Melbourne Waterway Research-Practice Partnership 2023-2028

Draft Project Proposals

Year 1: August 2023

THE UNIVERSITY OF MELBOURNE

www.mwrpp.org

Melbourne Water

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Intent of this Document

To provide a summary of potential research projects for year 1 of the Waterways Research-Practice Partnership Round 3 2023-2028 (MWRPP), including their purpose and specific benefits to Melbourne Water.

- **Table 1:** outlines projects that are fully funded by the core research agreement between Melbourne Water (through the Research and Modelling team) and The University of Melbourne.
- **Table 2:** outlines research projects that can be partly funded through the core research agreement, although additional funding from Melbourne Water is needed for them to proceed as described.

These projects complement other research collaborations through the Waterways and Wetlands Research portfolio (**Figure 1**) and are based on Key Research Areas and project needs identified by Melbourne Water and our stakeholders during the development of the Healthy Waterways Strategy 2018 and the recent mid-term review. The MWRPP 2023-2028 research projects were initially prioritised by 24 Melbourne Water representatives from across the business during a planning workshop held in June 2023, and then subsequent email feedback from 26 individuals or teams on the project shortlist, and finally meetings with interested staff to help shape the proposals (**Appendix 1**).

We are seeking broader feedback from the business regarding:

1) Projects that you think are especially important to your team (including whether you would like to nominate a representative to be on a research project team involving 2-3 meetings a year)
2) How project outputs are likely to be used by your team (this will help us refine the proposed milestones, outputs and knowledge adoption opportunities)
3) General comments on the clarity of proposals, including stated objectives, rationale, overview of methods and deliverables
4) Did we miss anything that you think is critical? (this will help with future research planning)

Based on feedback and co-funding support from various teams, the proposals for Year 1 of the Partnership will be finalised and presented to the MWRPP Research Management Committee (RMC) for approval in September 2023. The Partnership has a dedicated Knowledge Exchange and Impact Framework that will work towards efficient integration of research findings into Melbourne Water business. Included in this document is background information on the MWRPP, namely the aims, governance and knowledge exchange (**Appendix 2**).

A summary of each project is provided below, with full project proposals provided in the *Melbourne Waterway Research-Practice Partnership 2023-2028 Year 1 Project Proposals - Supporting Document*.

Figure 1: Waterways and Wetlands Research Portfolio Partnerships, Lead Research Partners and Current Projects

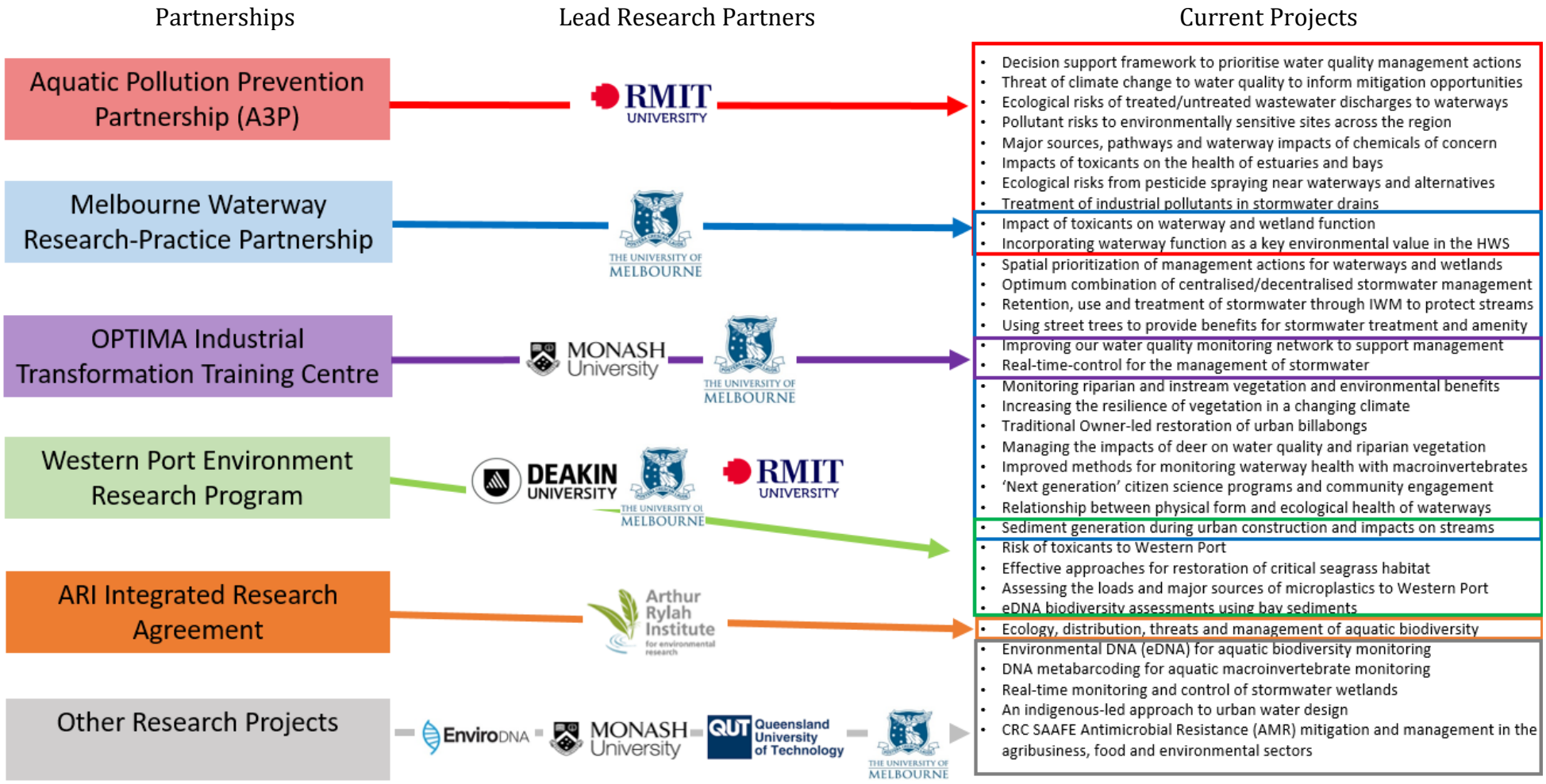


Table 1: Melbourne Waterways Research-Practice Partnership Summary of Projects that are Fully Funded for Year 1

Title	Objective(s)	Expected Impact	Strategic Goal Alignment	Proposed Duration
Scaled Stormwater Management: Exploring the optimum combination of centralised and decentralised approaches to stormwater management	Investigate optimum combinations of centralised and decentralised approaches to stormwater management to achieve Healthy Waterways Strategy stormwater performance objectives, including stormwater harvesting and infiltration, as well as the protection of headwater streams.	Increased ability of Melbourne Water teams to utilise different SCM scenarios in the planning process, and improved decision-making on when and where to implement actions to protect headwater stream in urbanizing areas.	Keeping the Core Strong, IWM	2023-24
Real Time Control: Application of real-time-control technology to the management of stormwater	Test and develop applications of real-time control (RTC) technology to the management of urban stormwater, enhancing Melbourne Water's ability to protect waterways and deliver more sustainable and liveable urban landscapes under urban growth and climate change.	An improved understanding of the potential for application of RTC to support the management of stream health and performance of constructed wetlands.	IWM, Decarbonisation and Climate Change	2023-28
Modelling Waterways & Wetlands: Development and application of stream and wetlands habitat suitability models to support Healthy Waterways Strategy planning	Combine best-available biological and spatial data to continuously improve models, tools and capabilities to support defensible, cost-effective prioritisation of management actions for waterways and wetlands taking into account future threats and risks to support the development and review of the Healthy Waterways Strategy.	Improved capability for: i) modelling the impacts to habitat suitability of climate and land cover change scenarios and their interactive effects; and ii) quantifying the difference made by management actions.	Keeping the Core Strong, Managing and Governing	2023-28
Deer Management: Assessment of deer control effectiveness at the Cardinia, Silvan and Upper Yarra water supply reservoirs	Assess the effectiveness of deer control to reduce the risks of faecal contamination of water supplies and impacts on vegetation; assess the accuracy of density estimates by comparison with known number of deer removed from fenced catchments during the control program; and improve understanding of the associations between deer density and indices of deer abundance and vegetation impacts to inform effective deer management by Melbourne Water.	Capacity for Melbourne Water to develop and implement improved deer eradication and control programs.	Keeping the Core Strong	2023-26
Billabongs (Traditional Owners): Traditional Owner-led restoration of urban billabongs	Led by Wurundjeri Woi-wurrung, this project aims to demonstrate the importance and efficacy of TO-led wetland management and restoration of remnant billabongs, including environmental watering regimes, along the urbanised lower Birrarung (Yarra River).	Enhanced i) ability for Melbourne Water teams to manage billabongs, through the use of flooding and cultural burns; and ii) participation and leadership by Wurundjeri in management.	Walk Country Together, Keeping the Core Strong	2023-27
Climate Impacts & Vegetation: Approaches to increasing the resilience of vegetation in a changing climate	Clarify and consolidate lessons on climate impacts on remnant vegetation, revegetation and invasive weeds and their management from recent research; exploring how this knowledge relates to planning and delivery of revegetation programs and articulate the limitations and opportunities for implementing climate resilient practices in the short-term.	Improved understanding of the impact of provenance on long-term revegetation success, leading to more appropriate selection of climate adjusted seed/plant genetics	Decarbonisation and Climate Change	2023-25
DNA Barcoding: Improving stream management using ecological modelling and DNA barcoding	Develop robust DNA barcoding methods and DNA reference barcode library to enable routine species-level macroinvertebrate identification; build knowledge of species-level macroinvertebrate distributions, environmental habitats, and responses to human activities; and better quantify and track macroinvertebrate species losses or gains in response to pressures or mitigation actions.	Improved understanding of: i) high macroinvertebrate biodiversity areas/hotspots (and the converse) and ii) candidate management actions and determinants of where they can be applied.	Keeping the Core Strong	2023-25

