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Murray–Darling Basin Authority

Hydrometric Networks and Remote Sensing (HNRS) Program Project Closure Report

Final – all projects

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Acknowledgement of the Traditional Owners of the Murray–Darling Basin

We acknowledge the Traditional Owners and Custodians of Country throughout the Murray–Darling Basin and their continuing connection to land, waters and community. We offer our respects to the people, the cultures and the Elders past and present.

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

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List of Acronyms

API	Application Programming Interface
BoM	Bureau of Meteorology
CHA	Collaborative Heads Agreement
DAWE	Australian Government's former Department of Agriculture, Water, and the Environment
DCCEEW Cwlth	Commonwealth Department of Climate Change, Energy, the Environment and Water
DRDMW	State of Queensland Department of Regional Development, Manufacturing and Water
EPMO	BoM's Enterprise Project Management Office
GA	Geoscience Australia
HNRS	Hydrometric Networks and Remote Sensing
HNRS Program	Hydrometric Networks and Remote Sensing Program
ICT	Information and Communications Technology
ITA	Independent Technical Assessor
JAICT	Joint Agency Information and Communications Technology
LiDAR	Light Detection and Ranging
MAR	Milestone Assessment Report
M–D Basin	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
MOU	Memorandum of Understanding
NRAR	State of New South Wales Natural Resources Access Regulator
NSW DCCEEW	State of New South Wales Department of Climate Change, Energy, the Environment and Water
PMO	Project Management Office
PoC	Proof of Concept
OFWSE	On-Farm Water Storage Explorer
QGCDG	State of Queensland Government Customer and Digital Group
RWF	State of Queensland Rural Water Futures
SAD	Solution Architecture Design
SDS	Service Delivery Standards
SFTP	Secure File Transfer Protocol
TOGAF	The Open Group Architecture Framework
WIP	Water Information Portal

Executive Summary

Introduction

Water management and monitoring are key issues across the Murray–Darling Basin (M−D Basin). Off the back of growing community concern about increased use of water, water theft, declining health of the northern M−D Basin rivers, and the need for accurate water use and water flow information, the Hydrometric Networks and Remote Sensing Program (HNRS Program) was established.

The HNRS Program was established by the Australian Government (through the former Department of Agriculture, Water and Environment [DAWE]) to strengthen public confidence in Basin water management (i.e. improve transparency and compliance outcomes) by:

- expanding the hydrometric network, supplemented with cost efficient measurement devices
- automating and making available online water accounting, monitoring, and reporting tools for water entitlement holders and compliance officers
- using remote sensing data to improve measurement and monitoring to support water management and compliance
- making water information available to the public via the M−D Basin-Water Information Portal (WIP).

In December 2020, the Australian Government announced 4 complementary projects to improve how the northern M-D Basin water is measured and monitored and to give communities access to more water information. Together these projects comprised the HNRS Program, funded through $35 million from the Australian Government plus additional cash and in-kind contributions from Program Partners.

This project closure report relates to all four HNRS Program projects. It is the final document that officially ends the projects. It includes all important project information to help stakeholders, auditors, and future project managers clearly understand what was accomplished during the projects and the Program and how the work was completed.

The primary purpose of this report is to provide a complete picture of the delivered elements, successes, challenges, benefits, and lessons learnt from the projects. This report accompanies an evaluation report, where the performance of the Program's benefits are evaluated for appropriateness, effectiveness, and efficiency.

The HNRS Program overview

The HNRS Program was a collaborative effort between the State of New South Wales Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW), the State of Queensland Department of Regional Development, Manufacturing and Water (DRDMW), the Bureau of

Meteorology (BoM), Geoscience Australia (GA), and the Murray–Darling Basin Authority (MDBA). Collectively this group of agencies and government departments were referred to as Program Partners.

The HNRS Program created an opportunity for the Program Partners to work together to deliver outputs that improve decision making by water users and provide better compliance outcomes. Ultimately, the HNRS Program sought to improve public confidence in management of the northern M-D Basin.

The 4 projects that comprised the HNRS Program were:

- development of a water accounting and reporting tool for water entitlement holders and compliance officers (Project 1)
- development of a M–D Basin Water Information Portal and supporting systems (Project 2)
- improved Cross-Border Measurement and Monitoring (Project 3)
- operationalising Remote Sensing and Spatial Compliance (Project 4).

Together these projects identified the limitations of current data, information, and systems, and developed tools, processes, and dashboards to meet identified needs to achieve:

- improved compliance outcomes
- improved access to water information
- improved measurement and monitoring of water use
- reduced data costs.

HNRS Program inception and delivery

Initiation of the HNRS Program involved a Commonwealth Heads of Agreement (CHA) and Project Agreements being developed. The HNRS Program CHA nominated the MDBA as the program partner to also provide a project management office (PMO) to manage the program funds and delivery. The CHA also outlined how the HNRS Program Steering Committee and HNRS Program Technical Panel should be established to oversee and help coordinate program delivery.

Deliverables were established, scoped, and budgeted within each Project Agreement. However, consistent with an adaptive management approach, some changes in scope were necessary due to COVID impacts and once preliminary investigations were complete.

These changes, described as recalibration, were approved by the HNRS Program Steering Committee, and demonstrated how the program's agile and collaborative approach to delivery enabled the program to realise benefits beyond those initially envisaged.

The HNRS Program's governance arrangements, including the Steering Committee and Technical Panel, oversaw and helped coordination of program delivery. Program Partners had their own internal governance arrangements to provide suitable levels of project oversight and assurance.

A project lead department/agency was nominated for each project; however, this role was primarily limited to reporting. Milestones were developed for each project and resourced by Program Partners as required to enable delivery.

The key inputs, outputs and outcomes produced by each project are summarised in Table 1.

Table 1: Summary of project inputs, outputs, and outcomes

Project	Description	Inputs	Deliverables	Outputs/Products	Outcomes
Project Planning	Program planning and inception	$1.4M	• Scoping and planning HNRS Program governance and management arrangements across Project Partners • Align Program Partner project management arrangements • Plan HNRS Program and project configuration	• Collaborative Heads Agreement • Memorandum of Understanding – MDBA/DCCEEW Cwlth • Project Agreements	• HNRS Program Inception and management
Project 1	Collecting, managing, and reporting data, to create a water accounting and reporting tool for entitlement holders and compliance officers	$6.5M	• Improving data and information management platforms • Data feed (data sharing) - application programming interfaces (APIs) • NSW Compliance Officer Interface • NSW Data Quality Improvement Register	• WaterIQ Customer Portal (Qld) https://water-monitoring.information.qld.gov.au/ • WaterIQ App – android/iOS (Qld) • WaterIQ Manager (internal) (Qld) • Water Insights Portal (public facing) (NSW) WaterInsights - WaterNSW • NRAR's Intranet Hub (Compliance Officer Interface and Dashboards) (internal) (NSW) • Data Pipeline (internal) • Data Quality Improvement Register (internal)	• Improved transparency and tools for decision making by water users • New and improved data • Improved compliance outcomes

Project	Description	Inputs	Deliverables	Outputs/Products	Outcomes
Project 2	Developing a public water information portal that makes water information available to the public	$7.7M	• Data Sharing Agreement • Water Information Portal • Data services (application programming interface or APIs) • Data services to support data products developed in related projects (Project 3, Project 4)	• Water Information Portal (public facing) • Water Data API • Water Source API • Storage Balance API	• Improved public access to water data, information, and tools
Project 3	Improving monitoring and compliance across the northern M-D Basin by expanding the hydrometric network and the use of remote sensing technologies	$10.1M	• Installation and commissioning of new or upgraded hydrometric stations • Low-cost monitoring technology evaluation report • Baseline mapping of floodplain infrastructure • Floodplain Harvesting Analytics Tool • Remote sensing methodology to determine storage volumes and areas • On-Farm Water Storage Explorer (OFWSE) calculation tool • Farm scale change detection method and map	• 20x gauging stations (new or upgraded) • Floodplain Harvesting Analytics Tool (internal) • Property Measurement Plans and Geodatabase (internal) • Measurement Technical Panel establishment • On-Farm Water Storage Explorer (OFWSE) calculation tool (internal) • LiDAR acquisition and analysis • Synthetic Aperture Radar (SAR) derived elevation and interferometry (InSAR) Tool for Catchment and Farm scale change detection PoC (internal) • Report on foundation data enhancement and development (internal) • Low-cost water monitoring technology evaluation	• New and improved data, methods and tools for decision making • New and improved data • Improved compliance outcomes • Identified priorities for testing emerging technology • Enhanced development of future standard instruments • Reduced duplication through collaboration and transparent sharing of knowledge across Project Partners • Extensive topographic and more public elevation mapping services of the

Project	Description	Inputs	Deliverables	Outputs/Products	Outcomes
				• Emerging water technology scoping report • 3x supplementary gauging PoC stations (new) • 50x supplementary rainfall telemetry PoC stations (new) • Corporate systems interfacing with emerging instruments • 8294 km2 longitudinal survey of part of the Moonie and Border Rivers catchments • Automation of non-contact stream gauging PoC • Farm scale change detection PoC	floodplain and structures • Digitised survey records of relevant floodplain structures (PoC) • Automated rainfall records in gaps (new) • Validation that working in remote geographies remain challenging • Publishing and presentation of project data accessible through API
Project 4	Adopt remote sensing acquired in Project 3 to enhance real-time measurement and compliance at a Basin scale.	$9.3M	• Acquisition of field data • Remote sensing tools • Water balance tools • Compliance tools	• Crop Information System PoC (internal) • Irrigated Crop Area Time Series (internal) • Water Surface Area Time Series (internal) • Volume Estimation tool (internal) • Google Earth Engine development environment • Reach/Catchment Water Balance Model Tool (public facing) • Farm Scale Water Balance Tool (internal)	• New and improved data, methods and tools for decision making • New and improved data • Improved compliance outcomes • Time saving decision support tool (internal) • Confirmation of the limits of remote sensing • Identified foundation priorities to develop water balance enhancements

Project	Description	Inputs	Deliverables	Outputs/Products	Outcomes
				• Remote sensing gap analysis • Farm scale water storage geographic information system analysis methodology (PoC) • Reach water balance tool (PoC) (internal) • Anomaly Detection – water meter compliance tools (PoC) • Extractor uplift (internal) • IrriSat uplift (public facing)	• Reduced duplication through collaboration and transparent sharing of knowledge across Project Partners • Identified limits of foundation data available to interface
Total		**$35M**			***Improved public confidence in the management of water in the northern M–D Basin***

Delivering the HNRS Program resulted in many 'wins' brought on by the collaborative culture that was implemented amongst Program Partners. The HNRS Program created lots of goodwill, facilitated trust and commitment, and encouraged the cross pollination of new processes and ways of thinking and working among the Program Partners.

The challenges experienced in delivering the HNRS Program were headlined by COVID and highlighted that the knowledge required to deliver the HNRS Program resided in a small number of individuals, and therefore resourcing competed with other state and Commonwealth requirements. Furthermore, delivering the Program showed that building relationships takes time and relationship building remains 'a work in progress'.

Several key lessons have been learnt from delivering the Program that have been categorised by governance, planning and delivery. In summary, it is recommended that:

- governance procedures are established prior to Program commencement
- internal and external communication strategies are developed prior to Program commencement
- project management including quality assurance procedures are developed and understood prior to project scoping and budgeting
- program resourcing including budgets and schedules include contingencies and recognise the need for on-boarding and succession planning
- delivery is tracked over time to identify any issues, enable communication, and enable adaptive management
- the need for on-going funding to realise long term outcomes is recognised.

The Program Partners have provided business readiness and closure statements for their respective elements of each project. The closure of the HNRS Program is also supported by the HNRS Program Steering Committee, Technical Panel and PMO who have approved all project milestones.

Conclusion

In delivering the HNRS Program, the Program Partners have developed a suite of online dashboards, tools and methods that will have long lasting benefits for all decision makers involved with the management of water resources in the northern M–D Basin. Furthermore, the Program has highlighted the limitations of data, and invested in infrastructure, equipment and satellite services that will provide on-going benefits.

The HNRS Program has produced foundational outputs that, with continued use, will contribute to the intended benefits of the Program, namely improved compliance outcomes, improved access to water information, improved measurement and monitoring of water use, and reduced data costs. Ultimately, the HNRS Program will result in improved public confidence in the management of water resources in the northern M–D Basin.

However, the full realisation of benefits and long-term outcomes from using these outputs will require continued investment in the maintenance, operation, and awareness of these foundational outputs by all stakeholders.

1 Introduction

1.1 The study area

The Murray–Darling Basin (M–D Basin) is approximately 1 million square kilometres in size and comprises a complex arrangement of catchments, rivers and groundwater sources. The Basin has multiple jurisdictional governments (Figure 1), varied densities of communities, over 40 First Nations Peoples, differing landscape types, assorted industry and agricultural endeavours and complex water dependent environments. The common thread in the M–D Basin is water which flows inevitably towards its end at the Murray Mouth at Goolwa in South Australia. The productivity of the end of the M–D Basin and everything in between depends on how well the upstream system is managed, treated, and administered.

Figure 1: Murray–Darling Basin boundaries.

Since the development of irrigated agriculture, the M–D Basin's water systems have been managed with a complex array of regulation that seeks to ensure that upstream water capture and use leaves sufficient shares for downstream. Drought, compliance failures including water theft, river health issues such as blue green algae blooms, fish deaths, and blackwater events have increased the community's awareness and concerns that governments need to be managing water with accurate information to back up the regulations that ensure the equitable and legal distribution of water.

1.2 Background

1.2.1 Driver of change

In the late 20th century and into the 21st century, the northern M−D Basin, which constitutes the Border Rivers between NSW and Queensland, the Queensland/NSW Intersecting Streams and the NSW northern M-D Basin rivers, experienced accelerated irrigated agriculture development. The northern M-D Basin is relatively sparsely populated compared with the southern M−D Basin and requires water measurement at scales involving complex and difficult logistics given the sheer size and remoteness of the region. Inevitably the effects of behaviour and misuse upstream draws scrutiny from communities downstream and from those concerned with the health of the waterways.

In 2017 governments came under scrutiny arising from the ABC 4Corners television program "Pumped" (https://www.abc.net.au/news/2017-07-24/pumped/8727826) which threw a light on the plight of communities and river environments that were feeling the effects of mismanagement, irregularities in official dealings and water theft.

This led to the 2017 Murray−Darling Basin Water Compliance Review (https://webarchive.nla.gov.au/awa/20200921173818/https://www.mdba.gov.au/sites/default/files/pubs/MDB-Compliance-Review-Final-Report.pdf) , which found low levels of public confidence in the management of water and compliance with water regulations. The review also noted concerns about the lack of transparency about and resourcing of compliance activities in the northern M-D Basin.

The review identified the value of better measurement of water diversions (extractions and floodplain harvesting/overland flow capture) through increased use of emerging technologies such as remote sensing and improvements in hydrometrics/measurement. State water management and policy agencies and organisations tasked with roles in water data collection, compliance[1] and management were engaged to design a program of works, measures and tools to fill the information gaps and encourage and embed the mechanisms by which the information can be shared.

In summary, the findings from the 2017 M−D Basin Water Compliance Review (as shown in Figure 2) can be summarised as 3 core problems leading to the HNRS Program.

[1] Initially the MDBA held the role of ensuring compliance with the Water Act 2007 (Cwlth) in the M−D Basin. The statutory position of the Inspector-General of Water Compliance (the Inspector-General) was established on 5 August 2021 which separated the compliance function from the MDBA to the independent Inspector-General.

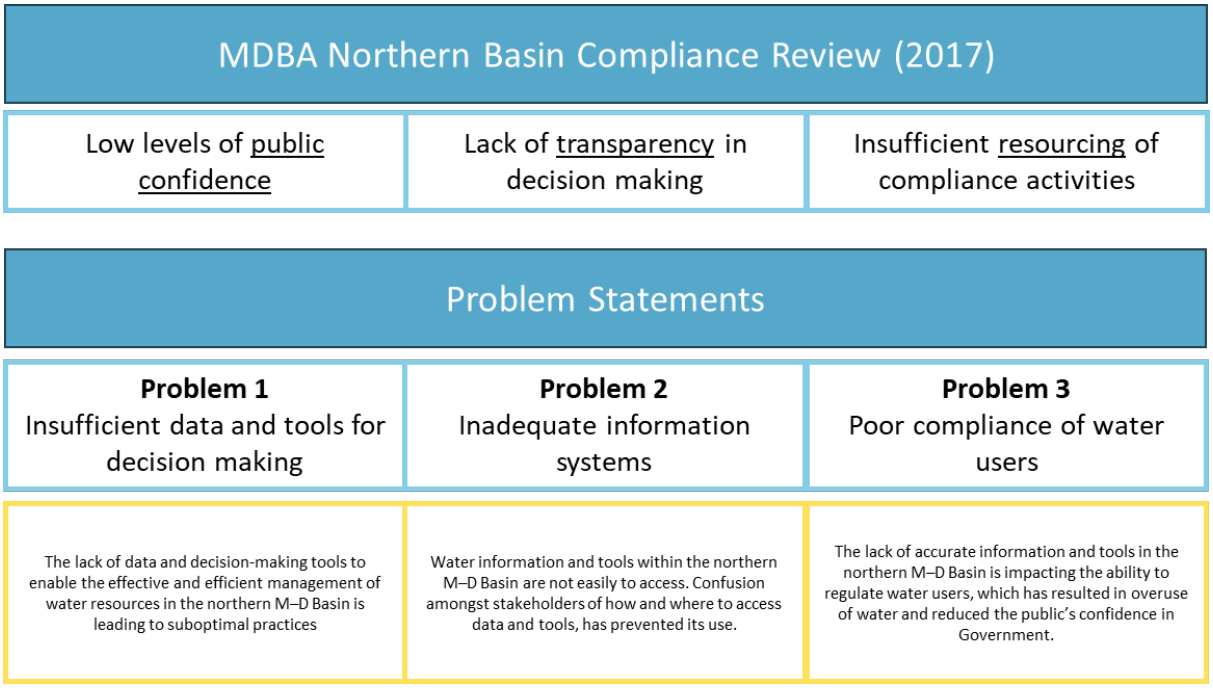

Figure 2: Defining the problem

1.2.2 The solution proposed

The Hydrometric Network and Remote Sensing Program (HNRS Program) was established by the Australian Government (through the former Department of Agriculture, Water and Environment [DAWE]) to strengthen public confidence in M−D Basin water management (i.e. improve transparency and compliance outcomes) by:

- expanding the hydrometric network, supplemented with low-cost measurement devices
- automating and making available online water accounting, monitoring, and reporting tools for entitlement holders and compliance officers
- using remote sensing data to improve measurement and monitoring to support water management and compliance
- making water information available to the public via the M−D Basin - Water Information Portal (WIP).

In December 2020, the Australian Government announced four complementary projects to improve how the northern M−D Basin's water is measured and monitored and to give communities access to more water information.

These projects were:

- development of a water accounting and reporting tool for entitlement holders and compliance officers (Project 1)
- development of a northern M−D Basin Water Information Portal (WIP) and supporting systems (Project 2)
- improved Cross-Border Measurement and Monitoring (Project 3)
- Operationalising Remote Sensed and Spatial Compliance (Project 4).

Together these projects comprised the HNRS Program, funded by $35 million from the Australian Government plus additional cash and in-kind contributions from Program Partners.

