complement HEW during a flow event. Designed to achieve additional environmental outcomes during specific flow events at important sites. Two EBMs have been completed (2020 and 2023) for the Narran Lakes, involving (i) payments to water entitlement holders to forego taking of water during a water harvesting event and (ii) payments to a private landholder to release water from private storages into the Narran River. Potential future EMBs include purchase or lease storage infrastructure to take HEW under water entitlement into storage for later release, for the following outcomes: • More efficient use of existing HEW entitlements that has been purchased from willing sellers (which compromises the ability to achieve targeted e-benefits) • Ability to achieve more targeted environmental benefits/utility (including connectivity) • More cost effective than simply purchasing more water from willing sellers.	Improve connectivity between the river and terminal wetlands, as well as between waterholes. (NBTK project)
A10. Constraints Relaxation Implementation Roadmap	A roadmap to support Basin states maximise the benefits of their constraints projects to deliver environmental outcomes in a consistent and prioritised way. Due to be prepared by end of 2024. The roadmap will identify issues and actions needed to be agreed jointly by the states. It is also working to agree on a collective pathway for the cross-state resolution of:	Improved connectivity through improved capacity to deliver environmental water. (Will only have limited relevance to improving longitudinal connectivity in the northern Basin,

Activity/initiative	Description	Intended contribution to connectivity outcomes
	• flow rates for nominated 'reaches' across the Basin • approaches to managing impacts associated with flows that target the floodplain • approaches for managing regulatory approvals at the state and Commonwealth levels • integrated river operating arrangements to deliver environmental water in a way that targets the floodplain • funding and cost sharing • communication and stakeholder engagement approaches, particularly for the upper and mid Murray reaches.	specifically the work in the Gwydir - see action A15).
A11. Implementation of Measures to Improve Environmental Outcomes in the Northern MDB and Northern Basin Toolkit	Intergovernmental Agreement on a range of measures to improve environmental outcomes via (i) targeted recovery of water; (ii) protection of environmental flows; (iii) event-based mechanisms, including temporary trade by event, options for pumping into wetland sites, and store and release of environmental water; (iv) Improved coordination of environmental flows; (v) removal of constraints in the Gwydir catchment; and (vi) environmental works and measures to promote fish or broader ecological health. Implemented in part via the Northern Basin Toolkit, which involved a collection of initiatives supporting a 70 GL reduction in water recovery targets in the northern Basin to: • improve real-time management and protection of water for the environment • coordinate delivery of water for the environment • environmental works and measures projects to improve native fish and broader ecological outcomes in the northern Basin (e.g. fish movement) • removal of physical constraints in the Gwydir catchment to improve flows to the Gwydir wetlands and downstream into the Barwon-Darling River. A $180 million Commonwealth investment in works and measures and Gwydir constraints measure projects with funding approved for project implementation (8 projects) and business case development (3). Details of key projects of relevance are captured below.	Improve connectivity through: • better information to guide decision-making • better management of environmental water • removal of barriers to the delivery of water and movement of biota (primarily fish).
A12. Macquarie Marshes Enhanced Watering	A Northern Basin Toolkit project involving stabilising and restoring the bed level of a stream that has eroded as a result of major flood events. Restoration works are now complete.	Improve connectivity by: • improving effectiveness of environmental watering during dry periods by increasing the volume of flow remaining in the Macquarie River during low flow periods, and

Activity/initiative	Description	Intended contribution to connectivity outcomes
project (NBTK project)		• increasing the volume of water reaching the southern Macquarie Marshes.
A13. NSW Fish for the Future: Reconnecting the Northern Basin project (NBTK project)	The project aims to address barriers to fish passage by installing rock-ramp fishways at priority weir sites at Banarway, Calmundi and Louth, as well as an assessment of reinstated fish passage at Toomelah Weir. Work underway along the Barwon-Darling and Border Rivers consists of: • Stage 1 early works in Border Rivers– Blockbanks A and B in the Macintyre River near Boomi, Holdfast Crossing on the Macintyre River near Yetman. Holdfast Crossing has been completed, and investigations are ongoing on Blockbanks A and B. • Stage 2 Phase 1 works along Barwon-Darling – construction of fishways at Banarway Weir, Calmundi Weir and Louth Downstream Weir. A structure at Mt Murchison near Wilcannia is being removed. An assessment of reinstated fish passage at Toomelah Weir found the site did not impede fish passage and required no infrastructure solution. • Stage 2 Phase 2 works in Barwon-Darling – funding for construction of a fishway at Tilpa Weir has been approved.	Improve connectivity across the northern Basin by reinstating the movement and abundance of migratory native fish species. Tilpa is a priority site for fishways.
A14. Toorale Water Infrastructure Project	Purchase of Toorale Station and associated water access entitlement in 2008. Activities to remove, modify or decommission instream water infrastructure on Toorale to improve water flows for environmental purposes: • Removal of Peebles Dam (completed 10/19) • Modifications to Boera and Homestead dams (completed 7/22)	Improve connectivity by: • Increasing the maximum flow rate that can be delivered to the Darling River • Improve fish passage connectivity
A15. Gwydir Reconnecting Watercourse Country Program (NBTK project)	Part of the Northern Basin Toolkit, the program aims to increase the effectiveness of held environmental water deliveries. Involves on-ground measures to construct, modify and in some cases remove physical constraints to improve delivery and outcomes from environmental water. $37.68 million from the Commonwealth for NSW to implement three environmental projects.	• Improve the passage, flow and distribution of moderate-sized flow events in the Lower Gwydir and Gingham watercourses. • Reinstating variability and control of flows to the Lower Gwydir and Gingham watercourses in spring/summer.
A16. Wilcannia weir replacement project	Proposed construction of a new weir and fishway downstream of the existing failed weir. The project seeks to improve water security for the township of Wilcannia, enhance cultural connection to the river for local communities and deliver improved native fish migration along the river system.	Improved fish passage.

Activity/initiative	Description	Intended contribution to connectivity outcomes
	The project is currently paused, pending the completion of an independent review into the environmental impacts, along with safety and operational concerns.	
A17. CEWH Environmental Activities	Environmental activities funded through proceeds for temporary trading of CEWH water holdings. Activities are selected using the CEWO Environmental Activities Framework. Funding supports projects that improve the capacity of Commonwealth water to achieve environmental outcomes in the Murray–Darling Basin. Potential activities include: • infrastructure upgrades that improve the efficiency of environmental water delivery • re-snagging or fish screening projects that help restore and protect native plant and animal populations and habitats • research projects that improve scientific knowledge to help inform the delivery of environmental water • projects that incorporate Traditional Owners knowledge into environmental watering planning.	Improved connectivity through enhanced environmental water delivery. Improved fish passage.
A18. Review of Menindee Lakes Operating Rules	MDBA-led review of the suitability and performance of current water management arrangements for Menindee Lakes. Review will explore opportunities for both improved operating rules and procedures along with opportunities for new or improved infrastructure. Review will take place from June 2024 to December 2025.	Improve connectivity from north Basin to south basin by protecting and transferring environmental flows from north to south. Improve reconnection of the Lower Darling after a prolonged drought. Maintain minimum flows to support water quality outcomes.
A19. Northern to southern Basin environmental flow protection trial	Trial to shepherd environmental flows in the Barwon-Darling through Menindee. If successful will allow for environmental flows to be protected from Queensland to the Murray mouth. Environmental inflows will be passed through Menindee lakes when the lakes are a shared resource. 12-month trial from May 2024 to June 2025. An initial 44 GL was protected through the first trial arrangements from May 2024 to June 2025.	Improve connectivity between the northern and southern Basin and expand the environmental benefits from environmental flows in the northern basin to improve flows in the southern Basin. Improve connectivity by enhancing low flows and fresh flows, particularly in the unregulated river systems.
A20. Australian Government response to	Funding for a range of new initiatives to address the findings and recommendations in the Vertessy Report related to fish deaths in the Lower Darling. Includes funding towards:	• Improved connectivity between the Warrego and Darling Rivers • Improved connectivity for native fish

Activity/initiative	Description	Intended contribution to connectivity outcomes
the Independent Assessment of the 2018-19 Fish Deaths in the Lower Darling	• Toorale Water Infrastructure Project (see action A14) • Planning for improved fish passage • A Native Fish Recovery Strategy • Improved metering in the northern Basin • Real-time water monitoring and water accounting. This involved an investment of $12.5m each to NSW and Qld to build metering and telemetry capacity in the northern Basin. Both NSW and Qld activities were completed by June 2024 (see actions A49 and A50).	• Improved information to support decision-making regarding the management of environmental water
A21. Native Fish Recovery Strategy	Developed by the Basin governments, the strategy sets out a program of actions involving government, communities and industries to recover native fish. 30-year horizon, with 10-year implementation stages. Strategy areas include: • Improving connectivity and removing barriers • Address knowledge gaps relating to flow • Understand and adapt to climate change impacts	• Improved longitudinal connectivity to support native fish populations • Improved understanding of importance of different flows for native fish.
A22. Governance to support environmental watering	Various governance structures are in place to support engagement and collaboration between agencies and jurisdictions to improve environmental outcomes, including improve connectivity outcomes. These include: • The Basin-scale Environmental Water Committee: facilitates cross agency collaboration and provides coordinated advice on environmental water issues and opportunities to the Basin Officials Committee, including as the conduit for advice from the Southern Connected Basin Environmental Water Committee and the Northern Basin Environmental Watering Group. • The Northern Basin Environmental Watering Group: Established in 2019, the group helps coordinate the planning and delivery of water for the environment in the northern Murray–Darling Basin. It aims to enhance connectivity and improve environmental outcomes. Chaired by the Commonwealth Environmental Water Holder and including representatives from the DCCEEW (Cth), the Authority, Qld and NSW water agencies, and Northern Basin First Nations peoples. • NSW Environmental Water Advisory Groups: catchment-based advisory groups, including two in the Northern Basin, to advise on PEW and HEW. • Lower Balonne Roundtable: brings together local, state and federal governments, water agencies, and community stakeholders to address local water-related issues and progress the roll-out of the Northern Basin Toolkit measures	Improve connectivity through better coordination and management of environmental water.