Monitoring Water Quality: Review and refining our long-term water quality monitoring network to support waterway management under a changing climate	Review the suitability of the water quality network to meet Melbourne Water's current and expected future needs, and optimise future data collection through site selection and integration of a range of sampling methods and measurement frequency.	Support development of HWS targets for waterways water quality and improved targeting of management intervention programs.	Keeping the Core Strong, Decarbonisation and Climate Change	2023-28
Citizen Science: The impacts of 'next generation' citizen science programs	Improve Melbourne Water's understanding of how the transition to digital platforms for volunteer environmental monitoring influences the participation and retention of volunteers.	Improved volunteer programs, that i) better cater for the desired experiences of volunteers, and ii) ensure MW receives high value data.	Keeping the Core Strong	2023-24
Street Trees: Irrigating the urban forest with stormwater	Understand whether streetscapes can be designed to promote infiltration of stormwater and achieve the dual benefits of protecting urban streams and increasing canopy cover.	Better design and construction of passive irrigation systems, that result in improved performance and stormwater management outcomes.	IWM	2023-28

Table 2: Melbourne Waterways Research-Practice Partnership Summary of Projects that Require Additional Funding for Year 1

Title	Objective(s)	Expected Impacts	Strategic Goal Alignment	Proposed Duration
Sunbury & headwaters: Protecting Sunbury streams and headwaters from urbanisation	Evaluating the waterway health benefits of the Sunbury IWM project; development of conceptual models of headwater stream ecosystem structure and function; and identification of the key drivers and mechanisms of headwater stream degradation.	Clarification of the critical assumptions in the HWS MERI on the benefits of higher levels of stormwater treatment during/for urban development, which will Inform policy and standards for stormwater treatment in new urban developments.	Keeping the Core Strong, IWM	2023-26
Vegetation Values: Monitoring riparian and instream vegetation condition, extent and benefits for environmental values	Assess changes in the condition and extent of remnant vegetation and revegetation; better understand factors that influence vegetation management outcomes; identify how key environmental values benefit from revegetated and remnant habitats; and improve our understanding of instream vegetation distribution and its correlation with environmental factors.	Improved monitoring and assessment of riparian and instream vegetation, that will lead to improved tracking of progress towards HWS vegetation targets.	Keeping the Core Strong	2023-28
Waterway Functional Indicators: Developing methods, metrics and strategic management frameworks for waterway function as a key environmental value	How best to monitor, report, and manage waterway function as an environmental value for the next Healthy Waterways Strategy.	Greater understanding of the importance of both waterway function and structure and how functional indicator(s) relate to environmental conditions, other values, and management actions methods.	Keeping the Core Strong	2023-28
Physical Form: Investigating the relationship between physical form and ecological health of waterways	Understand how channel morphology influences ecosystem structure and functioning, what aspects of physical form are most important and how they can be quantified or measured to inform the next Healthy Waterways Strategy.	Adoption of new methods for measuring aspects of physical form, with revised metrics being adopted for the next HWS.	Keeping the Core Strong	2023-28
Sediment dynamics: Major sources and fate of sediments in streams, wetlands, estuaries and bays to inform management opportunities	Improve models of urban, peri-urban and rural sediment budgets and to inform plans and strategies to decrease sediment loads to receiving waters, with a focus on urban construction in the Westernport catchment.	Updated sediment budget and conceptual model, leading to more effective sediment control measures and sediment management planning.	Keeping the Core Strong	2023-25

Scaled Stormwater: Exploring the optimum combination of centralised and decentralised approaches to stormwater management

Objective(s)

To investigate optimum combinations of centralised and decentralised approaches to stormwater management to achieve Healthy Waterways Strategy (HWS) stormwater performance objectives, including stormwater harvesting and infiltration, and protection of headwater streams.

Why this research is important

In recognition of the negative impact that conventional stormwater management has on waterway health, stormwater harvesting and infiltration targets have been developed in the HWS to manage excess volumes of stormwater generated by urbanization. This research will provide a clearer understanding of what combinations of stormwater interventions could be implemented at a range of scales and for a given set of development density, rainfall, and soil conditions, as well as the trade-offs in terms of cost, land-take and management responsibilities. This will help Melbourne Water and its stakeholders improve stormwater management by supporting planning and decision making to achieve the HWS stormwater harvesting and infiltration objectives. Specifically, the project aims to:

- Understand what type of stormwater interventions are required to achieve the HWS harvesting and infiltration targets;
- Understand what stormwater interventions are required to protect headwater streams in urbanizing areas; and
- Support evidence-based decision making around what stormwater interventions could and should be applied, and where.

Contribution to Melbourne Water research priorities

- SW13 Identification of effective measures for the protection of streams in newly urbanised areas, including the relative benefits of catchment-scale harvesting and the protection of small headwater streams.
- SW11 Understand the social and ecological costs and benefits of distributed versus centralised stormwater treatment assets in urban landscapes.

Approach

Four research components are proposed for year one:

- Optimizing the selection and location of SCMs to achieve stormwater harvesting and infiltration targets; through a review of previous MWRPP research and knowledge gap analysis.
- Development of tools and principles for protecting headwater streams in urbanizing areas; through the collaboration of an international working group.
- Development of concept designs for protecting headwater streams in urbanizing areas with a case study co-design workshop (Aitken Creek).
- Knowledge transfer on previous efforts to restore the health of urban streams by way of stormwater management (Little Stringybark and Dobsons Creek projects); through a series of practitioner-focused communications.

Key Outputs

- Synthesis report on stormwater management.
- Interactive visualisation tool: scaled stormwater management for stream protection
- Journal paper: Tools and principles for protecting headwater streams
- Technical Report: Concept designs for protecting headwater streams from urbanization using Aitken Creek as a case study
- Synthesis report: Little Stringybark Creek and Dobsons Creek projects.

Expected benefits

- Knowledge and resources relating to the possible combinations of SCMs that can achieve stream protection under a range of rainfall, soil and development densities.
- Resources that inform decision-making on when and where to implement actions to protect headwater streams in urbanizing areas.
- Clearly articulated outcomes of dispersed, whole-of-catchment intervention projects, detailing the successes and shortcomings, and practical recommendations to inform the design of future stormwater interventions.

Project team

University Of Melbourne: Belinda Hatt, Moss Imberger, Matt Burns, Tim Fletcher, Yung En Chee.
Melbourne Water: TBC.

For more information, contact Belinda Hatt, Belinda.Hatt@melbournewater.com.au, or see the full project proposal in the prospectus supporting document.

Real-Time Control: Application of real-time-control technology to the management of stormwater

Objective(s)

To test and develop applications of real-time control (RTC) technology to the management of urban stormwater, enhancing Melbourne Water's ability to protect waterways and deliver more sustainable and liveable urban landscapes under a changing climate

Why this research is important

The advent of real-time control technology has been well-documented over the last few years, along with its potential to improve the management of urban stormwater. This potentially covers everything from improving the performance of individual stormwater control measures, through to creation of new smart networks, allowing a whole range of 'new actors' to participate in the management of the urban water cycle. However, simply 'imagining' such a future will not deliver it. There is a need to undertake rigorous testing of the performance of RTC to deliver improved performance of assets. Even more ambitiously, there is need to create and test (in the real-world), new business models and approaches that exploit the capability of RTC to facilitate contributions to individuals.

Contribution to Melbourne Water research priorities

- **MWRPP-3 (H10, H11, SW5, SW6, SW14, SW15):** Real-time monitoring and control of Water Sensitive Urban Design (WSUD) assets for multiple benefits
- **MWRPP-11 (H5, H6):** Better understanding of relationship between hydrology and key environmental values to help set environmental flow objectives
- **MWRPP-18 (S4):** Effective engagement with the general public in 'catchment thinking' to inform waterway management activities (though Monbulk Creek and Smart Rainwater Grid components)
- **MWRPP-14 (SW2, SW8, SW16):** Understanding and managing the threat of urban stormwater to waterway health under a changing climate.

Approach

The project is made up of three components, each funded through existing Australian Research Council (ARC) projects for which Melbourne Water is an industry partner:

Activating lazy stormwater wetlands through real time monitoring & control. Aiming to activate stormwater wetlands (Troups Creek West) using real time monitoring and control strategies, delivering improved hydrological and treatment performance to deliver improved social and ecological outcomes.

Can real-time control deliver environmental flows to protect urban streams? Exploring the potential of real-time control technology to deliver environmental flows to protect urban streams from climate change and stormwater (Monbulk Creek Smart Water Network).

Making optimal use of stormwater in cities: a market-driven smart-grid. Exploring how a smart-grid network could enable consumers to reduce their water demand as well as incentivising the release of water to drought-affected streams, and mitigating flood-risk by drawing down water storages prior to large storms (Monbulk Creek Smart Water Network).

Key Outputs

- Foundational knowledge, delivered through a series of reports, journal publications, fact sheets and seminars, on the potential for RTC to support the management of stormwater
- Expert input to Melbourne Water where there are opportunities to improve waterway and stormwater management through use of RTC

Expected benefits

- Understanding of how a real-time controlled network of rainwater tanks and large online storages can be used to optimize stream flow.
- Knowledge on how to improve wetland quality treatment performance of stormwater wetlands, by optimizing their maintenance and operation.
- Knowledge of the potential of a Smart Rainwater Grid – where rainwater tank owners would be financially rewarded for their contributions to alleviation of flood risk and supply of environmental flows.

Project teams

Stakeholders for this project include: University Of Melbourne, Melbourne Water, Service Programs, Service Enablement, South East Water, Yarra Ranges Council, Monash University / QUT & DEECA.

For more information, contact Tim Fletcher, Tim Fletcher, timf@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Sunbury & Headwaters: Protecting Sunbury streams and headwaters from urbanisation

Objective(s)

This project will contribute to: i) testing if stormwater runoff can be adequately retained, used and treated to protect stream ecosystem structure and function as part of the Sunbury IWM project; ii) the development of key conceptual models of headwater stream ecosystem structure and function; and iii) identification of the key drivers and mechanisms of headwater stream degradation.

Why this research is important

Distributed harvesting, infiltration and treatment of urban stormwater close to source and across large spatial scales for the purposes of stream protection is a central tenet of the HWS. Up until now, however, there has been no demonstration project that clearly illustrates this is possible in the context of urbanizing areas. The Sunbury IWM project and its associated monitoring program is a critical demonstration project that is expected to provide a strong and defensible case for the continued application of IWM approaches for new developments both in stormwater priority areas and across the MW management region more broadly.

