



Murray–Darling Water and Environment Research

Annual Progress Update 2021–22





Table of Contents

1.	Introduction	4
2.	Context	4
3.	Key achievements	5
4.	Progress towards objectives	5
5.	Progress in the strategic research stream	9
	5.1. Climate adaptation	9
	5.2. Hydrology	12
	5.3. Environmental outcomes	14
	5.4. Social, economic, and cultural outcomes	16
6.	Progress in the tactical investment stream	18
	6.1. Explaining the causes of reduced flow through the northern Basin	18
	6.2. Innovation sweep, scoping and development of drone-based waterbird monitori	ng.18
	6.3. Riverbank stability and erosion	19
	6.4. Summary and analysis of blue-green algae trends in the Basin	19
	6.5. Waterbirds foraging habitat	20
7.	2022 Annual symposium	21
8.	First Nations engagement	22
9.	Annual financial acquittal	23
10.	Glossary of terms	24

Note: A Machinery of Government change occurred to the Australian Government department responsible for water which came into place on 01 July 2022. The Department of Agriculture, Water and the Environment (DAWE) is used for the purposes of this report as it pertains to the period 01 July 2021 to 30 June 2022.

Cover photograph: La Trobe University Professor Nick Bond addresses the 2022 MD–WERP Annual Symposium.

Chair's foreword

Now more than ever, the way we manage our rivers needs to be based on the best available knowledge so we can maximise the benefit of water use for industry, environment, First Nations, and communities.

Conditions in the Murray–Darling Basin are changing. These changes are affecting Basin ecosystems and the way we live, farm, and interact with rivers. We need to make sure we are well prepared for what is coming.

This is where science and knowledge play an important role - by helping to inform water and environment management decisions to improve outcomes for the Basin and its communities.

The Murray–Darling Water and Environment Research Program (MD–WERP) is a comprehensive, multi-party collaboration involving a rich and diverse blend of more than 17 government and non-government institutions. It is apparent as the program progresses that investing in connections across the themes will be critical to its success.

Two project highlights for me include:

- a climate adaptation project developing a toolkit consisting of new and existing information, knowledge, and models. This toolkit will allow end users to select from a range of future climate scenarios, model the flows associated with those scenarios, and incorporate other relevant information to understand the response of identified values be they social, cultural, environmental, or economic. This project will allow policy makers to simulate a range of possible adaptation options and assess the overall outcome for those values.
- The exciting technology of artificial intelligence and drones to identify and monitor waterbirds across the Basin. Outcomes from this project will mean it's easier and more accurate to monitor Basin conditions across the landscape.

During the past 12 months, the Governing Panel and program partners have learned many lessons working with First Nations partners, and our commitment to continuous improvement remains strong.

Finding linkages across themes will allow for new information to influence other research projects as they progress. Understanding how the knowledge is going to be applied requires a concerted effort and our direct connection with end users is progressing this.

I'm heartened program participants have such a practical orientation and are committed to demonstrating the benefit of their work to Basin stakeholders. Thank you to all involved in delivering this impressive work during the past 12 months.

Professor Rob Vertessy Chair, MD–WERP Governing Panel

1. Introduction

The Murray–Darling Water and Environment Research Program (MD–WERP) is an Australian Government initiative to strengthen scientific knowledge of the Murray–Darling Basin

It is designed to help inform water and environment management decisions which will improve outcomes for the Basin and its communities.

The Murray–Darling Basin Authority, Commonwealth Environmental Water Holder and the Department of Climate Change, Energy, the Environment and Water have identified 4 priority themes to be the focus of the strategic research component of the Murray–Darling Water and Environment Research Program:

- Climate adaptation
- Hydrology
- Environmental outcomes
- Social, economic and cultural outcomes.

The program is made possible by the \$20 million commitment by the Australian Government to improve Basin Plan outcomes through targeted research. The program will deliver 3 components:

Strategic research: Collaboration between Commonwealth partners and the Murray–Darling Water and Environment Research Consortium to co-design and deliver applied research.

Practical information for water managers: Synthesis and communication products that summarise existing science for water managers.

Tactical investment: Use of existing science and expertise for urgent high need projects. These projects will be very focused and likely to be completed within short 2-to-6-month timeframes.

In December 2020, Commonwealth partners announced that 2 consortia, led by both CSIRO and La Trobe University, have been selected through a tender process to deliver the strategic research component of the program. The consortia have formed the Murray–Darling Water and Environment Research Consortium and bring \$7 million of their own resources and numerous multi-disciplinary collaborators, significantly extending the reach of the program.

This update provides an annual summary of progress across all streams and against all themes.

2. Context

MD–WERP is now well established, and we a delivering a complex, multi-party collaboration involving more than 17 government and non-government institutions. There are more than 100 people involved in the research delivery across the Australian Government and the Research Consortium, with a further 90 or more Australian Government and state government staff involved through the end user advisory groups.

The end of the 2021–22 year saw MD–WERP complete the first full year of implementation of our 4-year program. It's been a busy and

productive year for the research and policy teams across all 4 research themes, with promising and relevant results and progress being made across climatic, hydrologic, environmental, and social-economic-cultural research projects.

The ongoing COVID-19 pandemic affected the ability of a number of research projects to get underway and the ability of all those involved in the program to meet face to face to build relationships.