The objectives of the HNRS Program were to facilitate an efficient and effective framework for northern M−D Basin state governments, the MDBA and the Commonwealth to work together to improve, develop, build, install and implement tools, techniques, devices, processes, and systems for enhancing the quality, availability and transparency of water monitoring and information for the northern M−D Basin.

1.3 Report purpose

This projects closure report relates to all four HNRS Program projects and includes contributions from each of the Program Partners involved in the respective projects. The primary objective of this report is to provide a complete picture of the delivered elements, successes, challenges, benefits, and lessons learnt from delivering the projects.

This report is the final document that officially ends the projects. It includes all important project information to help stakeholders, auditors, and future project managers to clearly understand what was accomplished during the projects and the Program and how the work was completed.

This report collates and comments on the Program Partner contributions to the Program benefits at a deliverable level. Fully detailed information on project milestones is not provided but is available as part of respective Program Partner archives.

2 HNRS Program snapshot

2.1 Overview

The HNRS Program was a collaborative effort between the State of New South Wales Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW), State of Queensland Department of Regional Development, Manufacturing and Water (DRDMW), the Bureau of Meteorology (BoM), Geoscience Australia (GA) and the Murray–Darling Basin Authority (MDBA). Collectively this group was referred to as the Program Partners.

The Program was funded by the Commonwealth, underpinned by a Collaborative Heads Agreement (CHA), and overseen by an independently chaired HNRS Program Steering Committee, supported by a HNRS Program Technical Panel. For more information refer to Section 3.1.1.

The four projects that comprise the HNRS Program are described in Table 2. The table also demonstrates the delivery partners involved and the reporting lead agency.

Table 2: Program overview (Lead agency in bold)

Project	Project description	Delivery partners
Project 1	This project aimed to improve transparency and accountability across northern M–D Basin catchments. The project collected, managed, and reported data, to create a water accounting and reporting tool for entitlement holders and compliance officers.	**QLD** MDBA NSW
Project 2	This project developed a public water information portal that makes water information available to the public in a clear and transparent way, drawing information from a range of sources. This project also reported on environmental watering within the M–D Basin.	**MDBA** BoM NSW QLD
Project 3	This project improved monitoring and compliance across the northern M–D Basin by expanding the hydrometric network and using remote sensing technologies to provide additional data for compliance monitoring and reporting. This project supported improvement in measurement of flows and floodplain harvesting technologies.	**QLD** MDBA NSW
Project 4	This project operationalised remote sensing undertaken in Project 3, to enhance real-time measurement and compliance at a M–D Basin scale. This project improved information on water balance in the M–D Basin.	**NSW** MDBA Qld GA

The relationship between each project, the scope, and the intended beneficiaries is shown in Figure 3 (next page).

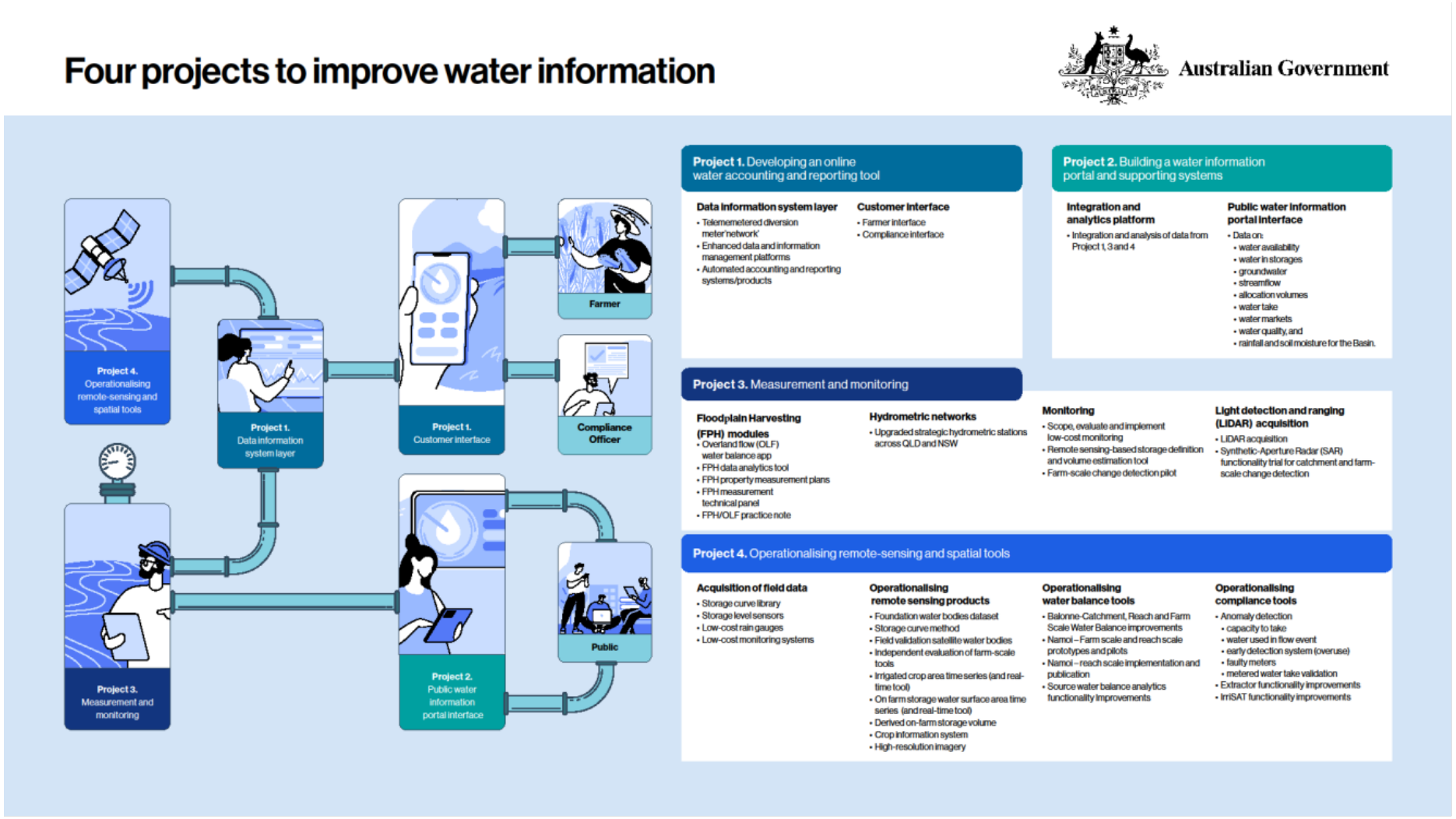

Figure 3: Project scope and relationship with intended beneficiaries

2.2 Program benefits

The HNRS Program was developed to deliver the following benefits:

- **B1 Improved compliance outcomes** - Compliance officers will have access to improved compliance tools, including access to real-time water use information and remote sensing and water balance tools and analytics allowing State and Commonwealth compliance staff to focus on areas or individuals at highest risk of non-compliance.
- **B2 Improved access to water information** - The public will have access to real-time information on flows, extractions, as well as registers of water entitlements and trade improving transparency in northern M–D Basin water management. Entitlement holders will have access to real-time information on flows, extractions, and rules relevant to their entitlements, reducing administration and compliance costs for the entitlement holder.
- **B3 Improved measurement and monitoring of water use** - Compliance officers and water managers will have improved monitoring capability through the use of remote sensing tools, application of automated reporting of water takes and agreed specifications for the measurement of floodplain harvesting/overland flow take.
- **B4 Reduced data costs** - A data sharing agreement will clarify the arrangements for sharing data between partners, including the status, and availability. This agreement will reduce the effort required to agree individual data use requirements and will be used as a template for future data-based programs.

These benefits and their relationship with the problem statements and the overall outcome sought is demonstrated in the Programs Benefits Map shown in Figure 4.

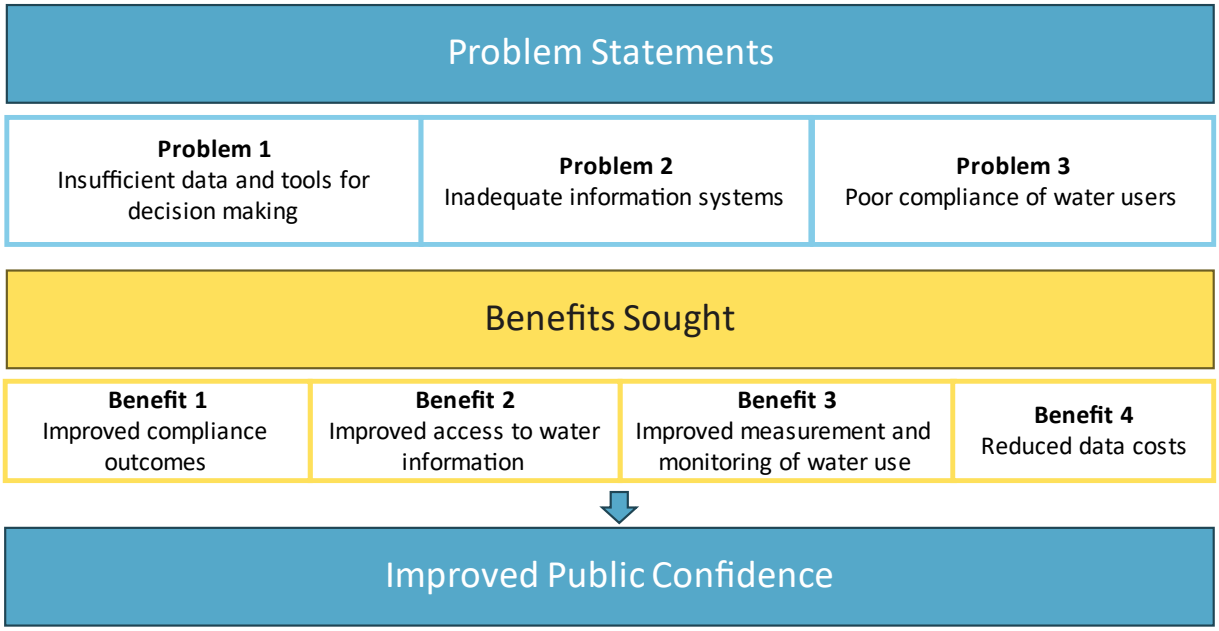

Figure 4: HNRS Program Benefits Map

2.3 Program budget

The HNRS Program was funded $35 million in May 2020 by the Australian Government (through the now Department of Climate Change, Energy, the Environment and Water [DCCEEW Cwlth]) and delivered in partnership with the Program's delivery partners, who also provided cash and in-kind resources.

The Program budget allocated to each delivery partner is shown in Table 3.

Table 3: Program budget allocated to Program Partner

Partner	Allocated budget
BOM	$3,395,887
GA	$1,330,000
MDBA	$5,678,388
NSW DCCEEW	$13,222,370
RMDW	$11,373,354
Total	**$34,999,999**

2.4 Program change and continuity

In October 2022 the HNRS Program Steering Committee approved a series of project change orders that authorised the scope, delivery approach and schedule for deliverables in HNRS Program Project 3 (improved measurement and monitoring) and Project 4 (operationalising remote sensing and water balance tools) to be changed.

In approving the changes, the Steering Committee asked the HNRS Program Technical Panel to also undertake a review of Project 1 and Project 2. The change requests sought to align the deliverables under Project 1 and Project 2 with the recalibrated Project 3 and Project 4 to ensure that Program linkages and data flows were appropriately mapped across all four projects. Included in the change request were minor changes to Project 3 and Project 4 due to flooding and minor project corrections.

The purpose of the recalibration was to align the scope, delivery approach and schedule of Project 1 and Project 2 deliverables with the recalibrated Project 3 and Project 4 (change requests September and October 2022). In December 2022, the Steering Committee (Meeting 25 on 5 December 2022) further approved the recalibration of Projects 1 and 2 to align the scope, delivery approach and schedule of Project 1 and Project 2 workstreams/deliverables with the previously recalibrated Projects 3 and 4. The changes ensured that the authorised scope of project deliverables would achieve the HNRS Program objectives.

This included changes to the below workstreams:

- Project 2, Commonwealth Compliance Portal (MDBA)
- Project 2, Program Management and Administration (MDBA)
- Project 2, Data layers (BoM, MDBA, NSW & QLD)
- Project 1, Entitlement and Compliance Officer Interfaces (QLD and NSW)
- Project 1, Data Enhancement (NSW)
- Project 1, Data Quality Improvement Register (NSW).

The realignment of the deliverables is depicted in Figure 5.

Project 1			
Original Project Agreement Deliverables/Outputs		**Approved Recalibration**	
D1	Improving data and information management platforms	**D1**	Improving data and information management platforms
D2	Data feed APIs	**D2**	Secure data feed Application Programming Interfaces (APIs) built and available
D3	Entitlement Holder Interface	**D3**	Entitlement Holder Interface
D4	Compliance Officer Interface	**D4**	Compliance Officer Interface
DSA	Resolution of the Data Sharing Agreement	**DSA**	Resolution of the Data Sharing Agreement

Project 2			
Original Project Agreement Deliverables/Outputs		**Approved Recalibration**	
D1	Water Information Portal (public facing content)	**D1**	Public Water Information Portal
D2	Data Services (APIs) to support existing data products	**D2**	Defining and creating data services layers
D3	Data services to support data products developed in BoM lead, MDBA and States 30 December 2022 related projects (P3, P4)	**D3**	API Support from data providers
D4	Water Compliance officer portal	**D4**	Compliance Portal
DSA	Resolution of the Data Sharing Agreement	**D5**	HNRS Program Management
N/A	Not applicable	**D6**	HNRS Program Administration
		D7	HNRS Program Communications
		DSA	Resolution of the Data Sharing Agreement

Project 3			
Original Project Agreement Deliverables/Outputs		**Approved Recalibration**	
D1	Installation and commissioning of 23 (20 in NSW, 3 in QLD) hydrometric stations	**D1**	Installation of hydrometric stations
D2	Low cost monitoring technology evaluation report by QLD	**D2**	Low-cost monitoring
D3	Baseline mapping of floodplain infrastructure	**D3**	Farm scale change detection
D4	A workable floodplain harvesting estimation methodology that is demonstrated in both NSW and QLD	**D4**	LiDAR acquisition and analysis
D5	Remote sensing methodology to determine storage volumes and areas	**D5**	Floodplain harvesting modules
D6	Farm scale change detection method and map for characterising change in floodplain structures including storage areas.		

DSA	Resolution of the Data Sharing Agreement	**DSA**	Resolution of the Data Sharing Agreement

Project 4			
Original Project Agreement Deliverables/Outputs		**Approved Recalibration**	
D1	Data acquisition	**D1**	Acquisition of field data
D2	Remote sensing tools	**D2**	Acquisition of high-resolution imagery
D3	Water balance tools	**D3**	Operationalising Remote Sensed and Spatial Tools
D4	Compliance tools	**D4**	Operationalising Water Balance Models
DSA	Resolution of the Data Sharing Agreement	**D5**	Compliance Tools
		D6	Section 71 reporting tools
		D7	Project support: MDBA
		DSA	Resolution of the Data Sharing Agreement

Figure 5: Realignment of milestones and deliverables pre and post recalibration

The changes identified any unallocated funds or underspends across the HNRS Program and authorised further Steering Committee consideration of the scope, delivery approach and schedule of new proposals aligned to the HNRS Program objectives.

Funds that were freed via the process of recalibration were distributed to the relevant Program Partners for the delivery of the recalibrated projects and to a contingency fund. The contingency fund was, in part, an acknowledgement that Program Close Out and issues arising from the finalisation of deliverables may need additional funding. Access to contingency funds was via a contingency access approval from the HNRS Program Steering Committee.

3 HNRS Program Delivery

This section describes the delivery elements of the HNRS Program that were largely consistent within each project.

Information specific to the delivery of each project can be found in Section 4.

3.1 Governance, project management and quality assurance

3.1.1 Program Governance

The HNRS Program's governance structure and processes were codified in the Commonwealth Heads of Agreement (CHA) and the Project Agreements. The HNRS Program CHA established the MDBA as the Program Partner to provide a project management office (PMO) to manage the Program funds in accordance with the legislation, regulations, policies, and guidelines as described, and in accordance with the Program governance arrangements. The MDBA had 4 contracts enabling financial arrangements aligned to the Project Agreements with the following organisations: BoM, GA, DRDMW and NSW DCCEEW.

Governance of HNRS Program CHA was overseen by the HNRS Steering Committee with technical input and coordination from the HNRS Program Technical Panel whose roles are briefly described as:

HNRS Program Steering Committee

The Steering Committee was responsible for overseeing program implementation and evaluation providing strategic oversight with the mandate of achieving program objectives.

The Steering Committee was comprised of all the Program Partners. Representatives of NSW DCCEEW, DRDMW and the MDBA had voting rights. The Australian Government (DCCEEW Cwlth), BoM and GA were observers. All members and observers contributed to Steering Committee proceedings and discussions. The Steering Committee operated on a cooperative consensus model and was arbitrated, if necessary, by the Independent Chair.

The Steering Committee approved the completion of project milestones and tasks and informed the MDBA that invoices could be paid.

HNRS Program Technical Panel

The Technical Panel was responsible for deciding whether the technical parameters of the individual milestones had been met and then making an appropriate recommendation to the HNRS Program Steering Committee. The Technical Panel was chaired by the MDBA HNRS Program Technical Director, and all Technical Panel members contributed to the proceedings. Other organisations involved in delivery of the HNRS Program were included on the Technical

Panel, including NSW DCCEEW, DRDMW, GA, WaterNSW and BoM. The DCCEEW Cwlth regularly provided an observer to Technical Panel meetings.

Program management

Program management for the HNRS Program was supported by the MDBA's Project Management Office (PMO) who undertook the following tasks:

- steering committee secretariat duties
- technical panel chair and secretariat duties
- monitoring and collating the reporting of the progress of the projects
- documenting and administering the considerations by the Steering Committee and Technical Panel and the PMO associated with Program risk and issue management
- program benefit realisation planning and coordinated advice to the Steering Committee
- administering processes associated with tracking, assessment, approval and payment of milestones
- program reporting (closure, evaluation, benefits realisation etc).

The MDBA operated within a Memorandum of Understanding (MOU) with the DCCEEW Cwlth, which constituted an agreement and framework for financial and administrative arrangements. The MOU detailed the MDBA's roles and responsibilities, established the HNRS Program timeframes and funding functions.

Financial delegations were maintained within the MDBA's financial management system TechOne. Where high level financial decisions were required, these were ratified via the appropriate approvals, managed, and tracked in the MDBA's and Australian Government's Parliamentary Document Management System, PDMS+.

Where expertise was not available within MDBA resources, or if independent external work was required, the PMO purchased the relevant expertise from the market. This included:

- HNRS Program probity assurance
- HNRS Program communications strategy
- HNRS Program risk profiling and management strategies
- benefits realisation framework planning and designs
- program assessment and reporting
- program audit.

Program quality assurance

The MDBA provided quality assurance for the program through the establishment and maintenance of the governance structure which was established by the Project Agreements and CHA. This included the Technical Panel who provided recommendations to the Steering Committee who in turn approved program activities and milestone deliverables including any changes deemed necessary.