Activity/initiative	Description	Intended contribution to connectivity outcomes
A23. Murray-Darling Basin Compliance Compact (including projects under the Hydrometric Networks and Remote Sensing Program)	Establishes an agreed workplan for governments and the MDBA to ensure water rules are complied with and enforced. Includes agreed activities and timelines for implementation related to: • Transparency and accountability • Compliance and enforcement frameworks • Metering and measurement • Finalising water resource plans • Protecting and managing environmental water	Improved connectivity through better protection of environmental water, including in the Lower Balonne and the Barwon-Darling River, through revisions to water resource plans/water sharing plans. Enhance the hydrometric network to allow for better management of stream connectivity, compliance, environmental water releases, and extreme events.
A24. Improved northern Basin gauge network	High-tech river gauges have been installed or upgraded at 20 key locations across the northern Murray-Darling Basin. Part of the Australian Government funded $35 million Hydrometric Networks and Remote Sensing Program.	Provide detailed live information on the volume of flows which will improve understanding of connectivity, flood risk, and drought preparedness.
A25. Fencing Northern Riverbanks project (NSW and Queensland)	Grant program for fencing and off-stream stock watering points. Project aims to support regeneration of the river and surrounding habitat by excluding stock from the riparian zone. Primary objective is to support the recovery and protection of native fish.	Program focussed primarily on improving habitat and water quality, especially for fish, through improved riparian condition. May be some connectivity benefits associated with reduced sedimentation.
A26. Licensing of floodplain harvesting in NSW and floodplain harvesting measurement	Floodplain harvesting licences are in place in all the northern valleys except for the Namoi, which will be in place by the early 2025 In 2022, statutory protections were introduced 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, to provide for downstream critical needs before water is taken by lower priority licences upstream. Supported through $57 million in Commonwealth funding under the NSW Healthy Floodplains project.	Protect downstream flows and maintain connectivity at times of reduced volume in Menindee.

Activity/initiative	Description	Intended contribution to connectivity outcomes
A27. Northern Murray-Darling Basin Metering Program	Funding to support a series of projects in Queensland and NSW related to building capacity of metering and telemetry and improving the information available to water users and compliance officers.	Improved compliance resulting in improved connectivity
A28. Cold Water Pollution Mitigation at Pindari Dam	Installation of a bubble plume destratification system and an offsite and onsite solar array and battery system at Pindari Dam to mitigate the impacts of cold-water pollution for up to 200km downstream of the dam along the Severn and Macintyre rivers. Project is expected to be completed by December 2026.	Improve health and resilience of fish populations
NSW		
A29. Regional Water Strategies	Catchment-based strategies, including strategies that apply across the northern Basin. Identify critical challenges, and priorities and actions in response. Set out a roadmap to deliver on five key objectives related to water for communities, economic prosperity, Aboriginal water rights, protecting the environment and improving affordability. The key challenges identified include: • *"Reduced connectivity impacts critical needs"* (Regional Water Strategy – Western). • Delivering water to the end of the system and connected valleys is identified as a challenge (Regional water strategies for the NSW Border Rivers, Gwydir, Namoi and Macquarie) In response to these challenges, the strategies prioritise a range of actions, including: • Improving connectivity across the northern Basin (Priority 3, Western Regional Strategy), • Share water differently to address critical needs of Border Rivers and downstream users (Priority 4 – Border Rivers • Water for critical human and environmental needs (Priority 1- Gwydir) • Improve the health and resilience of water-dependant ecosystems (Priority 3- Namoi) • Reduce water security risks in the region's west (Priority 2, Macquarie-Castlereagh). Actions under the Western Regional Strategy include: • Recovery of water for environmental purposes • Changes to the Barwon Darling water sharing plan to improve connectivity (see below).	Better understanding of risks to connectivity in the northern Basin. Actions taken to enable water to flow across connected catchments of the northern Basin to: • protect the first flush of water after an extended dry period 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 • suppress algal blooms • support fish migration.

Activity/initiative	Description	Intended contribution to connectivity outcomes
	• Operating dams and infrastructure to avoid cease-to-flow periods for as long as possible, prolonging low flows periods by keeping the river running and reducing no flows. Actions under the NSW Border Rivers, Gwydir, Namoi and Macquarie-Castlereagh strategies strategy include: • Investigate ways to improve connectivity within the Barwon-Darling on a multi-valley scale. • Improve fish passage at priority sites.	
A30. North-West Flow Plan	Plan limits access to supplementary flows in the northern Basin tributaries, and B- and C-class flows in the Barwon-Darling River until particular fish, algal suppression and riparian rights targets in the Barwon-Darling River are met. Requirement to meet the targets was added to the water sharing plans for the Border Rivers, Gwydir, Namoi and Macquarie but it has not been implemented. The plan has now been superseded by the work of the Independent Panel.	Maintain connectivity during dry periods to ensure minimum flows to achieve targets associated with: • riparian flows • algal suppression flows, and • fish migration flows.
A31. Water sharing plans	Plan objectives relate to protect and, if possible, improve water-dependent ecosystems, access to water for economic and industrial purposes, water quality, cultural purposes, etc. These objectives are dependent to some degree on connectivity but the objectives do not explicitly mention connectivity. Water sharing plans include: • strategies to "reserve a portion of natural flows to maintain hydrological connectivity between the water sources and other connected water sources" and • Prohibit the construction of in-river dams in certain locations. Within regulated water sources, the operator must operate the system in a way to ensure "maintenance of water supply" for certain water users (including stock and domestic, native tile rights, and high security water access licences) during a repeat of the period of "lowest accumulated inflows to the water source". (These rules are subject to ongoing review – see below). The plans establish a range of measures that contribute to connectivity outcomes, including: • A, B and C Class licence pumping thresholds along the Barwon–Darling	• Protect/maintain minimum flows for environmental purposes, stock and domestic • Prevent construction of physical barriers that limit connectivity For the Barwon-Darling: • Allow for protection of environmental flows • Restore connectivity following extended dry periods • 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

Activity/initiative	Description	Intended contribution to connectivity outcomes
	• 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 • managing to long term plan limits to control growth in use • cease to pump rules for unregulated rivers. Specific changes to improve connectivity were made to the Barwon-Darling water sharing plan in 2020 (see below). Plans are subject to audits to determine whether the plan's rules are being put into practice. **Example provisions from the Barwon-Darling water sharing plan** Barwon Darling – objectives include: to protect and contribute to the enhancement of… the longitudinal and lateral connectivity within the water source and between the water source and other water sources to support target ecological processes… Strategies include (Section 10(3)): • restrict the take of water to protect Active Environmental Water and to restore connectivity within and between water sources following an extended dry period, and • reserve a portion of flows to maintain longitudinal connectivity within and between the water source and other connected water sources. A range of changes were made to the water sharing plan in 2020 to improve connectivity, including: • **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. One of the	