Headwater streams make large contributions to regional biodiversity and provide the dominant source of water, sediment, and organic matter, and are critical filters of inflows. Despite their importance, research is lacking on the mechanisms and fates of headwater streams, particularly in urbanizing areas. There is insufficient understanding of key fundamental processes, how they vary in response to climatic and geographic variability and how they respond to the application of current approaches to stormwater control and other land-use management practices. This lack of understanding places their protection at risk, because it means that Melbourne Water and its stakeholders are currently unable to demonstrate how and if, headwater streams can be protected in the face of urban development.

Contribution to Melbourne Water research priorities

- MWRPP 10 (SW7, SW11, SW12, SW13, SW17) Optimum combination of centralised and decentralised stormwater control measures (SCMs) to achieve Healthy Waterways Strategy stormwater harvesting and infiltration targets and protect headwater streams.
- MWRPP 11 (H5, H6) Better understanding of relationship between hydrology and key environmental values to help set environmental flow objectives

Approach

The project will be delivered as two sub-components:

- For the **Sunbury IWM Project**: i) continuation of the monitoring program, including water quality, hydrological and biological data; and ii) commencement of geomorphic surveys, to identify stream erosion thresholds.
- Continuation of the **Headwater Stream Monitoring** program (established in the previous round of the partnership), as well as the analysis and publication of existing data.

Key Outputs

- Publication(s) on the effects of land-use change on headwater stream ecosystem structure, function and hydrology.
- Publication(s) on the effects of large scale distributed SCMs on the protection of headwater stream ecosystem structure, function and hydrology.
- Publication(s) and internal reports on the interpretation of indicators of ecosystem function.

Expected benefits

- Support the preparation of Drainage Schemes and Precinct Structure Plans, and to communicate objectives to developers.
- Support the identification of solutions to achieve HWS stormwater targets.
- Provide proof of concept of how Sunbury IWM stormwater harvesting has benefited waterways.
- Facilitate the selection and interpretation of functional indicators for inclusion in the next HWS.

Project team

University Of Melbourne: Moss Imberger, Ryan Burrows, Mathew Burns, Gen Hehir, Peter Poelsma, Claudia Nicklason. Melbourne Water: TBC.

For more information, contact Moss Imberger, Moss Imberger, moss.imberger@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Modelling Waterways & Wetlands: Development and application of stream and wetlands habitat suitability models (HSMs) to support Healthy Waterways Strategy planning

Objective(s)

To combine best-available biological and spatial data to continuously improve models, tools and capabilities to support defensible, cost-effective prioritisation of management actions for waterways and wetlands taking into account future threats and risks to support the development and review of the Healthy Waterways Strategy

Why this research is important

Accurate spatial datasets of stream networks and waterbodies previously developed or improved by the MWRPP provide critical data for mapping, visualisation and performance reporting at multiple levels of aggregation. Environmental data libraries associated with stream networks and waterbodies spatial data provide a rich set of utility and environmental descriptors which are an ongoing research and management resource with multiple uses.
These data can be used to develop a range of tools such as HSMs and to drive applications such as formulating management actions, designing scenarios of interest, and action prioritisation to guide Healthy Waterways Strategy planning and target-setting.
These tools and capabilities support continuous improvement of HWS implementation by providing an advisory and critical review role in the MERI Framework and the Rivers, Wetlands and Estuaries Monitoring and Evaluation Plans (MEPs).They also support strategic activities such as HWS Mid-term Evaluation and forthcoming activities such as MW's Pricing Submission to the Essential Services Commission (~2026).

Contribution to Melbourne Water research priorities

- MWRPP-8 (W1, W2, W5): Models and decision support tools to model the status of waterway and wetland environmental values, explore threats and likely future conditions & prioritise management interventions most likely to protect or improve waterway and wetland values
- MWRPP-13 (W6, W7, W11): Managing the impacts of climate change on the health of estuaries and wetlands
- MWRPP-15 (B7): Impacts of barriers to the dispersal of key environmental values across the landscape

Approach

This research provides, maintains and improves foundational data, which in turn enables the development of models, tools and applications that support high-resolution scenario exploration, strategic action planning and prioritization, and reporting. Foundational data includes both biological (macroinvertebrates, native fish, platypus, frogs and wetland-dependent birds) and spatial information (e.g. updated stream network layer, waterbodies layer and associated environmental data libraries). The tools and applications will cover: planning support for environmental value monitoring programs, HSMs, scenario analyses and management action prioritisation analyses.

Key Outputs

- Macroinvertebrate database maintenance
- HWS 2018 stream network + Data Library; Updated stream network + Data Library and Waterbodies spatial data + Data Library
- HSMs for instream and wetland-dependent environmental values
- Potential management actions, associated costs, and spatial variation in costs.
- Action prioritisation analyses using Zonation.

Expected benefits

- Ability to predict habitat suitability of instream and wetland biota in streams and wetlands throughout the region
- Better understanding of candidate management actions and determinants of where they are likely to be suitable/not suitable to apply
- Identification of most cost-effective action at stream reaches or wetlands at landscape scale.
- Ability to explore management options of strategic concern from the perspective of stream or wetland biota habitat suitability, urban growth and climate change.

Project team

University Of Melbourne: Yung En Chee, Chris Walsh, Ryan Burrows. La Trobe University: Michael Shackleton, Nick Bond. Melbourne Water: TBC. Parks Vic: TBC. Other: TBC.

For more information, contact Yung En Chee, Yung En Chee, yechee@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Deer: Assessment of deer control effectiveness at the Cardinia, Silvan and Upper Yarra water supply reservoirs

Objective(s)

To: 1) assess the effectiveness of deer control to reduce the risks of faecal contamination of water supplies and impacts on vegetation; 2) assess the accuracy of density estimates by comparison with known number of deer removed from fenced catchments during the control program; and 3) improve understanding of the associations between deer density and indices of deer abundance and vegetation impacts to inform effective deer management by Melbourne Water.

Why this research is important

Deer present a high risk of introducing pathogens to Melbourne's drinking water supply by faecal contamination, and cause significant impacts to native vegetation within catchments managed by Melbourne Water. Melbourne Water aim to eradicate deer from the fenced water storages at Cardinia and Silvan and reduce deer density within the unfenced Upper Yarra water supply catchment over the next 5 years.

Deer abundance and density is currently estimated in Melbourne Water catchments primarily using two methods: detections of deer from camera traps that provide both a density estimate and an index of abundance; and counts of deer faecal pellets along transects, which provides an index of abundance that is assumed to be approximately linearly associated with true density. However, the relationship between true density and indices of deer abundance and impact have not been examined in south-eastern Australia. The eradication programs planned for the fenced Cardinia and Silvan catchments provide a rare opportunity to assess the accuracy of density estimates with the total number of known animals within the population (number culled) and improve our understanding of the relationships between density and indices of abundance and impact.

Contribution to Melbourne Water research priorities

- MWRPP_5 (RV7, RV9): Methods for the effective management of key invasive plants and animals to reduce their impact on instream and riparian vegetation communities.

Approach

This project will be delivered though 4 tasks:

- Task 1. Deer abundance-vegetation impacts surveys at Cardinia, Silvan and Upper Yarra
- Task 2. Maintaining camera trap sites in the Upper Yarra
- Task 3. Processing of camera trap images
- Task 4. Analyses and reporting on effectiveness of deer control program

Key Outputs

- Report on the assessment of the effectiveness of deer control at Cardinia, Silvan and Upper Yarra
- Assessment and report on the accuracy of density estimates by comparison with known number of deer removed from fenced catchments during the control program.

Expected benefits

- Knowledge that will inform adaptive management of deer control program as part of the Silvan System Deer Management Plan to a) reduce risk to water supplies, and b) reduce impacts to riparian vegetation.
- Identification of thresholds to inform effective deer management by Melbourne Water to manage risks to water supply and impacts to native vegetation in unfenced catchments such as the Upper Yarra.
- Improved understanding of the associations between deer density and indices of deer abundance and vegetation impacts.
- Validation of appropriate deer density estimation methods to improve Melbourne Water's ability to manage the threat posed by deer more broadly.

Project team

University of Melbourne: Ami Bennett, Joe Greet.
Melbourne Water: TBC. Parks Vic: TBC. DEECA: TBC.

For more information, contact Ami Bennett, bea@unimelb.edu.au , or see the full project proposal in the prospectus supporting document.

Billabongs: Traditional Owner-led restoration of urban billabongs

Objective(s)

Led by Traditional Owners (TOs; Wurundjeri Woi-wurrung), in collaboration with University of Melbourne researchers and waterway manager Melbourne Water, this project aims to demonstrate the importance and efficacy of TO-led wetland management and restoration of remnant riverine wetlands (billabongs) along the urbanised lower Birrarung (Yarra River).

Why this research is important

Rivers and wetlands have long been critical to human societies and hold significant cultural and ecological value. Despite their critical role in sustaining healthy societies and ecosystems, rivers and wetlands are some of the most degraded ecosystems globally. More than half of the world's wetlands have been lost due to draining and conversion for agriculture or urban development over the past two centuries, and wetland loss is a major contributor to the current global 'extinction crisis'.

First Nations peoples' knowledge of wetland ecosystems stems from managing and identifying with their land and waterscapes for millennia. In recent decades, the value of including First Nations people and their knowledge in research and management of wetland ecosystems has increasingly been recognized. Despite this recognition, the inclusion of Indigenous knowledge and Traditional Owners in the scientific investigation and management of freshwater environments in Australia remains limited, particularly in urban contexts.

Contribution to Melbourne Water research priorities

- MWRPP_1: Understanding Traditional Owner priorities for waterway protection and improvement across the region

The project also strongly aligns with HWS Regional Performance Objectives that:

- Traditional Owners and Aboriginal Victorians have an increased expertise in contemporary land and waterway management (RPO-1)
- Partnerships are fostered between Traditional Owner groups and research groups (RPO-6)

Approach

Three complementary research approaches underpin this project, and will facilitate the development of a framework for the future management and care of culturally and ecologically significant wetlands that is grounded in Indigenous knowledge and supported by empirical data:

1. Determine the historical changes in fires, floods and vegetation of billabongs of the lower Birrarung through sediment core analyses of charcoal, sediments, and pollen (e.g. analyses at Bolin Bolin).
2. Determine billabong vegetation, faunal and water quality responses to cultural burns and wetting and drying through TO-led monitoring and assessment programs (including field-based surveys, eDNA analyses and water quality monitoring).
3. TO-led development of restoration and sustainable management guidelines for culturally and ecologically significant urban wetlands.