3. Key achievements

The priority during 2021–22 was to transition the program from design to implementation. Key achievements during the year included:

- endorsing the research implementation plans for all 4 strategic research themes
- commencing research for 3 strategic research themes
- finalising 7 milestone deliverables from strategic research projects
- initiating 4 short-term tactical projects that support Basin Plan objectives and respond to emerging issues
- hosting the inaugural MD–WERP Annual Symposium by the Science Leadership Team showcasing project co-design and progress
- implementing the Monitoring, Evaluation, Reporting, and Improvement framework
- implementing the Risk Management Plan
- endorsing the Communication, Adoption, Transparency and Engagement Framework
- delivering against the MD-WERP Communication Plan
- convening 12 end user advisory group (EUAG) meetings, providing a platform for ongoing codesign of impact pathways between end users and researchers
- increasing transparency with regular research updates provided on the <u>MD–WERP website</u> and 2 editions of the MD–WERP e-newsletter

4. Progress towards objectives

Objective 1: Invest in applied research that delivers better-informed water for the environment management decisions by Commonwealth agencies and improved outcomes for communities.

To meet this objective we need to ensure our research is useful and used by end users. We do this by:

- implementing impact planning pathways for strategic research activities across the 4 themes
- developing benefit realisation maps to graphically represent the relationship between the research, outputs, and outcomes, and how they align to Australian Government objectives and vision
- endorsing and commencing 5 tactical investment projects designed to address Australian Government priorities or gaps while avoiding duplication with other programs
- mapping science outputs to policy outcomes to outline how the program will realise benefits for the water reform objectives of the Australian Government.

Objective 2: Maximise value to water reform and management from investment.

The program meets this objective by consulting with Australian Government partners, state collaborators, and members of the research and knowledge community on research projects to address knowledge gaps. Activities included:

- activating and implementing quarterly end user advisory groups, one for each theme, consisting of Australian Government and state policy makers
- delivering the inaugural MD–WERP Annual Symposium
- ongoing development of the MD–WERP website
- publishing 2 MD–WERP e-newsletters
- publishing the MD–WERP 2020–21 Annual Progress Report.



A panel discussion at the MD–WERP Annual Symposium 2022 included Andrew Reynolds (Acting Chief Executive, MDBA), Dr Matt Coleman (Project Delegate, MDBA), Hilton Taylor (Commonwealth Environmental Water Holder), Rachel Connell, (First Assistant Secretary, Water, DAWE) and Marcus Finn, (Assistant Secretary, Water, DAWE) Please note all titles correct as at June 2022.

Objective 3: Leverage co-investment with research providers and key stakeholders.

The program meets this objective by building on, linking to, and leveraging research that has occurred or is underway.

Activities included:

- the Research Consortium co-investing a minimum of 40% for the strategic research activities
- establishment of the Commonwealth Advisory Team

• regular engagement and briefing with key stakeholders and committees to understand research linkages and connections.

Objective 4: Facilitate adoption of research by advancing cooperation between users and researchers.

The program aims to meet this objective by engaging with end users in the design, development, and delivery of the research through:

- a regular avenue of communication between researchers and end users to provide timely feedback on the development and delivery of the research via quarterly end user advisory group meetings for all 4 themes
- establishing the Science Leadership Team, a multi-disciplinary group of end users and research leaders promoting thought leadership.
- developing benefits realisation maps for the whole program and each strategic research theme.

Objective 5: Be a platform from which to launch a more enduring research program that supports effective water management over the long term.

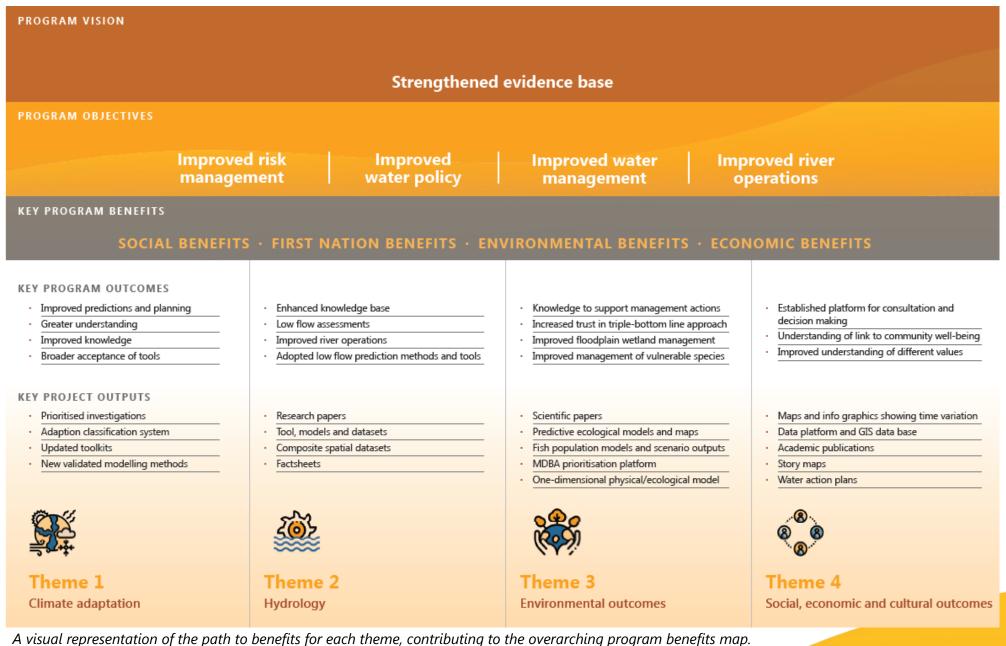
The program aims to deliver this objective by building foundations to show the importance of new knowledge generated and by applying the research outputs in decision-making. Successful delivery of the program and achievement against the strategic objectives will contribute to the justification for ongoing investment in water research and highlight the critical value of science and knowledge toward achieving sustainable outcomes in the face of an uncertain future. Activities included:

- demonstrating program benefits, particularly in building collaboration between the research community and policy makers
- delivering of research outputs that result in outcomes and impact within the program's duration and as a legacy, and ensuring that synthesis and tactical projects deliver useful outputs early
- planning for a mid-program independent evaluation in July 2023, followed by an end of program review.