Additional to the Technical Panel, the PMO engaged a sufficiently qualified contractor, GHD, via a competitive procurement process to be the milestone Independent Technical Assessor (ITA). The ITA assessed project milestones technical robustness on a fee-for-service basis. The Program Partners did not engage with the ITA.

3.1.2 Program Partners

Program Partners had their own internal governance arrangements to provide project oversight and assurance.

MDBA

Governance

The MDBA is an authority that has specific functions within the structure of the Australian Commonwealth Government Department of Climate Change, Energy, the Environment and Water (DCCEEW Cwlth) and is enacted under the *Water Act 2007 (Cwlth*). As such the MDBA is bound by the legislation, regulations, policies, and guidelines common to Australian Government Departments.

For the HNRS Program there were MDBA frameworks for:

- procurement
- privacy and data management
- financial management and delegation
- security
- work Health and Safety
- industrial relations.

Project management

Internally the MDBA managed the HNRS Program as a report to the MDBA Executive Board, and as an MDBA project within its project management system known as PPMS.

In accordance with Australian Government regulation and policy, the MDBA provided access to its relevant personnel and systems including data and information technicians, legal services personnel, hydrometric systems interfaces, and data specifications.

Quality assurance

When the MDBA was involved as both a project contributor and as the PMO, the HNRS Program assessment and approvals processes governed quality assurance processes. Performance was scrutinised at each Technical Panel meeting and Steering Committee meeting and comprised a robust external quality assurance framework.

Internally, the MDBA, as an Australian Government Agency/Authority, was required to comply with and report against the Australian regulations, guidelines, and practices relevant to program and

project management. At any time, the MDBA was also required to report to the Australian Government Senate Estimates Committee and to the Australian National Audit Office if required.

DRDMW

Governance

The delivery of HNRS Program outcomes forms part of Queensland's broader approach to improving water management outcomes under the auspices of the Rural Water Futures (RWF) Program. The RWF Program was established in 2021 and includes a comprehensive program of activity focussed on improving the State's ability to manage precious water assets via new business capabilities that empower entitlement holders and drive advanced decision making and transparency at all levels.

Figure 6 outlines the scope of the RWF Program that includes several supporting initiatives that have been formed to achieve the intended outcomes and benefits.

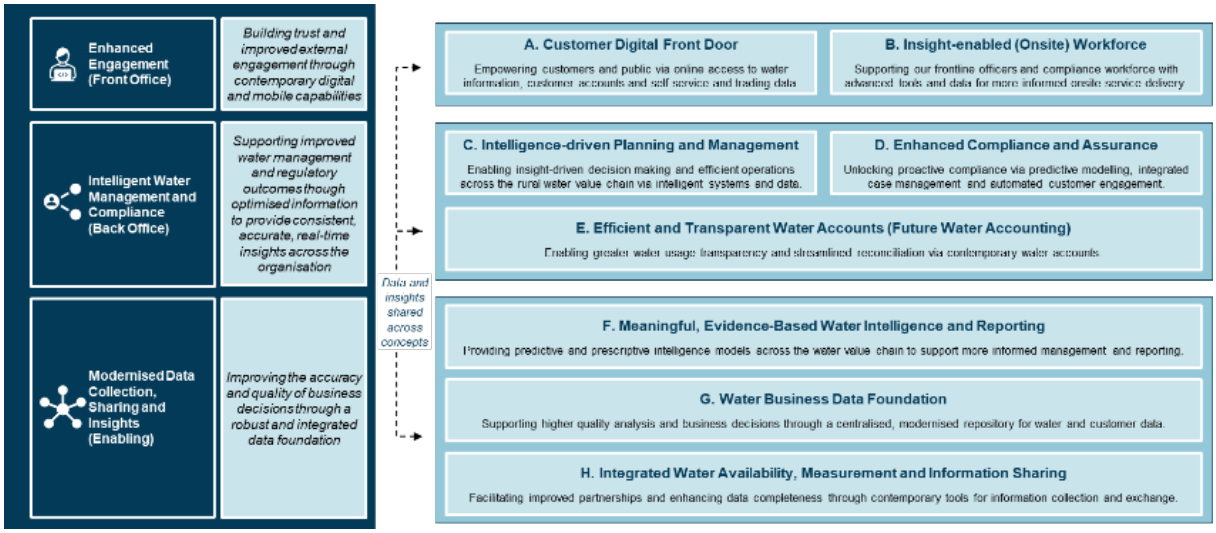

Figure 6: Scope of the RWF Program

The HNRS Program was sponsored by the Executive Director for the RWF Program. The Projects Board for the RWF was made up of the key senior users who were responsible for the DRDMW business. The Projects Board met on a regular basis to endorse HNRS Program project operations.

Project operations fell under the responsibility of a nominated Project Manager, who ensured that the work program was progressing according to plan. A nominated Technical Lead provided oversight across the Program ensuring technical synergy and excellence for DRDMW.

The project leads were embedded in operational business units to ensure that the daily activities undertaken were in accordance with the approved project plans; ensuring that the project produced the required deliverables on time, within budgeted cost, and at the level of quality outlined within the Project Agreement and Product Description.

Additional information on Queensland governance arrangements is included in Appendix A.

Project management

All HNRS Program related projects were subject to the application of the departmental Project Management Methodology, including the related start-up and initiation documentation for a Project Initiation Document (PID).

Project Managers and product leads followed the Program Governance Framework, which outlined the purpose, structure, and plan for successful governance and management of projects within DRDMW. Delivery Plans defined the objectives, timeline, budget, personnel, and risks to achieve the desired outcomes.

The Project Manager ensured the work program was progressing according to plan. Monthly reports were submitted to the HNRS Program PMO to update the Steering Committee and Technical Panel of DRDMW progress. Project working groups were convened across Program Partners to discuss progress and collaborate on projects.

Quality assurance

The DRDMW RWF has an overarching Quality Strategy and Plan that all projects are required to adhere to. This includes the Queensland Government gated assurance methodology and the consistent application of related controls, checks and balances.

A major quality management mechanism included the development of product descriptions that define quality checks for the quality criteria, which align with the relevant corporate standard. The relevant delegated authority (Project Sponsor) was required to approve product descriptions and monitor delivery.

Additional methods that underpinned the DRDMW's quality assurance included:

- project managers reviewed the quality dimensions against defined metrics on a day-to-day basis and performed quality checks as required throughout delivery
- the Project Plan delegated the product lead as responsible for feedback to address business and customer expectations, for example, including targets to infill identified gaps
- delivery partners for specialised data products were delivered by suppliers, who were selected and contracted using the Queensland Government Procurement Policy Framework.

Submissions made to the HNRS Program PMO were independently quality assured and all HNRS Program deliverables were subject to established quality management practices.

NSW DCCEEW

Governance

The NSW HNRS Program Governance Committee agreed and adhered to its HNRS Program Charter. The NSW charter outlined the purpose of the HNRS Program projects, the structure of the HNRS Program projects, and the plan for successful governance and management of the HNRS Program projects.

The NSW HNRS Program Governance Committee was made up of the key program team members who were responsible for the oversight, operation, and delivery of NSW's milestones under the HNRS Program, and overarching Program objectives. The Committee's Chair was the NSW Program Manager, its members included the NSW Program Sponsor, the HNRS Program Steering Committee Representative, the NSW Program Manager, the NSW Technical Lead/Panel Representative, and the NSW Workstream Leads. Its Secretariat was the NSW Program Coordinator. The Committee met on a regular basis to establish, maintain, and enforce Program governance, and respond to any escalated issues.

The Program Sponsor was the principal owner of the program for NSW. Key responsibilities included:

- approving the requirements, schedule, resources, and budget
- authorising the provision of funds/resources (internal or external)
- approving the Program Delivery Plan, Project Plans and Product Descriptions
- ensuring that major business risks were identified and managed.

Workstream leads held Stream/Technical Working Group sessions to strategise and propel delivery, including resourcing needs, project constraints/changes/progress. The NSW HNRS Program workstreams were required to comply with the requirements of the joint agency information and communications technology (JAICT) Steering Committee. The NSW Governance Secretariat was required to provide monthly progress update on the Program to the JAICT Steering Committee and sub-groups.

The Program Coordinator held monthly (and out of session where needed) progress meetings with Stream and Technical Leads and the Program Manager to manage timelines, budget, risks, and issues and for reporting capture. The NSW HNRS Program progress was reported to the JAICT Steering Committee and sub-groups monthly.

The NSW Government water sector's approach to managing engagement with NRAR and WaterNSW is documented in the JAICT and the Roles and Responsibilities Agreement between NSW DCCEEW (formerly known as Department of Planning and Environment), NRAR and WaterNSW.

Project management

The NSW HNRS Program Governance Committee agreed and adhered to its HNRS Program Charter. The Program Manager ensured that the work program was progressing according to plan. The Technical Leads provided oversight across the Program ensuring technical synergy and excellence for NSW.

The Workstream Leads ensured that the daily activities undertaken on the Program were in accordance with the approved Program Delivery Plan and project plans. The Workstream Lead was responsible for ensuring that the project produced the required deliverables on time, within budgeted cost, and at the level of quality outlined within the Project Agreement/Product Description.

The Program Coordinator supported the Program Manager and Workstream Leads in program management activities to keep the work program running smoothly and efficiently.

Quality assurance

The NSW HNRS Program Governance Committee was responsible for undertaking quality reviews against performance measures and quality criteria in the Project Agreement/Product Description through the milestone assessment request.

Under the NSW Program Charter, Workstream Leads had the responsibilities of ensuring performance measures and quality criteria in the Project Agreement and Product Description were met, and monitoring and reporting on project performance, including quality.

BOM

Governance

As specified by BoM's Enterprise Project Management Office (EPMO), involvement in the HNRS Program involved identification of a:

- project Sponsor at General Manager level who was BoM's representative on the HNRS Program Steering Committee
- senior Supplier
- senior User
- project Manager.

Prior to signing the CHA and any Project Agreement, a submission was required to be approved by BoM's Major Transactions Committee. The submission detailed the Project's strategic alignment; customer value; capability and collaboration requirements; risk mitigation strategies; commercial strategy; and financial implications and needed to be endorsed by the General Manager of all contributing BoM groups.

Project management

BoM's EPMO required project delivery to have a dedicated Project Manager responsible for:

- preparation and tracking of project plans – both waterfall and agile
- creation and maintenance of a project Risks, Actions, Issues and Decisions (RAID) log
- financial management and reporting
- submission of monthly reports to EPMO, approved by the Project Sponsor, which reported on progress against schedule, expenditure, risks, and issues.

Quality assurance

The methods BoM used to ensure quality assurance included:

- product descriptions were approved by the Project Sponsor prior to commencement of design and development
- internal testing of products was undertaken by BoM’s lead tester followed by the MDBA's technical tester

- test summary reports were approved by the Project Sponsor, senior user, Project Manager, business analyst, and solution architect
- any proposed changes to the WIP were approved by BoM's Change Advisory Board
- the solution architecture design (SAD) was approved by BoM's Chief Architect
- the development of the data service layers was developed under the Open Group Architecture Framework (TOGAF), and the designs themselves were required to adhere strictly to the Australian Government National API Design Standard, OAuth 2.0 and OpenAPI specifications.

GA

For the purposes of this report and the way in which GA organised its project, please refer to their project closure report.[2]

3.2 Communications

3.2.1 Program

As the governing agency, the MDBA had oversight of communications for the HNRS Program. In this role the MDBA led foundational program communications activities and shared this with delivery partners for their use.

The MDBA focused communications efforts on Program level content housed on its website and the development of a Communications Protocol. This content was the guiding document of communications on the Program; providing a holistic view of the projects; co-investment and collaborative efforts from delivery partners; and how the Program fitted into the Basin Plan. It was updated regularly to reflect key Program milestones and project deliverables.

The other key focus was on internal communications to delivery partners and supporting them. The MDBA supported communication activities of delivery partners by cross-promoting, using social media channels and the River Reach newsletter.

A key output of the Program was the development of a Communication Strategy. The *Communications Strategy 2022-2024 Hydrometric Networks and Remote Sensing Program* was developed to provide a strategic, coordinated, consistent and planned approach to communicating the Program level narrative in a cross-jurisdictional environment.

The Communication Strategy identified activities which were the responsibility of all delivery partners and their respective agencies to perform. Furthermore, all delivery partners had a responsibility to share program level messages and adhere to the Communications Protocol.

[2] The Geoscience Australia HNRS Program Project Closure Report is available from the Murray Darling Basin Authority upon request.

Implementation activities included internal and external communication that was further identified as:

- Year one: Building foundational tools
- Year 2+: Proactively sharing the benefits.

Ongoing communications relating to the tools, interfaces and products derived from the HNRS Program became the responsibility of the adopting organisations. Eventually the aim for specific outputs of the HNRS Program was for their use to be undistinguishable from business-as-usual.

3.2.2 Program Partners

MDBA

Internal MDBA communications included the preparation of briefing papers for Steering Committee and Technical Panel meetings. External MDBA communications included website content and social media.

Delivery of specific actions included in the Communication Strategy were delayed by both the COVID epidemic and staff shortages. In late 2023, the MDBA was able to use an internal MDBA Communications Officer to assist in the roll-out of specific communications activities and products.

DRDMW

DRDMW implemented a comprehensive approach to communications and change management which included communications and engagement with internal and external stakeholders.

A summary of the Queensland communications approach is outlined below:

- all communications activities were informed by sound stakeholder mapping, planning and targeted engagement, using a multichannel approach to increase communications impact both inside and external to the organisation
- awareness of the HNRS Program was generated via product showcasing, and demonstrations that were regularly provided to the HNRS Program Steering Committee, the HNRS Program Technical Panel, DRDMW Executives and other industry stakeholders
- external DRDMW communication was published on the RWF program website with links to social media, and included information sheets, video user guides, annual reports, and annual progress reports.

More detailed information on external communication can be found in Appendix B.

NSW DCCEEW

NSW DCCEEW communications included:

- external DCCEEW communications including Joint Commonwealth and NSW Minister announcements, NSW Water Minister announcements, conferences, public consultation, radio interviews, website content, WaterNews newsletter articles and social media
- internal communications were published on DCCEEW intranet and included, InFlow (DCCEEW Internal newsletter) and internal promotion of completed activities when milestones were reached.
- program awareness, product showcasing, and demonstrations were regularly provided to the HNRS Program Steering Committee, the HNRS Program Technical Panel, DCCEEW Executives and other industry stakeholders
- preparation of briefing papers for HNRS Program Steering Committee and HNRS Program Technical Panel meetings.

Specific external project communications are documented in Appendix B.

BOM

An overarching Communication Plan was developed and delivered by BoM's Communication team at the commencement of the WIP project. For each of the major releases of the WIP, a Communications Implementation Plan was prepared and submitted to the MDBA for approval. Each Communication Implementation Plan included:

- media release
- social media posts
- article to be provided to stakeholders
- a video - Murray–Darling Basin Water Information Portal (youtube.com).

A communications digipack was provided to all HNRS Program Partners and other stakeholders for use through their own communications channels. For example, New features go LIVE on the Murray–Darling Basin Water Information Portal | Murray–Darling Basin Authority (mdba.gov.au).

Specific external project communications undertaken by BoM are documented in Appendix B.

GA

For the purposes of this report and the way in which GA communicated its role and outcomes, please refer to their project closure report.[3]

3.3 Successes

There have been many wins from delivering the Program including the creation of goodwill, trust, and commitment amongst Program Partners, particularly given that collaboration across borders is challenging where State objectives and priorities change. The Program has allowed and encouraged cross-pollination of new processes and ways of thinking and working amongst the Program Partners.

Specific observations identified by Program Partners included:[3]

- agile and innovative approach to trialling and piloting new technologies allowed a continuous learning and improvement cycle to be established, increasing the quality of the final outcomes
- interjurisdictional collaboration and shared learnings provided significant benefits to all stakeholders and assisted to inform future design approaches
- the creation of goodwill in relation to sharing funding, working for the social good (this group understood that the water flows across borders)
- facilitating trust and commitment, particularly given that collaboration across borders was always going to be challenging where the State's objectives and priorities change (and where competing objective and priorities exist)
- allowing and encouraging cross-pollination of new processes and ways of thinking and working among the Program Partners
- enabling the States and Commonwealth to share successes and challenges, with the effect of increasing the efficiency of decision making without spending the same money again
- agility and facilitating a shift in Program design allowing for recalibration, which enhanced the achievement of Program objectives in short time frames
- aaccepting the differences in the State frameworks and not seeking to influence each other's legislation
- the creation of products and outputs that have enduring benefits across the water and other industries
- the creation of products and outputs that have enduring benefits to the water dependent environments of the Murray- Darling Basin.

3.4 Challenges

The challenges experienced in delivering the HNRS Program were headlined by COVID and included insufficient resources to do everything that Program Partners may have desired, limited budgets, and staff turnover.

Specific observations identified by Program Partners included:

- the Program received input from busy and experienced people. However, these experienced professionals needed to be supported with better resourcing, particularly by staff who were embedded in the agency and interested in learning
- building relationships requires time, and some relationships were still forming, which becomes challenging with staff turnover
- not having sufficient resources directed towards project administration, which meant that key project delivery staff were required to satisfy administration tasks where their skillsets were less suitable

[3] The Geoscience Australia HNRS Program Project Closure Report is available from the Murray–Darling Basin Authority upon request.

- recognising that the knowledge required to deliver the HNRS Program resided in a small number of individuals, and therefore resourcing competed with other State and Commonwealth requirements
- changing availability of technologies, the emergence of new technologies and retirement of old technologies during the life of the Program had to be factored into the delivery of several projects, as did the finalisation of some water management policy positions
- timelines to deliver on-ground works and some products can be adversely affected by flooding and other severe weather conditions, the availability of key stakeholders, and the requirements to obtain specific approvals, which may be outside the control of delivery partners.

3.5 Lessons learnt and recommendations

Several workshops were held within the Program to tease any lessons learnt from Program Partners. These lessons learnt were collated and are summarised in Table 4.

Table 4: HNRS Program lessons learnt from Program Partners

Lesson Learnt	Recommendations
Governance	
Need to accept the differences in each jurisdiction's governance frameworks and legislation and not seek to influence.	Early understandings of each jurisdiction's/organisation's business and governance structures should be shared when designing multi partied projects/programs.
Governance was established concurrently to the Program commencement leading to pivots in deliverables and technical requirements during the Program.	Establishment of governance procedures need to be progressed prior to commencement of the Program recognising the best governance structure (efficiency vs accountability).
Need to define project management requirements from the onset of the Program.	The Program should be guided by best practice project management methodologies and frameworks. Adopting a standard methodology (perhaps Prince2) may be appropriate. Ensuring that Program Partners have relevant personnel trained and adept in this framework is money well spent. Also need experienced senior program /project directors and personnel for guidance.
Having an independent Chair of the Steering Committee that understood the sector and the procedures of each delivery partner provided structure and supportive guidance.	Independent knowledge, detail and skill are essential in a multi partied program/project.
Planning	
Not enough time was invested in the planning stage limiting the clarity of what could be produced and therefore needed to be delivered.	While collaborative planning and co-design can work well, to build communications and understanding, naming conventions and descriptions for milestones should be developed at the outset.