Key Outputs

- Wurundjeri-led billabong management guidelines.
- Better understanding of appropriate land (fire) and water (environmental watering) management of urban billabongs.

Expected benefits

- This project will provide an important case study for Melbourne Water and other natural resource agencies on working effectively with TOs to improve environmental and cultural outcomes in wetland management.
- Capacity-building of Narrap Rangers to integrate both scientific and Indigenous ways of knowing and apply this knowledge to the management of urban wetlands.

Project team

University Of Melbourne: Joe Greet, Michael-Shawn Fletcher. Melbourne Water: Sarah Gaskill, Rhys Coleman. Wurundjeri Woi-wurrung Aboriginal Cultural Heritage Aboriginal Corporation: Delta Freedman, Rephael Lankri, Uncle Sean Hunter, Narrap Rangers.

For more information, contact Joe Greet, Joe Greet, greetj@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Vegetation Values: Monitoring riparian and instream vegetation condition, extent and benefits for environmental values

Objective(s)

To: i) assess changes in condition and extent of remnant vegetation and revegetation; ii) better understand factors that influence vegetation management outcomes; iii) identify how key values benefit from revegetated and remnant habitats; and iv) improve understanding of instream vegetation distribution and associated environmental factors.

Why this research is important

Vegetation management and revegetation are key activities that Melbourne Water undertakes to maintain and/or improve riparian and waterway habitat. In the HWS MERI framework and HWS mid-term review, several key evaluation questions (KEQs) focus on maintaining, managing and restoring vegetation along waterways. Understanding what vegetation management activities deliver in practice and the benefits for environmental values are critical questions. Assessing vegetation condition and extent, the effectiveness of revegetation outcomes, how these outcomes influence faunal values, and a better understanding of instream vegetation is vital to manage vegetation more effectively as a key value and the biodiversity it supports.

Contribution to Melbourne Water research priorities

- MWRPP-4 (RV3): Measuring changes in waterway vegetation condition and extent across the region using remote sensing methods.
- MWRPP-2 (B3, B4, RV11): Investigating streamside and instream habitat restoration activities and outcomes for key environmental values.
- MWRPP-9 (RV1, RV5, RV14, RV15): Opportunities to incorporate instream vegetation into future Healthy Waterways Strategies.

Approach

This project consists of three work programs: *Assessing remnant vegetation and revegetation condition and extent*. Will explore the use of aerial and satellite imagery and data for vegetation condition modelling and monitoring; as well as vegetation extent and change.

Monitoring and evaluation of vegetation restoration effectiveness and fauna use. Will analyse and report on Melbourne Water's Riparian Outcomes Monitoring Program (ROMP) data and explore the ability of the Melbourne Water WAVE tool to use Nearmap images and AI to estimate plant numbers and vegetation cover.

Instream vegetation. Will conduct extensive surveys of instream vegetation and develop a better understanding the drivers of instream vegetation presence.

Key Outputs

- Report on how Nearmap AI data pack products can be used to quantify vegetation extent and change in extent
- Report on the analysis of ROMP-monitored sites to date and a report of findings on how sites are changing over time
- Report on instream vegetation survey methods tested and where possible used to update Melbourne Water's Veg Visions, ROMP and Detailed Vegetation monitoring data collection methods

Expected benefits

- Ability to track regional-wide changes in vegetation condition and change over time to complement field data collection and help track progress towards HWS vegetation targets.
- Ability to better understand and communicate the factors that influence instream vegetation and describe potential management opportunities for inclusion of instream vegetation as a value in the next HWS.
- Better understanding of the use of revegetated areas by bird species and communities.

Project team

University Of Melbourne: Sacha Jellinek, Yung En Chee, Joe Greet, Scott McKendrick, Kathy Russell. Melbourne Water: TBC. Arthur Rylah Institute: Chris Jones, Matt White. RMIT: Mariela Soto-Berelov, Simon Jones, Sam Hislop. Birdlife Australia: Kerryn Herman, Darren Quin.

For more information, contact Sacha Jellinek, sachamj@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Climate Impacts & Vegetation: Approaches to increasing the resilience of vegetation in a changing climate

Objective(s)

To clarify and consolidate lessons on climate impacts on remnant vegetation, revegetation and invasive weeds and their management from recent research; exploring how this knowledge relates to planning and delivery of revegetation programs and articulate the limitations and opportunities for implementing climate resilient practices in the short-term.

Why this research is important

Vegetation management and revegetation are key activities of Melbourne Water for the maintenance and/or improvement of riparian and waterway habitat and condition. Climate change is a major threat to native vegetation and a challenge for its ongoing management. Updated climate change projections have revealed that we have likely underestimated long-term predicted impacts to environmental conditions and values. To deal with these risks requires strategies that can foster remnant vegetation and revegetation resilience to the range of climate and compound impacts.

Contribution to Melbourne Water research priorities

- MWRPP-12 (RV4, RV6, RV8): Managing the impacts of climate change on remnant vegetation, revegetation and weeds.

Approach

This project will commence with a synthesis of the relevant climate impacts and vegetation climate resilient management frameworks and guidelines that have been undertaken by Melbourne Water and other agencies/research institutions. The synthesis may explore issues relating to: problem frames and statements; proposed strategies/management options; knowledge needs and gaps for decision making; and current opportunities and constraints. Additionally, the project will explore how the genomic and climatic data and resources of the Research Centre for Ecosystem Resilience (ReCER - Royal Botanical Gardens, Sydney) could be helpful for Melbourne Water knowledge, decision making and practitioner needs.

The project will also work with Melbourne Water to better understand where climate adjusted plantings are being undertaken (e.g. Dandenong Climate Future Plots), and opportunities to establish and assess these areas in the future.

Key outputs

- Synthesis report on the relevant climate impacts and climate resilient revegetation practices and tools, and identifying critical constraints and opportunities that could be the focus of management efforts or future research by the Partnership.
- A workplan to work with the Research Centre for Ecosystem Resilience (ReCER - Royal Botanical Gardens, Sydney) to build on their genomic and climatic data and resources for Melbourne Water needs and applications.

Expected benefits

- Overview of the different options, and the viability of these options that Melbourne Water could undertake to manage vegetation under a changing climate.
- Information to support updates to Melbourne Water revegetation guidelines.
- Identify how plant genetics provide resilience for revegetated and remnant areas. Open access tools to help managers design and plan climate resilient revegetation (e.g. Restore and Renew website).

Project team

University Of Melbourne: Sacha Jellinek, Yung En Chee, Chris Szota. Melbourne Water: TBC. Royal Botanic Gardens, Sydney: Maurizio Rossetto.

For more information, contact Sacha Jellinek, sachamj@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Waterway Functional Indicators: Developing methods, metrics and strategic management frameworks for waterway function as a key environmental value

Objective(s)

How best to monitor, report, and manage waterway function as an environmental value for the next Healthy Waterways Strategy.

Why this research is important

A healthy waterway is one that maintains its ecological structure (what is in an ecosystem) and function (what happens in an ecosystem) over time. However, Melbourne Water only assesses changes to, and prioritises management actions for, ecosystem structure. Only a broader program that monitors and assesses ecosystem function alongside ecosystem structure will holistically characterise and evaluate changes to waterway health. What remains a challenge is not the development of suitable methods but their application in waterway monitoring programs and strategic management frameworks. Of particular importance will be (a) selecting functional indicators that perform well at the required spatial and temporal scale, (b) identifying reference or benchmark values that should be used, and (c) understanding what constitutes a significant change in response to changing conditions including due to management actions. An understanding of how the chosen functional indicator(s) respond to natural variation and environmental stressors may lead to guidance on how particular actions such as environmental flow delivery can impact ecosystem function and assist with future waterway planning to maximise ecosystem health.

Contribution to Melbourne Water research priorities

- A3P_MWRPP_1 (B1, WQ9): Develop methods, metrics and strategic management frameworks for waterway function as a key environmental value.
- MWRPP_11 (H5, H6): Better understanding of relationship between hydrology and key environmental values to help set environmental flow objectives.
- MWRPP_20 (RV13): Relationship between physical form and ecological health of waterways.

Approach

The research will be delivered according to the overlapping steps below. **Step 1**. Information and data synthesis. Leverage learnings from existing programs and data. **Step 2**. Provisional selection of functional indicators that perform well at the required spatial and temporal scale of assessment and maximise relevance for business activities. **Step 3**. Setting reference or benchmark values for chosen functional indicator(s). Understand how values respond to natural variation and environmental stressors. **Step 4**. Trail the most promising functional indicators in representative streams and rivers. **Step 5**. Integration into next Healthy Waterways Strategy.

Key Outputs

- Waterway functional indicators technical report: concept, methods, and framework for implementation.
- Toolbox of functional indicators relevant for MW assets (Rivers, Wetlands, Estuaries).
- Data management plan so that data produced is appropriately stored/available going forward.
- Conceptual model(s) linking functional indicator(s) with environmental conditions, other values, and management actions.
- Rating scales based on empirical data for the chosen functional indicator(s).
- Scientific paper(s): functional indicators for monitoring and assessment.

Expected benefits

- Greater understanding of the importance of both waterway function and structure
- Methods describing functional indicator(s) for use in the next Healthy Waterways Strategy
- Conceptual understanding of how functional indicator(s) relate to environmental conditions, other values, and management actions

Project team

University Of Melbourne: Ryan Burrows, Moss Imberger, Matthew Burns, Kathryn Russell, Yung En Chee. Melbourne Water: TBC. RMIT: Sara Long, Kathryn Hassell, Jackie Myers, Vincent Pettigrove, Monica Tewman.

For more information, contact Ryan Burrows, ryan.burrows@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Physical Form: Relationship between physical form and ecological health of waterways

Objective(s)

To improve the understanding of how channel morphology influences ecosystem structure and functioning, what aspects of physical form are most important and how they can be quantified or measured for inclusion in the next HWS.

Why this research is important

Melbourne Water manages waterway health across the region, focusing on supporting a range of key values (including environmental and social). These key values are supported by number of waterway conditions, including physical form. Stream physical form that is reasonably stable (e.g. natural rates of erosion) is likely to support higher levels of key values. However, Melbourne Water, like many waterway management agencies across the world, does not yet have an effective way to quantitatively measure or track physical form condition or to set physical form objectives. There is a need for better understanding of physical form responses to pressures and management interventions, as well as the integration of improved metrics, objectives and monitoring methods in the next HWS. This will ultimately help support planning and decision making for physical form protection and rehabilitation and help build the case for proactive interventions.