Activity/initiative	Description	Intended contribution to connectivity outcomes
	recommendations of the Connectivity Expert Panel is to extend the resumption of flow rules up into the tributary valleys. The department is doing further analysis of this recommendation. The critical dry condition triggers reported in the Western Regional Water Strategy were intended to achieve the same outcome. protecting HEW from extraction as it moves though the Barwon– Darling (active management) – see action A32.	
A32. Active management to protect environmental flows (NBTK project)	The active management arrangements provide that when protected environmental is in the river, commence-to- pump heights are raised to allow the environmental water to remain instream to deliver its intended environmental outcome. This applies to both HEW and PEW. Active management is in place in the Barwon-Darling and the Gwydir and Macquarie unregulated water sources. NSW is working on a method to recognise held environmental water that has crossed the Qld/NSW border and flowing via the NSW Intersecting Streams into the Barwon-Darling, so it can be protected under active management arrangements rules in the Barwon-Darling.	Protect environmental flows and improve the connectivity outcomes associated with the flows
A33. Review of minimum inflows in NSW regulated water sharing plans	Independent review of water allocations methods and options for incorporating climate change into how water is allocated by water sharing plans. Forms basis for making available water determinations in regulated water sources, by ensuring water would be able to be supplied during a repeat of the period of lowest accumulated inflows to the water source, to meet priority requirements for basic landholder rights, domestic and stock, local water utility and high security access licences. Review being undertaken in accordance with the requirement within various water sharing plans (including those related to the regulated river water sources for the Border Rivers, Gwydir, and Macquarie Cudgegong) to review requirements relating to protection of minimum flows during the 'period of lowest accumulated inflows' or 'minimum inflows'. A revised methodology has been developed to incorporate consideration of climate variability and change into water allocation decisions. The methodology is about to undergo independent peer review.	Maintain minimum flows during extreme dry periods, and in the face of a changing climate If additional water for essential needs is reserved as a result of this review, it will support improvements to low flow connectivity during extreme dry periods (e.g. more water reserved to deliver essential needs during extreme dry periods).
A34. NSW Northern Basin	Program aims to enable water to flow across connected catchments of the northern NSW Murray-Darling Basin and downstream at important times.	Improved understanding of the policy and regulatory options for improving connectivity,

Activity/initiative	Description	Intended contribution to connectivity outcomes
Connectivity Program	Established the Independent Connectivity Expert Panel to review adequacy of analyses existing and proposed protections in water sharing plans across the northern Basin to meet downstream needs. Expert panel has provided a series of recommendations to improve connectivity, including: • floodplain harvesting restrictions • changes to rules for unregulated water sharing Ongoing response by the NSW Government includes: • review of unregulated water sharing plans to improve connectivity. next steps will include water sharing plan amendments to improve connectivity which will be consulted on in late 2025 for implementation by mid- 2026. • complete comprehensive hydrologic and economic analyses of the panel's recommendations to fully understand the potential benefits and impacts by December 2024 • release results of analysis and meet with key stakeholders in early 2025 to discuss findings and provide their input on on-ground experience and issues • development of a 'Pathway to improved northern Basin connectivity' which will outline the next steps the government will take and be released mid-2025.	leading to implementation of new arrangements to improve connectivity to: • protect the first flush after an extended dry period • reduce the impact of cease-to-flow periods and improve low-flow connectivity • support water quality • support fish migration.
A35. Long-term watering plans	Plans to guide the management of water for environmental outcomes over the longer term by describing the flow regimes that are required to maintain or improve environmental outcomes in the relevant catchment. Contribute to the achievement of the Basin-wide environmental water strategy by identifying • priority environmental assets and functions • ecological objectives and ecological targets for those assets and functions • environmental watering requirements needed to meet those targets and achieve the objectives. Aim to improve the way water is managed to maximise river and wetland health outcomes from all available water within and between catchments. Set objectives, targets and watering requirements for key plants, waterbirds, fish and system functions (including river connectivity) over 5-, 10- and 20-year timeframes. Watering plans are in place for all of the NSW catchments within the northern Basin.	• Maintain longitudinal connectivity within and between catchments to protect environmental functions including moving nutrients and sediments, allowing for organisms to disperse and improving water quality. • Maintain connectivity between key planning units and the provision of end of system flows to support inter-catchment flows.

Activity/initiative	Description	Intended contribution to connectivity outcomes
A36. NSW Government response to independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee	Includes a range of measures to reduce the risk of more mass fish deaths, including measures related to: • Fish passage: funding from the Australian Government of $2.3 million to plan for permanent fish passage solutions at Menindee Lakes and the Lower Darling-Baaka River. In the short term, temporary fish passage solutions are being considered and the remainder of Old Town Weir has been removed from the weir pool to help improve flows in the Lower Darling-Baaka River • Embargoes: the Department plans to restrict low priority licences as drier conditions escalate, when it is in the public interest • Rule changes: an Independent Connectivity Expert Panel is providing recommendations on changes needed to NSW water sharing plans to improve downstream outcomes (see action A34) • Water releases: actively managing releases from Lake Pamamaroo to maintain water quality in the Menindee town weir pool and reduce the risk of more mass fish deaths.	Maintain minimum flows during extreme dry periods and improve fish passage
A37. Compliance against the Longer Term Annual Average Extraction Limits (LTAAEL)	Each water sharing plan specifies how LTAAEL compliance is to be assessed. A compliance assessment is be completed yearly for inland regulated and Barwon-Darling unregulated water sharing plans using the best available models. A risk-based strategy will be used to determine the extent and timing of updates to the current conditions models. In other water sharing plans, LTAAEL compliance assessment will only be enabled when sufficient data becomes available through the non-urban water metering policy.	Support connectivity outcomes through retaining instream flows by ensuring that long-term extraction limits are being complied with.
A38. Northern Basin First Flush Assessment	Independent assessment into the management of the 2020 Northern Basin First Flush event following the 2018-2019 drought in the Northern Murray-Darling Basin. The objectives of the assessment were to • Provide transparency about the decision-making processes that were used to manage the event under the Water Management Act 2000 (NSW), and • Recommend strategies to improve the management of first flush events in the future.	Improve connectivity through more effective management arrangements for protecting first flows to meet critical human water needs and meet critical environmental water needs.
A39. Critical dry condition triggers to reduce risk to	Draft triggers designed to reduce the risk of critical water shortages leading to severe damage to water-dependent environments and failure of surface water supply for towns and landholders. The triggers are a signal that management action should be undertaken to reduce the risks. The triggers will initiate temporary water restrictions, for example when:	Protect flows during extreme dry times and the first flows after an extended dry period.

Activity/initiative	Description	Intended contribution to connectivity outcomes
environmental and human water needs	• There is a high confidence forecast cease-to-flow period of 120 days at Wilcannia (20 ML/day at Darling River at Wilcannia) • There is a high confidence forecast cease-to-flow for 60 days (0 ML/day at Darling River at Bourke • Menindee Lakes storage is forecast to fall below 195 GL capacity.	
A40. Water quality governance roadmap	Roadmap for improving governance related to measures for improving water quality. Includes two key pathways for improving water quality outcomes across NSW • Better integrating management of land, water and natural resources • Improving water quality data management and monitoring.	Improve flows, particularly low flows and related connectivity, that contribute towards maintenance of water quality.
A41. Fish friendly waterway crossings	Policy and legislative requirements related to planning, design and construction of waterway crossings in NSW.	Maintain connectivity for fish passage.
Queensland		
A42. Water plans and water management protocols	Water plans are subordinate legislation that define ecological, economic, social, and cultural outcomes; environmental flow objectives; and water allocation security objectives. These are supported by water management protocols and other instruments (resource operations licences, operation manuals) which establish rules for active flow management of water to support environmental outcomes including, connectivity-related outcomes. Water plans (and related accredited water resource plans) are in place for all Queensland Murray-Darling Basin (QMDB) catchments. Environmental objectives of significance for connectivity outcomes include (for example, for the Condamine Balonne) objectives related to: • No. of days in no-flow periods to support water hole persistence, and • No. of days between fish migration flow events. The plans prevent any increase in abstractions (through granting of new entitlements or changes to existing entitlements) to meet the sustainable diversion limits (SDLs) set by the Basin Plan. (Surface water SDLs have been met in all resource units except the Condamine	Improve longitudinal connectivity through: • Maintaining water for environmental, stock and domestic purposes • Protecting low flow events, including maintaining connectivity between waterholes • Protecting the ability of medium flow events to wet the watercourse and fill waterholes • Maintaining connectivity with terminal wetlands, such as Narran Lakes.

Activity/initiative	Description	Intended contribution to connectivity outcomes
	and Balonne where a further 8.48 GL needs to be recovered to meet the SDL target of 100 GL.) As most of the take of surface water is under unsupplemented (unregulated) water entitlements, there are limited opportunities to undertake watering actions through managing PEW or HEW. Protection of environmental flows during flow events is achieved primarily by restricting the take of water under water entitlements based on the flow conditions, e.g. by limiting take unless flow thresholds have been met or through announcements as to when entitlement holders can take water. This includes flow event management rules that provide for the active management of flow events to improve environmental outcomes. Rules are in place in the following water management areas: Lower Balonne: • Passing and storing of water for environmental, stock and domestic (ESD) purposes rule in Lower Balonne • Managing low flow event (including reducing water harvesting by 10% during low flow events) • Managing medium flow event (including reducing water harvesting by 10% during medium flow events) • Managing flow events to support Narran Lakes (including reducing water harvesting by 10% during flow events) • Protecting held environmental water through the Lower Balonne that has been recovered upstream of Beardmore Dam. Border Rivers: • 25% of flow volume protected as an environmental allowance through water harvesting announcements • 100 ML/day naturally occurring inflow protected from regulated take during period from September to March. Macintyre Brook: • To provide for environmental flows, first 100 megalitres per day of inflow into Coolmunda Dam must be released through the outlet works when the water level	

