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Acknowledgement of the Traditional Owners of the Murray-Darling Basin

The Murray-Darling Basin Authority pays respect to the Traditional Owners and their Nations of the Murray-Darling Basin. We acknowledge their deep cultural, social, environmental, spiritual and economic connection to their lands and waters.

The guidance and support received from the Murray Lower Darling Rivers Indigenous Nations, the Northern Basin Aboriginal Nations and our many Traditional Owner friends and colleagues is very much valued and appreciated.

Aboriginal people should be aware that this publication may contain images, names or quotations of deceased persons.

Errata

Errors have been identified in the following:

Chapter 1, point 4: First Nations involvement in co-design and delivery of strategic research included • research themes 1 and 2 (climate adaptation and hydrology) which are being actioned in 2021-22, not 2020-21.

The text has been amended in this current version of the document.

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Chair's Foreword

The Murray–Darling Basin continues to be a focus of vigorous debate on how best to manage our scarce water resources. Many communities, enterprises and ecosystems in the Basin depend on water and don't always get what they need to flourish – increasingly so lately because water availability has been declining. Water policies and management arrangements in the Basin are periodically reformed to redress shortfalls and inequities but identifying how to change and when is a constant challenge. Experience shows that Basin water reforms are most successful when they are underpinned by strong evidence and authentic engagement with affected stakeholders.

As we approach the review date for the Basin Plan in 2026, the Murray–Darling Water and Environment Research Program (MD-WERP) has been established to contribute to such an evidence base and to provide a platform for dialogue with stakeholders. MD-WERP brings together the diverse expertise of scientists, researchers, First Nations groups and private sector specialists to tackle 4 research themes: climate adaptation, hydrology, environmental outcomes, and social, economic and cultural outcomes. The research is being led by 2 consortia headed by CSIRO and La Trobe University who have established the Murray–Darling Water and Environment Research Consortium (Research Consortium). The Commonwealth is providing \$20 million in funding to support MD-WERP and the Research Consortium is contributing \$7 million of its own resources.

Over the next 4 years, the Research Consortium will undertake practical research that will enhance the ability of water agencies like the Murray–Darling Basin Authority and the Commonwealth Environmental Water Office to undertake their missions more effectively. The research will involve working with First Nations people on Country, examining how they have managed water sustainably and equitably over tens of thousands of years, spanning cycles of profound environmental change. It will also involve engagement with other Basin stakeholders with an interest in improving social, economic and environmental conditions in the Basin.

One of the strongest determinants of research success is the quality of research planning. As this annual progress report shows, considerable work has been put into setting up MD-WERP for success. I commend the researchers, practitioners, and other advisors for their exemplary efforts in planning research projects that will be supported by the program. I'd also like to thank the MD-WERP Implementation team at the MDBA and my fellow members of the Governing Panel for their dedication to providing a high standard of administration and governance for the program. A great start has been made and an exciting program of research is now underway. I have every confidence that this will make a positive contribution to future Basin water reforms and yield a huge dividend for the Basin and its people.

Professor Rob Vertessy Chair, MD-WERP Governing Panel

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1. Highlights from 2020–21

- The Murray–Darling Water and Environment Research Consortium has been established bringing together world class and multi-disciplinary research capabilities, science leadership and First Nations collaborators to deliver high quality, practical research on the Murray–Darling Basin.
- 2. A co-design process was undertaken, entailing strong collaboration between the Consortium and the Commonwealth to ensure that both researcher and end-user perspectives are built into the research program design.
- Through the co-design process, the research questions outlined in the Research Prospectus were refined to ensure that investments are directed to high value projects with defined pathways to impact.
- 4. First Nations have been involved from the inception of the research scoping and co-design stages, and are key collaborators across strategic research themes 3 and 4, environmental outcomes and social, economic and cultural outcomes.
- 5. Research implementation plans have been completed to guide the strategic research to be undertaken over the next 4 years. A tactical investment stream has also been created to support short-term, critical-need studies.

2. About the program

The Murray–Darling Water and Environment Research Program (MD-WERP) is a \$20 million Commonwealth-funded science program designed to strengthen the evidence base for water and environment management decisions to improve outcomes for the Basin and its communities.

The concept was initiated in 2019 as a partnership between the Department of Agriculture, Water and the Environment (DAWE), the Commonwealth Environmental Water Office (CEWO), and the Murray–Darling Basin Authority (MDBA).

The program seeks to deliver impact through the adoption of knowledge generated through 3 streams of investment:

- Strategic research: collaboration between the Australian Government and the Research Consortium to co-design, co-invest and deliver practical applied multi-year research.
- Tactical investment: Delivery of short-term and responsive outputs to assist decision and policy makers on water management, river operations, and Basin Plan implementation.
- Synthesis activities (including communication and adoption support): synthesis and explainer products and activities which synthesise new and existing science for a variety of audiences).

Most of the activities are scheduled to occur over 4 years between 2021-2025 with a focus on 4 main themes

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

2.1. A partnership approach

Recognising the many experts and organisations involved in Murray–Darling Basin science, the program brings together a number of these interested parties to develop and deliver research that is most aligned to Australian Government needs.

The Australian Government is funding the program through the <u>Sustainable Rural Water Use and</u> <u>Infrastructure Program</u> which is managed by DAWE. The MDBA administers the program under the guidance of the MD-WERP Governing Panel (see Section 8). The funding is provided under a Memorandum of Understanding between DAWE and the MDBA.

The MD-WERP Governing Panel oversees the design and implementation of the program and consists of an independent chair, Professor Rob Vertessy, and representatives from DAWE, the Commonwealth Environmental Water Holder, and the MDBA.

Commonwealth partners will collaborate with the Research Consortium to deliver research to benefit the Basin and its communities for years to come.

2.2. A focus on co-design & adoption

Research is a complicated space: while always useful in one aspect, there is always a risk that once it is complete it will not be translatable to government policy needs and outcomes. To help circumvent this, MD-WERP has been purposely designed with a co-design focus that includes the end users (specifically government policy makers) throughout the life of the program.