Contribution to Melbourne Water research priorities

- MWRPP_20 (RV13): Relationship between physical form and ecological health of waterways.

Approach

This project will be delivered via five work programs:

- Predicting channel form disturbance in response to urbanization : PhD project investigating prediction of channel enlargement and simplification due to urbanization (Toomuc Creek).
- Reviewing field-based physical form pilot data: review the pilot dataset and develop recommendations for the next stage of data acquisition.
- Developing metrics and targets for physical form for the HWS: defining key knowledge gaps and plans for integration of new knowledge into the HWS.
- Relating lidar-derived information, field-based physical form data and biological data.
- Quantifying effectiveness of catchment and waterway interventions through a series of industry workshops.

Key outputs

- Literature review on controls on global variation in channel enlargement due to urbanisation.
- Review of physical form field pilot data and recommendations for rollout of a comprehensive physical form monitoring program to support the HWS.
- Technical report detailing recommendations for improved physical form metrics and targets in the next HWS.
- Report on relationships between physical form field and remote-sensing metrics, and between physical form and ecosystem health metrics.

Expected benefits

- Greater understanding of the influence of urbanization on channel form in a system with complex legacies, greater understanding of timeframes of adjustment to urban impacts
- More extensive physical form dataset with strategic spatial coverage to target key knowledge gaps
- Better ways to track and report on long-term trends in physical form across the region, clearer guidance on data acquisition needs, clearer definition of ‘good’ condition in different contexts
- Greater understanding of which aspects of physical form are most important for key values, and which aspects can be measured using remote sensing data

Project team

University Of Melbourne: Kathy Russell, Scott McKendrick, Yung En Chee, Ryan Burrows, Moss Imberger, Lukman Adeboye Soboyejo (PhD student).
Melbourne Water: TBC.

For more information, contact Kathy Russell, kathryn.russell@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Sediment Dynamics: Major sources and fate of sediments in streams, wetlands, estuaries and bays to inform management opportunities

Objective(s)

To improve models of urban, peri-urban and rural sediment budgets and to inform plans and strategies to decrease sediment loads to receiving waters, with a focus on urban construction in the Westernport catchment.

Why this research is important

Western Port is a sensitive environment, containing seagrass beds that are under threat from light attenuation, due to fine sediment inputs from the catchment and coast. A sediment load target was specified to allow sediment to flush from seagrass areas of the bay. Melbourne Water, in partnership with DEECA, is now scoping the need for further planning to achieve that target based on commitments in existing strategies and plans for Westernport. While sediment loads from rural lands and channel erosion are reasonably well-understood, several uncertainties remain around sediment sources in the catchment, including a knowledge gap on sediment liberated by different stages of urban development. There is also a need to better quantify aspects such as bank erosion and sediment deposition/resuspension. These knowledge gaps need to be addressed in order for Melbourne Water to manage sediment loads to Western Port in accordance with the *Environment Protection Act* and HWS.

Contribution to Melbourne Water research priorities

- HWS Key Research Area: Undertake priority research projects identified in the Western Port Environment Science Review and synthesis report
- HWS RPO-17: Water quality in waterways and bays is improved by reducing inputs of sediment and other pollutants from urban construction and development.

Approach

This research consists of a suspended sediment monitoring program and two PhD projects (jointly Lyon University and University of Melbourne).

Suspended sediment monitoring program
A continuation of established sediment monitoring sites in developing catchments, and to provide a valuable long-term dataset that tracks suspended sediment effects of different stages of urban development.

Sediment sources in peri-urban areas (PhD)
Disentangling the variability of sediment sources from different stages of development within the catchments using turbidity monitoring, allowing for the validation and quantification of the conceptual model and targeted management interventions.

Sediment transfer in peri-urban areas (PhD)
Exploring the problem of sediment transfer in peri-urban streams and its interaction with riverbed morphology.

Key outputs

- Technical report: Sediment load monitoring in urbanising areas of the Westernport catchment
- Journal article (in collaboration with RMIT): Sediment and pollutant loads from urbanising areas of Melbourne.

Expected benefits

- Refine capability to model sediment loads from urban construction.
- Better understand the relative risk of specific stages of urban construction versus mature urban estates in terms of sediment loads.
- Support the evaluation of management opportunities to reduce sediment loads from urban construction.
- Improved understanding of the physical and chemical impacts of construction and urbanization.
- New understanding of sediment transfer in peri-urban areas.

Project team

University Of Melbourne: Kathy Russell, Paulo da Silva, Maria Gisi, Peter Poelsma, Rob James, Claudia Nicklason, Darren Bos. Melbourne Water: TBC. RMIT: Claudette Kellar, Vincent Pettigrove, Monica Tewman; CNRS (France) Frederic Cherqui, Oldrich Navratil, Etienne Cossart.

For more information, contact Kathy Russell, kathryn.russell@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

DNA Metabarcoding: Improving stream management using ecological modelling and DNA metabarcoding

Objective(s)

To: i) develop robust DNA barcoding methods and DNA reference barcode library to enable routine *species-level* macroinvertebrate identification as part of Melbourne Water's HWS MERI Framework; ii) build knowledge of *species-level* macroinvertebrate distributions, environmental habitat determinants, and responses to human activities; and iii) better quantify and track macroinvertebrate species losses or gains in response to pressures or mitigation actions.

Why this research is important

Freshwater macroinvertebrates contribute to many ecological processes and functions and are essential to maintaining waterway health and ecosystem services such as water filtration and nutrient cycling. Their diverse ecological roles across multiple trophic levels and varying sensitivity to disturbances make macroinvertebrate assemblages sensitive, informative ecological indicators for biological monitoring of freshwaters. This monitoring function is critical for adaptive management, planning and accountability. This research will generate new *species-level* macroinvertebrate data and a robust DNA reference barcode library for the Port Phillip and Westernport region. These biological datasets will support greater understanding of key values across the region, and bioassessment of stream health and multipurpose reporting. In doing so, this project will improve the ability of Melbourne's waterway managers to monitor and improve stream health and biodiversity by developing a suite of interconnected molecular (DNA), spatial and quantitative tools to provide data-driven, comprehensive, landscape-scale decision support.

Contribution to Melbourne Water research priorities

- MWRPP-8 (W1, W2, W5): Models and decision support tools to model the status of waterway and wetland environmental values, explore threats and likely future conditions and prioritise management interventions most likely to protect or improve waterway and wetland values.

Approach

This is an existing ARC Linkage project being conducted over four years (we are currently in year 3), beginning with site selection and sampling from 400 sites (300 in year 1 and 100 in year 2) and DNA metabarcoding in years 2-3. A trial testing DNA metabarcoding of bulk material was conducted in years 1-2 to inform the sub-sampling approach (laboratory sorting or direct DNA processing of bulk material). DNA metabarcoding will be followed by individual DNA barcoding of new species.

The first modelling will be undertaken at the end of the third year when high-quality species data will be available for 300 sites. Species data for the final 100 sites will be available in year 4, permitting validation and refinement of the models, biodiversity ranking and action prioritisation in year 4, with an increasing focus on publishing project outcomes, knowledge exchange and promoting outputs.

Key outputs

- Standardised sampling method for DNA metabarcoding, a high-quality species dataset for ~400 sites and 600 new macroinvertebrate DNA barcodes to public repositories
- Species-level macroinvertebrate biodiversity priority rank map for Melbourne's waterways
- Development of a suite of interconnected molecular (DNA), spatial and quantitative tools to provide data-driven, comprehensive, landscape-scale decision support

Expected benefits

- Significant advances in understanding of poorly-known freshwater macroinvertebrate species biodiversity and how it is impacted by natural environmental and human impact gradients.
- Improved ability to monitor and improve stream health and biodiversity across the region.
- Characterisation of biodiversity patterns including identification of high biodiversity areas, strongholds for particular species
- Better understanding of candidate management actions and where to apply them.
- Better understanding of detailed cost estimation process for candidate actions and spatial variation of costs for a given action.

Project team

University Of Melbourne: Yung En Chee, Chris Walsh, Melissa Carew, Ary Hoffmann, Tom Wilkins and Gen Hehir. Melbourne Water: TBC.

For more information, contact Yung En Chee, yechee@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Monitoring Water Quality: Review and refining our long-term water quality monitoring network to support waterway management under a changing climate

Objective(s)

This project will review the suitability of the water quality network to meet Melbourne Water's current and expected future needs, and optimise future data collection through site selection and integration of a range of sampling methods and measurement frequency.

Why this research is important

The waterways long-term ambient water quality monitoring network (the network) has been operating since the 1970s to detect long-term trends across the Greater Melbourne region. The network currently monitors physicochemical parameters at 134 sites and draws on a long historical dataset. Since establishment, the design and uses of the network have changed in many ways, as have many contextual factors (such as urbanization growth, agricultural practices and climate). Reviews of the network have confirmed the value of network for management of waterways in the region, but also identified opportunities to significantly increase the benefits to Melbourne Water and stakeholders. These recommendations include undertaking a review of the network's ability to deliver on key goals and develop proposed improvements to redesign the network, which is the purpose of this research project.

Contribution to Melbourne Water research priorities

- A3P_MWRPP_4 (H4) Understanding the threat of climate change to water quality in waterways to inform mitigation opportunities.

Approach

This research will be delivered through a PhD project (Vaughn Grey). It will require a review of international best practices, detailed interrogation of the existing datasets, the collection and analysis of additional waterways water quality samples and/or further modelling where required. Within the overarching intent to design an efficient and effective monitoring program, the network review will describe the advantages and disadvantages of any options that may emerge to alter the cost of delivering the program in the future. More specifically, the project will:

- Interrogate a range of existing datasets (e.g. Model outputs from the Port Phillip and Western Port Source Catchments model)
- Undertake additional sampling as required to support the interrogation and analysis of the existing datasets (e.g. additional high intensity grab sampling)
- Analysis using mathematical techniques and modelling

Key Outputs

- Assessment of water temperature changes across the region over the past 30 years
- Methods to accurately detect trends and site means of stream water temperature using the Melbourne Water long-term water quality monitoring network
- A method to identify reaches or waterways of expected homogenous water quality, and generalization of expected ambient water quality from monitoring sites
- A method to optimize the sampling network to meet multiple needs, including spatial coverage.