Activity/initiative	Description	Intended contribution to connectivity outcomes
	in Coolmunda Dam is less than full supply level and greater than 311.44 m AHD up to a volume of 6,000 megalitres per year. Upper and Lower Warrego: • If less than six months has passed since a passing flow greater than 1,000 megalitres, then access to water harvesting restricted until peak of flow has passed • If greater than six months has passed since a passing flow greater than 1,000 megalitres, then access to water harvesting restricted until 36 hours has lapsed since the flow peak has passed. Within the supplemented water supply schemes, rules are in place to support the connectivity-related outcomes by managing: • Use of waterholes • Storage operating levels • Change in rate of release • Pass flows.	
A43. Lower Balonne Water Management Area Water harvesting announced period guide	Establishes protocols for giving effect to water plan requirements related to: • Release of ESD water from Beardmore Dam • Protecting ESD water from water harvesting • Protecting HEW recovered upstream of Beardmore Dam • Announcing when water can be taken under water harvesting entitlements, and under which entitlements • Reductions in take in accordance with a flow event management rule.	As above for water plans
A44. Performance and Assessment Reports	Assessment of the effectiveness of water plans and their implementation. Prepared by the Minister under the Water Act at least every five years. Amongst other things, reports set out the extent to which a plan is advancing sustainable water resources management, risks to water plans outcomes, any non-compliances under water entitlements, and findings of research and monitoring.	Promote adaptive management and transparency of outcomes.
A45. Accounting for held environmental water passing	Established method for accounting for HEW passing the Qld/NSW border, developed in conjunction with NSW Department and CEWH. Commenced on 1 July 2021. Has accounted for more than 440 GL since that date. Provides basis for protection of HEW as it passes into NSW.	Allow New South Wales to actively manage HEW that passes the border to ensure that it continues to provide in-stream benefits within New South Wales, including connectivity-related outcomes.

Activity/initiative	Description	Intended contribution to connectivity outcomes
the Qld/NSW border (NBTK project)	Method is based on Queensland water plan rules and is consistent with the water allocation security objectives, environmental flow objectives and no growth rules set out in the relevant plans.	
A46. Environmental Flows Assessment Program (EFAP) and other research programs	Research to support water planning in Queensland. Current research focussed on connectivity in the Northern Basin includes: • Condamine-Balonne Fish Movement Project: focuses on golden perch and Murray cod movements in relation to river regulation and alterations to connectivity to understand the flow requirements of these species. • Hot Place Hypoxia Project: a range of environmental data is being collected to inform a waterholes' water quality model to better understand the carrying capacities of refugial waterholes in the QMDB. This project is also aimed at better managing the risks associated with fish kills. • Queensland government scientists also work collaboratively with other basin states on projects dealing with connectivity issues. An example of this is the use of the basin-wide acoustic array to explore fish movement throughout the basin.	Provide improved science related to connectivity and its role in achieving environmental outcomes, to support management decisions.
A47. Long-term watering plans (LTWPs) and Annual environmental watering priorities (AEWPs)	Made in accordance with the Basin Plan, LTWPs identify priority environmental assets and ecosystem functions, objectives and targets for the identified assets and functions, and corresponding environmental watering requirements. This includes objectives and targets that specifically provide for connectivity at various spatial scales. LTWPs are in place for all catchments in the Queensland Murray-Darling Basin. AEWPs are published annually by the Queensland government. which provide advice to the Commonwealth Environmental Water Holder – the only holder of e-water in Queensland. The AEWPs make recommendations about environmental watering, including those associated with the provision of longitudinal connectivity.	Contribute to within-catchment connectivity, including: • Increase frequency and/or duration of low in-channel flows that provide connectivity between neighbouring waterholes • Increase frequency and/or duration of medium or high flows that provide connectivity between river reaches • Increase the frequency or duration of flows that create connectivity with anabranches • Increase delivery of higher flows to create larger-scale longitudinal connectivity (e.g. to Narran Lakes) Contribute to outcomes in the basin-wide environmental watering strategy for basin-scale longitudinal connectivity.

Activity/initiative	Description	Intended contribution to connectivity outcomes
A48. Collaborations with and advice to the Commonwealth Environmental Water Office (NBTK project)	Various initiatives and ad hoc inputs to improve coordination of environmental water management in the Northern Basin. Includes: • Participation in the Northern Basin Environmental Working Group, co-ordinated by the Commonwealth Environmental Water Office, which determines watering actions in the Northern Basin (see item A22). • Provision of advice to the CEWO regarding watering actions based on EFAP outcomes. • Collaboration with CEWO and the NSW government to deliver environmental flows in the Northern Basin, in including: the Northern Connectivity Event (2018); the Northern Fish Flow (2019); and the Northern Waterholes Top-up (2020/21). • Work with the CEWO on new opportunities to provide environmental water e.g. event-based mechanisms and private store-and-release options.	Improve effectiveness of the management of environmental water, including extent to which it improves longitudinal connectivity between catchments.
A49. Overland flow water licencing and measurement	Controls to prevent growth in take of overland flow. Measures in place include: • Moratoriums on new overland flow works and modifications to existing works in place since 2000/2001 for all Queensland Murray-Darling Basin catchments. • Requirement for notification of existing overland flow works in place in 2003/04 (as required by water plan). • Requirement for water licensing of overland flow works in high- risk areas, such as the Lower Balonne floodplain. Where a water licence is required, the works must be certified by a Registered Professional Engineer. This provides the basis for a technical and hydrologic assessment of volume of water taken by the works and the basis for setting of water licence parameters. • Currently undertaking a process to grant and amend water licences for the take of overland flow water on the relevant floodplains of the Border Rivers and Moonie catchments. • Measurement is required in high risk areas in accordance with the recently-updated Non-Urban Water Measurement Policy and implementation plan (see action A50).	Protect longitudinal connectivity by ensuring no increase in take of overland flow water.
A50. Strengthened water measurement	A range of initiatives to increase the coverage and standard of metering, enable farm-scale measurement of overland flow, provide accurate data on water take, and improve compliance and enforcement. Being undertaken in accordance with the Qld Non-Urban Water Measurement Policy and legislative amendments to the *Water Act 2000* (Qld) passed in September 2023 and *Water Regulation 2016* (Qld) that commenced in July 2024.	Improve confidence that water take is in accordance with water entitlements, as a basis for protecting volumes and flows that have been allocated for environmental and connectivity-related outcomes

Activity/initiative	Description	Intended contribution to connectivity outcomes
	In accordance with the implementation plan, meter revalidation will be completed across the Qld Murray-Darling Basin by the end of 2026, and with the vast majority completed by the end of 2025. Current projects include: • improve the measurement and accounting of take of overland flow • subsidising telemetry for water users • improved measurement of large-take, high-risk water entitlements • strengthened metering policy using timeframes that consider water resource pressure and drought implications.	
A51. Requirements for constructing or raising waterway barrier works	Requirements under the Qld Planning Act and Fisheries Act for 'accepted development' (i.e. works that does not require a development permit). Applies to waterway barrier works, including new dams and weirs, and culverts and bed level crossings. Requirements are intended to minimise the extent to which waterway barriers inhibit the free movement of fish along waterways and onto floodplains.	Maintain connectivity for fish passage.

Appendix C – Mapping of connectivity-related activities against requirements

	Requirements:	R1. Objectives are defined	R2. Sufficient water is allocated to support connectivity objectives				R3. Flows are managed to achieve connectivity objectives, including during emergency events			
	Components:	Identify values and services (economic, ecological, cultural, social) that are dependent on longitudinal connectivity and Define objectives for longitudinal connectivity	Limit on total water taken (long-term) from watercourses and connected groundwater systems	Recovery of water for the environment	Water sharing arrangements	Regulation of overland flow take/interception activities	Water infrastructure operations	Abstraction management	HEW management	PEW management
Activities/initiatives:										
Commonwealth/Joint programs	A1. Water Act 2007 (Cth)	✓		✓						
	A2. Murray-Darling Basin Agreement				✓					
	A3. Murray-Darling Basin Plan 2012	✓	✓	✓						
	A4. Water recovery programs			✓						
	A5. Aboriginal Water Entitlements Program			✓						
	A6. Cultural Flows for Cultural Economies Program			✓						
	A7. Basin-wide Environmental Watering Strategy	✓							✓	
	A8. CEWH Annual Water Management Plan	✓							✓	
	A9. Event based mechanisms								✓	
	A10. Constraints Relaxation Implementation Roadmap									
	A11. Northern Basin Toolkit			✓						
	A12. Macquarie Marshes Enhanced Watering project									
	A13. NSW Fish for the Future: Reconnecting the Northern Basin project									
	A14. Toorale Water Infrastructure Project									
	A15. Gwydir Reconnecting Watercourse Country Program									
	A16. Wilcannia weir replacement project									
	A17. CEWH Environmental Activities									
	A18. Review of Menindee Lakes Operating Rules				✓			✓	✓	✓
	A19. Northern to southern Basin environmental flow protection trial				✓				✓	✓
	A20. Australian Government response to the Independent Assessment of the 2018-19 Fish									
	A21. Native Fish Recovery Strategy									
	A22. Governance to support environmental watering								✓	✓
	A23. Murray-Darling Basin Compliance Compact									
	A24. Improved northern Basin gauge network									
	A25. Fencing Northern Riverbanks project (NSW and Queensland)									
	A26. Licensing of floodplain harvesting in NSW					✓		✓		
	A27. Northern Murray-Darling Basin Metering Program									
	A28. Cold Water Pollution Mitigation at Pindari Dam									