Program benefits

MD–WERP exists to realise benefits for the Australian Government. A key activity in 2021–22 was collaboration between the Research Consortium and the Australian Government teams to develop a visual representation of the path to benefits for each theme, contributing to the overarching program benefits map (see illustration below).

The research implementation plans were integral in informing the benefits maps to ensure alignment across the delivery of capabilities, management of transition and adoption, embedding of outcomes and measurement and tracking of benefits. The maps outline the relationship between the research, outputs and outcomes and how they align to benefits and the organisational objectives and vision.



5. Progress in the strategic research stream

This stream of the program consists of applied research investments delivered by a collaboration between the Australian Government and the Murray–Darling Water and Environment Research Program (MD–WERP) Research Consortium to co-design, co-invest, and deliver applied research by mid-2025. It is the bulk of the MD–WERP investment.

Benefits from strategic investment

A key activity in 2021–22 was collaboration between the Research Consortium and the Australian Government teams to develop a visual representation of the path to benefits for each theme, contributing to the overarching strategic benefits map (see illustration below).

The research implementation plans were integral in informing the benefits maps to ensure alignment across the delivery of capabilities, management of transition and adoption, embedding of outcomes and measurement and tracking of benefits. The maps outline the relationship between the research, outputs and outcomes and how they align to benefits and the organisational objectives and vision. Impact maps for each theme.

5.1. Climate adaptation



The Murray–Darling Basin is one of the world's most variable hydroclimate regions. Catchment inflow can be more than 20 times greater in a wet year than in a dry year. The system also faces profound future challenges to adapt to a hotter, drier climate.

The aims of the MD–WERP climate adaptation theme are to:

- better understand how climate change will impact the Murray–Darling Basin
- identify and evaluate options to adapt to change
- evaluate potential outcomes for Basin values.

Progress and achievements

All 3 projects in the climate adaptation theme made strong progress during the first 12 months of research.

Foundational Science – developing modelling methods to better understand some of the indirect impacts of climate change on water supply and demands.

• Completed a synthesis of existing knowledge on the indirect impacts of climate change.

Climate Assessment Toolkit – developing methods and workflows to enable the impacts of climate change and adaption options to be assessed.

• Started a rapid Basin-scale vulnerabilities and values assessment developed a novel flow-assets-values framework to underpin the analysis.

• Developed the architecture for the toolkit and showed its application for assessing and comparing environmental outcomes of different streamflow scenarios.

Showcasing AdaptAbility – investigating options to adapt to climate change and their potential impacts.

- Conceptual work to summarise and categorise options currently being considered by governments and water managers to adapt to climate change.
- Documenting how evidence for the efficacy of adaption options can be assessed using river systems and other modelling approaches.
- A case study of catchment and river basin scale analysis of adaptation under climate change is being co-designed with the MDBA, the Commonwealth Environmental Water Office (CEWO) and New South Wales agencies.

Impao stater	ct ments	Outputs	Medium term outcomes		Benefits/Impact		Objectives		Vision
o cl	fagnitude f impacts of limate change n water supply*	Synthesis of existing knowledge on indirect impacts of climate change New validated modelling methods for characterising interactions between climate change and indirect impacts Evaluations of the relative impacts of the direct and indirect effects of climate	Additional tools available to Australian Government and states for planning purposes " # + Assessments of a range of policy options that consider both the direct and indirect consequence of climate change " + Broader acceptance of tools used by		ECONOMIC Enhanced sustainable economic development in the Basin	\rightarrow			
so fo	limate adaptation cience toolkit or holistic water lanning*	Scan of Australian Government tools in use for water planning purposes Scan of existing workflows Architecture design for toolkit workflow	government for planning purposes ^A * # Assessments of a range of policy options for climate adaptation #	l	ENVIRONMENTAL Sustainable management of key environmental	\rightarrow	Improved water policy with respect to achieving Basin Plan objectives		
		Toolkit demonstration Toolkit kit applied to adaptation investigations	Assessments of a range of adaptation options for a future climate ^		values and vulnerabilities in the Basin 1	-	Improved capacity to manage risks with respect to		A strengthened evidence base for water and environment management
o cl sc	ssess adaptation ptions using a limate adaptation cience toolkit	Classification system for adaptation options	Broader consideration of the compound effects of change, e.g., hydrological, climate, policy, in assessments of various policy decisions on economic, environmental, social and First Nations values & vulnerabilities *		SOCIAL		water availability and prioritising water use	Í	decisions to improve outcomes for the Basin and its communities
	or use in water lanning^	Prioritisation of adaptation investigations Adaptation investigation into MDBA adaptation options & associated trade-offs	Better knowledge and predictions on the impact of various adaptation options on economic, environmental, social and First Nations values & vulnerabilities ^ +	٦	Enhanced social values in the Basin	\rightarrow	Improved river operations and water management outcomes		
	4 Enhance knowledge, tools and capability to incorporate impacts of a changing future climate in water planning ⁺	Pilot implementation of adaptation options	Better knowledge and predictions on the impact of various policy decisions on economic, environmental, social and First Nations values & vulnerabilities #						
to in fu		Series of additional adaptation investigations targeting a range of potential adaptation options Values & vulnerabilities of the Basin	Greater understanding of the outcomes of selected adaptation options by stakeholders and community groups ^ +	Η	FIRST NATIONS Greater support for Indigenous communities to enhance and protect social,	\rightarrow			
		Updated toolkit including bespoke tools to support adaptation investigations	Broader acceptance of tools and information used by government for planning purposes +	$\left \right $	economic, environmental and cultural values				
			-				plan (RIP) reference:	2	Benefit priority
							 Appendix A1 # Appendix A2 Appendix A3 + Appendix 4 		Split colours indicates shared between Impact Statements

Climate adaptation theme – relationships between outcomes, outputs and objectives.