Expected benefits

- Identification of management actions to address historical and anticipated future warming of stream temperatures
- Robust methods for interpretation of the data collected from the long-term water quality monitoring network, allowing certainty in interpretation and provision of reliable "water quality products" to key stakeholders
- Development of a method that allow for prediction of "expected water quality" at sites where sampling does not occur.
- Identification of reaches where alteration to the existing monitoring program is required to extend coverage to, and thus support the optimization of the network.
- Development of a robust method to create a strategy for optimization of the sampling regime of the long-term monitoring network.

Project team

University Of Melbourne: Vaughn Grey, Tim Fletcher, Kate Smith-Miles, Darren Bos. Melbourne Water: TBC.

For more information, contact Vaughn Grey, Vaughn Grey, vaughn.grey@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Citizen Science: The impacts of 'next generation' citizen science programs

Objective(s)

This project will improve Melbourne Water's understanding of how the transition to digital platforms for volunteer environmental monitoring influences the participation and retention of volunteers.

Why this research is important

Volunteers are increasingly important to biodiversity and environmental monitoring in Australia, given the urgent need for extensive data sets to inform the management of sites and species. In the last few years, a key trend has been the development and use of smartphones and internet technologies as the interface for data collection and capture, data storage, data analysis and review, and communication with organizers and other participants.

Melbourne Water is currently increasing its commitment to such 'next generation' digitally-mediated citizen science programs. Whilst there has been some research to date that considers how to do this, there has been relatively little research into the impacts of digitalisation on the experiences of volunteer participants in these programs. An understanding of the technologically mediated experiences of citizen scientists can inform the design of citizen science programs and their technological interfaces, as well as strategies for recruiting, supporting and retaining participants.

Contribution to Melbourne Water research priorities

- MWRPP_6: Effective engagement of stakeholders to support Heathy Waterways Strategy objectives
- HWS Key Evaluation Question 4a: To what extent are interventions appropriate and effective for achieving outcomes?
- Regional Performance Objective 37: Participation rates in education, capacity building, incentive programs and citizen science activities have increased and enable greater levels of environmental stewardship for our waterways.

Approach

The ongoing PhD research project employs a case study approach, with detailed and intensive focus on two citizen science programs in Australia: Frog Census (a citizen science initiative of Melbourne Water) and Beach Nesting Birds (a citizen science initiative of Birdlife Australia focused on monitoring Hooded Plovers). Data is being collected through three primary methods: i) semi-structured in-depth interviews with CS program participants and program staff (covering a diversity in roles, years of experience in citizen science, degrees of engagement in CS, age and gender); ii) participant observation (accompanying different participants in CS programs, participating in and observing CS activities alongside them); and iii) content analysis (of documents, communications and other materials generated by the two CS programs).

Key Outputs

- A final report translating research findings on the experiences of citizen scientists into recommendations to the business.
- Short, animated videos that summarize key research findings, designed to communicate the research to study participants, other participants in citizen science programs, citizen science practitioners, and researchers
- Journal Paper on biodiversity monitoring volunteers' knowledge practices.
- Journal paper on how digital tools shape volunteers' knowledge production and participation
- Journal paper on the significance of biodiversity records for volunteers.

Expected benefits

- Improved understanding of the diverse contributions of citizens scientists to the protection of ecosystems and species, including and beyond the collection of data.
- Improved understanding of the role of digital tools in facilitating the pathway from a citizen scientist's field observation to formalised evidence, including ways in which records are made valid, authoritative, credible, and relevant.
- Protocols for the use of digital technologies.
- Improved volunteer programs that support the desired experiences of volunteers as well as their contributions to protecting waterways

Project team

University Of Melbourne: Stephanie Lavau (Primary supervisor), Debbie Gonzalez Canada (PhD student).
Melbourne Water: TBC.

For more information, contact Stephanie Lavau, stephanie.lavau@unimelb.edu.au, or see the full project proposal in the prospectus supporting document.

Street Trees: Irrigating the urban forest with stormwater

Objective(s)

We want to understand whether streetscapes can be designed to promote infiltration of stormwater and achieve the dual benefits of protecting urban streams and increasing canopy cover.

Why this research is important

Urban streams are severely degraded by the large volumes of stormwater runoff created and conveyed by road networks. However, there is significant potential to create storage for stormwater in streetscapes and restore pre-development hydrological processes; specifically: infiltration and evapotranspiration. Streetscapes also represent one of the limited opportunities to establish tree cover to provide shade and cooling benefits to communities.

Trees benefit from additional water resources during establishment and established trees can transpire significant volumes of infiltrated water, providing one of the few mechanisms to reduce runoff volumes. Streetscapes therefore provide the opportunity to make use of runoff to rapidly increase tree canopy cover for urban cooling and amenity benefits, as well as benefit urban streams by substantially reducing stormwater runoff volumes.

Contribution to Melbourne Water research priorities

- This project directly relates to achieving infiltration targets for new developments in growth area councils primarily located in the Werribee and Westernport catchments
- The 2022 report card for the Healthy Waterways Strategy showed that infiltration targets for both catchments were significantly off track (<1% achieved to date)

Approach

The short-term focus of this project is the analysis and write-up of the various field experiments in motion with local government. This includes:

- An experiment in the City of Melton to compare stormwater runoff capture and tree growth for alternative system inlet types
- An experiment in the City of Port Phillip assessing a median strip biofiltration design
- Experiments using a permeable kerb and channel to be installed in partnership with: i) the City of Merri-bek (in Fawkner) and ii) John Holland Group and Sustainability Victoria.
- An experiment in Cardinia Shire where are testing a large infiltration trench which results suggest can reduce runoff volumes by 20%

In the longer term, the project will focus on developing an ARC Linkage grant. Through this grant, we will gain the advantage of a dedicated research fellow who will focus on quantifying the performance of systems in the field. We will continue to further develop designs and focus on the critical steps required to take this work from pilot-scale to common practice, through development of standard drawings and effective knowledge transfer.

Key outputs

- Data on runoff retention and tree growth performance.
- Guidance documents on design and construction of streetscapes which promote infiltration.

Expected benefits

- Increased infiltration of stormwater in priority areas to protect urban streams.
- Increased tree growth and canopy cover to provide cooling benefits to communities.

Project teams

University Of Melbourne: Chris Szota, Tim Fletcher and Paul Hanley. Melbourne Water: TBC.

For more information, contact Chris Szota, cszota@unimelb.edu.au or see the full project proposal in the prospectus supporting document.

Appendix 1 – Melbourne Water participants in the June 2023 Melbourne Waterway Research-Practice Partnership project prioritisation workshop and those who provided subsequent feedback on shortlisted priorities*

Workshop Participants

Name	Team
Al Danger	Service Enablement Healthy Waterways
Apanie Wood	Lower Yarra
Charlotte Hilbig*	Waterways Biodiversity and Environment
Dan Robertson	Upper Yarra
Digby Richardson*	Statutory Referral Permit Services
Freya Von Muller	Upper Yarra
Jared Polkinghorne	Bayside and Dandenong
Joanna Mundy	Maribyrnong
Josie McGushin*	Flood Strategy and Stormwater Policy
Kathy Cinque*	Research and Modelling
Katy Marriot	Catchment Planning and Engineering
Micah Pendergast	Service Governance, Coordination and Enablement
Paul Rees	Peninsula and Westernport
Priya van Ryn	Waterways Biodiversity and Environment
Rob Molloy	Yarra strategic Implementation
Shane Haydon	Applied Research
Sharyn RossRakesh*	Waterways Biodiversity and Environment
Shaun Corrigan	North West
Sri Patnaikuni*	Sustainable and Resilient Futures
Trish Grant	Waterways Biodiversity and Environment
Vaughn Grey	Waterways Biodiversity and Environment
William Steele	Waterways Biodiversity and Environment
Wira Yan	Land Management Strategy
Yvonne Cabuang	Community Capacity Building

* Provided input on priorities prior to the workshop

Individuals and/or Teams who Provided Feedback on the Shortlisted Projects from the Workshop

Name	Team
Al Danger	Service Enablement Catchments & Waterways
Alison Kemp	Waterways, Waterways, Biodiversity & Environment
Alison Rickard	Service Enablement Catchments & Waterways
Amanda Gunawardena	DSS Development Engineering & Planning Services
Cheryl Edwards	Sustainable Futures
Dan Green	Land Design & Community Planning
Dan Robertson	Waterways & Catchment Operations
Dana Grech	Waterways & Catchment Operations
David Galloway	Waterways & Catchment Operations
David Reginato*	DSS Strategic Engineering & Planning Services
Deborah Riley and Matilda Manning	Sustainable Futures
Grace Tjandraatmadja	Sustainable Futures
Josie McGushin*	Stormwater Policy Team
Josie McGushin*	IWM Team
Kathy Cinque	Research and Modelling
Leonie Williams	WTP Environment Compliance Officer
Louise Kerferd	Waterways & Catchment Operations
Michelle Ezzy	Sustainable Futures
Nino Polon*	DSS Strategic Engineering & Planning Services
Paul Rees*	Waterway and Catchment Operations
Priya Van Ryn*	Waterways, Waterways, Biodiversity & Environment
Rob Molloy	Yarra Strategic Plan
Sam Bradley	Waterway and Catchment Services
Shaun Corrigan	Catchment Partnerships
Suelin Haynes	Western Treatment Plant Environmental
William Steele	Waterways, Waterways, Biodiversity & Environment