Co-design activities are supported through Commonwealth partnerships in the design and implementation of the program as well as through the ongoing researcher – end user collaborations. These collaborations are particularly strong in the strategic research investment stream, where end-user advisory groups have been formed and are working closely with the researchers to assist with developing a shared vision for the research, articulating the expected impact of the research, and documenting these as impact pathways.

In the MD-WERP context the term 'adoption' means the uptake of information, concepts, tools or practices (innovations) that have been generated predominantly through the research.

Managing knowledge for adoption ideally starts before the research does, with building partnerships, identifying needs, scoping, and jointly developing research questions (unlike communication, the planning of which tends to begin after the research questions and methodology are determined). The approach of managing knowledge for adoption addresses how we create and share knowledge; conventional communications only address how we transfer it.

Increasing the likelihood of adoption of the research will be managed through hosting an annual end-user forum to share and discuss research progress and direction, theme workshops, Commonwealth and interjurisdictional briefings, and on-going support of the End User Advisory Groups.

2.3. Key elements of the program

The program has been designed to achieve a set of strategic objectives and high-level outcomes, agreed to by the Governing Panel. They inform policy and decision making about the program's implementation, shape its operation, and form the basis of evaluating its success.



High-level program outcomes

Figure 1: MD-WERP program logic

3. Program achievements 2020–21

The primary focus of this financial year has been to finalise the program's design including governance, investment approach and planning, building a culture of co-design, and communication and engagement to ensure solid foundations to deliver the program.

Figure 2 illustrates the key activities achieved in 2020–21 and how these relate to the guiding program objectives.

PROGRAM OBJECTIVES used to guide design of the program and activities for 2020–21

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

The program needs to be mindful of the broader objectives of water reform and the need to deliver outcomes for the Basin environment and communities.

Activities:

√ Impact planning pathways undertaken for strategic research activities across the four themes.

√ Commonwealth team (DAWE, CEWO and MDBA) consulted on tactical investment ideas to ensure tactical investments have maximal impact and avoid duplication with other programs.

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

The research questions and themes have been developed through engagement and consultation with Commonwealth partners, state collaborators and members of the research and knowledge community to address knowledge gaps related to water reform.

Activities:

√ Publication of MD-WERP Research Prospectus

✓ Completed 3 months co-design and commitment to ongoing codesign activities between researchers and end-users to guide the development and delivery of the research. Objective 3: Leverage coinvestment with research providers and key stakeholders.

The research needs to build on, link to and leverage research that has occurred and is underway.

Activities:

√ Minimum of 40% co-investment from research consortium for the strategic research activities

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

Adoption of research outputs and engagement with end users in the design, development and delivery of the research is critical to the successful delivery of the program.

Activities:

✓ Formed End User Advisory Groups to ensure engagement of relevant end-users in the development and delivery of the research,

√ Developed working relationships between end user leads and research leads

✓ Formed a multi-discipline end user/ research leadership team (Science Leadership Team) Objective 5: Be a platform from which to launch a more enduring research program.

The value of the new knowledge generated by the program needs to be demonstrated by ensuring that the outputs of research are applied in decision making. Success of the program, and achievement against these five objectives, would provide justification for support of further investment in water research.

Activities:

√ Demonstrate the benefits of the program's design and in building collaboration between research and policy.

✓ Deliver research outputs that result in outcomes and impact within the program's duration and as a legacy. Ensure synthesis and tactical projects deliver useful outputs early. Complete a 2-year and 4-year evaluation on the program

Figure 2: Illustration of MD-WERP design to meet program objectives and outcomes

3.1. Identifying the knowledge needs

The *MD-WERP Research Prospectus* was published in 2020 following extensive communication with key Commonwealth staff on the priority knowledge needed to improve how water is managed across the Basin. Four themes of knowledge needs emerged (Climate adaptation, Hydrology, Environmental outcomes, Social, economic and cultural outcomes), which were then used to support the tender process to select the research consortium and initiate the research co-design. The research prospectus can be found online at

https://getinvolved.mdba.gov.au/murray-darling-water-and-environment-research-program

Information on the proposed research under each of the themes is provided in Section 6.

3.2. Appointing the Murray–Darling Water and Environment Research Consortium

Finding the right, highly skilled organisations to partner with was a crucial step towards ensuring successful delivery of the strategic research within the program. An open and competitive tender process via AusTender occurred between 10 July to 21 August 2020 to seek submissions from interested parties.

An evaluation committee comprised of Commonwealth members and an independent member were appointed to evaluate the tenders. They provided a recommendation to the Governing Panel, who endorsed the MDBA to appoint the strategic research to 2 tenders comprised of consortia led by CSIRO and La Trobe University, each with additional collaborators, outlined in Table 1.

Once appointed, deed agreements were negotiated and signed between the MDBA and the 2 successful consortia. The agreements will be in place for the 4 years of the program ensuring clarity of governance and obligations, systems and tools, work requirements, and issues such as intellectual property are properly addressed.

The consortia bring \$7 million of their own resources and numerous multi-disciplinary collaborators, significantly extending the reach of the program and contributing to the program's strategic objectives to leverage co-investment.

Consortia lead	Collaborators	Leading themes
CSIRO	Deakin UniversityEwaterAlluvium	Climate AdaptationHydrology
La Trobe University	 Griffith University Northern Basin Aboriginal Nations Murray Lower Darling Rivers Indigenous Nations IDEEA Group 	 Environmental Outcomes Social, Economic and Cultural Outcomes

Table 1: MD-WERP Research Consortium and collaborators

3.3. Partnerships

The success of MD-WERP will be built through high-quality research that is developed through collaboration and partnerships between funders, researchers, and end users. This will help ensure the outputs from the research are fit for purpose to meet the needs of the Australian Government and other users.

