Australian Government

Murray–Darling Water & Environment Research

Murray–Darling Water and Environment Research

Annual Progress Update 2021–22

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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 co-design of impact pathways between end users and researchers
- increasing transparency with regular research updates provided on the MD–WERP website 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.

PROGRAM VISION

Strengthened evidence base

PROGRAM OBJECTIVES

Improved risk management | **Improved water policy** | **Improved water management** | **Improved river operations**

KEY PROGRAM BENEFITS

SOCIAL BENEFITS · FIRST NATION BENEFITS · ENVIRONMENTAL BENEFITS · ECONOMIC BENEFITS

Theme 1 Climate adaptation	Theme 2 Hydrology	Theme 3 Environmental outcomes	Theme 4 Social, economic and cultural outcomes
KEY PROGRAM OUTCOMES			
• Improved predictions and planning • Greater understanding • Improved knowledge • Broader acceptance of tools	• Enhanced knowledge base • Low flow assessments • Improved river operations • Adopted low flow prediction methods and tools	• Knowledge to support management actions • Increased trust in triple-bottom line approach • Improved floodplain wetland management • Improved management of vulnerable species	• Established platform for consultation and decision making • Understanding of link to community well-being • Improved understanding of different values
KEY PROJECT OUTPUTS			
• Prioritised investigations • Adaption classification system • Updated toolkits • New validated modelling methods	• Research papers • Tool, models and datasets • Composite spatial datasets • Factsheets	• Scientific papers • Predictive ecological models and maps • Fish population models and scenario outputs • MDBA prioritisation platform • One-dimensional physical/ecological model	• Maps and info graphics showing time variation • Data platform and GIS data base • Academic publications • Story maps • Water action plans

A visual representation of the path to benefits for each theme, contributing to the overarching program benefits map.

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.

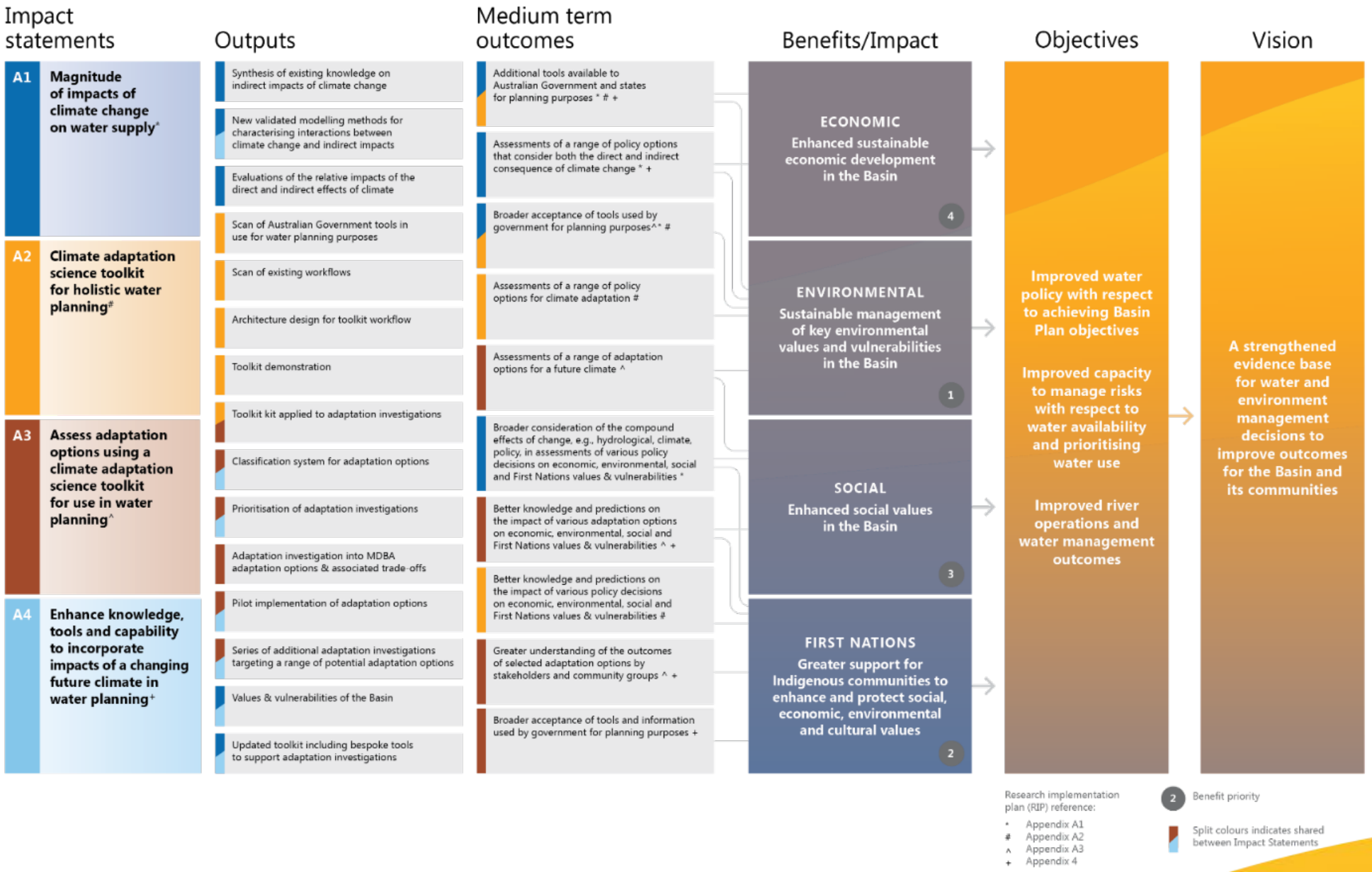
Climate Assessment Toolkit – developing methods and workflows to enable the impacts of climate change and adaption options to be assessed.