	Requirements:	R4.Infrastructure (including green infrastructure) is designed to support connectivity objectives (including non-water infrastructure, e.g. roads, bridges)			R5. Water markets	R6. Governance				R7. Communication and engagement
	Components:	Understanding extent to which design of existing infrastructure supports connectivity	Modifications to existing infrastructure to improve connectivity	Regulatory requirements for new infrastructure to support connectivity objectives	Markets allow for trading of water entitlements to support connectivity and Trading water entitlements doesn't have negative impacts on connectivity	Monitoring, measuring, accounting and compliance	Reporting on outcomes, understanding effectiveness of existing actions and responding to new information	Modelling and forecasting (operational)	Coordination and decision-making	Sstakeholder awareness and engagement including First Nations engagement
Activities/initiatives:										
Commonwealth/Joint programs	A1. Water Act 2007 (Cth)				✓					
	A2. Murray-Darling Basin Agreement									
	A3. Murray-Darling Basin Plan 2012									
	A4. Water recovery programs									
	A5. Aboriginal Water Entitlements Program									✓
	A6. Cultural Flows for Cultural Economies Program									✓
	A7. Basin-wide Environmental Watering Strategy									
	A8. CEWH Annual Water Management Plan									
	A9. Event based mechanisms									
	A10. Constraints Relaxation Implementation Roadmap	✓	✓							
	A11. Northern Basin Toolkit		✓			✓				
	A12. Macquarie Marshes Enhanced Watering project		✓							
	A13. NSW Fish for the Future: Reconnecting the Northern Basin project		✓							
	A14. Toorale Water Infrastructure Project		✓							
	A15. Gwydir Reconnecting Watercourse Country Program		✓							
	A16. Wilcannia weir replacement project		✓							
	A17. CEWH Environmental Activities		✓					✓		
	A18. Review of Menindee Lakes Operating Rules		✓							
	A19. Northern to southern Basin environmental flow protection trial									
	A20. Australian Government response to the Independent Assessment of the 2018-19 Fish		✓			✓				
	A21. Native Fish Recovery Strategy	✓	✓							
	A22. Governance to support environmental watering								✓	✓
	A23. Murray-Darling Basin Compliance Compact					✓				
	A24. Improved northern Basin gauge network					✓				
	A25. Fencing Northern Riverbanks project (NSW and Queensland)		✓							
	A26. Licensing of floodplain harvesting in NSW					✓				
	A27. Northern Murray-Darling Basin Metering Program					✓	✓			
	A28. Cold Water Pollution Mitigation at Pindari Dam									

	Requirements:	R1. Objectives are defined	R2. Sufficient water is allocated to support connectivity objectives				R3. Flows are managed to achieve connectivity objectives, including during emergency events			
	Components:	Identify values and services (economic, ecological, cultural, social) that are dependent on longitudinal connectivity and Define objectives for longitudinal connectivity	Limit on total water taken (long-term) from watercourses and connected groundwater systems	Recovery of water for the environment	Water sharing arrangements	Regulation of overland flow take/interception activities	Water infrastructure operations	Abstraction management	HEW management	PEW management
Activities/initiatives:										
NSW	A29. Regional Water Strategies	✓		✓			✓			
	A30. North-West Flow Plan									
	A31. Water sharing plans	✓	✓		✓		✓	✓		✓
	A32. Active management to protect environmental flows							✓	✓	✓
	A33. Review of minimum inflows in NSW regulated water sharing plans		✓				✓			✓
	A34. NSW Northern Basin Connectivity Program				✓			✓		✓
	A35. Long-term watering plans	✓							✓	
	A36. NSW Government response to independent review into the 2023 fish deaths in the Darling-Baaka River						✓			
	A37. Compliance against the Longer Term Annual Average Extraction Limits (LTAAEL)									
	A38. Northern Basin First Flush Assessment									✓
	A39. Critical dry condition triggers to reduce risk to environmental and human water needs									✓
	A40. Water quality governance roadmap									
	A41. Fish friendly waterway crossings									
Queensland	A42. Water plans and water management protocols	✓	✓	✓	✓		✓	✓		✓
	A43. Lower Balonne Water Management Area Water harvesting announced period guide						✓	✓		✓
	A44. Performance and Assessment Reports									
	A45. Accounting for held environmental water passing the Qld/NSW border								✓	
	A46. Environmental Flows Assessment Program (EFAP) and other research programs									
	A47. Long-term watering plans (LTWPs) and Annual environmental watering priorities (AEWPs)	✓							✓	
	A48. Collaborations with and advice to the Commonwealth Environmental Water Office									✓
	A49. Overland flow water licencing and measurement					✓		✓		
	A50. Strengthened water measurement									
	A51. Requirements for constructing or raising waterway barrier works									

	Requirements:	R4.Infrastructure (including green infrastructure) is designed to support connectivity objectives (including non-water infrastructure, e.g. roads, bridges)			R5. Water markets	R6. Governance				R7. Communication and engagement
	Components:	Understanding extent to which design of existing infrastructure supports connectivity	Modifications to existing infrastructure to improve connectivity	Regulatory requirements for new infrastructure to support connectivity objectives	Markets allow for trading of water entitlements to support connectivity and Trading water entitlements doesn't have negative impacts on connectivity	Monitoring, measuring, accounting and compliance	Reporting on outcomes, understanding effectiveness of existing actions and responding to new information	Modelling and forecasting (operational)	Coordination and decision-making	Sstakeholder awareness and engagement including First Nations engagement
Activities/initiatives:										
NSW	A29. Regional Water Strategies									
	A30. North-West Flow Plan									
	A31. Water sharing plans			✓	✓		✓			✓
	A32. Active management to protect environmental flows					✓	✓	✓		
	A33. Review of minimum inflows in NSW regulated water sharing plans						✓			
	A34. NSW Northern Basin Connectivity Program									
	A35. Long-term watering plans									
	A36. NSW Government response to independent review into the 2023 fish deaths in the Darling-Baaka River		✓							
	A37. Compliance against the Longer Term Annual Average Extraction Limits (LTAAEL)					✓				
	A38. Northern Basin First Flush Assessment						✓			
	A39. Critical dry condition triggers to reduce risk to environmental and human water needs						✓			
	A40. Water quality governance roadmap								✓	
	A41. Fish friendly waterway crossings			✓						
Queensland	A42. Water plans and water management protocols				✓		✓			✓
	A43. Lower Balonne Water Management Area Water harvesting announced period guide									
	A44. Performance and Assessment Reports						✓			✓
	A45. Accounting for held environmental water passing the Qld/NSW border					✓				
	A46. Environmental Flows Assessment Program (EFAP) and other research programs						✓			
	A47. Long-term watering plans (LTWPs) and Annual environmental watering priorities (AEWPs)									
	A48. Collaborations with and advice to the Commonwealth Environmental Water Office									
	A49. Overland flow water licencing and measurement					✓				
	A50. Strengthened water measurement					✓				
	A51. Requirements for constructing or raising waterway barrier works			✓						

Appendix D – Framework and analysis of connectivity-related activities

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
R1. Objectives are defined	Identify values and services (economic, ecological, cultural, social) that are dependent on longitudinal connectivity and Define objectives for longitudinal connectivity	Water Act	A1	Whole of basin	DCCEEW, MDBA, State water agencies	Ongoing	BAU	**Extent to which requirement is met** Requirement is well satisfied. Objectives related to longitudinal connectivity are included in plans and strategies at multiple levels, and hence embedded in 'business as usual' practices. Values are well defined at basin and catchment scales, including detailed ecological values. **Gaps, opportunities and other considerations** Some objectives are aspirational and/or do not lend themselves to reporting, notably flow objectives that are defined as long-term average (modelled) values. Consideration should be given to: - how objectives could be defined to better align with and support event-based management - scope for including regional or inter-catchment connectivity objectives including greater specificity where objectives simply refer to 'improving connectivity', without defining the type or level of connectivity targeted.
		Basin Plan	A3	Whole of basin	MDBA	Ongoing, next review in 2026	BAU	
		Basin-wide environmental watering strategy	A7	Whole of basin	MDBA	Ongoing, reviewed every 5 years	BAU	
		Long-term environmental watering plans (NSW and Qld)	A35 & A47	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 5 years	BAU	
		Water sharing plans (NSW)/ water plans (Qld)	A31 & A42	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 10 years	BAU	
		Regional water strategies (NSW)	A29	Regional (NSW)	State water managers	Ongoing – intended to meet requirements over 20-40 years	BAU	
		CEWH Annual Water Management Plan	A8	Whole of basin	CEWO	Annual plan, objectives updated annually	BAU	
R2. Water is allocated to	Limit on total water taken (long-	Basin plan	A3	Whole of basin	MDBA	Ongoing, next review in 2026	BAU	**Extent to which requirement is met** Requirement is very well satisfied.