End User Advisory Groups

As part of the co-design process (see Section 4), End User Advisory Groups (EUAG)s have been established for each of the 4 research themes. Over the life of the program, these 4 groups will draw upon a broad range of end user perspectives, expertise and experiences to support the development and implementation of research for each theme. The EUAGs are also vital for research impact – being involved throughout the program will ensure key users of the research are ready to adopt and apply the new knowledge as soon as it becomes available.

Each EUAG is led by a Commonwealth theme lead who is responsible for bringing together the group, managing the relationship with the theme researchers, and ensuring that membership reflects the needs of the theme area.

The EUAGs comprise ends users from the Commonwealth (DAWE, CEWO, MDBA), state governments, and the research sector who have an interest in the theme. The membership of the EUAGs will change and adapt to the needs of the themes and program over the 4 years.

Executive Leadership Team

An Executive Leadership Team (ELT) has been established to provide strategic and operational oversight of the strategic research. The ELT provide recommendations on investments and/or opportunities, as well as oversight on progress reporting, including escalation of program risks. The ELT is comprised of the leads from each consortia and the MD-WERP Project Delegate.

The ELT also review the outputs of strategic research to ensure alignment with agreed investments and program objectives. They contribute to reports, briefings and meetings to represent the strategic research investment.

Science Leadership Team

The MD-WERP Science Leadership Team (SLT) is a critical multidisciplinary team comprised of researchers, Commonwealth end users, First Nations representatives, and engagement specialists. It is led by the Research Consortium.

The team provides science leadership to ensure the delivery of rigorous and robust science to address end user needs and integration of the program's strategic research investment.

The SLT had its first meeting in March 2021 and met an additional 3 times (including a 2-day workshop) in 2020–21 to discuss the proposed research activities across the 4 themes.

4. Co-design of Strategic Research

Fostering a shared vision and sense of ownership of the program between researchers and end users is vital to delivering better research, better solutions to problems, and better use and adoption of outputs.

To this end, a co-design approach was adopted for the strategic research stream of the program. Bringing together end users, decision makers, water managers, and the participating researchers is not always easy. Following best-practice principles in co-design, we sought to achieve this by following 3 broad stages:

- Discovery: to explore and establish shared understanding between Commonwealth partners and the Research Consortium of the scope, objectives and outcomes.
- 2. Analysis and planning: to review the scientific knowledge base, engage with the knowledge of stakeholders, agree on approaches to the research, develop and prioritise research questions, and develop project plans to address these questions.
- 3. Refinement and production of the Research Implementation Plans: to consolidate project plans, integrate within and across the 4 research themes, agree on project governance within the already-established program governance arrangements, and finalise the Research Implementation Plans.

The nature of research co-design

"...the research question, the nature and delivery of the intervention and how its impact is measured, must be codetermined by researchers and other stakeholders - usually over weeks or months and in parallel with establishing programme governance, developing research capacity in community partners, building trust and working through conflict. These are ongoing and mutually reinforcing processes, not one-off procedures that can be ticked off as having been 'achieved'." (Goodyear-Smith et al, 2015, p3/5)

The Research Implementation Plans set out the overall research direction for 4 years with details covering the first year.

The **Discovery Phase** of the co-design process commenced with an inception workshop in late February 2021 where over 60 attendees from the Commonwealth partners and the Research Consortium came together online to share and explore the research needs and to start developing the Research Implementation Plans.

Between March-June 2021, the EUAGs and research teams met regularly, face to face when allowed, to progress the research design through **Analysis and planning** to the **Refinement Phase.** Draft Research Implementation Plans were submitted for consideration by the end of 2020–21.

The benefits from the initial 3-month co-design phase include:

- Building foundational relationships and collaboration forums between primary end-users, the Research Consortium, and other Commonwealth partners. These are supported by a clear and agreed approach for maintaining the relationships for the duration of the program.
- Developing agreed research questions that have clear links to critical user needs.
 Co-design worked to ensure the research questions are not duplicating existing research and that they consider the interdependencies across the research questions and themes.
- Developing quality research implementation plans that include clearly defined impact pathways.
- Enhanced capability and capacity for both the Research Consortium and Commonwealth, and a more in-depth understanding of the theme areas and relevant challenges and opportunities.
- Agreed approaches to implementing the strategic research activities including clear roles and responsibilities and operational requirements to manage project risks, ensure science quality and to meet the overall needs of the program.

As of July 2021, the Governing Panel had endorsed the Research Implementation Plans for Theme 1: Climate Adaptation and Theme 2: Hydrology. Some revisions, related to budget envelopes, were requested of Theme 3: Environmental Outcomes, and Theme 4: Social, Economic and Cultural Outcomes was still within the stages of co-design.

"From a CSIRO perspective, the codesign period was a great success.

Not only did we get a better understanding of the key issues facing the MDBA, CEWO and DAWE, but it will ensure that our research has greater real-world impact."

Dr David Post Director, CSIRO-led consortia "The co-design process has facilitated a strong dialogue between researchers and water managers.

This has enabled us to better understand knowledge needs, and to develop a research program that is aligned to government priorities. We look forward to the collaborative approach to research design continuing as we implement the program."

Professor Nick Bond Director, La Trobe University-led consortia The Governing Panel endorsed the requested budget and plan for 2021–22. Research Implementation Plans will be reviewed annually in April-May with the Governing Panel engaged to endorse the requested budget and plan, also annually.

5. Communicating and sharing the research

The MDBA's Advisory Committee on Social, Economic and Environmental Sciences (ACSEES) has been engaged in the research co-design process. This included a workshop in June 2021, where ACSEES was invited to provide technical feedback and advice on the research plans. The workshop provided an opportunity for members of the Research Consortium to engage with ACSEES members on the methodology, priorities, outcomes, and impact pathways across each theme. Feedback was used to help refine the plans, particularly around risks and opportunities.

In June 2021, the ELT and the Research Consortium briefed a notable number (over 150) of Australian and state government representatives on the strategic research focus of the program. Feedback was collated to help refine the plans before they were submitted to the Governing Panel for endorsement in July 2021.