Lesson Learnt	Recommendations
Governance	
The Program demonstrated the importance of having a process for on-boarding new employees.	On boarding packs and processes should be developed and delivered at both the project and program levels.
Original budget estimates were subject to a range of assumptions, sensitivities, and unknowns. Furthermore, project management and supporting governance overheads were not fully understood and allowed for during planning.	• Establishing project management requirements should be progressed before budget estimates are developed. • Costs for contingencies, overheads and PMO resourcing should be budgeted transparently.
Schedules to capture the time required for stakeholder endorsement including contingency were unrealistic.	Forward planning to allow sufficient time for endorsement (e.g., by First Nations groups) is required.
Schedules to access the sites in rivers to commission gauging stations including contingency were unrealistic.	Forward planning to allow sufficient time for delays during wet season flooding (e.g., more than three years) is required.
Limitations and challenges with foundational datasets, quality, and access.	Understanding of limitations prior to commitment of project scope and future programs including contingency funding to support development of foundational data sets and data cleansing are required.
• Communication of the HNRS Program internally and externally was organic. • A communication strategy which identified where, when and how stakeholders should be engaged was developed about two years into the Program leading to inefficiencies.	Early development of internal and external communication strategies and agreements is required.
Delivery	
Having many milestones (180 in total) created a significant administrative burden that came with program management challenges.	Look to reduce the number of milestones and consider combining milestones that require smaller payments to increase efficiency.
Budgets need to be reviewed at key stages of delivery and completion to ensure sufficient funds are available for the upcoming deliverables.	Delivery should be tracked over time to identify any issues, enable communication, and enable adaptive management.
• The program exposed rural water as a small niche with limited expertise in the market (consultants/advisers/staff). • This resulted in a “do it ourselves” culture, which may have contributed to staff burnout and turnover.	• Succession planning should be undertaken for the projects and program to minimize the impacts from staff turnover. • Program team should acknowledge and reach out when they lack expertise in their agencies and need additional support.

Lesson Learnt	Recommendations
Governance	
Limited expertise and specific skill sets within state departments to develop technical tools i.e. Business Analysts, Data Analysts, Remote Sensing Specialists.	Future programs require adequate funding to ensure expertise can be resourced.
Accuracy, reliability, and completeness of water data are required to make informed decisions and implement effective water management strategies.	Programs should invest in quality assurance measures, such as regular monitoring and validation processes to help maintain data integrity and credibility.
HNRS Program injection of funding to DRDMW increased the capability to invest and resource the development of regulatory tools to benefit compliance staff in supporting the monitoring of the laws that govern how water resources are accessed and used.	Continued investment in stream Enhanced Measurement is beneficial and required.
The long-term sustainability of HNRS Program outputs relies upon additional jurisdictional funding, potentially reducing the long-term sustainability, impact, and ability to scale HNRS Program capabilities.	Future programs should consider the longer-term requirements and craft suitable funding arrangements to reduce potential unsustainability of new capabilities.

3.6 End of program/project risks

The MDBA commissioned work in 2021 to undertake a review of probity and governance of the Program. At the same time, the PMO undertook a review and revision of the project planning to map inter and intra-project dependencies. The outcomes of both reviews formed the basis of a risk management plan, which was an evolution of a previous methodology derived from the requirements of the CHA and Project Plans.

Risks were identified in each of the 4 Project Plans, which were then incorporated into formal Project Agreements. In carrying out its obligations under this CHA, each party agreed to apply and comply with AS ISO 31000:2018, Risk management — Guidelines or an established framework based on the principles of ISO 31000 (HNRS Program CHA – clause 23, p23). Within the Project Agreements and Project Plans, risks were reviewed and updated on an agreed timeframe with the HNRS Program Steering Committee overseeing program risks. Each Project Plan has documented three types of risks: strategic, project and ongoing.

The Risk Assessment and Management Plan was focussed on the strategic risks. Project and ongoing risk assessment and management were coordinated by the Project Leads and delivery partners. The approach to managing the strategic (Program) risks was endorsed by the HNRS Technical Panel and the result of discussions with partners who have the decision-making responsibility for delivering the final and contributing capabilities.

Whilst each Program Partner had approaches for risk management compliant with the ISO 31000 standard, the standard does not provide mandated guidance on certain aspects of assessment, for example, the description of risk categories, description of characteristics for risk, likelihood or risk consequence. Each partner, including the MDBA, needed to comply with their own risk assessment criteria for the internal management of HNRS Program activities. The PMO via the Technical Panel coordinated risk identification, assessments, and treatments in order to collectively manage and aggregate risks where appropriate and to elevate these to the Steering Committee as necessary.

The Program and each project maintained a master risk register. The registers articulated the risks, their owners, causes, status, and controls, that may impact the delivery of the project's objectives and outcomes. The register classified risks under four categories: project, resource, strategic and operational and focused on the risks where risks were not tolerable.

There were periodic risk workshops that helped produce detailed project risk assessments, documented in the project risk register. The risk registers remained a live document through the project lifecycle and were regularly monitored and reviewed to ensure they remained current and supported the successful project delivery.

Project risks were finalised via a final project risk workshop held in a Technical Panel Meeting in session, which identified all open risks and closed them where that was the appropriate action. Where there were risks considered by the Technical Panel to not have closed or were of sufficient ongoing risk to the HNRS Program, these were elevated to the Program level for the Steering Committee to monitor and manage.

The end of project and Program risks owned by all Program Partners included:

- the HNRS Program deliverables will not perform as intended in a water management future state
- future funding is required to maintain, sustain, and improve HNRS services
- capacity is required within jurisdictions to transition HNRS Program deliverables into operations
- capability is needed within jurisdictions given the specialist skills sets required to maintain and develop specialist water management services
- future sustainability of HNRS Program deliverables and the potential for missed opportunities to maintain HNRS Program momentum
- interjurisdictional data sharing agreements may expire with no clear pathway to resolve, impacting integrated visibility into cross border water performance.

The HNRS Program managed project risks in registers. Workshops were held periodically, and records taken. These registers can be provided upon request.

3.7 PMO business readiness for service statement

The ITA milestone assessment process integrated with that of the Technical Panel was the primary driver of business readiness. The milestones and products derived by them were tested and peer reviewed.

The PMO recognised that business readiness would be achieved when the implementing organisations; BoM, DRDMW, NSW DCCEEW, NRAR, GA and WaterNSW have:

- adopted the project deliverables variously into their business operations
- included the project deliverables in pricing structures.

For the PMO, business readiness equated to the capacity of the States to accurately reflect their water resource plans' water take for reporting under S. 71 of the Basin Plan.

3.8 PMO closure statement

The PMO considered a project closed when:

- all milestones have been delivered, assessed, and paid for
- project risks have been closed or relegated to the Program for consideration and closure
- the final evaluation report has been accepted and approved by the Steering Committee.

4 Projects

The following section describes project deliverables[4] along with project closure and business readiness statements. For the purposes of this report all of the deliverables cited here are derived from the Project Agreements. Some of the deliverables were changed or omitted as a result of the recalibration process. Notwithstanding this, the HNRS Program outcomes remained intact.

All Program Partners contributed to the creation of a data sharing environment essential to the Program. This was built on the foundational requirement to share data within states and between states and organisations. To this end a Data Sharing Agreement relevant to the Program was made, refined, and extended so that the provision of services is ensured to June 2027.

4.1 Project 1

The DRDMW were the project lead for reporting progress on Project 1 deliverables and outcomes, with participation from NSW DCCEEW. Information in this sub-section was developed from information provided by each of the project partners as well as from the PMO.

4.1.1 Introduction

Project 1 aimed to improve the transparency and accountability of water management in the northern M−D Basin, aligning closely with commitment 1.2 (b) from the Basin Compliance Compact (https://www.mdba.gov.au/sites/default/files/publications/qld-basin-compliance-compact-2018-12-dec-18.pdf). The project focus was on making relevant information increasingly accessible to water entitlement holders, compliance officers within the States, and to the MDBA for compliance and aggregation to public reporting.

The project improved access to high quality, near real-time water management information. It provided information at the scale of individual water entitlements, considering the details of entitlements, river conditions, extractions, trade, and water sharing or water resource plan rules.

4.1.2 Project deliverables

Key deliverables under Project 1 were:

P1.1 improving data and information management platforms, including bringing on system and, in some cases, automating the production of water management assessments and plan interpretations

P1.2 data feed (data sharing) - application programming interfaces (APIs) to provide secure data feeds of water entitlement (individual water licence) scale information to the MDBA and

[4] Original and recalibrated deliverables are shown in Figure 5: Realignment of milestones and deliverables pre and post recalibration. Refer to page 18

parts of the Water Act 2007 (Cwlth) s71 Reporting Obligations, regarding water available, permitted to be taken, and various aspects of water trade[5]

P1.3 Water Entitlement Holder Interface

P1.4 NSW Compliance Officer Interface

P1.5 NSW Data Quality Improvement Register.

Specific commentary related to these deliverables is provided below. Additional information including information on the products developed is included in Appendix C.

DRDMW

DRDMW was the lead organisation for reporting the achievement of Project 1 deliverables and outcomes. This included the development of new products and services in the following areas:

- development of new digital services for water users (WaterIQ App and Portal) that provided entitlement holders with simplified reporting and easy to access information relating to water matters
- development of new digital services for water officers and staff, making it easier to access the right information, for the right place and at the right time to increase operational efficiency
- development of new capabilities that aggregate and orchestrate important water data into a single location, making it readily available to improve situational awareness and timely decision making.

The products developed by DRDMW are detailed in Appendix C.

NSW DCCEEW

The involvement of NSW DCCEEW in Project 1 included:

- WaterNSW delivering a public facing web (*Water Insights*) portal for use by water entitlement holders and compliance officers
- NRAR delivering the Compliance Officer Interface (and associated tools and dashboards), the Data Enhancement project, and the NSW Data Quality Issues Register.

The products developed by NSW DCCEEW, in collaboration with WaterNSW and NRAR, are detailed in Appendix C.

[5] This deliverable was removed at the time of the Program recalibration primarily due to other work being undertaken by others with respect to water trade reporting and other requirements. It is shown here for completeness. Refer to page 18.

4.1.3 Business readiness for service statements

DRDMW

During the HNRS Program, Project 1 products were initially made available to closed trial groups over an extended period. The trial period provided vital feedback to the department that was used to address user concerns and emerging requirements as part of an iterative and collaborative development process. There are several major business readiness considerations that the department is continuing to assess at the time of this closure report:

- with strong support for the WaterIQ application and portal from the pilot group, the department is now reviewing a sustainable approach to scale the deployment to more users within the Murray-Darling and more broadly across the State
- the WaterIQ app and portal are significant undertakings that require the allocation of specialist resources and funding to scale, maintain and continually improve. Currently there is no identified funding available to support these activities creating a low level of business readiness for this service.

The internal facing water information portal has however been rolled out across DRDMW and has been transitioned to service with existing support teams absorbing on-going management activities. There is a high level of business readiness for this deliverable.

More broadly the impact on the medium-term operating model and staffing is a major contributor to operational readiness and there is work remaining to explore how to transition from HNRS Program delivery into business-as-usual team structures.

Overall DRDMW will need to continue to invest in systems and processes to maximise the long-term adoption and associated benefits from the HNRS process. The phased implementation of the RWFP will support adoption and benefit realisation over time.

NSW DCCEEW

Project 1 for NSW delivered portals targeted at increasing public access to water information (Water Insights, delivered by WaterNSW) and providing compliance insights (Compliance Officer Interface and Dashboards, delivered by NRAR).

In both instances development activities were driven by solicitation of user requirements and implemented with:

- a focus on data security and integrity
- adherence to regulatory requirements and industry standards
- compliance with privacy and accessibility policy
- user centric design and intuitive interfaces
- customer feedback loops for continual improvement.

NSW are confident that the Water Insights Portal and Compliance Officer Interface and Dashboards will meet and exceed the expectations of our stakeholders, providing a powerful tool for sustainable water resource management.

4.1.4 Closure statements

DRDMW

The outcomes achieved from Project 1 have been highly valuable for Queensland stakeholders resulting in new products and services that have the potential to achieve an enduring impact on the management and use of the State's water assets. This is subject to the allocation of suitable capacity and capability to deliver the next stage activities, which currently remains a gap. Interjurisdictional collaboration has been highly effective and created the opportunity for cross border information sharing to develop cohesive services that meet the unique needs of each jurisdiction, whilst considering the cross border nature of water resources.

In terms of end benefits, improved visibility and transparency into water entitlements and the related use is a significant step forward in driving positive long-term change. This is a major contributor to the end state that Queensland is working towards whereby real time/near time information is open and transparent creating a self-regulating water environment, shifting the focus from reactive compliance-based water management. Project 1 outcomes when combined with the advanced water measurement capabilities achieved in Project 3 and Project 4 have created a generational shift that now positions the State to identify anomalies and act faster than previously possible, albeit in specific locations and use cases.

Project 1 deliverables have provided a strong platform for expansion both geographically across the State and via the continued development of new features and functions that benefit water users. The State is now working towards long term sustainable operationalisation of WaterIQ as part of RWF stage three that is subject to provision of funding.

With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, Queensland considers Project 1 to be formally closed.

NSW DCCEEW

Deliverables in Project 1 have provided NSW public benefit in delivering more accessible water insights through online public platforms and internal function specific dashboards. Those insights now drive internal departmental decision making, compliance actions and contribute to the NSW sector's commitment to open and transparent exchange of water information.

With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, NSW DCCEEW considers Project 1 to now be formally closed.

4.2 Project 2

The MDBA were the project lead for reporting progress on Project 2 deliverables and outcomes, with major input from BoM, DRDMW, and NSW DCCEEW. Information in this sub-section was developed from information provided by each of these project partners as well as from the PMO.

4.2.1 Introduction

Consistent with other projects, Project 2 aimed to restore confidence in the management of the northern M−D Basin by providing transparency in water management through improved access to water information. The project directly delivered against several requirements of the Compliance Compact.

This project delivered the northern M−D Basin Water Information Portal (WIP) Murray–Darling Basin water information: Water Information: Bureau of Meteorology (bom.gov.au) and the underlying technology layers required to interact with new and existing data and information. The WIP is a web-based interface to enable public access to water information and provide compliance officer level access to data and tools to support compliance functions.

This project developed the underlying architecture and protocols (support service layers) to allow digital content created through related projects (Project 1, Project 3, and Project 4) and existing raw data and data products to be accessible through the MD−Basin WIP interface. The data service layers provide a single point of interaction for the creation of other data products.

4.2.2 Project deliverables

The key deliverables for Project 2 were:

- P2.1 esolution of the Data Sharing Agreement consistent with clause 19 of the Collaborative Heads Agreement (recognising that this has application across the Program's projects)
- P2.2 Water Information Portal (public facing content)
- P2.3 Data services (application programming interface or APIs) to support existing data products
- P2.4 Data services to support data products developed in related projects (Project 3, Project 4)
- P2.5 Compliance Portal.[6]

Specific commentary related to these deliverables is provided below. Additional information including information on the products developed is included in Appendix C.

[6] This deliverable was removed under consideration with the recalibration of the HNRS Program. The Inspector General Water Compliance was the main client of this but is assessing its own needs as water take, environmental water use/protection auditor.

MDBA

The MDBA were the project lead for reporting progress on Project 2 deliverables and outcomes. The MDBA's PMO role enabled Project 2 deliverables to be extended to other projects (Project 3, Project 4) to support their requirements.

The MDBA coordinated milestones that extended beyond the 4 deliverables. It was within Project 2 that the PMO, including the HNRS Program Directors, were primarily funded. The HNRS Program Communications Strategy was funded as a milestone within Project 2, as was the funding for capital relevant to Project 2.

MDBA's involvement included:

- ensuring the HNRS Program Data Sharing Agreement was developed in line with current government policy (P2.1)
- market research for the public portal, planning, and development of data service layers, and planning development, testing and improvements of the WIP (P2.2)
- a supporting role in user service layers (P2.3), data services (P2.4), and the M–D Basin WIP (P2.2).

The convergence of milestone deliverables in September 2023 challenged the MDBA team. However, the renegotiation of timelines allowed milestones to be completed and had no major impacts on the other Project Partners.

The MDBA PMO considered Project 2 closed upon the acceptance and payment for the final milestones (BoM, cultural knowledge woven into the Gwydir and Murray catchments), and the closure of the project risks.

DRDMW

The DRDMW provided a supporting role in the delivery of Project 2 outcomes and specifically contributed the following activities:

- Qld Data Services – DRDMW delivered data services (API or file share) to enable BoM to populate its Data Information Services Layer to power a Commonwealth web portal feature for use by Water Communities (P2.3)
    - the user services layer provided the API endpoints and security protocols to allow access to the underlying analytics and data information systems layers
    - the data information systems layer was developed in three stages to enable additional data to be included as required or becomes available.
- API service specification that allowed for connection between existing raw data services and data computation products and was delivered to HNRS Project Partners in line with the Data Sharing Agreement (P2.4).

Additional information on the deliverables including information on the products developed is included in Appendix C.

NSW DCCEEW

NSW's involvement in deliverables included:

- WaterNSW Data Services – WaterNSW delivered data services (API or SFTP file) to enable BoM to populate its Data Information Services Layer to power a Commonwealth web portal feature for use by Water Communities, the Murray−Darling Basin WIP. WaterNSW developed Application Programming Interfaces (APIs) (or files), namely, Water Data API and Water Source API for use by the water community to receive information as specified in the Data Sharing Agreement (WaterNSW as the Licensor) (P2.3)
- NSW DCCEEW Data Services – NSW DCCEEW delivered State based data to HNRS Program Partners in line with the Data Sharing Agreement. NSW DCCEEW developed API domains water take, allocation, account balances and aggregated clusters (geospatial mapping of accounting data) (P2.3 and P2.4).

Additional information on the deliverables including information on the products developed is included in Appendix C.

BOM

BoM's involvement in deliverables for Project 2 included:

- leading the development of the Murray −Darling Basin WIP, which is a central source of water information for the Basin (P2.2). The WIP brought together current and historical information about water availability, water in storages, water for the environment, groundwater, streamflow, allocation volumes, water take, water markets, water quality, and First Nations cultural information for the M−D Basin
- leading development of the data services layers to support existing data products and to enable the delivery of data via APIs by the partners for inclusion in the Water Information Portal (P2.3)
- leading development of data services layers to support data products developed in related projects (Project 3, Project 4) (P2.4).

Additional information on the deliverables including information on the products developed is included in Appendix C.

4.2.3 Business readiness for service statements

MDBA

The deliverables for Project 2 have been integrated into the MDBA web interface with links to the Murray–Darling Basin WIP (Final version of the Murray–Darling Basin Water Information Portal released | Murray–Darling Basin Authority (mdba.gov.au)). Additionally, the Data Sharing Agreement

and its administration to 2027 have been assigned to an ongoing collective of the respective data providers, owners, and managers. Thus, the products and deliverables for Project 2 are either in service or are capable of being in service per the objectives of the Project.

QLD DRDMW

Project 2 deliverables have been fully integrated into DRDMW business as usual operations with high levels of business readiness including:

- incorporation of data sharing services into DRDMW's data integration and exchange environment
- automation of data integration services to minimise manual interventions
- ability of data feeds to be easily consumed both internally and externally to DRDMW in a secure manner
- training of related internal staff and handover into business-as-usual operations.