5.2. Hydrology



Robust knowledge and modelling of hydrological and water resources characteristics, under current and future climates, is essential to inform water resources management and planning. The MD–WERP hydrology theme is addressing the research questions in Table 3.

The first 2 research questions aim to enhance prediction at the ends of the flow spectrum: low flow and floodplain flow. The third and fourth research questions are

exploring and demonstrating adaptation to enhance hydrological outcomes from the same amount of available water. The fifth research question is linked to the tactical project (6.1) examining the causes of reduced flow in the northern Basin.

Progress and achievements

All 5 projects in the hydrology theme are progressing well and have delivered the Year 1 goals. This includes technical reports (MD–WERP deliverables) and numerous journal papers and presentations and leadership in Australian and international scientific forums.

- Produced 3 spatial datasets (available in CSIRO Data Access Portal)
- Completed description of low flow metrics
- Completed river reach classification
- Analysed trends
- Developing a robust loss function for river system modelling
- Developed 3 composite datasets (spatial high resolution digital elevation, water extent, hydrodynamic model outputs, and streamflow data) (available in CSIRO Data Access Portal)
- Defined floodplain inundation and volume model for testing at key locations
- Identified 2 forecasting case studies and started the first case study to characterise risks related to river regulation decisions in the upper Murray
- Assessed trends and causality in groundwater levels
- Assessed aquifer potential by combining importance and sensitivity indices
- Partnering between CSIRO and MDBA to prioritise key alluvial aquifers for in-depth analysis
- Completed data analysis on causes of reduced flow in the northern Basin.

pact itements	Outputs	outcomes		Benefits/Impact	Objectives		Vision
WERP hydrology theme *	Research papers to disseminate science outputs Technical reports to describe knowledge and methods for adoption by MDBA, CEWO and consultants Tools, models and datasets Results from application studies carried out jointly with the MDBA and stakeholders Engagement with the MDBA/Engagement with Stakeholders and communities through factsheets, participatory meetings and workshops	Demonstrated applications of low flow and floodplain flow prediction methods in key location Adoption of low flow and floodplain flow prediction methods and tools in river system modelling to inform water resources planning Knowledge of opportunities in using water forecas and better conjunctive GW-SW management to enhance water resources outcomes (greater outcome from the same amount of water) Enhanced knowledge base supporting review of and modelling for 2026 Basin Plan		ECONOMIC Greater economic outcome from enhanced water resources management and adaptation to climate change minimising impact on agricultural production and environmental and social values			
Enhanced low flow prediction RQ6 *	Summary document with defined list of salient low flow metrics Factsheet and spatial dataset on classification of river reaches	Demonstrated application of enhanced low flow prediction method to inform ecological outcomes and river systems modelling	U	٩			
	Report and/or research paper on low flow prediction method and application Report and/or research paper on demonstrated application to inform water resources planning	Assessment of low flow outcomes undercurrent and future climates, and under different adaptation options		ENVIRONMENTAL More optimum environmental watering and improved water	Improved water		
	Report and/or research paper on low flow outcomes under different flow conditions Low flow prediction method/tool for existing river system models	Adoption of low flow prediction method and tools in river system modelling to inform water resources planning		and inipioued water resources management and planning to reduce vulnerability of ecosystems to hydroclimate variability	policy with respect to achieving Basin Plan objectives		A strengthened evidence base
Floodplain inundation and volume prediction	Report describing floodplain inundation modelling methods Composite spatial datasets (DEMs, water	Floodplain inundation model applied and tested in key locations in the Basin		and under climate change	Improved capacity to manage risks with respect to water availability	\rightarrow	for water and environment management
RQ7 *	extents, hydrodynamic model outputs)for developing and testing floodplain models Report and/or research paper on development and testing of prototype floodplain prediction model	Floodplain volume model applied and tested in key locations in the Basin		SOCIAL Enhanced community	and prioritising water use		decisions to improve outcomes for the Basin and it communities
	Report and/or research paper on application of hybrid floodplain prediction model Report and/or research paper on floodplain volume prediction model applied to several key locations	Adoption of floodplain prediction model to inform environmental watering and water resources planning.		adaptation to climate change and greater confidence in the MDBA and state water	Improved river operations and water management outcomes		
Enhancing river operations using water forecasts and	Report of opportunities for improving river system operation using forecasts, and overview of two selected case studies Report on evaluation of forecast-informed	Improved river operations that is more robust under climate change		agencies in maximising water outcomes			
optimisation RQ8	river operation for the first case study Report on evaluation of forecast-informed river operation for the second case study	More efficient delivery of water to consumptive and environmental users					
Groundwater as an adaptation to current	Research paper describing benefits of forecast-informed river system operations Report on prioritisation of main alluvial aquifers in the MDB	Identification and analysis of opportunities for enhancing groundwater use and management.		FIRST NATIONS Enhanced water resources management including			
water resource management	Research paper on groundwater trends Report and/or research paper on opportunities	Enhanced languages have a survey of a set of		equitable allocation for cultural flows in the Basin			
RQ8b	to enhance groundwater use Report on opportunities to improve groundwater use, sustainability and management	Enhanced knowledge base supporting review of 2026 Basin Plan groundwater components		2			

Hydrology theme – relationships between outcomes, outputs and objectives.