The foundations for effective and relevant communications across the program are in place with several frameworks, strategies and planning documents being approved this year.

This planning is anchored in the *Communications, Engagement and Adoption Framework*. This document ensures communication, engagement and adoption activities to support the program align with the overall program objectives, are coordinated and roles and responsibilities are clear. The framework guides the development of a suite of planning documents, and the planning and delivery communications, engagement and adoption tactics

Program-level communication and engagement will be delivered by the MDBA to promote the Australian Government's commitment to practical and meaningful science and encourage participation in the program. The *MD*–*WERP Communications Plan* and the *MD*–*WERP Engagement and Adoption Plan* guide these activities and a science communications specialist is now engaged to assist with the delivery of program-specific content. The contract and relationship management for this specialist is being delivered by the MDBA.

Communication and engagement at the project level will be led by the relevant research consortia. It will involve activities designed to communicate the objectives and outcomes of individual projects funded through the program, and to seek ways to increase the likelihood of adoption of the research. A template for project communication and engagement has been created for program partners, to facilitate planning, and support consistent evaluation.

The MD-WERP branding guidelines underpin all efforts, to ensure consistency.

A *Communications and Engagement Steering Committee* provides an active forum for expert advice and coordination of communication and engagement across program partners. It comprises members from the Research Consortium and the Commonwealth, with the aim of information sharing and coordinating communication and engagement activities at a project and program level. Support and coordination of this committee is the responsibility of the MDBA.



Figure 3 : Key stakeholder groups involved in the development and implementation of the program

6. Four themes of strategic research

Through the strategic research investment funding stream, we aim to deliver applied research to directly inform, influence, and guide key decisions in water reform and operating the river. Strategic research is the main component of MD-WERP with a budget up to \$14M from the Australian Government.

The investments have been guided by the *MD-WERP Research Prospectus*, which was developed in 2020 through an independent consultative process. The process involved participants from across Commonwealth and state governments, academia and the community. The prospectus identifies 14 priority research questions across the 4 themes of Climate adaptation, Hydrology, Environmental outcomes, and Social, economic and cultural outcomes.

As detailed in Section 4, co-designing the strategic research part of the program began in February 2021 between researchers and key end users. The strategic research will commence in early 2021–22.

Projects funded under MD-WERP will generate tools and uncover new information to inform innovations that will have strong input to MDBA strategic outputs such as the Murray–Darling Basin Outlook Report, Basin Plan Evaluation, and the 2026 Basin Plan Review. The development of strong relationships and cooperation between end users and researchers is important to ensure that the tools and innovations deliver impact.

6.1. Theme 1: Climate adaptation

The Murray–Darling Basin is one of the world's most variable climate regions. Catchment inflow during a wet year can be more than 20 times greater than the inflow in a dry year. However, it is also a system facing profound future challenges to adapt to a hotter, drier climate. The aims of this theme are to:

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

Climate change impacts will occur either directly through the effects of reductions in rainfall on river flows, or indirectly through other threats such as the increased threat of bushfire. The adaptation research will synthesise current knowledge, deliver new modelling methods, and generate projections of plausible futures of water availability in the Basin.

The research will identify adaptation options and evaluate their efficacy across economic, environmental, social and First Nations' values. The research outcomes aim to support policy decisions and reduce the risk of outcomes that are more harmful than helpful (Table 2).

Because of the inter-related and overlapping nature of the research questions below, 3 projects comprising a series of activities are proposed to:

1. enhance the foundational science that supports understanding the direct and indirect impacts of climate change on Basin water management

- 2. develop a toolkit for assessing adaptation options
- investigate and assess a range of those adaptation options designed to address the 5 proposed research questions holistically

The first project will produce a synthesis of existing knowledge on the indirect impacts of climate change on water demand and supply. It will deliver new validated modelling methods for characterising the interactions between climate changes and those indirect impacts on water demand and supply, enabling an evaluation of the relative impacts of each effect.

The second project will produce a scan of Commonwealth tools currently used for water planning purposes and a scan of existing workflows used by the MDBA and CSIRO. An architecture for the toolkit workflow will be designed, demonstrated and implemented. Flow-related values and vulnerabilities across the Basin will be assessed and updated, and new tools added to the toolkit. The toolkit will then be implemented to support the adaptation investigations in Project 3.

The third project will produce a classification system for adaptation options and a prioritisation of those options for the purpose of selecting adaptation investigations. Adaptation investigations will include a 'no-regrets' adaptation investigation into MDBA adaptation options, and the trade-offs associated with those options. Additional adaptation investigations will target the range of potential adaptation options. For a selected number of those, pilot implementation will occur where practical.

A fourth project will produce syntheses of research across the climate adaptation theme, with a focus on Basin-wide recommendations. Capacity development will also be a key outcome.

Key questions		Key outputs and outcomes	
•	Which of the Basin's economic, social, environmental, and cultural values are most vulnerable to the flow-related impacts of climate change?	•	Foundational science – an improved understanding of the water-related impacts of the future climate, both through direct (i.e. hydrological) and indirect (e.g. bushfires)
•	How do other threats interact with climate change to affect vulnerabilities? What is the best way to evaluate the effectiveness of water management arrangements to manage risks, including climate change?	•	changes. Science applications & assessment toolkit – an enhanced ability to assess and compare the outcomes of adaptation options for catchment & Basin-scale water planning under climate change.
•	What adaptation options can provide better protection to vulnerable values in the basin? How do we undertake climate adaptation at regional scales that are most relevant to communities and environmental assets?	•	On-ground climate adaptation case studies – 4–6 strategically selected case studies to identify and explore adaptation pathways at multiple scales and across values, including through community participation.

Table 2: Summary of key questions, outputs, and outcomes for the Climate Adaptation theme.

6.2. Theme 2: Hydrology

Having reliable knowledge of the characteristics and movement of water, under current and future climates, is essential to informing water resources management and planning. The Hydrology theme will focus on the two ends of the flow spectrum: low flows and floodplain flows (Table 3).