NSW DCCEEW

Project 2 deliverables have been fully integrated into WaterNSW/NSW DEECCW business as usual (BAU) operations with high levels of business readiness including:

- incorporation of program developed APIs into NSW's BAU commitments
- Automation of data integration services via API to minimise manual interventions and ensure consistency
- handover of support into business-as-usual operations.
- ensuring enduring provision of services via agreement to extension of the Data Sharing Agreement (DSA) for a three-year term to June 2027.

BOM

In compliance with the requirements of BoM's Enterprise Project Management Office, a Go-Live Document (GoLD) was prepared to ensure the operational readiness of the WIP to be transitioned from a project to operations.

The purpose of the Go-Live Document was as a reference document that connects all the information and artefacts required by a project to be transitioned to operations. It provided a high-level overview of information such as:

- solution and security overview
- go-live approach
- project completeness
- operational readiness
- support mode
- business engagement
- post Go-Live residual tasks.

The M−D Basin WIP GoLD was reviewed and approved by the:

- GM Agriculture & Water – Project Sponsor
- GM Environmental Prediction Services – Product Owner
- GM Digital Channels
- GM Application Services
- GM Security/Chief Information Security Officer
- Lead Architect – Architecture.

The Go-Live Document described how BoM would ensure that the M−D Basin WIP met all the requirements for transfer to operations. The Go-Live Document also outlined whether sufficient funding and resourcing was available for the ongoing support of the WIP.

The GoLD was part of a pack of related documents required to be submitted for Change Advisory Board (CAB) approval prior to production implementation and operation.

In addition to meeting the requirements described above, the ongoing WIP is also:

- accessible via desktop, iPad and mobile
- WCAG 2.0 (Web Content Accessibility Guidelines) compliant meaning that the content is accessible for people with disabilities including the visually impaired through the incorporation of a Screen Reader and all functionalities being keyboard accessible.

Cultural information presented on the WIP was done so with the free, prior and informed consent of the Elders through an Indigenous Cultural and Intellectual Property (ICIP) Letter of Consent.

4.2.4 Closure statements

MDBA

The primary objective of Project 2 was satisfied with the addition and integration of the northern M−D Basin components to BoM's M−D Basin WIP. The live and functioning M−D Basin WIP and supporting systems have been embedded into BoM's website to provide the community with current, accurate and publicly available data and information relevant to the water sources of the northern Basin. This data and information are a foundation for monitoring and understanding water take.

DRDMW

The establishment of common data sharing arrangements and supporting technical capabilities has achieved a major step forward in providing consistent visibility into water performance across borders. There is however an on-going effort required to maintain these arrangements, including the establishment of clear leadership roles to drive continual improvement. Currently data sharing arrangements are finite in nature and are set to expire, threatening on-going supply of data in accordance with a common agreement. With the completion, acceptance, and acquittal of all

milestones in accordance with the related HNRS Program Project Agreements, Queensland considers Project 2 to be formally closed.

NSW DCCEEW

The M−D Basin WIP and contributing data services provide valuable water insights at the basin scale including integration of jurisdictional insights. With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, NSW DCCEEW considers Project 2 to now be formally closed.

BOM

Water information across the whole of the M−D Basin is now available from a central location via the M−D Basin WIP. The development of the M−D Basin WIP using a customer centred design approach means that the information presented is what Basin communities want in a format that they find easy to use. The provision of water information rather than data better meets the needs of Basin communities (although the data is available to be downloaded if required).

The inclusion of river diagrams and photos makes it easier for customers to understand where the water is coming from; where it is flowing to; and to be able to visualize rivers, storage infrastructure and significant locations. This serves to improve the water literacy of M−D Basin communities.

The cultural information included in the M−D Basin WIP in the form of recordings, stories and photographs will raise cultural awareness amongst both Indigenous and non-Indigenous people.

With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, BoM considers P2 to be formally closed.

It is also noted that future enhancements to the WIP could include:

- the application of the Cultural Information pilot study to the lands of other First Nations people across the Basin
- the inclusion of additional photos of sites of cultural, environmental and water management significance.

4.3 Project 3

The NSW DCCEEW were the project lead for reporting progress on Project 3 deliverables and outcomes, with significant contributions from the DRDMW, and minor participation by the MDBA and BoM. Information in this sub-section was developed from information provided by each of these project partners as well as from the PMO.

4.3.1 Introduction

The aim of Project 3 was to contribute to better measurement of flows and diversions in the northern M−D Basin through an improved hydrometric network; the investigation of low cost or cost-

effective flow monitoring systems and remote sensing information and techniques; and the measurement of take by floodplain harvesting (NSW) and by overland flow (QLD).

Specifically, Project 3 sought to:

- improve flow measurement and accounting of water through expansion and strengthening of the near-real time hydrometric networks with a view to improve both the frequency and availability of accurate and timely data to support planning, river operations, modelling, flood warning, compliance, and active management workflows
- evaluate effective and fit for purpose low-cost measurement devices and networks (e.g. depth sensors, remote cameras) as 'infill' monitors to supplement the high-cost hydrometric network in remote, detached or event-based geographies
- improve information availability of water taken from the floodplain (i.e. overland flow and floodplain harvesting) including volumes and built temporary storages to improve compliance, auditing, and information for future modelling
- develop measurement standards and methodology for both Qld and NSW for the take of floodplain harvesting and overland flows
- utilise LiDAR or equivalent data to inform farm scale auditing inclusive of situational awareness, property specific investigations and cataloguing of infrastructure. For example, water storage locations and volume, diversion channel layout, construction of levees etc
- implement change detection methodologies at floodplain and farm scale including on-farm storage volumes. For example, to monitor the construction of unauthorized floodplain structures across large and remote geographies to inform modelling and compliance related activities.

4.3.2 Project deliverables

Key deliverables under Project 3 were:

P3.1 Resolution of the Data Sharing Agreement consistent with clause 19 of the Collaborative Heads Agreement (recognising that this has application across the Program's projects)

P3.2 Installation and commissioning of 23 (20 in NSW, 3 in QLD) hydrometric stations

P3.3 Low-cost monitoring technology evaluation report by QLD

P3.4 Baseline mapping of floodplain infrastructure

P3.5 NSW Floodplain Harvesting Analytics Tool

P3.6 Remote sensing methodology to determine storage volumes and areas

P3.7 On-Farm Water Storage Explorer (OFWSE) water storage capacity calculation tool

P3.8 Farm scale change detection method and map for characterising changes in floodplain structures including storage areas

P3.9 Property Measurement Plans (PMPs) and geodatabase.

Specific commentary related to these deliverables is provided below. Additional information including information on the products developed is included in Appendix C.

NSW DCCEEW

NSW DCCEEW in collaboration with WaterNSW and NRAR was responsible for:

- installation and commissioning of 20 new/upgraded Hydrometric Gauging Stations (P3.2)
- improving baseline mapping of floodplain infrastructure by acquiring and analysing new LiDAR (Light Detection and Ranging) data covering gaps in the existing LiDAR footprint in northern NSW M−D Basin valleys (P3.4)
- delivering an analytics platform (the Floodplain Harvesting Analytics Tool) serving as a compliance tool for determining when floodplain harvesting events have occurred (P3.5)
- piloting a Floodplain Harvesting Measurement Technical Panel to provide policy advice on floodplain harvesting
- developing Property Measurement Plans (PMPs) and geodatabase through direct engagement with licence/approval holders (P3.9)
- developing the On-Farm Water Storage Explorer Tool (P3.7)
- delivering a report that investigates the distribution and measurement of water across NSW farms to highlight issues and potential improvements for the measurement and distribution of water at a farm scale (P3.8)
- piloting the Synthetic Aperture Radar (SAR) derived evaluation and interferometry (InSAR) Tool for Catchment and Farm Scale Change Detection (P3.8).

Additional information on the deliverables including information on the products developed is included in Appendix C.

DRDMW

DRDMW collaborated as a project partner in working groups led by NSW DCCEEW to scope emerging technologies and to identify data gaps across jurisdictions, including:

- the DRDMW had a key role in the deliverables to evaluate low-cost monitoring technology (P3.3) and acquire LiDAR for floodplain measurement and volume estimation (P3.4)
- these deliverables manifested specifically into the following activities:
    - Rain Gauge Satellite Trial that included the deployment of 47 tipping bucket rain gauges, including real time telemetry and publication of information via website and Application Programming Interfaces (API)
    - ‘Computer Vision’ on-farm storage measurement using contactless methods to determine storage volumes
    - groundwater well cap telemetry trials
    - experimentation with new on-farm survey technologies including drones (water and air) combined with advanced sensing technologies (e.g. sonar, radar, sounders, portable LiDAR etc.).

- DRDMW played a supporting role in other deliverables. These Proof of Concept (PoC) activities and the related evaluation and analysis activities informed the development of the final Project 3 Milestone reports, including:
    - low-cost Gauging Station (HNRS Program Project 3 Milestone 10)
    - Farm Scale Change Detection (HNRS Program Project 3 Milestone 16)
    - enhancing hydrological monitoring capabilities utilising computer vision (HNRS Program Project 3 Milestone 18).

Additional information on the deliverables including information on the products developed is included in Appendix C.

BOM

Although not officially involved in Project 3, BoM contributed operational knowledge about data exchange and corporate systems used to receive data transmitted from the field.

The Bureau's Rainfall and River Conditions data layer was used to scope the geographical location of gauges in order be able to infill the manual and automated reporting network.

MDBA

The MDBA played a minor role in the support of other project partners in the delivery of this project.

4.3.3 Business readiness for service statements

NSW DCCEEW

Project 3 for NSW delivered a mix of investigative reviews (PoC and Pilots), acquisitions and data development activities.

Each activity was undertaken and governed by a team of multi-disciplinary and agency professionals who ensured not only peer review but business readiness activities for each deliverable for those moving to operational use. Such considerations included identifying a product owner, ongoing funding sources and integration with business function support and maintenance regimes. Where acquisitions or data assets were capitalised, these have been moved to appropriate asset registers with custodial agencies.

DRDMW

Project 3 investments have contributed to new skills for DRDMW staff via targeted education and training. However, those skills are typically embodied in a small group of subject matter experts. The development of new and emerging measurement approaches has resulted in measurable improvements to efficiency via automation and improved data quality. This creates new opportunities for our people to focus higher up the value chain.

DRDMW have a very small number of nominated staff who have carriage of sustaining and enhancing Project 3 deliverables to ensure a level of continuity beyond the HNRS Program. DRDMW is continuing some partnerships through grant funding.

In terms of overall business readiness, the following key points summarise next stage readiness considerations and activities:

- new practices and processes are emerging within the organisation that further extend and embed new water measurement approaches
- the deployment of advanced data aggregation and integration services has resulted in a moderate level of readiness and ability to derive additional value in other service delivery areas
- the sustainment and expansion of new measurement services is directly driving organisational focus and future investment considerations
- the future operating model design is considering how advanced measurement technologies impact upon our future business model and service delivery approach.

4.3.4 Closure statements

NSW DCCEEW

For NSW DCCEEW this project has delivered important and enduring acquisitions including new/upgraded hydrometric gauging stations (20), broadscale high resolution LiDAR data, testing of innovative SAR routines and development of analytics platforms for Floodplain Harvesting. Each of these contribute to a significant uplift in the agency's ability to detect, monitor and manage water resources. With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, NSW DCCEEW considers Project 3 to now be formally closed.

DRDMW

The introduction of enhanced measurement capabilities beyond traditional approaches is a highly desirable business capability that DRDMW see as being pivotal to increasing both scale and resolution of water use and availability. Combined with the introduction of new technologies to improve on-farm survey capabilities, there is a strong potential to increase the accuracy and reliability of the related data and modelling outputs, ultimately empowering waters users and DRDMW staff with better information than was previously available.

As the lead agency for the Emerging Technologies Scoping Document (HNRS Program Project 3 Milestone 4), the State has derived significant value from being able to further test, trial and evaluate those identified technologies and increase the current toolkit available within the department and directly to water users.

Armed with new learnings and a series of new enhanced measurement services, next stage activities are focused on how the State maximises the benefits of the HNRS Program investment via increased adoption and extended use.

With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, DRDMW considers Project 3 to be formally closed.

4.4 Project 4

The NSW DCCEEW were the project lead for reporting progress on Project 4 deliverables and outcomes, with participation from the DRDMW, the MDBA and GA. Information in this sub-section was developed from information provided by each of these project partners as well as from the PMO. The information in this sub-section should also be read in conjunction with that in an earlier closure report from GA. (NOTE: for the purposes of this closure report the HNRS Program Steering Committee has accepted that the *HNRS Project Closure Report Geoscience Australia November 2022* comprises the contribution from GA – available from the MDBA upon request).

4.4.1 Introduction

Project 4 aimed to combine the collaborative efforts of northern M−D Basin States (NSW and QLD) into a works program that employed innovative technologies, robust and interoperable frameworks to support water management and compliance. It provided operationalised remote sensing analytic and spatial water balance tools to improve monitoring and compliance across spatial scales.

Specifically, Project 4 sought to:

1. operationalise remote sensing methods to support compliance functions, water balance calculations and improve transparency of water management
2. operationalise real-time water balance tools to improve accounting of water in the landscape
3. operationalise an alert system to further investigate compliance activities.

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4.4.2 Project deliverables

Key deliverables under this Project were:

P4.1 Resolution of the Data Sharing Agreement consistent with clause 19 of the Collaborative Heads Agreement (recognising that this has application across the Program's projects)

P4.2 Acquisition of field data[7]

P4.3 Remote sensing tools

P4.4 Water balance tools

P4.5 Compliance tools.

[7] Note: Through the recalibration, NSW amended its delivery to this from field data to Crop Information System PoC.

Specific commentary related to these deliverables is provided below. Additional information including information on the products developed is included in Appendix C.

NSW DCCEEW

NSW DCCEEW led the reporting for Project 4 and took a lead role in many deliverables. Specific responsibility for deliverables extended to:

- developing and operationalising remote sensing tools (P4.3) including the:
    - Volume Estimation tool
    - Water Surface Area Time Series
    - Irrigated Crop Area Time Series
    - Irrigated Crop Area Google Earth Engine Application
    - Surface Water Area Google Earth Engine Application.
- Developing water balance tools (P4.4) including:
    - the Farm Water Balance Tool
    - a Reach/Catchment Water Balance Model Tool.
- Developing compliance tools (P4.5) including the Crop Information System PoC. Furthermore, NRAR in collaboration with external suppliers developed and enhanced satellite remote sensing tools used by the irrigation community (IrriSAT) and NRAR (Extractor).

Additional information on the deliverables including information on the products developed is included in Appendix C.

MDBA

The MDBA contributed operational knowledge about corporate systems used to publish analysis ready remote sensing, water balance tools and present information to stakeholders.

DRDMW

The DRDMW supported NSW DCCEEW as the lead organisation and specifically contributed the following deliverables:

- Several initial scoping activities and deliverables that were used to shape future investments:
    - On-farm Survey Scoping Document
    - Field and Remote Sensing Data Preliminary Report (August 2021)
    - Field and Remote Sensing Data Gap Analysis Report (November 2021).
- Remote sensing proof on concept (PoC) activities, including:
    - Foundations – Waterbodies/Storage Curve Library Demo
    - Farm Storage – Farm Storage Characterisation and Water Volume

- River Flow – BOM Flow Event Viewer.

- Water balance tools PoC activities including:
  - Water Harvesting Desktop: Condamine/Balonne Water Resource Allocation Computing Environment (QWRRACE)
  - Water Harvesting Desktop: Warrego Allocation Manager (WAM)
  - Field validation of Satellite Water Body Filling Farm Scale.

- Compliance tools PoC activities to improve detection of anomalies including:
  - faulty meters
  - early overuse detection
  - capacity to take water
  - water use during a flow event
  - metered water valuation (Crops).

These PoC activities and the related evaluation and analysis activities informed the development of the final Project 4 Milestone reports, including:

- operationalising Remote Sensing (HNRS Program Project 4 Milestone 5c)
- operationalising water balance tools (HNRS Program Project Milestone 6c)
- operationalising compliance tools (HNRS Program Project Milestone 8b).

Additional information on the deliverables including information on the products developed is included in Appendix C.

GA

GA contributed operational knowledge about corporate systems used to publish analysis ready remote sensing, water balance tools and present information to stakeholders.

GA were active early partners in the HNRS Program via inputs into Project 4. GA's expertise in the collection and provision of free and open satellite imagery through its Digital Earth Australia (DEA) Program formed a foundational role in the HNRS Program.

Their involvement included the operationalising Remote Sensed (D4.3) and Spatial Compliance Tools (P4.5).

GA continued as a Program Partner following the Program recalibration (see Section 2.4) and maintained a watching brief for the life of the Program at a technical and strategic level.

4.4.3 Business readiness for service statements

NSW DCCEEW

Project 4 for NSW delivered a mix of analytical process development, portal implementations and data development activities. Each was undertaken and governed by a team of multi-disciplinary and

agency professionals who ensured not only peer review but business readiness activities for each deliverable for those moving to operational use.

Such activities included identifying a product owner, ongoing funding sources and integration with business function support and maintenance regimes. Where acquisitions or data assets were capitalised, these were moved to appropriate asset registers with custodial agencies.

MDBA

The MDBA supported the finalisation of Project 4 as a function of its PMO role. All appropriate administrative and governance arrangements have been finalised.

DRDMW

Overall readiness for services varies across the different focus areas included within the scope of Project 4 including:

- all services defined and developed under Project 4 have been subject to structured training and quality management activities, increasing overall readiness of our people and the related technologies
- like other streams, this knowledge and capability was typically limited to smaller working groups and requires additional investment to extend across the organisation
- the future capacity required to fully operationalise remote sensing and other tools under Project 4 remains a work in progress within the context of the broader RWF Program
- next stage funding is required to support sustainment, while enhancement and extension of Project 4 services remain subject to further consideration
- the future operating model to support sustainable use of remote sensed products and services is a critical path next step to ensure medium term business readiness
- the balanced use of internal teams and external services providers remains a major consideration for future readiness and operating model.

4.4.4 Closure statements

NSW DCCEEW

With a focus on development of analytical routines, testing of technologies and delivery of insights platforms to drive water resource management decision making, Project 4 for NSW has delivered valuable capability to assist in many agency business functions. Furthermore, acceptance as market leading approaches by peers and technical reviewers galvanises the innovative collaborative efforts of contributors in delivery of these outcomes.

With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, NSW DCCEEW considers Project 4 to now be formally closed.

MDBA

The MDBA supported the closure of Project 4 as a function of its PMO role. All appropriate administrative and governance arrangements have been finalised.

DRDMW

The advancement of remote sensing capabilities and advanced water balance tools have contributed to major learnings within Queensland and contributed to an overall increase in maturity. The approach towards testing and trialling these services has allowed all stakeholders to test hypotheses in a real world setting and to generate operational insights.

By developing a stronger understanding of remote sensed modelling techniques across numerous use cases, new approaches to anomaly detection at large scales have resulted, improving the State's ability to conduct compliance activities. This is anticipated to also contribute to more timely identification of potential water use issues and allow action to be taken sooner than was previously possible. As with all other steams, these new capabilities when used in conjunction with those delivered in Project 1 – Project 3 have allowed major steps forward via the HNRS Program.

With the completion, acceptance, and acquittal of all milestones in accordance with the related HNRS Program Project Agreements, DRDMW considers Project 4 to be formally closed.

5 Supporting Documents

A summary of the supporting documents for this projects closure report are provided in Table 5.