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
support connectivity objectives	term) from watercourses and connected groundwater systems	Water plans/water sharing plans	A31 & A42	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 10 years	BAU	Sustainable diversion limits (SDLs), given effect through the basin plan and state water resource plans, establish a robust limit on the total water taken over the long term. Establishing SDLs, and recovering water to meet the SDLs, has been the major focus under the basin plan. These requirements are embedded in the water resource management framework through water resource plans and given effect through water access entitlement regimes. In NSW there is a further plan limit (the long-term average annual extraction limit) set at the water sharing plan scale. This rule has already been used to reduce allocations to control growth in the Namoi, Gwydir, and NSW Border Rivers. State processes have or are considering the implications of climate change for water availability, water access entitlements and/or allocations. Given the relatively short period that the SDLs have been in place, it is difficult to assess their adequacy in, or specific contribution to, achieving on-ground outcomes. **Gaps, opportunities and other considerations** The basin plan review presents an opportunity to assess whether the approach is appropriate under climate change scenarios. There are limits on the extent to which managing the average, long-term take of water can deliver connectivity outcomes in a highly variable and mostly unregulated system like the northern Basin. In the future
		Review of minimum inflows in NSW regulated water sharing plans	A33	NSW catchments	Office of the Chief Scientist & Engineer	Review underway, report due March 2025	Requires outcomes to be incorporated into water sharing plans	
	Recovery of water for the environment	Water Act 2007	39	Whole of basin	MDBA	Sets revised timeframe to recovery water for the environment (December 2027)	Outcomes dependent on water recovery	
		Basin Plan	A3	Whole of basin	MDBA	Ongoing, next review in 2026	BAU	
		Water recovery programs	A4	Condamine-Balonne and NSW Border rivers catchments	DCCEEW	Targets recovery water for the environment (December 2027)	Dependent on adequate funding/delivery of projects to recovery water to meet targets	
		Regional water strategies (NSW)	A29	Regional (NSW)	State water agencies	Ongoing – intended to meet requirements over 20-40 years	BAU	
		Implementation of Measures to Improve Environmental Outcomes in the Northern MDB and Northern Basin Toolkit	A11	Northern basin	DCCEEW and State water agencies	Projects to be completed by December 2026	Program limited to available funds. Sustainability of individual projects varies.	
		Aboriginal water entitlements program	A5	Whole of basin	DCCEEW	Forthcoming	Program limited to available funds. Benefits from purchases constrained by capacity	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
							of FN groups to effectively manage entitlements.	it may be appropriate to shift the focus in the northern Basin to improving management of individual flow events to improve connectivity outcomes (i.e. event-based management). The management of First Nations water entitlements may contribute towards connectivity outcomes in some instances and there is an opportunity to coordinate the management of this water and environmental water where objectives align.
		Cultural Flows Planning for Cultural Economies	A6	Whole of basin	DCCEEW	Currently open for proposals	Program limited to available funds. Benefits from plans contingent on FN groups owning entitlements and having capacity to deliver on plans.	
	Water sharing arrangements	Murray-Darling Basin Agreement	A2	Whole of basin	MDBA, State water agencies	Ongoing	BAU	**Extent to which requirement is met** Requirement is well satisfied but remains a significant work in progress. Water sharing arrangements across the basin are well established and provide certainty to State agencies, environmental water holders and water users regarding how water will be made available under different conditions. **Gaps, opportunities and other considerations** Ongoing activities to better protect environmental flows, including those crossing the Qld/NSW border, to reach and pass through the Menindee Lakes system provide a significant opportunity to improve connectivity outcomes through the northern Basin and into the lower Darling.
		Water plans/water sharing plans	A31 & A42	Catchment based, but capturing entire basin	Water plans/water sharing plans	Ongoing, reviewed every 10 years	BAU	
		NSW Northern Basin Connectivity Program	A34	Northern Basin – NSW	NSW water agency	Ongoing – implementation by mid-2026	Outcomes dependent on changes being incorporated into water sharing plans	
		Review of Menindee Lakes operating rules	A18	Menindee Lakes (impacts downstream)	MDBA	To run from June 2024 to December 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	
		Northern to southern Basin environmental flow protection trial	A19	Menindee Lakes and lower Darling	MDBA and State water managers	12-month trial from May 2024 to June 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	
	Regulation of overland flow/ floodplain harvesting	Overland flow licensing and measurement	A49	Northern basin – Qld (high risk areas)	Qld water agency	Licensing for overland flow being expanded to Border Rivers and Moonie	Requires resource commitment to further expand licensing	**Extent to which requirement is met** Requirement is satisfied, noting that it remains a work in progress. Robust controls are in place that aim to limit any further growth in interception activities and the