The low flow component will focus on improving the simulation of low flows that are important to maintain environmental/refugia conditions, avoid the risk of poor water quality, and to support downstream water uses.

This is a long standing and complex problem faced by hydrologists and water authorities across Australia (and the world) that needs to be addressed strategically and fit-for-purpose for the applications. The hydrological processes controlling low flows are markedly different in perennial and ephemeral streams (e.g. southern versus northern Basin), and in unregulated and regulated systems. New methods, building on current knowledge and modelling, will be developed to improve low flow estimation in unregulated and regulated river reaches, to better inform ecological outcomes and water resources planning.

The MDB has numerous floodplain reaches where river flows can overtop the river bank and spread across the floodplain during high flows (from natural flood events or from controlled storage and/or environmental flow releases). To support and enhance water resource management, it is important to know how much of flow goes to the floodplain under different flow regimes and for how long, how much of it fills up wetlands, evaporates and infiltrates, and how much of it eventually returns to the river. This project has two research activities to address knowledge gaps in (i) predicting flood inundation extent, depth and duration and (ii) predicting floodplain volumes.

Other research under the Hydrology theme related to real time operations and environmental water delivery are still undergoing co-design. This project will work with MDBA managers and operators, CEWO, state water agencies to investigate how to improve river operations.

Key questions	Key outputs and outcomes	
 How can low flow prediction be improved to support water resources management planning? How can floodplain flow volumes, components, and inundation prediction be improved to support environmental watering and water resources planning? How can adaptation through enhanced river operations and water resources management improve water outcomes? How to better disentangle and model the impacts of climate and development drivers on the hydrology of the basin? 	 Enhanced low flow outcomes (for ecosystems, water quality and communities) through water resources management and planning informed by improved low flow prediction and modelling. Enhanced floodplain outcomes (for ecosystems and communities) through environmental watering and water resources management informed by predictive floodplain inundation model. Still in development related to operations and environmental water delivery Improved understanding, quantification and communication of drivers of northern Basin hydrology (including uncertainty and gaps in knowledge) supported by evidence-based science. 	

Table 3: Summary of key questions, outputs, and outcomes for the Hydrology theme.

6.3. Theme 3: Environmental outcomes

The ecological health of the Basin's rivers and other water systems is central to a healthy, working Basin now and into the future. Recent severe droughts and extreme ecological events in parts of the Basin have highlighted the significant challenges ahead in adaptively managing Basin ecosystems (and environmental water) to achieve environmental outcomes under a changing climate.

Key knowledge gaps have emerged in our understanding of Basin management to sustain the health of these ecosystems (Table 4). Better understanding of the factors maintaining ecological resilience during low flow periods (including the role of persistent riverine waterholes and hydrological connectivity) is critically important to inform water planning and management, particularly under a changing climate. First Nations' traditional knowledge of these systems is an essential source of knowledge which, alongside western science, will help identify risk factors for low flows to help planners and policy makers.

Increasing water scarcity will require prioritisation of environmental assets and values for targeted management to sustain and restore their conservation values. There is a significant need to include First Nations' perspectives on what is valuable and where priorities should be.

Improved predictive capability using models and tools will also allow research end-users to understand the spatial distribution of environmental assets and values, how they respond over time to water management, and the risks to future species population and ecosystem sustainability. This work/research will provide a more deeply informed basis for decision-making to support the ecological health of the Basin.

Table 4: Summary of key questions, outputs, and outcomes for the Environmental Outcomes theme.

K	ey questions	Key outputs and outcomes
•	What are the key factors that influence ecological resilience of refuge waterholes during low flow periods? How do we maintain ecological resilience at riverscape and whole-of-population scales? How can we best prioritise water- dependent ecosystems for management to ensure representative populations and communities of native biota are protected	 Improved understanding of low flow requirements of the Basin's environmental assets and values to inform water planning and management, particularly under a changing climate. Prioritisation of environmental assets, values and functions for targeted water management and complementary measures to sustain and restore their conservation values. Development of predictive models to better understand the anatisk distribution of
•	and, if necessary, restored? How can predictive ecological modelling be used to evaluate environmental outcomes of water management?	environmental assets and values, how they respond over time to water management, and the risks to future population and ecosystem sustainability from ecosystem stress.

6.4. Theme 4: Social, economic and cultural outcomes

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

The Research Implementation Plan for this theme was still in the co-design phase at the end of June 2021, with approval expected by the end of 2021. This theme is primarily focused on the relationship between riverine health and social, emotional, and economic well-being (Table 5). It has 3 core components.

The first is the relationship between ecological outcomes and social, economic, and cultural benefits of environmental water. The role of agricultural-related capital is much better understood than the role of other forms of human, social, financial, physical, and natural capitals. This theme therefore explores a range of these less investigated dimensions to build understanding of the economic and health improvement opportunities in the Basin.

The second component investigates how the cultural, economic and social outcomes for First Nations people can be improved. Traditional knowledge has a significant role to play and is central to the collaborative work with First Nations partners to grow economic opportunities for First Nations within the Basin, including meaningful access to water. Having NBAN and MLDRIN as part of the Research Consortium helping to deliver the research, and involved in the co-design from the start, will ensure the research delivers impact for First Nations across government.

Thirdly, it is widely understood in the social sciences that the way people and communities frame or understand a challenge or opportunity plays a significant role in how resilient they are and how they adapt. This theme therefore will investigate the outcomes valued by different Basin communities in response to a water future that will likely have less water.

Key questions		Key outputs and outcomes
•	What is the relationship between the condition of the riverine ecosystem and social, economic and cultural values?	Still in development
•	What are and how can the cultural, economic, and social outcomes for first nations people be improved?	
•	How can communities adapt to and be more resilient to a future with less water? What makes a community more resilient and adaptable to a future with less water?	5

Table 5: Summary of draft key questions, outputs, and outcomes for the Social, Economic and Cultural Outcomes theme.