The list includes only those documents that are available to the public that summarise the outputs for the HNRS Program. Further documents can be provided on request that describe preliminary deliverables including progress reports, proof of concept reports and pilot trial findings.

Table 5: Supporting documents

Document name	Location
Murray–Darling Basin Water Information Portal (BoM)	Murray–Darling Basin water information: Water Information: Bureau of Meteorology (bom.gov.au) Report; MDB WIP Cultural Information Pilot Report - available from BoM
Water Insights Portal (NSW)	https://www.waternsw.com.au/water-services/water-data/water-insights
Elevation and Depth Foundation Spatial Data Portal (ELVIS Portal)	https://elevation.fsdf.org.au/
IrriSat Development	https://www.irrisat.app/
Reach/Catchment Water Balance Model Tool	https://water.dpie.nsw.gov.au/our-work/allocations-availability/water-accounting/water-balance-tool
Objectives to deliverables mapping Document	TBA
Collaborative Heads Agreement (CHA)	TBA
Project Agreements, GA, DRDMW, BoM, NSW DCCEEW	TBA
HNRS Communications Strategy	TBA
Program Evaluation Framework	TBA
Program Risk Strategy	Available from MDBA
Program Benefits Realisation Plan	TBA
HNRS Program whole of life budget	Available from MDBA on request application
Program Partners financial statements	Available from Program Partners on request application

Appendices

Appendix A

Queensland governance arrangements

Delivery of the RWF Program (up to stage 2) involved a combination of funding made available under HNRS Program, DCCEEW Cwlth and Departmental allocations with each source contributing to the development of new operational capabilities as per Figure A-1. This approach was undertaken to maximise the impact of the related investments and to deliver long term sustainable capability that could scale beyond proofs of concepts and in-field trials.

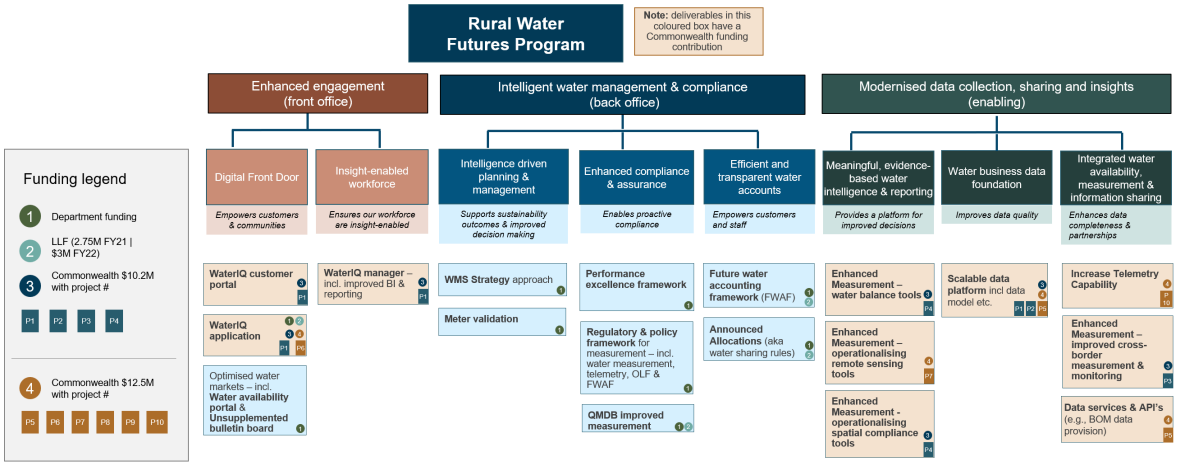

Figure A.1: RWF Program funding and operational capabilities

From a Queensland perspective the HNRS Program was governed within the RWF Program that included the following structures and arrangements.

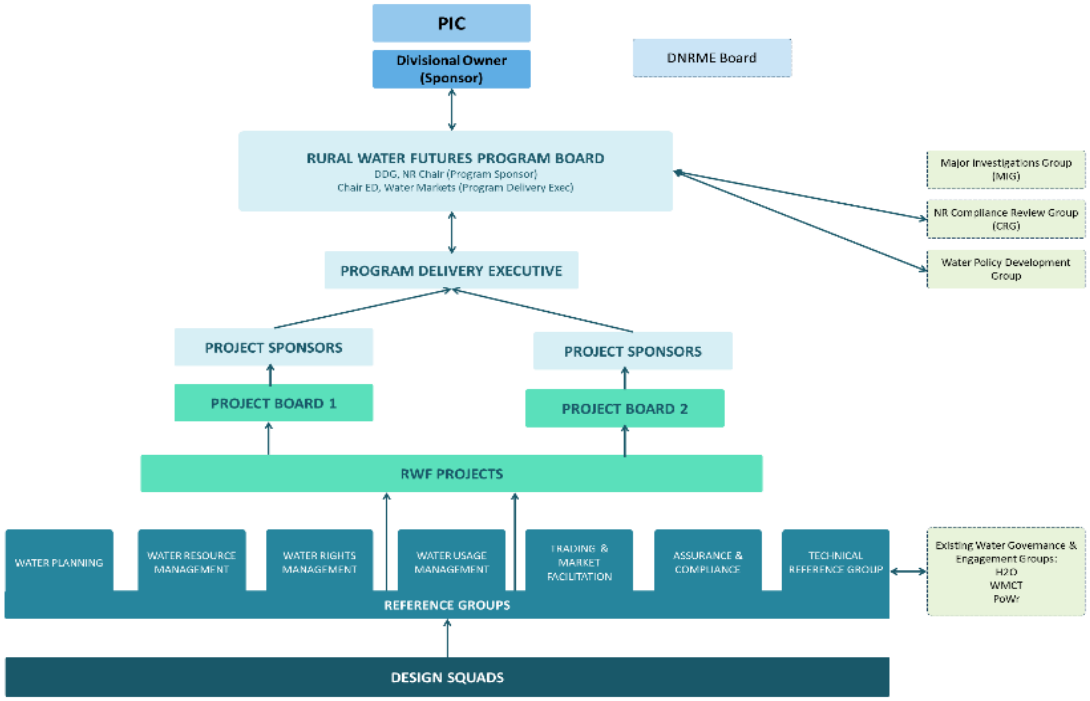

Figure A.2: RWF Program governance structures and arrangements

The RWF Program Board continued to review performance of HNRS Program deliverables against committed milestones to achieve delivery within allocated tolerance levels whilst ensuring integrated use of available funds achieved value for money and maximised intended benefits.

- The HNRS Program is sponsored by the Executive Director for the RWF Program. The Project Board for the RWF is made up of the key senior users who are responsible for the DRDMW business. The Project Board meets on a regular basis to endorse project operations.
- Project operations fall under the responsibility of a nominated Project Manager, who ensures that the program is progressing according to plan.
- The nominated Technical Lead provides oversight across the program ensuring technical synergy and excellence for RDMW.
- The Project Leads are embedded in operational business units to ensure that the daily activities undertaken are in accordance with the approved project plans; ensuring that the project produces the required deliverables on time, within budgeted cost, and at the level of quality outlined within the Project Agreement/Product Description.
- The RDMW progress is reported to the Project Board monthly.

Appendix B

External project communication

Additional to the communications efforts previously reported, the efforts of the Program Partners included the following consistent with their own business protocols and the Communications Strategy.

B-1 Project 1

External communication specific for Project 1 included:

- Rural Water Futures program website (https://www.rdmw.qld.gov.au/water/consultations-initiatives/rural-water-futures)
- Rural Water Futures annual progress report
- joint Commonwealth and NSW Minister Announcement: New and improved gauges in the northern MDBA
- NSW Water Minister Announcement: Locations of first 5 gauges in the northern MDB
- program awareness, product showcasing and demonstrations at Water Engagement Forum (WEF) industry presentations.

B-2 Project 2

External communications specific for Project 2 included:

- website content and social media
- WaterNews (NSW DCCEEW external newsletter) sent to subscribers
- Program awareness, product showcasing and demonstrations.

The BoM adopted a customer centred design approach for the development of the M−D Basin WIP. This involved an iterative process of testing each proposed release with customers; adjusting it in response to feedback and then retesting. The retesting was conducted using 1 hour 1:1 interviews; 'guerilla' testing at conferences etc.

- Interviews with and demonstration of initial wireframe to ~30 people from BoM's BOM ideas Community.
- Briefing sessions with Commonwealth and Basin state water organisations to demonstrate M−D Basin - WIP website design.
- Demonstrations at the MDBA's Community Forum.
- Presentations at the MDBA's River Reflections in 2022 and 2023.
- Presentations at the Murray-Darling Association Conference in 2022 and 2023.
- Presentation to the Lower Balonne Roundtable.
- Presentation to the annual meeting of the Australian Water Brokers Association.
- Presentations to the MDBA's Basin Community Committee.
- Demonstrations to the MDBA Regional Engagement Officers and regional office staff.
- Conducting a cultural information pilot with Elders of the Gomeroi/Kamilaroi nations, which involved a series of 4 workshops conducted on-country over an eight-month period.

In conjunction with the release of each of the five versions of the M−D Basin WIP, the following communications were undertaken:

- email advice to the Minister's Office
- Bureau media release
- Bureau social media posts – LinkedIn and Facebook
- enews article for stakeholders
- external article for regional media and industry publications
- internal enews article
- YouTube video – with a link provided on social media posts
- Bureau website tile ad
- Talking points and Q&As
- Information sheets and cards with information on the new features and a QR code to provide feedback for distribution at external events, conferences etc.

B-3 Project 3

External communications included:

- website content and social media
- WaterNews (DCCEEW external newsletter) sent to subscribers
- Gauging Stations Factsheet at Regional Water Strategies Roadshows (Menindee 15/06/22, Walgett 28/06/22 and Bourke 30/06/22).
- Rainfall gauge satellite trial (Enhanced Measurement Project)
- Alternative Measurement River Sites (Enhanced Measurement Project)
- Transparent water information | Rainfall gauge satellite trial
- Water Queensland and DRDMW social media via LinkedIN
- Facebook – DRDMW and Water Queensland pages
- LinkedIn – DRDMW, Water Queensland profiles
- Water Engagement Forum (WEF) meetings
- DRDMW Annual Report
- Rural Water Futures annual progress report.

Program awareness, product showcasing and demonstrations at:

  - executive updates at interjurisdictional workshops including Joint, Basin Community Committee)
  - Basin Community Committee meeting
  - DRDMW, Business & RWF websites
  - several northern M−D Basin River Operations Stakeholder Consultation Committee (ROSCCos) meetings
  - several northern M−D Basin Customer Advisory Groups (CAGs) meetings
  - Dumaresq-Barwon Border Rivers Commission (DBBRC) meeting
  - DBBRC Service Delivery and Asset Committee meetings
  - NSW DCCEEW Water Group Knowledge Streams Seminar Series
  - Modelling Advisory Group (MAG) meetings
  - NSW Joint Agency ICT (JAICT) Coordination Groups, Steering Committee & JTAG meetings.

- Dept Regional NSW S&P Water Collaboration Group meeting.
- NSW & Queensland Water Regulation Representatives.
- M−D Basin Community Committee meeting.
- LOCATE24 May 2024 conference.

Public consultation to gain input on the proposed site locations for the gauging stations was via the online have your say website which ran from 1 November 2022 to 31 December 2022 – Hydrometric Gauging Stations Installations and Upgrades | Water (nsw.gov.au). This public consultation was promoted through Electronic Direct Messaging to subscribers to communication channels.

B-4 Project 4

External communications specific for Project 4 included:

- website content and social media
- WaterNews (DCCEEW external newsletter) sent to subscribers

Program awareness, product showcasing and demonstrations at:

- several northern M−D Basin River Operations Stakeholder Consultation Committee (ROSCCos) meetings
- several northern M−D Basin Customer Advisory Groups (CAGs) meetings
- Dumaresq-Barwon Border Rivers Commission (DBBRC) meeting.
- DBBRC Service Delivery and Asset Committee meetings.
- NSW DCCEEW Water Group Knowledge Streams Seminar Series.
- Modelling Advisory Group (MAG) meetings.
- NSW Joint Agency ICT (JAICT) Coordination Groups, Steering Committee & JTAG meetings.
- Departmental Regional NSW S&P Water Collaboration Group meeting.
- NSW & Queensland Water Regulation Representatives.
- M−D Basin Community Committee meeting.
- LOCATE24 May 2024 conference.

Appendix C

Project deliverables and products

Many of the products derived from the Program are in the public domain. They will be assumed and adopted for projects with objectives beyond those of the HNRS Program.

C-1 Project 1

C-1-1 Improved access to data and information (P1.1, P1.2)

These deliverables included NRAR's Data Enhancement Project which provided a 'data pipeline' from a recent 'stand-alone' NSW water database, known as the Duly Qualified Personnel (DQP) Portal, to the primary NSW water database known as the Enterprise Data Base (EDB), which contains all NSW water licensing and water accounting data. The Data Enhancement project has enabled NRAR data analysts to more efficiently and effectively combine data from within the DQP database with water licensing and water accounting data within the EDB. Improving NRAR's ability to combine information held in separate water databases has further enhanced NRAR's efficiency and effectiveness in monitoring compliance. NRAR have successfully completed this project in collaboration with WaterNSW.

The DRDMW deliverables included 3 products which enable water users and managers to access data and information, namely 2 external-facing products: the *WaterIQ Customer Portal* and *WaterIQ App*, and an internal departmental platform - *WaterIQ Manager*.

The functionality of the external-facing products (*WaterIQ Customer Portal* and *WaterIQ App*) enables water users to:

- submit meter reads via the web portal or app
- view all meter readings and the status of each reading
- see the amount of water taken between each meter reading
- access photos of meter readings to support submitted data
- obtain additional details about meter readings
- receive notifications for submitting validated meter readings
- receive notifications confirming successful issue report
- receive notifications when a meter reading is due
- access all related water entitlement data and contact records
- report issues related to meters or other water management data
- log in securely using MyGovID
- view water trading information.

The functionality of the internal-facing product (*WaterIQ Manager*) enables Government officers to:

- display water dashboards tailored to their personal needs
- access various water reports, including those detailing water client information, authorisations, applications, and water meters
- view published water trades and un-supplemented temporary trade prices
- develop a register for water applications with integrated workflows and notifications
- access meter readings received via the customer portal and app
- set notification reminders for meter readings
- enhance client enquiry management with the addition of a register

- allow system managers to access security roles for workload allocation
- view internal service delivery standards (SDS), KPI metrics and calculations, including configured due dates and on-hold durations, using the job tracker
- configure a dashboard to display reported issues.

The NSW DCCEEW together with WaterNSW provided the public facing *Water Insights* portal. The functionality of the *Water Insights* web portal enables entitlement holders, the public, and compliance officers to:

- actively manage environmental water
- identify water take mandatory conditions as documented in all northern M-D Basin Water Sharing plans
- identify water available (and allocated) by licence category
- identify the status of pumping developments
- access aggregated data on water order history and meter reading.

C-1-2 NSW Compliance Officer Interface (P1.4)

The NSW Compliance Officer Interface (COI) involved NRAR developing Water Accounting and Reporting Tools for Entitlement Holders and Compliance Officers to enhance compliance with, and bring increased transparency and accountability to, water management in the M–D Basin.

The COI provides a comprehensive array of dashboards designed to facilitate efficient compliance monitoring activities. Notable dashboards available within the interface include:

- Bore Extraction Limits (BEL) dashboard - This dashboard facilitates bore/groundwater compliance. Leveraging mined extraction limits from conditions, the dashboard provides comprehensive assessment and monitoring capabilities
- Negative Account Balances (NAB) dashboard - This dashboard offers a comprehensive view of all New South Wales (NSW) water licenses with negative water balances
- Non-Urban Metering Compliance (NMC) dashboard - This dashboard assesses compliance rates at the bulk scale, ensuring efficient, transparent, and accountable monitoring and reporting of Non-Urban Metering Reform implementation progress.

The COI provides a ‘landing page’ for NRAR Compliance Officers to access these compliance monitoring dashboards and their associated documentation that elucidates its proper usage within NRAR’s WATERS web portal.

C-1-3 NSW Data Quality Improvement Register (P1.5)

A Data Quality Improvement Register was developed by NRAR within DPE Water’s ‘issues ticketing system’ known as the Water Actions Management System (WAMS). Within this register, NRAR has raised the most pressing data quality issues related to the NSW Water Licensing and Water Accounting Systems that impact on NRARs ability to undertake efficient and effective bulk state-wide compliance monitoring activities. Rather than logging ‘single issues’, NRAR undertook a risk-based approach to bulk analyses across NSW water databases, enabling a corrective focus on the most pressing data elements in need of remediation that are linked to the largest risk.

C-2 Project 2

C-2-1 Water Information Portal (P2.2)

BoM's deliverable for Project 2 was the M–D Basin Water Information Portal which provides customers with near-real time information from their desktop, mobile, or iPad on:

- key irrigation storage volumes and % capacities, updated daily, for the complete period of record (up to 50 years)
- flow and height information for 200 key river gauges
- salinity data at over 100 sites
- water quality information (water temperature, pH, turbidity, dissolved oxygen)
- water taken (used) and water available for 29 catchments
- annual actual water take information (prepared as part of the MDBA's Water Take Report)
- water markets data including water price and volume traded for both current and historic time periods at a weekly level as well as strike date and reason for trade
- groundwater levels for representative bores
- groundwater quality information and groundwater use information
- groundwater trade information
- interactive river diagrams for the entire Basin as well as a whole-of-Basin diagram
- photographs of rivers, storage infrastructure and significant locations
- Cultural information for the Gomeroi/Kamilaroi nations, including recordings of Elders recalling their experiences growing up on missions; their connection to country; and the important role waterways play in creating their sense of identity
- accompanying the recording are photos and stories of culturally significant sites, including Boobera Lagoon, known to local First Nations people as the resting place of Garriya, the Rainbow Serpent.

The Murray–Darling Basin Water Information Portal was developed using a Customer Centred Design approach which put customers at the centre of all decisions about information included and how it was presented. New features and functionalities were added to each of the five main releases based on feedback from customers.

The Customer Centred Design approach adopted an iterative approach of testing each proposed release with customers; adjusting in response to feedback; and then retesting afterwards. Figure C.3 shows the process adopted over the life of the project.

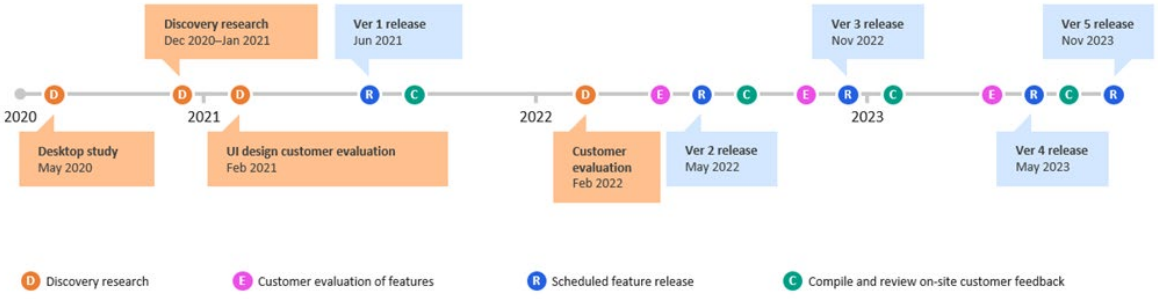

Figure C.3: Iterative Customer Centred Design Approach

The iterative approach adopted a variety of testing methods including one hour 1:1 interviews; 15 minute in person surveys; 'guerilla' testing at conferences etc. Examples of the testing that was conducted are provided below:

- interviews with and demonstration of initial wireframe to ~30 people from BoM's BOM ideas Community
- briefing sessions with Commonwealth and Basin State organisations to demonstrate the M–D Basin - WIP website design
- MDBA Community Forums
- MDBA Basin Community Committee and customers from several M- D Basin communities
- River Reflections 2022 and 2023
- Murray Darling Association Conference 2022 and 2023
- MDBA Regional Engagement Officers and regional office staff
- Annual meeting of the Australian Water Brokers Association
- Cultural information pilot study on the lands of the Gomeroi/Kamilaroi nations in the northern M–D Basin.