- 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.

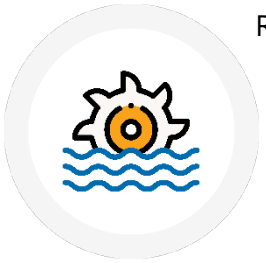
Showcasing AdaptAbility – investigating options to adapt to climate change and their potential impacts.

- 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.



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

5.2. Hydrology



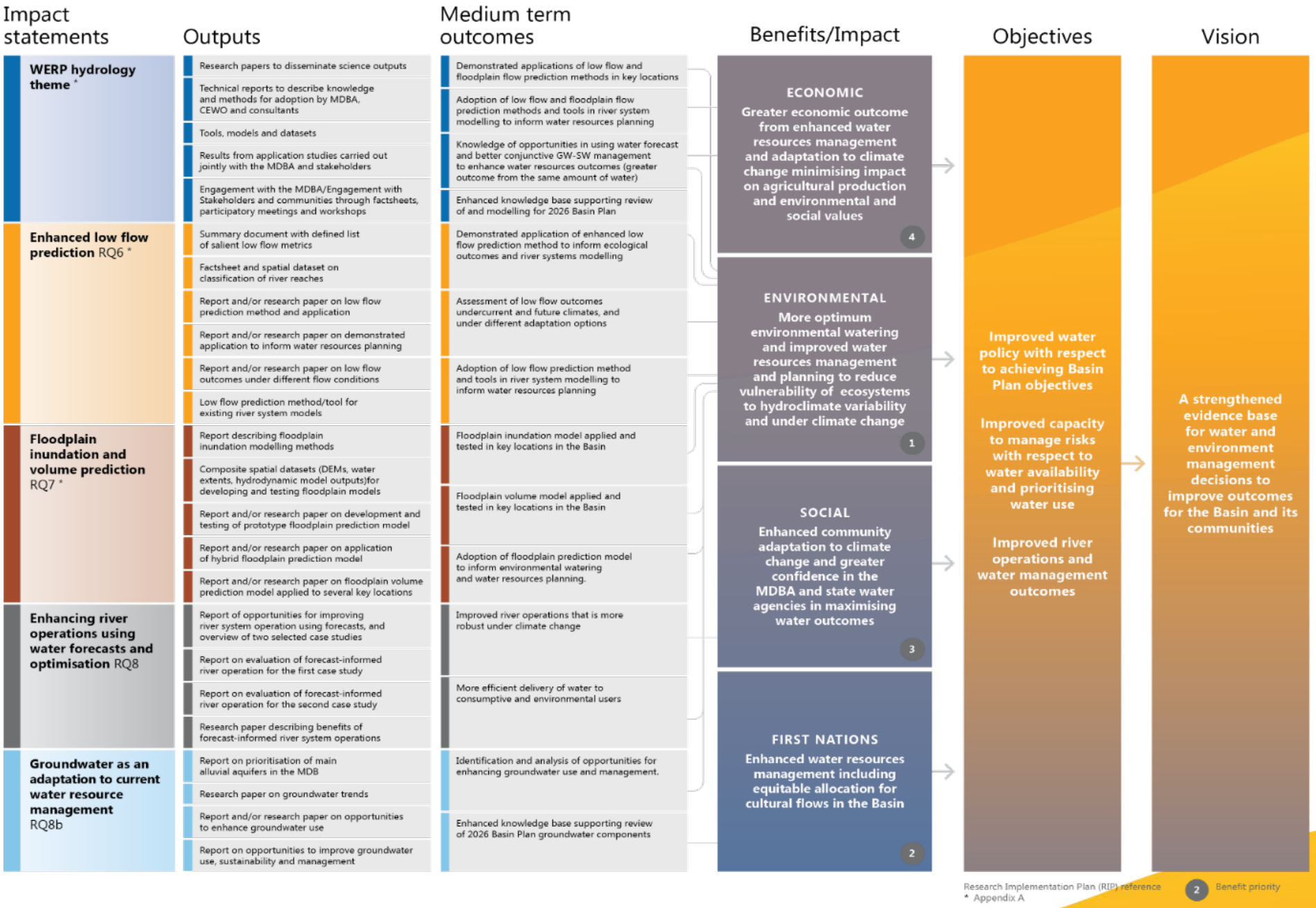
Robust knowledge and modelling of hydrological and water resources characteristics, under current and future climates, is essential to inform water resources management and planning. The MD–WERP hydrology theme is addressing the research questions in Table 3.