7. Investing in short-term and responsive outputs

MD-WERP will assist the Australian Government in addressing Basin Plan objectives and responding to emerging issues by investing in short-term, tactical projects.

Tactical investments will assist in addressing high priority needs over the program's 4-year duration and to inform the Commonwealth's response to emerging issues. These investments will involve the delivery of short-term outputs to assist decision and policy makers on water management, river operations, and Basin Plan implementation. They will typically involve engaging experts to undertake analysis, review or synthesis identified by a Commonwealth water agency.

As short-term activities these will generally not undertake new primary research and/or collect new data, rather, they will likely deliver outputs such as packaging together the best-available knowledge in an area or apply current knowledge to a specific problem.

It is expected that a short-term project would take less than 12 months. Proposals for investment will be limited to the Commonwealth partners in the initial project intakes; however, this may be opened wider in the future. The procurement approach will be determined by the capability required to meet the need. Currently, two tactical projects have been approved to commence in 2021–22, with another previously completed.

7.1. Explaining the causes of reduced flow through the northern Basin Initiated

Multiple recent reviews have highlighted a growing need to examine the causes of flow changes that have been observed across the northern Basin over recent years. This project aims to address this need to examine the causes of the reduced flows. The work will collate available information regarding changed northern Basin flows, categorise which drivers are expected to be the leading contributors to this change, and make recommendations for future research.

The outcomes of the project can be used to inform future, larger research projects, including those that will underpin future modelling and policy responses, including the Basin Plan Review.

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

Initiated

With the invention of drones, easy access, affordable satellite imagery and GPS, and artificial intelligence (i.e. object recognition software), come new possibilities for collecting data on animals and vegetation across the large landscape of the Basin. This project aims to use this technology to increase capacity to understand trends in water-bird populations.

The expected outcome of this project is that the MDBA will be better placed to invest in broad landscape monitoring techniques which will serve well into the future – future proofing our monitoring investment and better able to adopt the new technology when it arrives.

7.3. Hydro-climate storylines

Completed

The hydroclimate of the Murray–Darling Basin (MDB) is changing. The future will be warmer and is likely to be drier with more severe droughts. These changes pose a threat to sustainable management of the basin as they are likely to have significant impacts on the Basin's water availability, agricultural production, communities and the environment.

This project developed expert advice on the projected impacts of climate change on water availability in the MDB, including the generation of a small suite of storylines (synthetic climate scenarios) to support a climate risk assessment across social, economic, cultural and environmental outcomes. It also developed guidance on a long-term strategy for assessing climate risks in basin water management as part of MDBA's climate change program.

The advice and storylines will provide the basis for understanding and simulating the scale of changes projected to flow regimes, and water availability in the MDB.

8. Program governance

Delivering a 4-year, cross-agency program successfully will depend on robust and multi-level program governance. The Governing Panel endorsed the governance structure and Terms of Reference for the program in November 2019. The structure was updated in April 2021 to reflect the changes made as the program matured. Figure 4 illustrates the agreed governance structure.

Details of the Governing Panel can be found below, and the membership and Terms of Reference of the other working groups can be found at Appendix 2. Implementation and administrative support for the program is provided by the MD-WERP Implementation Team within the MDBA.

8.1. Governing Panel

The program is overseen by a Governing Panel who reports to the Federal Minister for Water. Terms of Reference for the panel can be found at Appendix 2. Membership of the Governing Panel consists of:

Core members

- Independent Chair
- Commonwealth Environmental Water Holder, CEWO
- First Assistant Secretary, Water Division, DAWE
- Executive Director, Basin Strategy and Knowledge, MDBA

Advisory and observer members

- MDBA Project Delegate
- CEWO Representative
- DAWE Representative

The following changes were made to Governing Panel membership during 2020–21:

- Change in CEWH representative
- Change in DAWE representative

The Governing Panel met 8 times during 2020–21. A summary of achievements is provided below.

- Oversight of the request for tender and evaluation process to appoint the Research Consortium.
- Emphasis placed on end users, via impact pathways, ensuring the research continues to be used and developed by others after the four-year program.
- Maintained oversight of governance, budget allocation and expenditure, and a focus on demonstrating value for money regarding the co-design process.
- Endorsement of 2 tactical investment proposals to commence in 2021–22 and maintained emphasis that proposals should, where possible, complement existing work being done elsewhere and focus on the strategic value of the research.
- Maintained focus on strategic alignment opportunities with other research programs/organisations.



Figure 4: MD-WERP Governance Structure

9. Continual monitoring and improvement

A monitoring, evaluation, reporting and improvement (MERI) framework is in its final stages of development and will play a critical role in tracking the progress of a program. It will ensure accountability, aiding decision making, generating, and disseminating knowledge, and ultimately guiding program improvement.

The overarching purpose of MERI throughout the program is to facilitate ongoing improvements to the program to ensure it meets the program objectives, outcomes and needs to stakeholders. Elements of MERI will also support risk management, ensure transparency around the operation of the program, and communicate outcomes of the program.

Appendix 1: Annual financial acquittal

2020–21 Financial expenditure (actuals)

A total of \$460,167 (excl. GST) has been spent during 2020–21. Table 6 shows a breakdown of this expenditure.

Table 6: 2020–21 Financial expenditure

Expense	Actual expenditure
Program Administration	
Salary (including contractors)	\$264,982
Operating (travel, workshops)	\$5,762
Governing Panel	\$25,000
Total	\$295,744
Strategic Research	
Legal (RFT process, probity, Deed development)	\$78,092
Co-design Inception Workshop	\$45,009
Climate Adaptation	\$34,992
Evaluation Panel	\$6,400
Total	\$164,423
Grand Total	\$460,167

Summary of in-kind contributions to the program

During 2020–21, the MDBA contributed \$515,286 in in-kind to support the program's administration, including program management, procurement and legal services to support the Request for Tender (RFT), RFT evaluation process, Deed and contract development, and to support the co-design process.