5.3. Environmental outcomes



A healthy Basin relies on healthy ecosystems. However, parts of the Basin face a challenging future: severe droughts and extreme ecological events highlight the significant challenges in managing Basin ecosystems.

Drought conditions associated with fish deaths are likely to become more common in some parts of the Basin and increasing water scarcity will require careful prioritisation of which environmental assets to protect.

Climate change, land use, and the opportunities provided by traditional Indigenous knowledge holders in managing Basin ecosystems are central to this research.

This research theme seeks to improve our understanding of how rivers and individual species will respond to future environmental conditions.

It will:

- help identify areas of high priority conservation value and prioritise collaboration with First Nations partners to collectively develop better indicators of ecological stress in Basin rivers and floodplains to produce a better understanding of how less water affects the abundance of aquatic life and examine how fish populations may respond to the changing climate
- map surface water and waterhole connections to determine how much fish habitat is available along the Lower Darling channel
- collate a data atlas of environmental and socio-economic values.

Progress and achievements

The anticipated July 2021 start of research was significantly delayed by the enduring impacts of the COVID-19 pandemic. The lockdowns prevented a range of face-to-face planning meetings. Nevertheless, 8 of the 10 theme projects have since been approved and are underway. Two remaining projects are under discussion and are expected to get underway during year 2 (2022–23) of the program – at this stage this is not expected to affect project deliverables.

Good progress was made in the last half of the year, with delivery of several productive meetings and workshops, detailed project planning and preparatory science work – literature reviews, conceptual model compilation, architecture design, and data collation.

The high flow conditions across the Basin have posed challenges to the low flow projects, but researchers have adapted and devised an alternate research focus – an examination of ecosystem recovery post-drought.

The end user advisory group supported the refined list of projects for each research question and is starting to contribute ideas and data.

Pro	jects	Outputs	Outcomes		Benefits/Impact		Objectives		Vision
9.1	Drivers of ecological resilience and persistence during low flow and cease-to-flow conditions in the northern Murray-Darling Basin	Publication: literature review/conceptual models of current low flow knowledge Presentations (webinars, community forums, scientific audiences) Final summary reports	Review of low flow, cease-to pump and first flush protection rules in Water Allocation Plans Review and setting of restoration and environmental watering targets and objectives Knowledge to support management		ECONOMIC More efficient use of				
9.2	Forecasting risks to fish and their available habitat from low flows and hypoxia	Publications (scientific papers, information for fact sheets/webinars) One-dimensional physical/ecological model of waterhole water quality and fish response	actions to reduce frequency of fish kills and other harmful effects of low flows Guidance on knowledge gaps and future knowledge needs		water and other resources directed towards protecting environmental assets 2	_			
10.1	A data atlas for conservation prioritisation	A consolidated data atlas of assets, values, functions and threats An easily useable GIS layer of water-dependent ecosystems A prioritisation platform for the MDBA, integrating data, methods	Improved science to support more sustainable water management Improved persistence of species and other assets across the Basin		ENVIRONMENTAL		Improved water policy with respect to achieving Basin Plan objectives Improved capacity		A strengthened evidence base for water and
10.2	Basin-wide analysis of protection and conservation prioritisation	and insights from the program Presentations (webinars, community forums, scientific audiences) Final summary reports Publications (scientific papers, information for fact sheets/webinars)	Outcomes that can inform longer term Basin plans Whole of Basin perspective and improved transparency around decisions regarding ecosystem tradeoffs		Comprehensive knowledge base that supports improved management outcomes for ecological assets in the MDB	\rightarrow	to manage risks with respect to water availability and prioritising water use Improved river	\rightarrow	environment management decisions to improve outcomes for the Basin and its communities
11.1	Spatially explicit population models for fish in the Barwon-Darling river system	Population models and scenario outputs for Golden perch, Murray cod, Silver perch and Bony bream Maps of predicted in-channel surface	Improved policy and management to protect and enhance native fish populations More effective management of		1		operations and water management outcomes		
11.2	Predicting changes to the persistence and connectivity of in-channel aquatic habitat in the lower Darling River	water extent and connectivity through time under future scenarios Maps of predicted spatial and temporal distribution of floodplain inundation in the MDB under future scenarios	in-channel refuge habitat for aquatic fauna during drought Enhanced ability to identify, prioritise and manage floodplain wetlands	Y.	SOCIAL				
11.3	Predicting changes in floodplain aquatic habitat availability at the Basin scale	Habitat suitability models and scenario outputs for priority fish and vegetation species and communities Presentations (webinars, community	under a changing climate Improved prioritisation and management of vulnerable species, ecological communities and locations		More engaged and informed community and stakeholders, including First Nations people	\rightarrow			
11.4	Assessing future vulnerability of species and ecological communities	forums, conferences) Final summary reports Scientific papers, fact sheets	Enhanced capacity of the Commonwealth and other responsible agencies to use the best available science to effectively manage water and environmental assets in the MDB	μ	3				

Reference: Theme 3 Work Order (Schedule 5 of Deed) – Annexures A, B and C 2 Benefit priority

Environmental outcomes theme - relationships between project outputs, outcomes and objectives.

5.4. Social, economic, and cultural outcomes



People rely on healthy ecosystems for their wellbeing and survival. Degraded landscapes and waterways affect the social, emotional, physical, and financial health of people and communities.

Although the role of agriculture-related capital in the Basin is well understood, the roles of other forms of human, social, financial, physical, and natural capitals

are less understood but also critical. The first component of the research maps these other forms of capital and investigates the relationship between healthy rivers and mental health, recreation, and tourism.