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
	take/interception activities	Licensing of floodplain harvesting in NSW and floodplain harvesting measurement	A26	NSW catchments	NSW water agency	Licences to be in place for all northern valleys by early 2025	Will require changes to the water sharing plans	take of overland flow/floodplain harvesting water. **Gaps, opportunities and other considerations** While the total amount of overland flow/floodplain harvesting water taken remains capped at a point in time (e.g. early 2000s in the case of Queensland), the measurement, regulation, management and modelling of overland flow/floodplain harvesting water has proven to be particularly complex and challenging. Consider opportunities for focussing more on the measurement and regulation of overland flow/floodplain harvesting water – and the implications for in river flows and connectivity – on an event-by-event (rather than annual) basis.
R3. Flows are managed to achieve connectivity objectives, including during emergency events	Water infrastructure operations	Regional water strategies (NSW)	A29	Regional (NSW)	State water managers	Ongoing – intended to meet requirements over 20-40 years	BAU	**Extent to which requirement is met** Requirement is satisfied, noting that there is significant work in progress. Infrastructure operating arrangements include provisions related to flow releases to maintain connectivity. Rules are subject to an ongoing process of continuous improvement, as evidenced by a range of reviews. **Gaps, opportunities and other considerations** Consider opportunities to adapt the findings from reviews of previous events to other locations in the northern Basin.
		Water plans/water sharing plans	A31 & A42	Catchment based, but capturing entire basin	State water managers	Ongoing, reviewed every 10 years	BAU	
		Review of minimum inflows in NSW regulated water sharing plans	A33	NSW catchments	Office of the Chief Scientist & Engineer	Review underway, report due March 2025	Requires outcomes of review to be incorporated into water sharing plans	
		NSW Government response to independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee	A36	Barwon-Darling and Menindee Lakes	NSW agencies	Various commitments over 12-month period to December 2024	Requires commitments to be implemented and future funding	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
		Lower Balonne Water Management Area Water harvesting announced period guide	A43	Lower Balonne (Qld)	Qld water agency	Ongoing	BAU	
	Abstraction management	Water sharing plans (NSW)/ water plans (Qld)	A31 & A42	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 10 years	BAU	**Extent to which requirement is met** Requirement is satisfied, noting that there is significant work in progress. Approaches to abstraction management have focussed primarily on meeting requirements related to the SDLs and long-term average levels of take. There have also been considerable efforts to improve compliance and enforcement, including in agency establishment and reform and development of improved water data capture, information and analytics (also see R6). There have been significant advances in abstraction management to adjust levels of take during different flow events, to support environmental and connectivity-related outcomes. **Gaps, opportunities and other considerations** An increased focus on event-based management will require a more sophisticated approach to managing water abstractions during flow events. This is a major focus of the ongoing work related to the NSW Independent Connectivity Panel. The close linkages between water sharing plans/water plans and requirements related to abstraction management will likely require periodic changes to plans to meet new management requirements, including in response to various ongoing reviews.
		Active management to protect environmental flows	A32	Barwon-Darling and the Gwydir and Macquarie unregulated water sources	NSW water agencies	Ongoing, method to be expanded in next 12 months to include cross-border e-water	BAU	
		Review of Menindee Lakes operating rules	A18	Menindee Lakes (impacts downstream)	MDBA	To run from June 2024 to December 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	
		NSW Northern Basin Connectivity Program	A34	Northern Basin – NSW	NSW water agencies	Ongoing, detailed response to expert panel report and implementation by mid-2026	Outcomes dependent on changes being incorporated into water sharing plans	
		Licensing of floodplain harvesting in NSW and floodplain harvesting measurement	A26	NSW catchments	NSW water agency	Licences to be in place for all northern valleys by early 2025	Will require changes to the water sharing plans	
		Overland flow licensing and measurement	A49	Northern basin – Qld (high risk areas)	Qld water agency	Licensing for overland flow being expanded to Border Rivers and Moonie	Requires resource commitment to further expand licensing	
		Lower Balonne Water Management Area Water harvesting announced period guide	A43	Lower Balonne (Qld)	Qld water agency	Ongoing	BAU	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
								Consider opportunities to adapt the findings from reviews of previous events to other locations in the northern Basin.
	HEW management	Basin-wide environmental watering strategy	A7	Whole of basin	MDBA	Ongoing, reviewed every 5 years	BAU	**Extent to which requirement is met** Requirement is well satisfied. Management of HEW has been a high priority over the last decade. Comprehensive planning arrangements are now in place and HEW is managed to achieve connectivity outcomes as part of business as usual. There is a process of continuous improvement in place. **Gaps, opportunities and other considerations** There are opportunities to expand approaches to accounting for and protecting HEW. This includes expanding the approach to active management to protect environmental flows that has been successfully applied, in the Barwon-Darling, the Lower Macquarie Bogan and the Gwydir, to other catchments and through Menindee Lakes. There are also opportunities to expand the use of event-based mechanisms. There is likely to be a need for more innovative approaches to accessing and utilising water in the northern Basin, given the limited extent of instream, public water infrastructure. Initial trials undertaken by the CEWO provide a good basis for expanding approaches to HEW management.
		Long-term environmental watering plans (NSW and Qld)	A35 & A47	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 5 years	BAU	
		Active management to protect environmental flows	A32	Barwon-Darling and the Gwydir and Macquarie unregulated water sources	NSW water agencies	Ongoing, method to be expanded in next 12 months to include cross-border e-water	BAU	
		Northern to southern Basin environmental flow protection trial	A19	Menindee Lakes and lower Darling	MDBA and State water agencies	12-month trial from May 2024 to June 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	
		Event-based mechanisms	A9	Lower Balonne (to date)	CEWO	Ad hoc – no timetable for ongoing implementation or expansion	Requires ongoing commitment to and expansion of EBMs	
		Review of Menindee Lakes operating rules	A18	Menindee Lakes (impacts downstream)	MDBA	To run from June 2024 to December 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	
		Governance to support environmental watering	A22	Whole of basin	DEECEW, State water agencies, MDBA	Ongoing	BAU	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
		Accounting for HEW passing the Qld/NSW border	A45	Northern Basin - Qld (but not all entitlements)	State water agencies	Ongoing	BAU	
		CEWH Annual Water Management Plan	A8	Whole of basin	CEWO	Annual plan, objectives updated annually	BAU	
	PEW management	Water plans/water sharing plans	A31 & A42	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 10 years	BAU	**Extent to which requirement is met** Requirement is well satisfied. There are extensive provisions in place as part of existing plans and supporting measures to provide and manage PEW to achieve connectivity outcomes. **Gaps, opportunities and other considerations** Objectives related to PEW are generally limited to the end of catchment. Consideration should be given to how catchment-level objectives and PEW requirements might be expanded to provide and protect PEW to support inter-catchment connectivity outcomes. This could include consideration of the role of the basin plan in this regard.
		Active management to protect environmental flows	A32	Barwon-Darling and the Gwydir and Macquarie unregulated water sources	NSW water agencies	Ongoing, method to be expanded in next 12 months to include cross-border e-water	BAU	
		Review of Menindee Lakes operating rules	A18	Menindee Lakes (impacts downstream)	MDBA	To run from June 2024 to December 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	
		Northern to southern Basin environmental flow protection trial	A19	Menindee Lakes and lower Darling	MDBA and State water agencies	12-month trial from May 2024 to June 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	
		Lower Balonne Water Management Area Water harvesting announced period guide	A43	Lower Balonne (Qld)	Qld water agency	Ongoing	BAU	
		Governance to support environmental watering	A22	Whole of basin	DEECEW, State water agencies, MDBA	Ongoing	BAU	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
		Collaborations with and advice to the CEWO	A48	Norther Basin – QLD	CEWO, Qld water agency	Ongoing	BAU	
		NSW Northern Basin Connectivity Program	A34	Northern Basin – NSW	NSW water agencies	Ongoing, detailed response to expert panel report and implementation by mid-2026	Outcomes dependent on changes being incorporated into water sharing plans	
		Northern Basin First Flush Assessment	A38	Northern basin – NSW	NSW water agency	Review complete, implementation of recommendations ongoing	Outcomes contingent on uptake of recommendations	
		Review of minimum inflows in NSW regulated water sharing plans	A33	NSW catchments	Office of the Chief Scientist & Engineer	Review underway, report due March 2025	Requires outcomes to be incorporated into water sharing plans	
		Critical dry condition triggers to reduce risk to environmental and human water needs	A39	Barwon-Darling	NSW water agency	Ongoing – revised modelling requested as a result of Connectivity Expert Panel recommendations	Requires outcomes to be incorporated into water sharing plans	
R4. Infrastructure (including green infrastructure) is designed to support connectivity objectives (including non-water infrastructure, e.g. roads, bridges)	Understanding extent to which design of existing infrastructure supports connectivity	Constraints Relaxation Implementation Roadmap	A10	Gwydir	NSW water agency	Roadmap due end 2024	Dependent on investment in actions to deliver on the roadmap	**Extent to which requirement is met** Requirement is satisfied. There has been substantial investment in modifying existing water infrastructure to improve connectivity outcomes, particularly related to fish passage. Most of the investment in infrastructure modifications has been for one-off projects. The review has not been able to assess the extent to which the improved connectivity associated with modifications to
		Native Fish Recovery Strategy	A21	Whole of basin	MDBA and State agencies	30-year horizon with 10-year implementation stages.	Dependent on investment in actions to deliver on the strategy	
	Modifications to existing infrastructure to	Review of Menindee Lakes operating rules	A18	Menindee Lakes (impacts downstream)	MDBA	To run from June 2024 to December 2025	Outcomes dependent on changes being adopted in MDB Agreement and water sharing plans	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
	improve connectivity	Implementation of Measures to Improve Environmental Outcomes in the Northern MDB and Northern Basin Toolkit	A11	Northern basin	DCCEEW and State water agencies	Projects to be completed by December 2026	Program limited to available funds. Sustainability of individual projects varies.	infrastructure requires ongoing maintenance/investment. Research projects provide some baseline information on barriers in Qld watercourses in the northern Basin and associated risks.[24] **Gaps, opportunities and other considerations** The review has not been able to determine whether there has been a systematic process for identifying barriers that are impacting on connectivity and for prioritising investment in removing or mitigating the impacts of those barriers. Consideration should be given to developing a master plan for the basin to prioritise future interventions and the allocation of funding to maximise connectivity benefits.
		Native fish recovery strategy	A21	Whole of basin	MDBA and State agencies	30-year horizon with 10-year implementation stages.	Dependent on investment in actions to deliver on the strategy	
		CEWH Environmental Activities	A17	Whole of basin	CEWO	Ongoing	Contingent on funds raised through temporary trading	
		Australian Government response to the Independent Assessment of the 2018-19 Fish Deaths in the Lower Darling	A20	Barwon-Darling	MDBA, NSW water agency	Complete? (Latest update online is from Dec 2021)	Varies for different responses	
		Macquarie Marshes Enhanced Watering project	A12	Macquarie River	NSW water agency	Complete	Outcomes expected to be enduring without further intervention	
		NSW Fish for the Future: Reconnecting the Northern Basin project	A13	NSW Border Rivers, Barwon-Darling	NSW agencies	Partly completed	Funding required to complete additional works. Ongoing funding unlikely to be required where works have been completed	

[24] Barriers database - Detailed information on the size, shape and drownout thresholds for all instream barriers in the QMDB based on 3d drone imagery; Assessment of the combined risk to migratory fish from flow regime change and barriers to dispersal (Marshall JC, Lobegeiger JS and Starkey A (2021) Risks to Fish Populations in Dryland Rivers From the Combined Threats of Drought and Instream Barriers. Front. Environ. Sci. 9:671556.)