Outlined in Table 7 is the in-kind contributions against the level and time committed support the program by MDBA and Commonwealth Partner employees.

Table 7: Commonwealth (MDBA & DAWE) In-kind staffing contribution (2020-21)

Commonwealth In-kind Contribution		
Number of staff (Full-time equivalent)	15	
APS 6	3	
EL1	4	
EL2	5	
SES	2	
Number of working days	593	
Total in-kind expenditure \$551,950		

Appendix 2: Program glossary

Term	Definition
Adoption	The uptake of information, concepts, tools or practices (innovations) that have been generated predominantly through research.
Advisory Committee on Social, Environmental and Economic Sciences (ACSEES)	The MDBA's independent scientific advisory body comprising seven committee members focused on delivering advice on Basin Plan implementation and the broader scientific context of the MDBA's work, including environmental watering, adaptive management, climate change and the monitoring and evaluation of Basin Plan outcomes.
Chair	Independent Chair, Professor Rob Vertessy, 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 and Engagement Steering Group	A group established to assist with supporting a coordinated approach to both communication and engagement activities to support the Murray–Darling Water and Environment Research Program.
Communication, Engagement and Adoption Framework	A framework developed to guide the development of all communications, engagement and adoption activities, and outlines expectations at program and project/thematic level.
Commonwealth Partners	A collaboration between Australian Government agencies to help deliver the program, comprising the Murray– Darling Basin Authority, Commonwealth Environmental Water Office, and the Department of Agriculture, Water and the Environment.
End Users	Individuals, groups, and organisations in which the findings and outputs of MD-WERP will have direct relevance and consequences to their work programs.
End User Advisory Groups (EUAG)	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.

Term	Definition
Evaluation	Systematic determination of the quality or value of something. Evaluation will be used to determine the value of the program and its activities. Formative evaluation through the life of the program will inform ongoing improvements, with summative evaluation being conducted to capture the overall worth of the program at its closure.
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).
Knowledge Prospectus	Identifies 14 priority research questions across the 4 themes of Climate Adaptation, Hydrology, Environment, and Social, Cultural and Economic. Developed in 2020 through an independent consultative process involving a range of participants including the Commonwealth and state governments, academia and the community.
Monitoring	Observing or checking the progress of something over a period of time. In the context of MD-WERP, monitoring may include performance monitoring or operational monitoring depending on the question it is being used to address. Monitoring will inform evaluation and reporting.
Murray–Darling Basin Authority (MDBA)	Responsible for administering the program, in collaboration with Commonwealth Partners, DAWE and CEWO, Basin stakeholders, and the Research Consortium.
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.
MDBA Project Delegate	MDBA General Manager, Applied Science, responsible for administering the program with the support of the MD- WERP Implementation Team.
Murray–Darling Water and Environment Research Program (MD-WERP)	A 4-year (2021-25), \$20 million Commonwealth funded research program designed to help inform water and environment management decisions, which will improve outcomes for the Basin and its communities.

Term	Definition
MD-WERP Implementation Team	Provides support to the MDBA Project Delegate in administering the program by managing the program administration, program streams, providing Secretariat support, and engaging with key stakeholders and program partners.
Memorandum of Understanding (MoU)	Funding for MD-WERP is provided under a Memorandum of Understanding between DAWE and the MDBA. The MDBA administers the program under the guidance of the MD-WERP Governing Panel.
Murray Lower Darling Rivers Indigenous Nations (MLDRIN)	A confederation of sovereign First Nations from the southern part of the Murray–Darling Basin. The organisation includes representation from First Nations from as far north as the Macquarie River in Wiradjuri Country, to the Coorong and Lower Lakes on Ngarrindjeri Country in South Australia.
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.
Northern Basin Aboriginal Nations (NBAN)	A confederation of sovereign First Nations from the northern part of the Murray–Darling Basin. The organisation includes representation from First Nations from as far north as Charleville in Gunggari Country to Tamworth in Kamilaroi Country in central New South Wales.
Impact Pathway	Outlines the key inputs, activities, outputs, and expected outcomes and impacts for each Theme and the relevant research questions in ensuring the research continues to be used and developed by others after the four-year program.
Reporting	Giving an account of something that has been observed, heard, done or investigated. Reporting will be used to track risks and disseminate monitoring and evaluation findings. Reporting will feed into ongoing improvement of activities and broader evaluation of the Program. Reporting plays a critical role in ensuring transparency.
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.
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 outlines the key inputs, activities, outputs, and expected outcomes and impacts for each theme and the relevant research questions.

Term	Definition
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 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 streams that comprise MD-WERP including 1) Strategic Research 2) Tactical Investments 3) Communications, Engagement and Adoption, and 4) Administration.
Sustainable Rural Water Use and Infrastructure Program	An Australian Government program managed by the Department of Water, Agriculture and the Environment, from which funding for the MD-WERP is provided.
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.
Theme Team	Comprising an MDBA Theme Lead and Theme Coordinator to oversee and support the strategic research investment of the program on behalf of the Commonwealth Partners, and to liaise with the End User Advisory Groups (EUAGs) in the codesign, monitoring, evaluation, and adoption of the research.