The second component investigates how to improve First Nations' access, use, and pursuit of water. First Nations people experience many technical, legal, and relationship barriers to the cultural and economic opportunities provided by Basin water. These projects will identify these barriers and contribute to enabling First Nations people's water-related aspirations, and improving social, cultural, and economic outcomes for First Nations from the use of water.

The way people and communities frame or understand challenges and opportunities plays a significant role in how resilient and adaptive they are. This final component of research investigates what makes a community better able to adapt to environmental and social challenges and how shared understandings about a future with less water emerge in Basin communities.

Progress and achievements

This theme supports social and economic science, humanities, and First Nations-led projects. It therefore required extended discussions in the co-design. Four of the 9 projects in this theme are underway. The other 3 projects are scheduled to begin early in Year 2. The start date was extended to accommodate delays, with work officially beginning in May 2022.

The First Nations Water Project has been divided into 2 separate pieces of work, one led by the Murray Lower Darling Rivers Indigenous Nations (MLDRIN), and another for the northern Basin. This reflects the geographic focus for each piece of work. The MLDRIN-led project will start in Year 2. The northern Basin proposal is still in discussion to finalise the approach and a start date.

Projects	Outputs	Outcomes	Benefits / Impact	Objective	Vision
12.1 The mental health benefits of improvements	Report on initial analysis of first survey	Advance scholarly understanding of the mental health / water relationships	EFFICIENCY		
to riverine ecosystem health	Academic papers	Promote the significance of social and mental health outcomes in water planning and decision making	Efficiency in supporting Commonwealth	\rightarrow	
	Final report	Enhance understanding by the general public of the role of healthy rivers to community well-being	agencies prioritising and coordinating future		
12.2 Recreational and tourism value of healthy rivers	Academic paper	Advance scholarly understanding of the benefits of healthy rivers to recreation and tourism	investments/projects		
nearthy rivers	Final project report to the MDBA	Advance awareness and significance of recreation and tourism in water planning and decision making			
	Plain english summary to the MDBA	Enhance understanding by the general public of the relationship of healthy rivers to community well-being	STAKEHOLDER RELATIONSHIPS		
13.1 First Nations' water-based	Water action plans	First Nations/policy makers have a conceptual and practical pathway to develop First Nations		Improved water policy	Strengthen the evidence base
outcomes in the Southern Basin	Water delivery action plan	water action plans	trust, satisfaction	Improved capacity	for water and environment
	Final report to policy makers and decision makers	First Nations / policy makers will have a conceptual and practical pathway to delivering water with First Nations	and commitment 2	to manage risks	management decisions to
14.1 Basin-wide socio-economic, socio-demographic	Data platform (draft version) as a GIS database	First Nations / policy makers have stronger understanding First Nations' water outcome aspirations and the specific steps to progress these	EFFECTIVENESS	Improved river operations and management	improve outcomes for the Basin and its communities
& biophysical data platform	Maps and info-graphics showing variation across the Basin and over time.	Increased capability to assess the stocks of various forms of capital in the Basin	Increased participation,	→	
	Improved availability of data for use in other MD-WERP research projects	of information producing a better result, with			
14.2 Pathways to community resilience	Final report on the findings	The community has an increased shared understanding of the roles of water in the landscape	more value		
		Improved understanding of how communities negotiate and make decisions			
		A platform for on-going effective community consultation			
14.3 Navigating change	Report for the MDBA on findings	Improve understanding of the diversity of values around environment and water	ECONOMIC	→	
	Story maps	Improved understanding of the ways communities negotiate and navigate change	Operational cost savings		
		Improved community understanding of change through on-line story map	4		

Source: Input S Kerr 8/08/22, adapted from Theme 4 Work Order (Schedule 5 of Deed) 21 April 2022



Social, economic and cultural outcomes theme - relationships between project outputs, outcomes and objectives

6. Progress in the tactical investment stream

This research stream comprises short-term, responsive investments delivered by a range of research and delivery partners. Each project is likely to be completed within a 6-to-12 month timeframe.

This funding stream allows the Australian Government to respond to short-term knowledge needs over the life of the program. Delivery of the projects is usually carried out in-house by the Commonwealth partner or in partnership with a research consortium member. If necessary, the whole project may be contracted to another supplier and managed through the Australian Government proponent.

6.1. Explaining the causes of reduced flow through the northern Basin

Ongoing

This project was initiated to explain the cause of reduced flow in the northern Basin.

The aims of the project are to:

- synthesise current hydrological knowledge of the northern Basin
- identify limitations in the knowledge
- recommend methods that can overcome the limitations.

Progress and achievements

There is a general understanding of the water balance in the northern Basin – that is, water inputs and outputs in the system at different time scales and at different locations – from measurements, modelling, and integrating multiple types of information. However, there are gaps in knowledge, particularly for some water fluxes or components and at the detailed level required to address issues. The report will contain recommendations to help overcome some of these gaps and will be published.

6.2. Innovation sweep, scoping and development of drone-based waterbird monitoring

Initiated

The Basin Plan outlines several obligations to maintain and improve water-dependent ecosystems, including waterbird breeding and populations. The developed tool has potential to assess the success of water management events by allowing waterbird numbers and colony sizes to be automatically counted. The innovation sweep component was to identify emerging technologies that could be used to monitor ecological outcomes for the Australian Government at the landscape scale.

Progress and achievements

The project started in September 2021 with a completion date of July 2022. There were 2 parts to this project:

- develop a tool to automatically count colonially nesting waterbirds from drone imagery for a test site
- conduct an innovation sweep of new and upcoming technologies that can be used for monitoring and evaluation, particularly in regard to the expected outcomes of the Basin-wide environmental watering strategy.