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
		Toorale Water Infrastructure Project	A14	Warrego River	NSW water agency	Complete	Outcomes expected to be enduring without further intervention	
		Gwydir Reconnecting Watercourse Country Program	A15	Gwydir River	NSW water agency	Ongoing. Expected to be completed by December 2026		
		Wilcannia weir replacement project	A16	Darling River	NSW water agency	Project paused pending independent review of environmental impacts	If implemented, outcomes expected to be enduring/ongoing	
		NSW Government response to independent review into the 2023 fish deaths in the Darling-Baaka River at Menindee	A36	Barwon-Darling and Menindee Lakes	NSW agencies	Various commitments over 12-month period to December 2024	Requires commitments to be implemented and future funding	
		Fencing Northern Riverbanks Project (NSW and Qld)	A25	Northern Basin	NSW and Qld agencies	Complete	Benefits from fencing projects contingent on landholders maintaining infrastructure	
	Regulatory requirements for new infrastructure to support connectivity objectives	Water sharing plans (NSW)/ water plans (Qld)	A31 & A42	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 10 years	BAU	**Extent to which requirement is met** Requirement is satisfied. New works in a waterway are generally required to accommodate fish passage. **Gaps, opportunities and other considerations** Both NSW water sharing plans and Qld water plans place restrictions on where/who can construct instream storages. Consideration should be given to whether there has been a strategic assessment of the implications of new infrastructure for connectivity and hence
		Requirements for constructing or raising waterway barrier works	A51	Northern Basin – Qld	Qld agencies	Ongoing	BAU	
		Fish friendly waterway crossings	A41	Northern Basin – NSW	NSW agencies	Ongoing	BAU	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
								whether these restrictions might be expanded/adjusted.
R5. Water markets	Markets allow for trading of water entitlements to support connectivity and Trading water entitlements doesn't have negative impacts on connectivity	Water Act	A1	Whole of basin	DCCEEW, MDBA, State water agencies	Ongoing Sets timeframe to recovery water for the environment (December 2027)	BAU Outcomes dependent on water recovery	**Extent to which requirement is met** Requirement is satisfied. The water market arrangements have broadly supported the recovery of water and water trading rules are in place to prevent or minimise impacts on environmental flows (including connectivity) as a result of water trading. **Gaps, opportunities and other considerations** We understand that there are concerns in some quarters that there is an actual or perceived inequity of trade opportunities for water entitlements for environmental purposes (i.e. differential treatment of e-water entitlements), and that consideration is being given to ensuring all water entitlements are treated the same. There is a risk that such changes to trading rules could limit options for managing environmental water. Consideration should be given to maintaining/maximising opportunities for trading environmental water, provided it does not adversely impact on other users. This recommendation is consistent with ongoing work as art of the Water market reform: final roadmap report.
		Water sharing plans (NSW)/ water plans (Qld)	A31 & A42	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 10 years	BAU	
R6. Governance	Monitoring, measuring, accounting and compliance	Compliance against the Longer Term Annual Average Extraction Limits (LTAAEL)	A37	Northern Basin - NSW	NSW water agency	Annual	BAU	**Extent to which requirement is met** Requirement is well satisfied. There has been significant investment and resultant improvement in governance mechanisms, including compliance, monitoring and reporting. A number of recent improvements have been delivered through one-off investments. It is not clear the extent to
		Active management to protect environmental flows	A32	Barwon-Darling and the Gwydir and Macquarie unregulated water sources	NSW water agencies	Ongoing, method to be expanded in next 12 months to include cross-border e-water	BAU	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
		Accounting for HEW passing the Qld/NSW border	A45	Northern Basin - Qld (but not all entitlements)	State water agencies	Ongoing	BAU	which ongoing funding is required or available to maintain assets and benefits. **Gaps, opportunities and other considerations** There will continue to be opportunities to improve and expand existing compliance, accounting and measurement. Notably, any increased focus on event-based management will likely need to be supported by strengthened arrangements in accounting, compliance, monitoring and measurement.
		Implementation of Measures to Improve Environmental Outcomes in the Northern MDB and Northern Basin Toolkit	A11	Northern basin	DCCEEW and State water agencies	Projects to be completed by December 2026	Program limited to available funds. Sustainability of individual projects varies.	
		Murray-Darling Basin Compliance Compact (including projects under the Hydrometric Networks and Remote Sensing Program)	A23	Whole of basin	Cth and States	Complete	Dependent on ongoing implementation of activities under the compact	
		Improved northern Basin gauge network	A24	Northern basin	MDBA, BOM and State agencies	Complete	Ongoing funding required to maintain assets/tools	
		Australian Government response to the Independent Assessment of the 2018-19 Fish Deaths in the Lower Darling	A20	Barwon-Darling	MDBA, NSW water agency	Complete? (Latest update online is from Dec 2021)	Varies for different responses	
		Overland flow licensing and measurement	A49	Northern basin – Qld (high risk areas)	Qld water agency	Licensing for overland flow being expanded to Border Rivers and Moonie	Requires resource commitment to further expand licensing	
		Strengthened water measurement	A50	Qld MDB	Qld water agency	Metering completed by end of 2026	Ongoing costs will be responsibility of water users	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
	Reporting on outcomes, understanding effectiveness of existing actions and responding to new information	Water plans/water sharing plans	A31 & A42	Catchment based, but capturing entire basin	State water managers	Ongoing, reviewed every 10 years	BAU	**Extent to which requirement is met** Requirement is broadly satisfied. Reporting on outcomes is via a mixture of periodic and one-off reporting. **Gaps, opportunities and other considerations** Consideration should be given to the extent to which existing reporting arrangements are meeting the expectations of stakeholders and providing them with confidence in the effectiveness of existing approaches to improving connectivity. As noted above with respect to objectives (R1), consideration should be given to whether objectives are currently defined in a way that allows for outcomes to be assessed against those objectives. Consideration should be given to how reporting, assessment of actions, and adaptive management might need to be adjusted in circumstances where and when there is a greater focus on event-based management.
		Performance and Assessment Reports	A44	Northern Basin - Qld	Qld water agency	Ongoing, reports on water plans every 5 years	BAU	
		Review of minimum inflows in NSW regulated water sharing plans	A33	NSW catchments	Office of the Chief Scientist & Engineer	Review underway, report due March 2025	Requires outcomes to be incorporated into water sharing plans	
		Critical dry condition triggers to reduce risk to environmental and human water needs	A39	Barwon-Darling	NSW water agency	Ongoing – revised modelling requested as a result of Connectivity Expert Panel recommendations	Requires outcomes to be incorporated into water sharing plans	
		Northern Basin First Flush Assessment	A38	Northern basin – NSW	NSW water agency	Review complete, implementation of recommendations ongoing	Outcomes contingent on uptake of recommendations	
		Active management to protect environmental flows	A32	Barwon-Darling and the Gwydir and Macquarie unregulated water sources	NSW water agencies	Ongoing, method to be expanded in next 12 months to include cross-border e-water	BAU	
		Environmental Flows Assessment Program (EFAP) and other research programs	A46	Northern Basin - Qld	Qld agencies	Ongoing	BAU, but subject to changes in funding and priorities	
	Modelling and forecasting (operational)	Active management to protect environmental flows	A32	Barwon-Darling and the Gwydir and Macquarie	NSW water agencies	Ongoing, method to be expanded in next 12 months to	BAU	**Extent to which requirement is met** Requirement is broadly satisfied although remains a work in progress.

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
				unregulated water sources		include cross-border e-water		There is substantial ongoing investment in improved modelling and forecasting, particularly to support planning initiatives, notably the basin plan review and for state water resources planning. **Gaps, opportunities and other considerations** Consideration should be given to the adequacy of existing modelling and forecasting systems to support event-based management in the northern Basin.
	Coordination and decision-making	Water quality governance roadmap	A40	Northern basin - NSW	NSW agencies	Roadmap released in June 2024, subject to ongoing implementation	Dependent on ongoing implementation of activities under the roadmap	**Extent to which requirement is met** Requirement is well satisfied. There appear to be good, established mechanisms in place to support collaborative decision-making and coordinated actions. **Gaps, opportunities and other considerations** Consider if there are additional opportunities to share the considerable experience that has been developed across agencies in managing water for connectivity outcomes, both through BAU operations as well as specific reviews.
		Governance to support environmental watering	A22	Whole of basin	DEECEW, State water agencies, MDBA	Ongoing	BAU	
R7. Communication and engagement	Stakeholder awareness and engagement (including First Nations)	Water plans/water sharing plans	A31 & A42	Catchment based, but capturing entire basin	State water agencies	Ongoing, reviewed every 10 years	BAU	**Extent to which requirement is met** Requirement is broadly satisfied. There are a range of measures in place to support communication and engagement with the stakeholder base. **Gaps, opportunities and other considerations** Improving stakeholder understanding of the role and importance of connectivity is implicit in delivering on many of the objectives for the northern Basin. The review has not considered the wide range of ways that agencies communicate with
		Performance and Assessment Reports	A44	Northern Basin - Qld	Qld water agency	Ongoing, reports on water plans every 5 years	BAU	
		Governance to support environmental watering	A22	Whole of basin	DEECEW, State water agencies, MDBA	Ongoing	BAU	

Requirement	Component	Activity	Ref.	Where	Who	Timescale	Sustainability of activity	Extent to which requirement is met, gaps, opportunities, and other considerations
		Aboriginal water entitlements program	A5	Whole of basin	DCCEEW	Purchasing FY24/25-25/26	Program limited to available funds and options determined by the water markets. Benefits from purchases constrained by capacity of FN groups to effectively manage entitlements.	stakeholders on water resources management issues. Any increased focus on event-based management will require an accompanying increase in effort to engage with stakeholders in planning, before, during and after flow events. Increasing opportunities for First Nations groups in water ownerships, management and inclusion in decision making is likely to require a substantial investment to achieve successful outcomes.
		Cultural Flows Planning for Cultural Economies	A6	Whole of basin	DCCEEW	FY 24/25 – 26/27	Program limited to available funds. Benefits from plans contingent on FN groups access to water entitlements and water expertise.	
		CEWH Environmental Activities	A17	Whole of basin	CEWO	Ongoing	Contingent on funds raised through temporary trading	
		Governance to support environmental watering	A22	Whole of basin	DEECEW, State water agencies, MDBA	Ongoing	BAU	