* Provided joint input on priorities based on team discussions

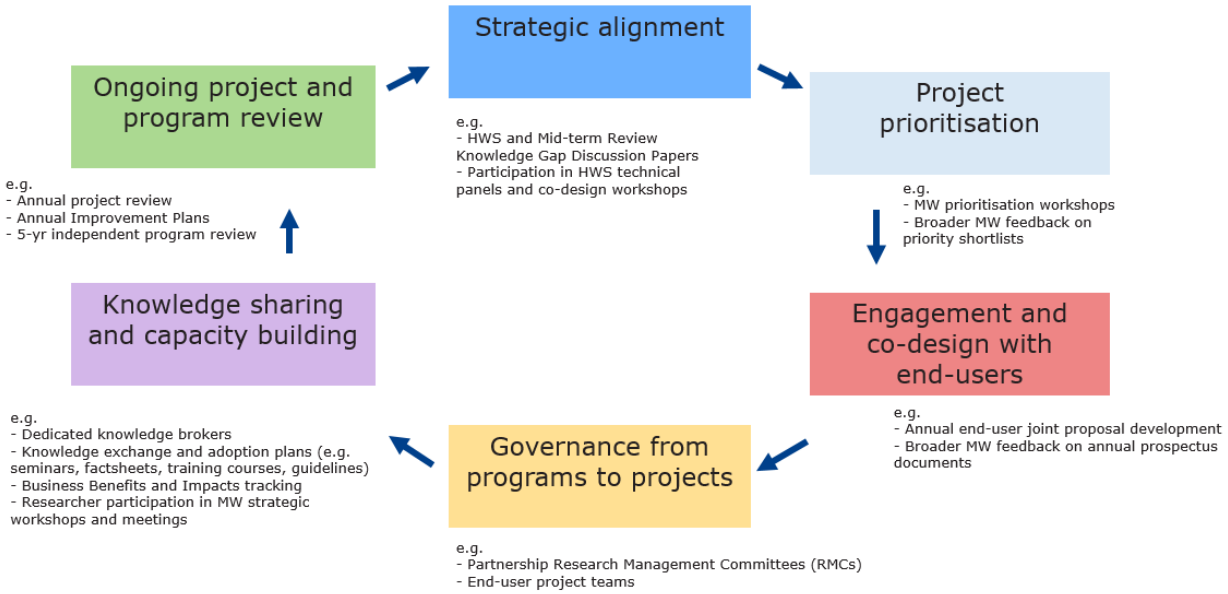
Appendix 2 – Background Information on the Waterways and Wetlands Research Program and the Melbourne Waterway Research-Practice Partnership 2023-2028

Melbourne Water's Waterways and Wetlands Research programs builds a knowledge base that informs and refines strategic decision-making and policy development, and improves the efficiency of actions to protect and improve waterways and wetlands, monitor investment outcomes and respond to risks and opportunities. This extends to improving our understanding of the current and historical health of rivers and creeks, how to best manage specific river health issues, how to prioritise and practically implement on-ground activities, how to set meaningful natural resource management targets, the investment outcomes from particular waterway management activities and validity of critical waterway management assumptions. Development of this understanding is considered in the context of progressive urban growth, climate change and economic uncertainty.

Melbourne Water's Waterways and Wetlands research program outsources most of its projects through collaboration with researchers and key stakeholders e.g. DEECA, EPA, Parks Victoria, local government, water utilities. This approach gives Melbourne Water the flexibility to access a broad base of expertise, the capacity to undertake a higher volume of research across a diversity of research themes, greater agility to respond to future risks and opportunities, and opportunities for co-funding. Melbourne Water is able to address diverse knowledge gaps by investment both in large-scale research collaborations that focus on national priorities and industry direction (e.g. cooperative research centres [CRCs]), and in collaborations that can be more responsive to local research needs.

Over the past 10+ years, the Waterways and Wetlands Research program has evolved to strengthen its approach across key elements of research management cycle including 1) strategic alignment, 2) project prioritisation, 3) engagement and co-design with end users of the research, 4) project and program governance, 5) knowledge sharing and business/industry capacity building and 6) continuous improvement through ongoing project and program reviews (**Figure 2**).

Figure 2. Melbourne Water's Approach to Waterways and Wetlands Research



Since 2018, Melbourne Water has delivered over 50 research projects with our research partners. During the mid-term review of the Healthy Waterways Strategy these projects were mapped against the original 41 Key Research Areas and are summarised in **Appendix 3**. Two major research partnerships account for the majority of research projects, namely the Melbourne Waterway Research-Practice Partnership (MWRPP) with The University of Melbourne and the Aquatic Pollution Prevention Partnership (A3P) with RMIT University.

This document focusses on the Melbourne Waterway Research-Practice Partnership (MWRPP), that commenced in 2013 and represents an approach to waterway management research within the Port Phillip and Westernport region that supports a truly dual focus of:

(i) applied research to underpin the improved management of waterways and

(ii) knowledge exchange that integrates research findings and broader science with Melbourne Water activities (and those of other stakeholders).

The Partnership focusses on the drivers of waterway ecosystem condition in both urban and rural environments, and the prioritisation and design of interventions from the catchment- to reach-scale for the protection and improvement of waterway health. As well as helping to inform strategic planning, the research program is designed to be flexible and responsive so that it can also support Melbourne Water's day-to-day activities. This includes providing direct and easy access to expert advice for Melbourne Water, through regular formal and informal interaction opportunities between researchers and waterway managers. The MWRPP provides Melbourne Water with strong research capacity in waterway health and its management, and complements other key waterway research initiatives for which Melbourne Water is a collaborator.

The aims of the Partnership are to:

1. Undertake dedicated timely and relevant research to improve the efficiency and effectiveness of waterway management across the region (the research scope covers both urban and rural waterways)
2. Develop formal strategies and activities to integrate findings from the research into Melbourne Water's policy and practice
3. Develop formal opportunities for staff development and two-way exchange between Melbourne Water staff and University researchers, through training courses, secondments, exchange programs and student research projects.

In order to achieve these aims, the Partnership is founded on a collaborative research model of two-way knowledge exchange between researchers and practitioners at all stages – from research idea development through to changed business practices (**Figure 3**).

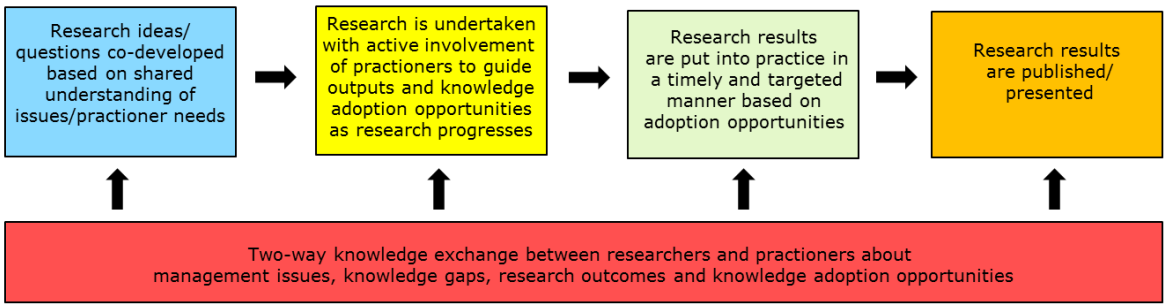


Figure 3. Melbourne Waterways Research-Practice Partnership collaborative research model

Partnership Governance

Formal governance of the Partnership as a whole occurs via the Research Management Committee (RMC) and includes representation from senior Melbourne Water managers from key waterway management related teams. The Research coordinators (Tim Fletcher and Rhys Coleman) have responsibility for overseeing Partnership activities, while senior researchers (Yung En Chee*, Joe Greet*, Stephanie Lavau*, Moss Imberger*, Belinda Hatt, Ryan Burrows, Sacha Jellinek, Kathy Russell, Chris Szota, Matt Burns, Ami Bennett) are responsible for co-ordination of projects (those with an asterisk are also on the RMC). Melbourne Water senior managers on the RMC, representing a range of business areas, are Anna Lucas, Dan Besley, Apanie

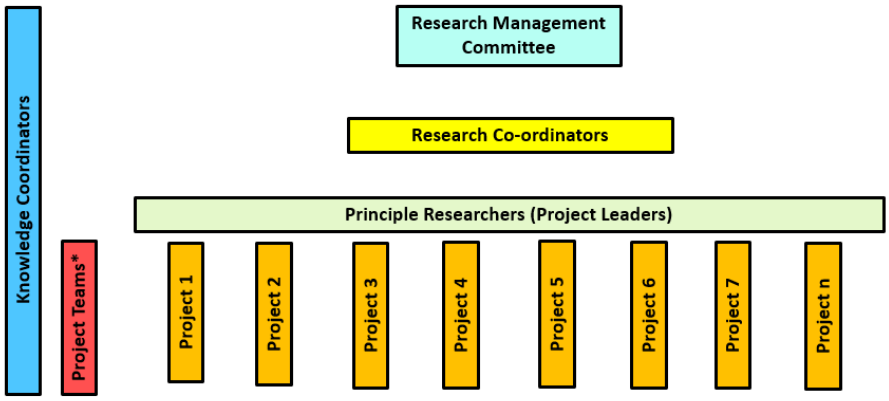
Wood, and Belinda Lovell. The RMC also includes the Knowledge Brokers (Darren Bos and Slobodanka Stojkovic) from the University of Melbourne and Melbourne Water (**Figure 4**).

The RMC meets quarterly and amongst other things, approves the annual research program, discusses research progress, resourcing, future research opportunities, knowledge transfer initiatives and health and safety. The RMC also has the following responsibilities:

1. Ensuring the research aligns with Melbourne Water's strategic knowledge needs
2. Reviewing progress against milestones and performance targets
3. Tracking captured benefits for each project against Impact Domain adoption targets
4. Planning future knowledge exchange initiatives and activities
5. Identifying and resolving any issues affecting the performance of the Partnership, including considering and approving (or otherwise) any proposals by The University of Melbourne to conduct work outside of the agreement
6. Actively overseeing the process of managing research by contributing to the development of, and tracking progress against, an Annual Improvement Plan that focusses on continual improvement.

At the project level, there are project teams comprising a research leader, researchers and Melbourne Water team members. The project teams are critical for helping shape the research projects, ensuring that research outputs are timely and relevant to Melbourne Water, providing management perspectives and insights, and supporting the transfer and adoption of knowledge. As part of establishing project teams, careful consideration of the 'Impact Domains' guides the composition of Melbourne Water participation i.e. those who are likely to be influenced by the research outcomes from planning to service delivery are represented on the team. The frequency of project team meetings with be project dependent, however, there should be 2-3 meetings per year.

Figure 3. Melbourne Waterways Research-Practice Partnership Governance



*Project teams = Research leader, key researchers and Melbourne Water stakeholders

Knowledge exchange

Knowledge exchange activities are led by a dedicated knowledge exchange officer at The University of Melbourne (Darren Bos) who works with Melbourne Water's Waterways and Wetlands Research Knowledge Broker (Slobodanka Stojkovic).

The purposes of knowledge exchange activities undertaken as part of the MWRPP are to: 1) promote the ways that the MWRPP can support better waterway management, 2) build awareness and understanding of research projects by potential users of the research, 3) encourage stakeholder engagement (including other agencies and research institutions), 4) establish a culture of knowledge sharing between researchers and practitioners, 5) generate a shared understanding of waterway management processes and context in which research will be adopted (including timeframes), 6) encourage integration of research findings into industry practice and 7) communicate the value of the research program in supporting Melbourne Water's operations.