6.3. Riverbank stability and erosion

Initiated

This project will help address the increasing community concern relating to bank erosion along the River Murray. The project will have 3 key elements:

- 1. Synthesis of the scientific knowledge of the influences on erosion within the different reaches of the River Murray and major anabranches from the confluence with the Swampy Plains River at the upper end of the system to the Murray Mouth. The synthesis will identify primary influences on erosion within each reach, knowledge gaps and the various structural or regulatory management measures undertaken. In addition, the project will document the roles and responsibilities relating to erosion within each state and identify any erosion monitoring that is occurring.
- 2. Preparation of communication material for use with communities to help with positive engagement and increased understanding of the complexity of the erosion issue.
- 3. Scoping of a strategic plan for monitoring erosion along the River Murray to fill the knowledge gaps and/or to address community concerns and support understanding of the issue with robust, fit-for-purpose information.

Progress and achievements

Alluvium Consulting was engaged to deliver the first element of the project (synthesis of scientific knowledge of the influences on erosion). The draft report has been prepared and will be finalised in 2022–23.

The project, representing the first phase, is due for completion in December 2022. Following this, projects for phases 2 and 3 will progress to develop communications material and (subject to further funding) to develop an erosion monitoring framework.

6.4. Summary and analysis of blue-green algae trends in the Basin

Initiated

Although blue-green algae blooms are a natural part of most aquatic environments in the Basin, communities are becoming increasingly concerned that they are becoming more common, lasting longer, and becoming more severe. Communities perceive more frequent recreational use alerts and restrictions. Communities are asking what can be done to better manage blue-green algae blooms; is the water safe to drink, is the river safe to swim in, and is the problem getting worse?

This project has 2 elements that will help build knowledge and support communication on the subject.

- 1. Analysis of recent trends in blue-green algae blooms. This will investigate whether blooms are happening more often, lasting longer, or becoming more severe. This will:
 - improve collective understanding of changing risks to water quality and to river users caused by algal blooms
 - better support jurisdictions with considering existing and emerging risks to shared water resources
 - identify further knowledge needs.
- 2. Summary of current knowledge on blue-green algae bloom dynamics, impacts, and current management options, as well as limitations.

The aim is to develop a summary document describing the latest science and management around blue-green algae blooms for use by the Basin's river communities.

The product will be an online resource that will be housed on the MDBA's water quality pages.

Progress and achievements

The project commenced in April 2022 and is due for completion in February 2023.

Milestone 1: a project inception meeting was held between La Trobe University and the MDBA on 19 May 2022. Work completed to date includes:

- a literature review with a focus on the environmental drivers of blue-green algae blooms, with a report expected to be delivered in August 2022
- sorting of data and classification of algae by toxic or non-toxic species
- analysis of trends of Chlorophyll-a, which is a marker for the presence of algae.

A project steering committee is also being established to further progress towards milestone 2 and provide oversight of the project approach and outcomes.

6.5. Waterbirds foraging habitat

Initiated

This project will enhance understanding of foraging habitat location and requirements and its spatial relationship near known important breeding locations. It will involve refining a conceptual lifecycle model for target waterbird groups, remote sensing analysis, and identifying likely climate change impacts on availability of foraging habitat. It will include developing maps of antecedent condition and relative importance of different locations for waterbird foraging.

The project will inform how to best apply water for the environment to treat climate change risks and to support waterbird lifecycle requirements into the future.

Progress and achievements

This project commenced in April 2022 and is ongoing.

Key progress and achievements include:

- developing preliminary conceptual models and priority indicators for obligate wetland-feeding large waders (highly dependent on surface water for foraging, for example spoonbills, herons and egrets) and non-obligate large waders (able to forage in more terrestrial environments, for example ibis)
- identifying data for remote sensing analysis, including outputs from complementary research
- testing methods and preliminary concepts.

7. 2022 Annual symposium

Communication and engagement are integral to the success of the program. A key component of this is delivery of an annual symposium. The inaugural MD–WERP Annual Symposium took place on 15 to 16 June 2022 in Canberra.

The symposium was hosted by the MD–WERP science leadership team and coordinated by the MD– WERP implementation team. This was the first opportunity for a gathering of the Research Consortium, policy makers across Australian and state governments, and the Commonwealth partners (DAWE, CEWO and MDBA) to contribute towards charting a path forward for the science and research coming out of the program.



The inaugural annual MD–WERP Symposium provided the opportunity for researchers and policy makers to explore synergies between projects.

The symposium was important for policy makers to hear what the latest research is telling us and what the implications might be, particularly as we confront the challenges of a hotter and drier climate.

Researchers heard updates on the Australian Government policy environment through presentations and a question-and-answer panel session. Fostering two-way connection and partnership between policy makers and researchers will be an ongoing feature of this research program. The 4 research themes presented progress made during the previous 12 months and showcased some of the research projects.

Post-symposium surveys show that Research Consortium colleagues and end users are both more satisfied with their relationship with the program compared with prior to the symposium. 86% of research colleagues and 63% of end users said that they have a high level of confidence in the program achieving its outcomes.

8. First Nations engagement

Throughout 2021–22 the MD–WERP Governing Panel and Commonwealth Partners had many learnings in partnering with First Nations groups. They remain committed to building stronger relationships with First Nations and relevant organisations across the program. MLDRIN and NBAN have co-designed some elements across research themes 3 and 4. CSIRO is now planning to work with MLDRIN to include input for themes 1 and 2, with this work to continue into 2022–23.

MD–WERP recognises its strong obligations to conduct culturally appropriate and safe research and to appropriately manage Indigenous cultural intellectual property. MD–WERP is deeply committed to meeting these obligations, including appropriately resourcing First Nations and relevant organisations involved in MD–WERP to contribute to culturally appropriate research. MD–WERP partners recognises they are on an ongoing learning journey with regard to this part of the program. Formal deed agreements with the Research Consortium partners, CSIRO and La Trobe University, explicitly outline requirements for the management of Indigenous cultural intellectual property.