Appendix 3: Governance Terms of Reference

Governing Panel	
Objective of the role	To provide oversight of the program.
Roles and responsibilities	 Endorse budget allocation across the program and within the four investment streams. Endorse program investments, including strategic research and tactical proposals. Endorse the program's annual progress report. Provide advice to inform the program's design. Review program reporting and agree on pathways for improvement. Provide strategic guidance and leadership to assist in delivering the program's outcomes. Identify any significant risks escalated from the program or identified by Australian Government partners and propose mitigation strategies. Facilitate Minister and government briefings and engagement, as required. Raise the profile of the importance of water research, including identifying opportunities to increase investment and an enduring platform.
	 Coordinate and chair panel meetings Provide science advice and leadership to inform the program's planning and implementation. Attend and provide briefings about the program, as required. Participate in media and communication activities, as required. Identify opportunities to leverage Australian Government investment and attract partners to improve outcomes.
Frequency	The panel will formally meet between 2 and 4 times annually.
Membership	 Independent Chair Commonwealth Environmental Water Holder First Assistant Secretary, Water Division, Department of Agriculture, Water and the Environment (DAWE) Executive Director, Basin Strategy and Knowledge, Murray– Darling Basin Authority (MDBA) Note: The MDBA position is also the MDBA Delegate. Advisors/Observers:
	 MDBA Project Delegate CEWO Representative DAWE Representative
To whom does this role report	Secretariat: MD-WERP Implementation Team
Qurom	All members

MDBA Delegate		
Objective	Responsible for the program.	
Roles and Responsibilities	 On advice from the Governing Panel: Approve budget allocation across the program and within the four investment streams. Approve program investments, including strategic research and tactical proposals. Approve the program's Annual Progress Report, before submission to DAWE for final approval. Approve the program's design. Provide strategic guidance and leadership to support the program's administration. Support government briefings and engagement, as required. Resolve any disputes within the panel. Escalate key risks, where a mitigation strategy cannot be agreed by the panel to DAWE. 	
Frequency	On-going	
Membership	Executive Director, Basin Strategy and Knowledge, MDBA	
To whom does this role report	DAWE	
MDBA Project Delegate (including MD-WERP Implementation Team)		
Objective	Responsible for administering the program.	
Roles and Responsibilities	 Manage program administration for the program, including: Program planning and delivery. Process, procedure and document development. Procurement negotiation and management. Financial management and reporting. Monitoring, Evaluation, Reporting & Improvement implementation. Risk management Manage the tactical investment, strategic research and communication, engagement and adoption program streams. Coordinate Australian Government's contribution to the program. Membership on the Executive Leadership Team. Lead the Commonwealth Advisory Team. Stakeholder management. 	
Frequency	On-going	
Membership	General Manager and MD-WERP Implementation Team, Applied Science, MDBA	
To whom does this role report	MDBA Delegate	

Executive Leadership Team (ELT)	
Objective	To provide strategic and operational oversight of the investment in strategic research.
Roles and responsibilities	 Provide strategic and operational oversight on development and delivery within their delegation. Provide recommendations on investments and/or opportunities. Provide oversight on progress reporting, including escalation of program risks. Review of strategic research outputs to ensure alignment with agreed investments and program objectives. Contribution to reporting, briefings and meetings to represent the strategic research investment.
Core activities & frequency	Monthly meetings and as required.
	Quarterly progress updates to the Governing Panel
Membership	 MDBA Project Delegate Research Consortium Directors Advisors: MD-WERP Implementation Team
	Secretariat: MD-WERP Implementation Team
To whom does this role report	MDBA Delegate and Governing Panel
To whom does this fole report	
Science Leadership Team (SLT)	
Objective	To provide leadership to ensure the delivery of rigorous and robust science to address end-user needs and integration of the program's investment in strategic research.
Roles and Responsibilities	 Review and discussion on strategic and operational matters that require both science and end-user input. Provide advice on arising science issues and risks for the program, including identify issues relating to scientific robustness or validity. Identify opportunities for communication, engagement and adoption. Ensure research and end-user engagement and identify opportunities for improvement. Ensuring interdependencies between the themes are managed and to identify new opportunities. Review of strategic research outputs, as identified by ELT. Contribution to science thought leadership, as identified by ELT.
Frequency	Quarterly meetings and tasks as identified by the ELT.

Membership	 Research Consortium Directors Theme leaders (Australian Government and Research Consortium) Engagement Leads Advisors/Observers: First Nations representatives MDBA Project Delegate MD-WERP Implementation Team CEWH representative DAWE representative Secretariat: Research Consortium
To whom does this role report	Executive Leadership Team
Commonwealth Advisory Team	
Objective	To support collaboration and engagement between Australian Government Partners and to assist in providing advice from an Australian Government perspective.
Roles and Responsibilities	 As required: Provide internal updates and briefings to respective Governing Panel members and within Australian Government partner organisations. Attend panel meetings, as observers. Coordinate advice and input from respective Australian Government partners. Submit tactical proposals for consideration by the panel and provide feedback on proposals. Provide advice to the Science Leadership Team, Executive Leadership Team and the Communication and Engagement Steering Group. Assist with building the profile and engagement of the program within respective organisations. Provide review of program materials. Assist with the dissemination of program outputs. Participate in End-User Advisory Groups or nominate individuals to participate.
Frequency Members	 As required. Meetings to align with panel meetings and when Australian Government input is required. MDBA Project Delegate (Chair) MD-WERP Implementation Team CEWO Representative DAWE Representative Secretariat: MD-WERP Implementation Team
To whom does this role report	MDBA Project Delegate

Communication and Engagement Steering Group		
Objective	To assist with supporting a coordinated and considered approach to both communication and engagement activities to support the MD- WERP	
Roles and responsibilities	 Share ideas to inform communication and engagement planning and implementation for both the program and research consortium. Assist with ensuring compliance with the MD-WERP's policies relating to communication and engagement, including review processes and alignment to the MD-WERP Branding Guidelines. Identify opportunities to assist with improving the coordination of communication and engagement activities between Australian Government Partners and Research Consortium. Contribute to the program evaluation and reporting to support the program's Monitoring, Evaluation, Reporting and Improvement (MERI). Identify opportunities through respective organisations, initiatives and networks to support the program. Identify any investment opportunities and/or risks to the Executive Leadership Team and/or MDBA Delegate. 	
Members	 MDBA General Manager Communication, Engagement and Policy (Chair) MDBA Project Delegate MD-WERP Implementation Team MD-WERP Research Consortium engagement and communication leads 	
	 Advisors MDBA Delegate MDBA Engagement Director First Nations representative CEWO representative DAWE representative 	
	Secretariat: MDBA Communications	
Frequenci	4–6 meetings annually	
To whom does this role report	MDBA Project Delegate and MDBA Delegate	