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

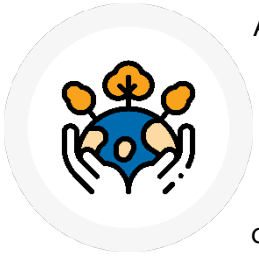
All 5 projects in the hydrology theme are progressing well and have delivered the Year 1 goals. This includes technical reports (MD–WERP deliverables) and numerous journal papers and presentations and leadership in Australian and international scientific forums.

- 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.



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.

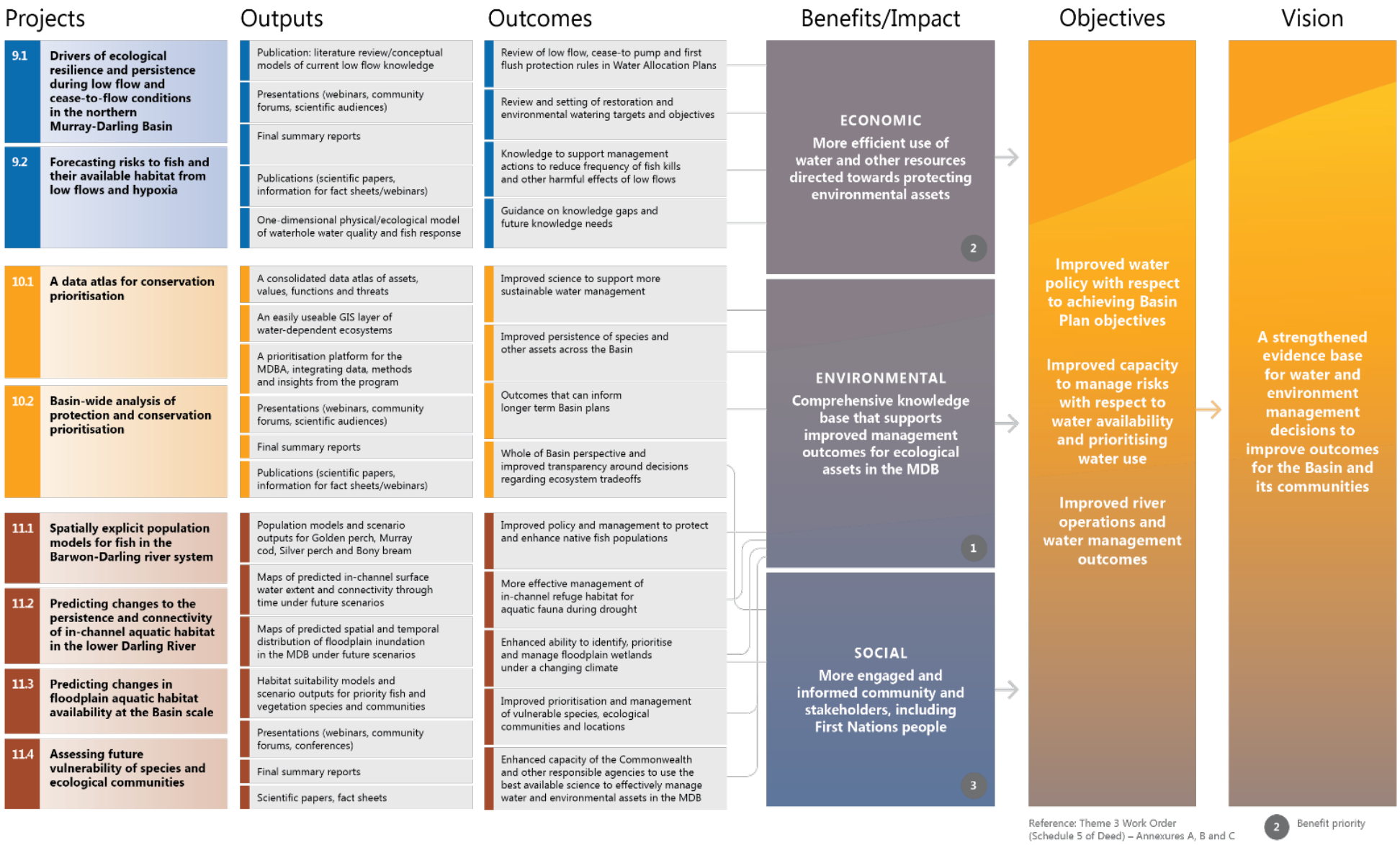
Progress and achievements

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.