C-2-2 Data services (P2.3, P2.4)

NSW DCCEEW and WaterNSW delivered the following deliverables and products for Project 2.

- WaterNSW developed Application Programming Interfaces (APIs) (or files), namely, Water Data API and Water Source API for use by the Water Community to receive information as specified in the Data Sharing Agreement (WaterNSW as the Licensor). These data services (API or SFTP file) enabled BoM to populate its Data Information Services Layer to power the WIP for use by Water Communities.
- specifically, BoM requested that WaterNSW develop a Storage Balance API that sources data from a datalake via the Water Source API to deliver storage balance with storage volume, inflow, and release (total not by type). The new Storage Balance API is registered and can be accessed via the WaterNSW API Management (APIM). NSW DCCEEW delivered State based data to HNRS Program Partners in line with the Data Sharing Agreement. NSW DCCEEW developed API domains Water take, Allocation, Account balances and Aggregated clusters (geospatial mapping of accounting data).

C-3 Project 3

C-3-1 Installation and commissioning of hydrometric stations (P3.2)

NSW DCCEEW constructed 20 new or upgraded gauging stations, delivered over 4 Tranches.

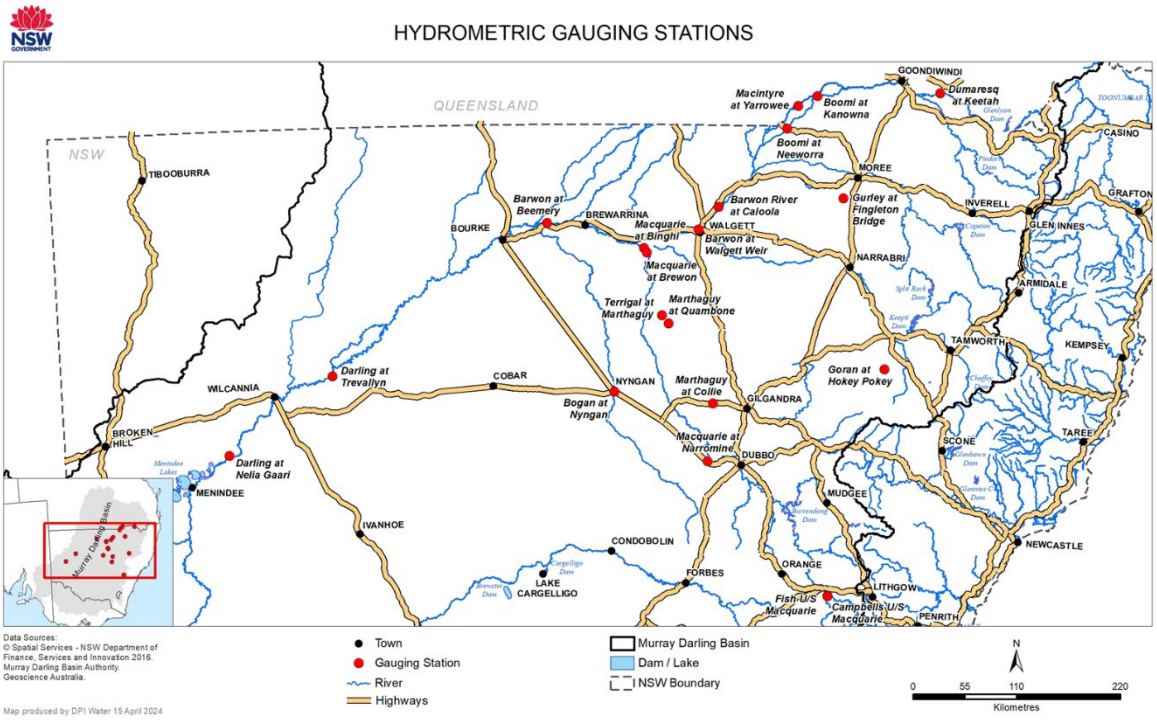

Figure C.4: Location of gauging stations in NSW

The map (above) shows the location of 20 NSW new or upgraded gauging stations. The installation of new or upgraded Hydrometric Stations will provide additional and more timely water flow information of greater accuracy and reliability. This will enable water managers to make more informed water management decisions in a quicker timeframe. The data from these sites will be consistent with the existing network using the same data collection, archiving, transfer and publication procedures and protocols.

This work package focused on providing greater flexibility for DRDMW to respond to emerging regional water management needs, including streamflow data gaps, and short to medium term gauging requirements.

a. The 3 Alternative Measurement River Sites equipment at each site consists of a pressure sensor, data logger and telemetry option. It is housed in a standard, stainless steel cabinet mounted on a steel post. This equipment was chosen to better understand reducing the cost of in-situ concrete footings and larger footprint fixed monitoring stations. To test the specification of the data systems reflecting the stakeholder requirements. Allowing more flexibility to support expanding to implement a supplementary network.
b. The 46 Rainfall Gauge Satellite Trial equipment sites compliment the hydrometric network. This equipment was chosen to better understand the effectiveness of the suppliers available

and reliability of this emerging direct to orbit satellite telemetry technology as a potential low-cost method to understand streamflow data gaps by correlations between rainfall and runoff in the catchment to streamflow.

c. Further work was done to better understand contactless measurement techniques. The 9 Computer Visions Stream Gauging sites were deployed in the field to monitor a variety of inland hydrological river conditions, including gauged and ungauged sites. This tested the use of edge computing and cloud-based data processing requirements, including the possibility of artificial intelligence to rapidly analyse optical videos of water flowing (image velocimetry) without the intervention of an operator on site.

This information is published as open data through the Queensland Government Water Monitoring Information Portal.

1. Alternative Measurement River Sites (Enhanced Measurement Project)
2. Rainfall Gauge Satellite Trial (Enhanced Measurement Project).

C-3-2 Low-cost monitoring technology evaluation report (P3.3)

The work package to expand the hydrometric network included consultation with 4 state government agencies and Australian hydrometric professional organisations to develop the Emerging Water Monitoring Technologies Scoping Document. The report recommended the findings should be used by water organisations to inform future investments in water monitoring, measurement, management and compliance services as part of a national approach to continuing to improve water services.

The recommendations from this collaboration led to the selection of project equipment chosen to expand the hydrometric network.

Deploying this equipment required increased capability development to ingest third party provider data into corporate systems through Application Program Interface (API) consumption, plus expansion of existing capability for a standardised self-specifying file format ingest, both of which are automated data exchanges.

DRDMW deployed emerging technologies focusing on evaluation of Telemetry market options as listed below.

- direct to Orbit Satellite Antennas integrated with Tipping Bucket Rain Gauges
- low-cost gauging stations (Alternative Measurement River Sites)
- non-contact cameras to optically gauge and data analytics of flows.

The non-contact cameras used optically measure water levels in still water and surface flow. The final report presented a technically sound, low cost, efficient method for monitoring water level of water storages and discharge of streams based on computer vision and cloud computing. The methodology has been applied on 9 trial sites over 2 years since 2022 and a total of 115,000 videos have been collected and analysed to date across these trial sites. The results from these trial sites successfully demonstrated the potential feasibility of the non-contact camera-based method in measuring stream discharge across a range of conditions.

C-3-3 Baseline mapping of floodplain infrastructure (P3.4)

Light Detection and Ranging (LiDAR) dataset plays a crucial role in floodplain mapping due to its ability to provide highly accurate and detailed topographic data with elevation. NSW acquired LiDAR data to cover gaps in the existing LiDAR footprint in northern M-D Basin valleys.

The initial plan outlined a LiDAR footprint of approximately 15,000 square kilometres, accompanied by concurrent imagery, based on allocated funds. The NSW Department of Customer Service (Spatial Imagery Group), an expert in LiDAR technology, was contracted for the project. To ensure efficient utilisation of resources and avoid redundancy, a working group comprising stakeholders from across department clusters was established. Regular communication with working group members facilitated coordination and synergy in data acquisition efforts.

Due to concerted collaboration, enhanced planning and optimised acquisition techniques, the final LiDAR footprint expanded significantly to cover 90,000 square kilometres. This outcome reflects not only the effective utilisation of allocated funds but also represents a remarkable value proposition, delivering extensive coverage and comprehensive elevation data for various applications and stakeholders across NSW.

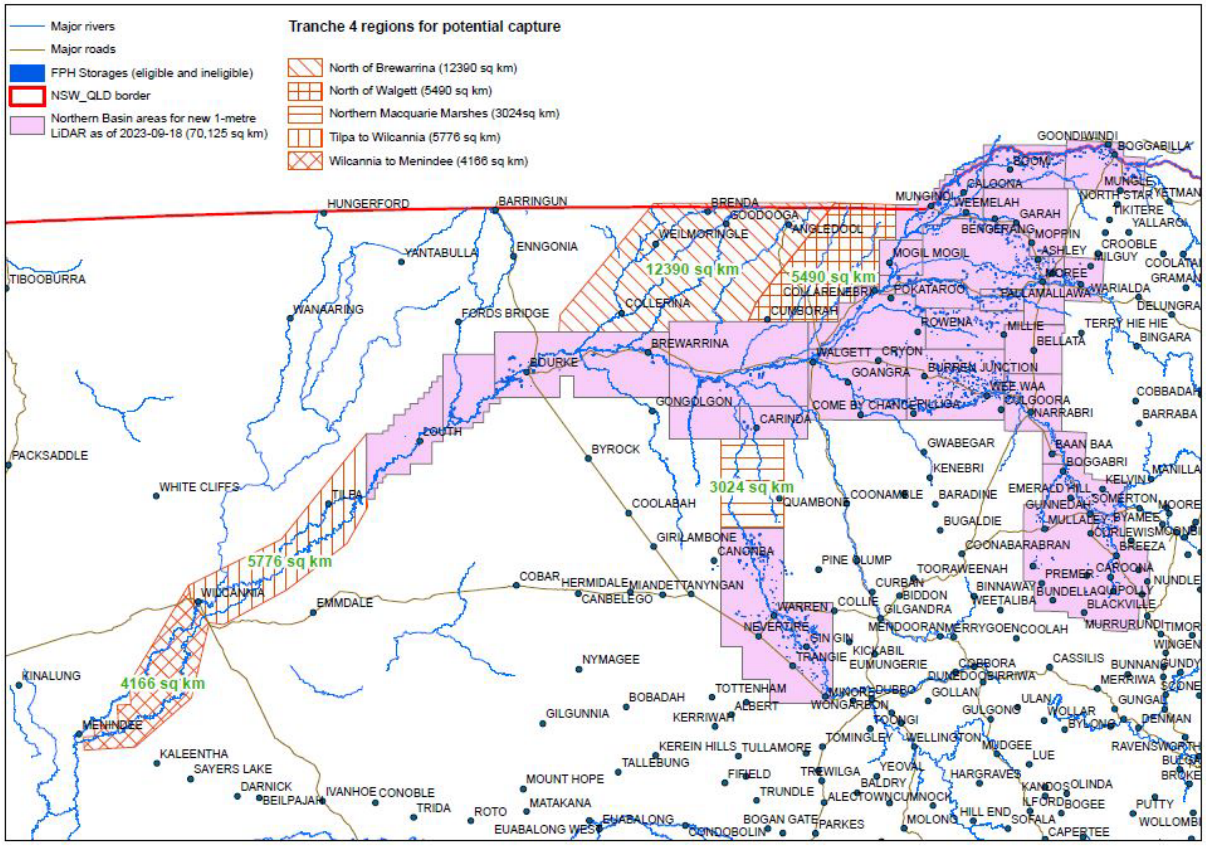

Figure C.5: LiDAR coverage (footprint) and its extension in Tranche 4

Led by Geoscience Australia with contributions from DRDMW and NSW – the Farm Storage Water Volume Estimates Report increased DRDMW capability to understand the tools and methods available to capture floodplain harvesting infrastructure. This work was informed by the Field and Remote Sensing Gap Analysis which focussed on conducting a gap analysis regarding the current and

future use of remote sensing and field data for the purpose of detection, analysis, measurement and reporting which built on the Field and Remote Sensing Data Preliminary Report.

This is new business for DRDMW as this type of large geographic area has not been captured before because of the high cost of survey technologies. However, advancements in emerging technologies have lowered the cost. This also increased the staff knowledge of market providers and methods to capture and analyse these large datasets.

The current baseline map is drawn from as-built plans of farm water storages. This baseline has limited geographical reach because the ground method is expensive and requires time for the information to be gathered on the ground and reported. This method has been complimented by airborne data capture methods. To extend this baseline map, airborne flight missions were deployed using Light Detection and Ranging (LiDAR) as a large-scale longitudinal survey tool. In total 8,294 square kilometres were captured.

This information has been processed into a Digital Elevation Model (DEM) and desktop Geographic Information Systems (GIS) applications can be used to produce individual site survey outputs. Where water was present during the time of capture, other important characteristics of the sites have been captured by the longitudinal survey. For example, the height of embankments.

This information is open data published on the:

1. Queensland Government Open Data Portal | Queensland elevation data extents – REST and WMS Services.
2. Commonwealth of Australia (Geoscience Australia) ANZLIC Committee on Surveying & Mapping Intergovernmental Committee on Survey and Mapping | Elvis – Elevation and Depth – Foundation Spatial Data.

C-3-4 Floodplain Harvesting Analytics Tool (P3.5)

NSW DCCEEW delivered an analytics platform serving as a compliance tool for determining when floodplain harvesting events have occurred and when measurement may be circumvented and moved towards automation detection of the event and measurement, removing the need for landholder data inputs.

The analytics tool gets data from a number of different sources, e.g. rainfall data, remote sensing data, river gauge data, input data for assumptions, storage meter data and meter data, to establish when a floodplain harvesting event occurs and how much water has been harvested so that this can be compared with landholder metering equipment and self-reported nomination of measurement periods (which is the only time landholders are permitted to take floodplain harvesting water).

Queensland contributed to the joint Floodplain Harvesting Practice Note – providing analysis on both New South Wales and Queensland policies identifying similarities and differences to make recommendations about tools for assessing Floodplain Harvesting capture, noting, the nomenclature for Floodplain Harvesting in Queensland is Overland flow (OLF).

An OLF water balance calculator PoC was developed to advance and demonstrate a water balance framework to infer the volume of water harvested into the on-farm water storage.

C-3-5 Remote sensing methodology to determine storage volumes and areas (P3.6)

C-3-6 On-Farm Water Storage Explorer Tool (P3.7)

The On-Farm Water Storage Explorer tool was developed for NRAR by Haizea Analytics Pty Ltd. The tool is an interactive web application that was designed to assist NRAR in quantifying the water capacity of on-farm water storages dedicated to irrigation. The tool detects water storages and derives volume curves combining high-resolution LiDAR-derived Digital Elevation Model (DEM) and a database that contains the centroid position of the on-farm storages. The released version of the On-Farm Water Storage Explorer web application allows users to interactively explore 1,217 on-farm storages located in the northern NSW M–D Basin.

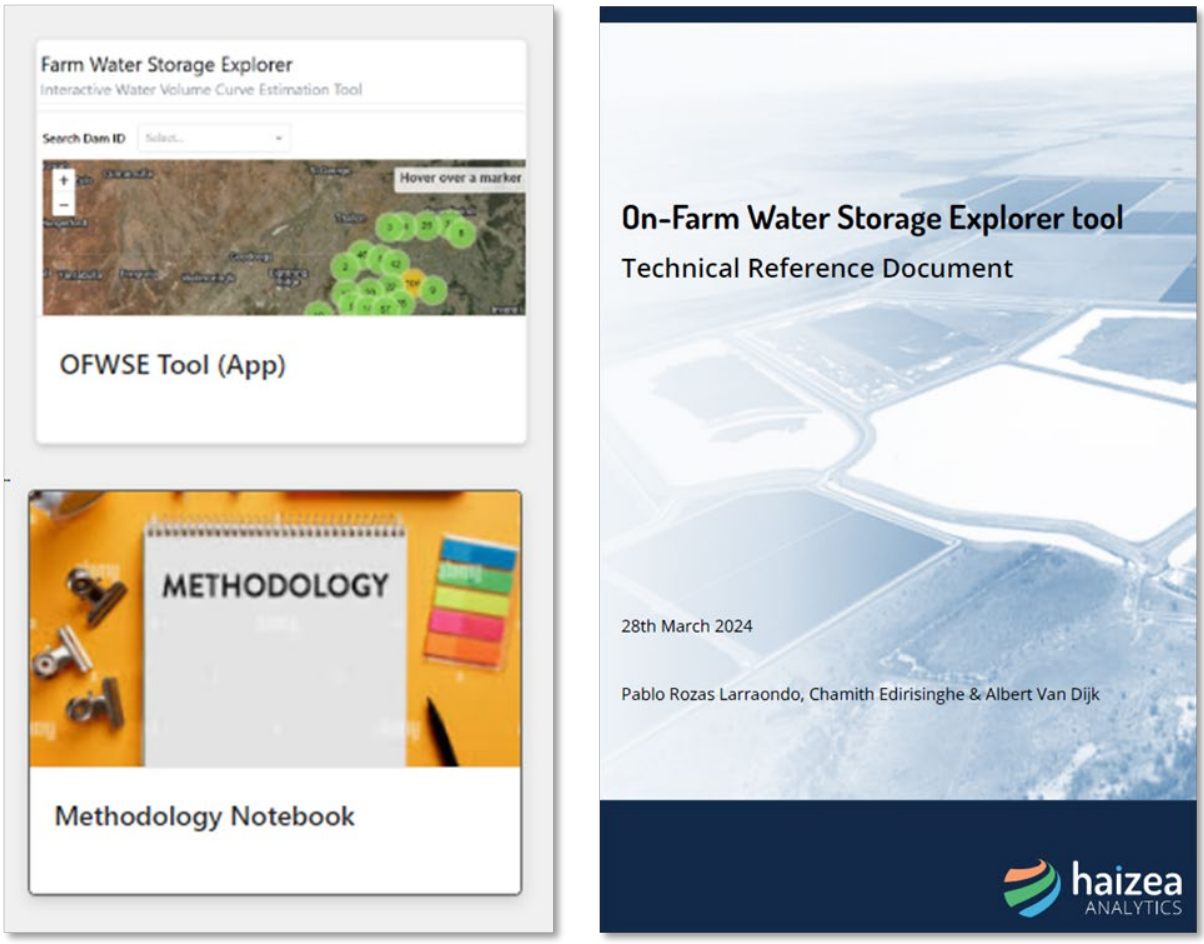

Figure C.6: On-Farm Water Storage Explorer Tool

C-3-7 Farm scale change detection method and map (P3.8)

This work package produced the Farm Scale Change Detection – Scoping Report including a range of priorities across short, medium and long term to inform a pilot project to test methodologies and capabilities. Engagement included NSW Government agencies, Geoscience Australia and the Murray–Darling Basin Authority.