To ensure a consistent approach and understanding across the program, MD–WERP committed to provide training to researchers involved in MD–WERP. Indigenous law firm Terri Janke and Company were engaged to deliver an introductory session on Indigenous cultural intellectual property to researchers at the MD–WERP Annual Symposium and to produce a recommendations report for ongoing training over the next 3 years. It will be delivered in the second half of 2022.

9. Annual financial acquittal

2021–22 Financial expenditure (actuals)

A total of \$5,455,704 (excluding GST) was spent during 2021–22. Table 14 shows a breakdown of this expenditure.

Table 14: 2021–22 Financial expenditure

Expense	Actual expenditure (\$)
Strategic Research	
Themes 1-4: Co-Design	1,001,860
Theme 1: Climate Adaptation	1,397,102
Theme 2: Hydrology	1,214,313
Theme 3: Environmental Outcomes	909,160
Theme 4: Social, Economic & Cultural Outcomes	390,869
Total	\$4,913,303
Tactical Investment	\$203,577
Communications & Engagement*	\$66,454
Program Administration	\$272,370
Grand Total	\$5,455,704

* Remainder of expenditure for annual symposium was invoiced during 2022-23 and will be covered in the next annual progress report.

Summary of in-kind co-investments to the program

Outlined in Table 15 are the in-kind contributions allocated to the program by the Research Consortium partners.

Table 15: In-kind contributions (2021–22)

Consortium in-kind contribution	
Climate Adaptation (CSIRO)	677,840
Hydrology (CSIRO)	715,021
Environmental Outcomes (LTU)	440,247
Social, Economic and Cultural Outcomes (LTU)	184,516
Total Consortium in-kind expenditure	\$2,017,624

10. Glossary of terms

Term	Definition
Chair	Independent Chair who provides strategic oversight of the program and leads the MD–WERP Governing Panel.
Co-design	Purposely designed to include end users throughout the life of the program to ensure it maintains its relevance.
Commonwealth Advisory Team (CAT)	A group established to support collaboration and engagement between Commonwealth Partners and to assist in providing advice from a Commonwealth perspective.
Commonwealth Partners	A collaboration between Australian Government agencies to help deliver the program, comprising the Murray–Darling Basin Authority, the Commonwealth Environmental Water Office, and the Department of Agriculture, Water and the Environment.
Department of Agriculture, Water and the Environment (DAWE)	Australian Government department partnering in the research program with the MDBA and CEWO. On 01 July 2022, the department became the Department of Climate Change, Energy, the Environment and Water – this will be reflected in the 2022-23 Annual Progress Report.
End Users	Individuals, groups and organisations for whom the findings and outputs of MD–WERP will have direct relevance and consequences to their work programs.
End User Advisory Groups (EUAGs)	Established to assist in developing a shared vision for the research program, including impact pathways, research questions and connected teams. Groups are comprised of ends-users from the Commonwealth (DAWE, CEWO, MDBA), state governments and the research sector who have an interest or expertise in a particular research stream.
Executive Leadership Team (ELT)	A leadership group comprising the MDBA Project Delegate, and Research Consortium leads to provide strategic and operational oversight of the Strategic Research Investment.
Governing Panel	An executive leadership group established to provide strategic oversight of the program, comprising an independent Chair, the Commonwealth Environmental Water Holder, First Assistant Secretary of the Water Division (DAWE), and Executive Director of Basin Strategy and Knowledge (MDBA).
MDBA Delegate	MDBA Executive Director, Basin Strategy and Knowledge, responsible for the program. Provides strategic guidance and leadership and oversees budget allocation, program investments, research design, and monitoring, evaluation and reporting.
Monitoring, Evaluation, Reporting and Improvement (MERI) Framework	Outlines the rationale, scope and approach for monitoring and evaluating the activities carried out under MD–WERP, the reporting activities and feedback loops for program improvement.
Research Consortium	Comprised of CSIRO and La Trobe University, each with additional collaborators, to lead and deliver the strategic research stream of the program over 4 themes: climate adaptation, hydrology, environmental outcomes, and social, economic and cultural outcomes.

Term	Definition
Research Implementation Plan	An outline of the research questions to be answered and the research planning for how these questions will be answered, including a defined impact pathway to outline the key inputs, activities, outputs and expected outcomes and impacts for each theme and the relevant research questions.
Research Theme	Four themes that form the strategic research stream of the program including: 1) climate adaptation 2) hydrology, 3) environmental outcomes and 4) social, economic and cultural outcomes.
Research Question	A set of agreed research questions identified by the <i>Knowledge</i> <i>Prospectus</i> across the 4 research_themes that have clear links to priority knowledge gaps and critical user needs.
Science Leadership Team (SLT)	A group established to provide science leadership to ensure the delivery of rigorous and robust science to address end-user needs and integration of the program's research investment.
Strategic Research Investment	One of 4 program streams involving a collaboration between the Australian Government and the Research Consortium to co- design, co-invest and deliver applied research across 4 themes. The strategic research component of the program will invest in priority research needs to improve the long-term management of the Murray–Darling Basin.
Streams	Four program funding streams that comprise MD–WERP including 1) Strategic Research 2) Tactical Investments 3) Communications, Engagement and Adoption, and 4) Administration.
Synthesis Activities	Creation of explainer products and activities that bring together information from across the program and communicate new and existing science for a variety of audiences.
Tactical Investment	Delivery of short-term and responsive outputs to assist decision and policy makers on water management, river operations and Basin Plan implementation.

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