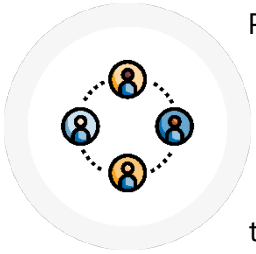
The high flow conditions across the Basin have posed challenges to the low flow projects, but researchers have adapted and devised an alternate research focus – an examination of ecosystem recovery post-drought.

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



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.

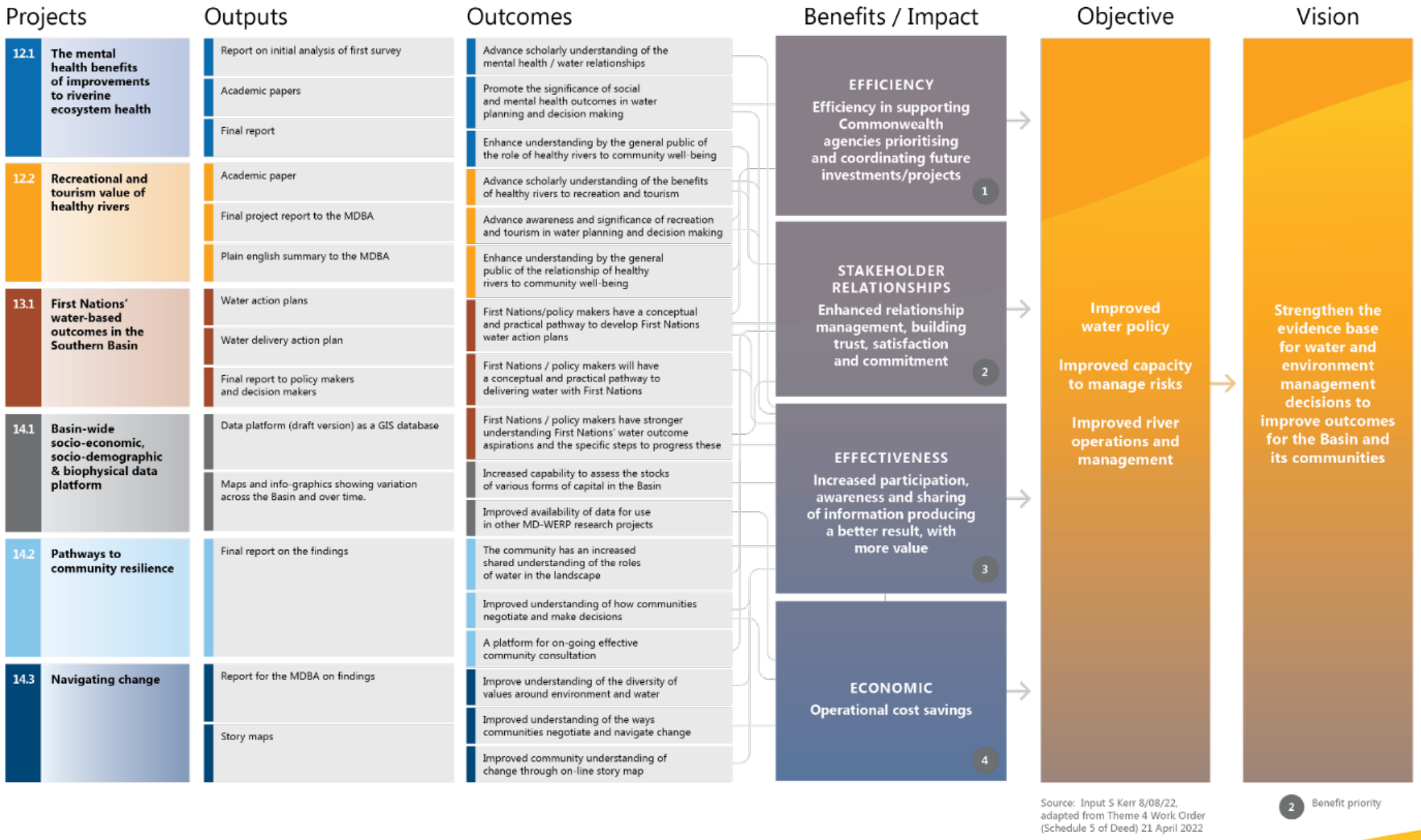
The second component investigates how to improve First Nations' access, use, and pursuit of water. First Nations people experience many technical, legal, and relationship barriers to the cultural and economic opportunities provided by Basin water. These projects will identify these barriers and contribute 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.



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 *Knowledge Prospectus* 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.