The results from the Pilot Activity can help stakeholders to:

- know what equipment and approaches are available for immediate use
- build a practical knowledge base and mutual understanding of suitable applications to monitor hydrological science changes and calculate water balance budgets
- deduce the key foundational data sets which can be used most effectively.

Several non-contact measurement techniques suitable for deployment in remote locations to improve the detection of changes at the farm scale were summarised, including remotely sensed satellite images and digital elevation models derived from airborne flight missions. On-ground instruments were deployed to compare the effectiveness of remote sensing and provide a better understanding of the emerging advances in optical cameras to gauge still water storage levels.

The purpose of this product was to develop a PoC report using Synthetic Aperture Rader (SAR) to establish a catchment and farm scale process for detecting floodplain structures and alteration of the water regime (e.g. storages, levees, banks, impoundments etc) by detecting and monitoring changes in the floodplain terrain. The SAR derived digital surface model will be trialled to monitor changes on the floodplain.

The PoC focused on science-based research to identify the capability and validate the SAR technology with a view to operationalise the SAR system.

Due to time constraints, only a PoC was undertaken, and the next phase of implementation was not completed. To ensure that the technology works across multiple environmental conditions, 2 study sites were selected, one in the state of NSW and the other in QLD. The specific objectives on both study sites were to:

- monitor the evolution over time of the water-land boundary of the reservoirs/dam
- generate change detection products using High or Very High-resolution SAR data for the two study areas
- generate a digital surface model over selected on-farm storages (to define a reservoir/storage curve) or other areas as appropriate for farm level changes in structures.

A number of SAR sensor data from moderate resolution (Sentinel-1, ALOS3D) to high resolution (Umbra, Capella, Cosmo-SkyMed, NovaSAR) were investigated. The study assessed and evaluated the usefulness of these datasets based on SAR data processing techniques of classification, InSAR DEM (Digital Elevation Model) generation and change detection.

Sentinel-1 data was evaluated for monitoring water level and volume changes in the on-farm storages. The combination of the Adaptive Non-Local Filter and Adaptive Nonlinear Filtering with Logic Detection (ANLD) proved to be the most effective, yielding the best performance in terms of preserving water surface edges. The high-resolution Capella and COSMO-SkyMed enable a better estimation of water boundaries. The InSAR approach for creating a DEM may be useful when the catchment conditions are dry. It does not provide good results when catchment condition is wet. NovaSAR data did not yield good results due to lack of fixed orbit, which prevented precise geocoding of images.

A report and map were produced that covers the distribution and measurement of water across NSW farms. The objectives for this deliverable were to highlight issues and potential improvements for the measurement and distribution of water at a farm scale and provide recommendations for future optimisation.

The report was developed through interviews and workshops with NSW DCCEEW and WaterNSW subject matter experts to derive and summarise the issues and opportunities for potential improvements.

C-3-8 Property Measurement Plans and geodatabase (3.9)

Property Measurement Plans (PMPs) were identified as a method to assist floodplain harvesters demonstrate how they comply with their floodplain harvesting measurement conditions.

Workshop engagement sessions were held to provide advice and assist landholders to develop a property measurement plan. This will improve their understanding of the rules and increase compliance (e.g. how they will nominate their measurement period and which measurement options to implement).

The property measurement plans describe the following:

- how a landholder harvests from the floodplain
- how the landholder will nominate the start and end of their measurement period
- location of primary and secondary metering equipment
- any subdivision of work approvals and differing measurement methods which apply
- any addition or removal of works on a property for floodplain harvesting
- any buffer zones.

These plans will be drafted with landholders and uploaded into a geodatabase for integration into WaterNSW systems beyond the HNRS project.

C-4 Project 4

C-4-1 Acquisition of field data (P4.2)

This work package focused on providing greater flexibility for DRDMW to verify water balance, remote sensing and compliance tool activities, including foundational data integration identified as short to medium term requirements in the Field and Remote Sensing Gap Analysis. Deploying equipment in the field required increased capability in supporting information systems, including development to ingest third party provider data into corporate systems through Application Program Interface (API) consumption, plus expansion of existing capability for a standardised self-specifying file format ingest, both of which are automated data exchanges.

This work supported the evaluation of the equipment deployed in the field:

- low-cost monitoring technology options for non-contact storage level sensors
- On-farm survey bathymetry

- Rain Gauge Satellite Trial
- low-cost monitoring technology options for non-contact river gauging.

High resolution PlanetScope imagery (3 metre/pixel) was acquired, capturing filling/emptying of storages in the northern valleys of NSW to be used for validation purposes.

C-4-2 Remote sensing (RS) tools (P4.3)

In the initial parts of the project, DRDMW worked alongside Geoscience Australia, the State of New South Wales, and the MDBA to build business requirements for a web tool that would reduce data costs by sharing a subscription to download high-resolution satellite imagery in bulk (and reduce duplication). This work helped DRDMW share knowledge about the platforms and imagery being used across the project.

DRDMW benefited from workshops that Geoscience Australia led about the analysis-ready imagery and datasets that are made freely available to download and access via Digital Earth Australia (DEA) web services. Workshops were also held throughout the project to share learnings and current practices for analysing structures on the floodplain using a digital elevation model. As a result of the workshops, DRDMW had access to the DEA Sandbox learning and analysis environment to get started with sample data and Jupyter Notebooks to explore proof-of-concept applications. During the project, DRDMW built the capacity to develop a PoC waterbody detection algorithm that can be used for imagery analysis to support compliance enquiries, including identifying the date of the first image where a new waterbody is detected. This forum provided an opportunity for DRDMW to expand the network across the industry by working with remote sensing specialists analysing water. DRDMW has experienced a substantial uplift including recruiting specialist resources to continue to support this new area of business.

DRDMW participated in a comprehensive assessment to recommend focused activities in remote sensing capabilities in each jurisdiction, including a level of maturity of data and gap analysis, producing the HNRS *Field and Remote Sensing Data Gap Analysis*. This report identified wide use of earth observation (EO) data for the detection of waterbodies and crops, but there were concerns and limitations for integration of this EO data with ancillary data such as evapotranspiration/storage/elevation data. Similarly, flow events required the integration of timely and concomitant ancillary data. Current limitations on the ability to integrate data from diverse sources and across different platforms hinders the automation of the RS capability, with integration of foundational datasets seen to be crucial for future development.

To build from the gap analysis, DRDMW produced a discussion paper scoping prototypes, including a summary of current challenges for foundational datasets. The discussion led to DRDMW creating data processes and work practices which helped identify data input/output quality issues. These documents are helping DRDMW to address these issues and further work will continue outside the project to understand how these prototypes can support regulatory objectives.

Three PoC were developed by DRDMW that serve as prototypes for further development.

1. In conjunction with industry experts, DRDMW developed a tool for the estimation of farm storage water demonstrating capability to deliver intelligence information pertinent to water storages. This tool combines waterbody spatial data, a storage curve library (SCL), elevation

data and moderate to high resolution satellite imagery, the output delivered via a simple user interface.

2. Project staff developed a crop water estimation tool which integrated the available IrriSAT (API) functions, combining data and visualisations into a single user interface to infer crop water requirements.
3. The Flow Event Viewer improved DRDMW's capability to deliver near real time mapping of targeted river flows. The analysis environment leveraged daily flow data from the Bureau of Meteorology via an API and displayed satellite visualisations as well as waterbody coverage (via GA web mapping services).

NSW DCCEEW delivered the following remote sensing products and tools.

- Volume Estimation tool - Volume calculation tool based on the storage capacity curve was developed to calculate volume estimates based on the water surface area of storages. The old version of the tool was in Delphi which was written in Python script and integrated with the water surface area time series to automatically generate volume.
- Water Surface Area Time Series - 35-year time series of storage monitoring was established based on the Landsat and Sentinel satellite sensors. This dataset is now a live dataset, updated weekly. This script was extended to include monitoring of all natural waterbodies in northern NSW M−D Basin valleys on request of Science and Inland Planning teams in NSW DCCEEW. The primary objective of this workstream was to establish a time series of on-farm storage monitoring dataset using the capabilities of high computing environment to create an automated system. The workstream delivered an automated pipeline along with a user interaction portal.
- Irrigated Crop Area Time Series – 35-year time series of irrigated crop area was generated for five valleys of the northern NSW M−D Basin. This dataset will be maintained and updated annually. This workstream primary objective was to automate irrigated crop area workflow in the Google Earth Engine (GEE) environment and develop an interactive interface.
- Irrigated Crop Area Google Earth Engine Application – A Google App (GEE) that allows a power user to derive crop area for a specific date range and enables user control on threshold.
- Surface Water Area Google Earth Engine Application – A Google App (GEE) that allows a power user to analyse and extract storage water surface area for a specific date range.

C-4-3 Water balance tools (P4.4)

In response to the identified needs of operational officers, in the regions, as short to medium term stakeholder requirements in the *Field and Remote Sensing Gap Analysis,* DRDMW produced the Water balance tools discussion paper. The paper shared background knowledge and discussed building foundational data sources for DRDMW.

Building on the knowledge learnt about the information systems project partners use, DRDMW focused on sharing knowledge describing the similarities and differences in operations. This discussion highlighted the challenges to integrating information systems, with highly variable rainfall and hydrological conditions (unsupplemented) when compared to river reaches regulated by major infrastructure and identified opportunities for this work package. This produced an analysis of the

current state of water management systems and platforms used to support water management operations, which feed into public-facing water balance portals.

Three water balance tools were developed for DRDMW users to test addressing these needs, including:

- QWRRACE water harvesting desktop at the reach scale
- WAM water harvesting desktop at the reach scale
- Field validation of satellites of water bodies filling at the farm scale.

Meanwhile, an initial concept plan outlining the proposed water balance tool for managing Overland flow (see Project 3) was produced. Minor delays enabled additional time for feedback from stakeholders, including work led by the MDBA, for NSW and QLD to progress a workable method to support future floodplain and overland flow analytics tools.

DRDMW benefited further from invitations to provide feedback at workshops led by the State of New South Wales, scoping the Water Balance Tool Implementation Plan requirements. The implementation built an improved understanding between project partners and progressed the scope of an innovative tool to automatically track water balance in near real time. The collaboration continued, refining the understanding of the effort required to integrate historical information with near real-time streamflow feeds and non-traditional sources of information, including scoping the possibility of integrating remote sensing analysis. The scoping clearly identified rural water hydrology quantity modelling as a niche skillset, which is already heavily allocated to catchment modelling used to support regulatory planning, particularly, Water Resource Planning. DRDMW continued to collaborate with NSW by providing coordinating feedback on the progression of their innovative daily water balance information reach scale pilot work package. DRDMW has experienced an uplift in this water balance tool area, including:

- enhancements to automate corporate systems previously used to manually analyse the unsupplemented inflows into water harvesting operations
- configuration of a database to archive farm-scale water storage field survey tables
- evaluation of field and satellite equipment commenced to improve understanding of the relationships between on-ground sensors and emerging satellite analysis techniques
- evaluation of emerging equipment commenced to improve understanding of using satellite telemetry systems to automate rainfall and streamflow data collection. This evaluation has the potential to extend foundational capability to strengthen reach-scale water models.

The *Farm Water Balance Tool* was developed in two major phases, the PoC and Pilot. The stated objective of this deliverable was to develop a real-time water balance tool that supports a multiple lines of evidence approach for compliance assessment and enhances regulators' capability.

The PoC was developed and run on 2 year historic dataset, in order to test the concept and validate results of the remote sensing-based farm water balance tool developed. The Pilot was run live starting from the water year 2023-24 and is still running in real-time. It provides a water balance estimate for each property in the pilot area at every satellite overpass.

A Farm Water Balance dashboard was developed that has live data connections and capability to perform rapid water balance analysis and compliance check with multiple lines of evidence, including metered take and remote sensing based crop water usage information.

The Farm Water Balance Tool can be used for soil water balance modelling (i.e. inclusive of losses due to runoff, evaporation and seepage) and can be used to provide water volumes estimates for on-farm reservoirs.

The Farm Water Balance dashboard is a secured data streaming service and can be accessed using the following link for NSW DCCEEW internal users only. https://watercontrolroom.hydronet.com/#/

A *Reach/Catchment Water Balance Model Tool* was also developed. This tool involved 3 major phases, PoC, Pilot and Implementation, culminating in the development and rollout of a fully operational reach and catchment Water Balance Tool for the Namoi Regulated River Water Source.

This automated tool provides a monthly breakdown of each water balance component, improving the understanding of losses and gains in each reach. The tool is externally published by DCCEEW at https://water.dpie.nsw.gov.au/our-work/allocations-availability/water-accounting/water-balance-tool.

C-4-4 Compliance tools (P4.5)

During the early stages of the project, the Inspector General of Water Compliance was being established. Initially, the project partners discussed the opportunity to have a single tool to support the reporting requirements of this newly established office.

The development of tools to assist with strengthening the way regulators monitor and identify compliance issues and provide assurance that water management outcomes are being achieved is fundamental to improving the overall water management framework and supporting sustainable water outcomes. Leveraging advancements in technology and meeting the challenges and demands of extreme climate and impacts, such as flooding or drought, require regulators to do more and be efficient in how they deliver it.

Queensland collaborated with NSW to the deliver the HNRS Compliance Tools Options Paper (May 2022) identifying available compliance tools and datasets to assist NSW and Queensland Compliance Officers. In parallel to this project Queensland developed a Scoping paper describing the key objectives and requirements to develop fit for purpose compliance tools and proposed investigating 5 sub projects.

- Anomaly Detection – Faulty meters
- Anomaly Detection – System for overuse
- Anomaly Detection – Metered crops
- Anomaly Detection – Capacity to take water
- Anomaly Detection – Water use during flow event.

In June-December 2022 Queensland facilitated the mapping of current and future state business processes with departmental compliance working groups, developed business requirements and user

stories for each sub-product and PoC specifications for two sub-products Anomaly Detection – Faulty meters and Anomaly Detection – Early detection system for overuse.

Queensland met the quality criteria in December 2022 with our progress reports provided to the Commonwealth clearly defining the project background, product descriptions, statement of works and identified required steps for operationalising.

In the next 6 months (January to June 2023) Queensland delivered in full against the HNRS Program quality criteria for two of the five sub-products, 'faulty meters' and 'capacity to take water' while partially delivering on the remaining sub-products for 'system for overuse', 'metered crops' and 'water use during flow events'. This partial delivery was due to time constraints, dependant projects progress and alignment, and challenges with foundational data quality and access.

In the sub-products 'metered crops' and 'water use during flow events' there were a number of dependencies on remote sensing inputs that needed to be resolved for this work to progress. Without remote sensing foundational datasets to ingest it was difficult to deliver a PoC for the 2 remote sensing sub-products. Similarly, for 'system for overuse', without foundational data needed for 'water accounting', the PoC was only able to inaccurately detect whether there was water overuse against an entitlement holder. Further challenges presented where the water management groups had a 'multi-year' accounting'.

An encouraging demonstration through the 'capacity to take water' PoC was that remote sensing capability can be used for compliance monitoring to support regional compliance officers. It also demonstrated the ability to connect authorisation data with compliance case data to remote sensing data of water storages in the 'capacity to take water' PoC.

Of the 5 sub-products the 'faulty meter' was the most advanced. The PoC delivered 2 Power BI reports, the first one being a data anomaly detection, using data analytics from meter read data and works by automating patterns of information that compliance officers look for when assessing meter reads. The second report is a compliance monitoring tool. There was limited automated oversight of faulty meter data across the state, the faulty meter monitoring tool provides state-wide visibility of all faulty meters to facilitate managing these meter cases before becoming non-compliant incidents.

A detailed assessment in June –July 2023 of the PoC resulted in the PoC being assessed as 'fit for purpose', and the project was recommended to operationalise the two reports and transition these tools to business as usual.

The following further investment to bolster the project investment and improvements were delivered in the July 2023 to February 2024 time frame to ensure transition to BAU:

- identification of any gaps or improvements to the tool by the business
- enhancements tested improving functionality including direct connection of the reports to CIRaM (compliance case data for faulty meters) and WMS data (authorisation, water accounts, meter) providing live connections to date uploads on a daily refresh
- availability of the tool in the PowerBI Service for ease of accessibility to all compliance officers

- development of implementation material such as procedures to support compliance officer use of the dashboards, additional video tutorials to step through key fields in the dashboard and key communication including presentations to DRDMW staff
- name change to Water Meter Compliance Tool to better reflect the two Power BI dashboards reports within this tool and the broader business application.

The Water Meter Compliance Tool released in early March 2024 is DRDMW's first regulatory tool. DRDMW will continue to invest and leverage funding opportunities to continue to create new regulatory tools to benefit compliance staff in supporting the monitoring of the laws that govern how water resources are accessed and used.

NRAR in collaboration with external suppliers have developed enhanced satellite remote sensing tools used by the irrigation community (IrriSAT) and NRAR (Extractor).

Tractix report – During inception, the HNRS Compliance Tools Options Paper (also known as Tractix Report) was developed focusing on identifying available compliance tools and datasets to assist NSW with improving water balance and floodplain harvesting assessment tools at a range of water scales. This report relates to NSW's P4 stream of deliverables which focuses on the availability and capability of new and existing compliance tools and foundational datasets to improve water balance and floodplain harvesting assessment tools at a range of water scales. This Options Paper was an initial step in the P4 compliance tools and foundational datasets improvement process and assisted with decision making of investment in future design deployment and operationalisation of compliance tools to improve compliance outcomes.

Extractor uplift – Extractor is an interactive, web-based, farm-scale water balance tool. The tool integrates Sentinel imagery, BoM/SILO[8] climate, cadastral, water licensing and water accounting data to estimate monthly crop evapotranspiration and On-Farm Storage (OFS) dam volume changes. It then probabilistically estimates a likelihood of non-compliance where metered water take on a farm is substantially less than satellite estimates of water take.

The tool enables NRAR staff to input property boundary and metered water take information across large 'project areas' such as Water Sharing Plans, to enable a comparison between satellite estimates of irrigated crop water requirements versus metered water take volumes at a per-property scale. The tool enables NRAR compliance officers to simultaneously analyse large numbers of properties in any project area and detect any properties that appear to have anomalously low metered water take volumes with regard to their irrigated cropping areas, crop water requirements and climatic conditions (rainfall, evaporation etc) experienced at the property. Detection of such anomalies would trigger further desktop, and if required, field investigations by NRAR staff.

IrriSAT uplift – A widely used, and publicly available irrigation decision support tool (IrriSAT) was updated to the latest Python code to help ensure its long-standing public availability, together with

[8] SILO refers to a comprehensive database of Australian climate data, managed by the Queensland Government.

enhancement of features for irrigators, agronomists and NRAR compliance officers to better estimate crop irrigation water requirements and irrigation scheduling.

The enhanced IrriSAT tool can be applied by any person or organization to any cropping area in Australia and is reliant only on publicly available information. Version 2 of IrriSAT featuring the upgraded Python code as supported by NRAR's HNRS initiative is publicly available for use at https://www.irrisat.app/.

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