Knowledge exchange is to be incorporated early in the research project development and implementation process. Whilst everyone in the MWRPP has a recognized role to play, knowledge exchange activities are planned and delivered with strategic oversight and coordination by the two knowledge brokers, who are also responsible for developing a Knowledge Exchange and Impact Framework (KEIF) that guides key activities on an annual basis. The KEIF provides a framework for all communication activities undertaken as part of the MWRPP to ensure that knowledge exchange activities support the goals of the Partnership, in particular ensuring researchers and practitioners share and adopt knowledge.

The KEIF recognises that knowledge exchange activities are not simply the 'communication' or 'translation' of research ideas, but the active integration into policy and practice. To achieve this, the plan considers the development of formal strategies and activities to integrate findings from the research into Melbourne Water's policy and practice, and formal opportunities for staff development and exchange between Melbourne Water and University staff. The plan also provides a template for preparing communications briefs for each of the Partnership's research projects and identifies important dates for timely input into policy development and practices.

Importantly, the KEIF documents research outcomes and anticipated timelines. For each project, the KEIF identifies internal and external stakeholders across Impact Domains who need to be engaged at various stages and the appropriate forms of engagement. This includes consulting with teams relevant to the target Impact Domain(s) to agree on how to effectively engage with them throughout the life of the project. A range of mechanisms to deliver research outputs to suit different audiences will be explored through the KEIF and project Business Benefits and Impact Tables (BBITs).

The Partnership adopts an active approach to knowledge exchange, working collaboratively to develop (i) seminars (ii) practice notes (iii) guidelines for monitoring, modelling and the design of technologies. All of these communication activities will be underpinned by a focus on scientific excellence through peer-reviewed publication, to ensure that communications materials are credible and tested.

Knowledge exchange and research integration through the MWRPP will continue to be supported by:

1. Direct input to Melbourne Water committees: direct input from researchers to committees such as the Healthy Waterways Strategy Mid-term Review Evaluation Panel.
2. Technical advice and review of Melbourne Water documents: researchers from the Partnership are available to Melbourne Water staff to provide technical advice on Melbourne Water strategic projects, including review of key technical documents.
3. Melbourne Water exchange program: flexible opportunities for Melbourne Water staff to work within the Partnership in order to facilitate more efficient knowledge exchange. The form of such opportunities shall be agreed upon by both parties, but could include (for example), (i) part-time secondments or (ii) project-based secondments.
4. Research Higher Degree program: the Partnership provides the opportunity for Melbourne Water staff (subject to eligibility criteria) to undertake higher degree training within areas focused on Melbourne Water's needs.
5. Short courses: The Partnership conducts short courses with the aim of communicating research outcomes to Melbourne Water and the water industry more broadly. Examples of short courses that have been run during the Partnership include: Stormwater 101, Stream Ecology 101, Riparian Vegetation Management and Physical Form Management.

The Partnership website (www.mwrpp.org) provides a central contact point for the partnership including a central repository for technical reports, list of all MWRPP research articles, updates on projects, and contact details for investigators.

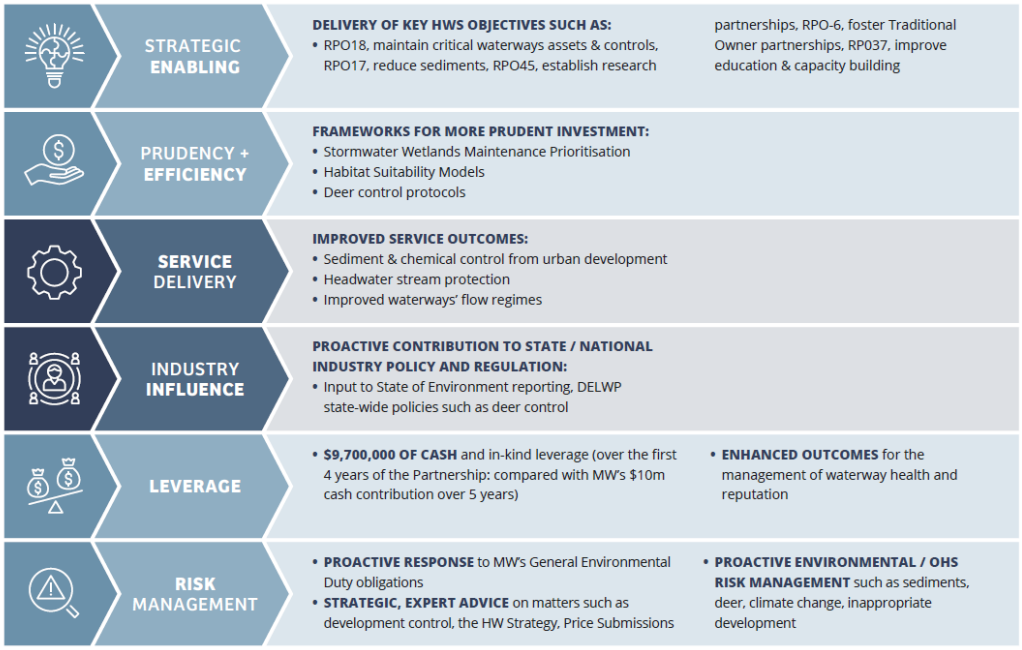
Partnership Review 2022

We recently signed a new 5-year Partnership agreement for the MWRPP from 1st July 2023 to 30th June2028. This renewal of the Partnership was supported by a formal review by Inxure Strategy Group in 2022 – with expertise in strategic water utility management, research program management and research adoption. The review had the following aims:

- To evaluate the benefits of the Partnership to Melbourne Water and our customers more broadly (e.g. DEWLP, EPA, Local Government).
- To identify the strengths of the Partnership (including structure, governance, project identification and prioritisation, performance of projects in terms of budget, timeliness and output, knowledge sharing and adoption, and publications); and
- To identify potential future improvements to the Partnership.

The review was founded on interviews and workshops with 50+ people (MW, Universities, Government organisations, consultants), with subsequent peer review by water industry experts. The review identified a broad range of substantial benefits to Melbourne Water and stakeholders (**Figure 5**) and recommended that the Partnerships continue along with a number of continuous improvement opportunities e.g. a more systematic to research benefits tracking.

Figure 5. Examples of the Types of Value Delivered by the Melbourne Waterway Research-Practice Partnership (MWRPP) identified by the Inxure Strategy Group Review



Research Prioritisation

Similar to the start of the last round of the MWRPP, a research planning workshop was held in June 2023 to reset and re-prioritise Partnership research projects (acknowledging that some committed projects would need to continue e.g. ARC Linkage and PhD projects) based on strategic knowledge gaps identified by the Healthy Waterways Strategy and the recent mid-term strategy review. This workshop was attended by both relevant Melbourne Water teams and research partners (**Appendix 1**) – with Melbourne Water staff determining knowledge gap priorities and researchers helping to facilitate discussions. The outcome of this workshop was a shortlist of research priorities (**Appendix 4**) that was subsequently circulated more broadly across Melbourne Water for feedback on projects considered as either a 'low', 'medium' or 'high' priority to particular teams. Participants were asked to prioritise projects in the context of the following considerations:

1. **Extent of existing research** i.e. knowledge sharing or a literature review may be sufficient where the knowledge gap has been adequately addressed.
2. **Importance** e.g.

   a. an area of high investment by the HWS but low confidence in management outcomes
   b. for delivering the current Healthy Waterways Strategy
   c. for developing the next strategy
   d. relates to a mid-term review major threat or substantial value decline
   e. provides benefits to multiple strategies e.g. IWM, flooding, Regional Catchment Strategy
3. **Feasibility** e.g.
   a. research can be delivered within the life of the strategy
   b. could be delivered by one of the existing Partnerships (either with the current expertise, or through a collaboration with known researcher from another institution)
4. **Cost** e.g.
   a. low cost relative to benefit
   b. substantial leverage of funds is likely or known to be possible
   c. synergies or dependencies with other projects can reduce costs

The prioritisation ratings from both the June workshop and subsequent business feedback helped identify projects that would be taken forward to research proposal development. Prior to drafting proposals, project scoping meetings were held with Melbourne Water representatives that showed an interest in certain projects. These staff members also provided feedback on draft proposals prior to inclusion of the proposal in this prospectus document. The direction and proposed outputs of each project will be reviewed annually as part of subsequent prospectus documents for Melbourne Water.

The highest priority projects, including those previously committed, that form the basis of the year 1 prospectus are:

- Spatial prioritization of management actions for stream and wetland values to support the Healthy Waterways Strategy
- Optimum combination of centralised and decentralised approaches to stormwater management
- Application of real-time-control technology to the management of stormwater
- Retention, use and treatment of stormwater through the Sunbury IWM project to protect urban streams and their headwaters
- Using street trees to provide benefits for stormwater treatment and amenity
- Monitoring riparian and instream vegetation condition, extent and benefits for environmental values
- Approaches to increasing the resilience of vegetation in a changing climate
- Traditional Owner-led restoration of urban billabongs
- Understanding and managing the impacts of deer on water quality and riparian vegetation
- Relationship between physical form and ecological health of waterways
- Sediment generation during construction of urban areas and impacts on streams
- Developing methods, metrics and strategic management frameworks for waterway function as a key environmental value
- Improved methods for monitoring waterway health with aquatic macroinvertebrates using genetic techniques
- Review and refining our long-term water quality monitoring network to support waterway management under a changing climate
- Impacts of ‘next generation’ citizen science programs on community engagement outcomes.

Appendix 3 – Summary of Healthy Waterways Strategy research themes, Key Research Areas, collaborative research outcomes since 2018 and additional research knowledge gaps identified during the mid-term review

Research Theme (recently updated wording underlined)	**Research Outcomes 2018-2023** (Some research outcomes span multiple research themes but are only listed once)	**Additional mid-term review research gaps** (Will be prioritised alongside original HWS research gaps)
Riparian Vegetation and Instream Habitat 1. Understand the potential impacts of climate change on riparian vegetation communities and opportunities to effectively build resilience or transition vegetation communities 2. Understand the impact and effective management of pest plants and animals on riparian vegetation and instream habitat 3. Develop decision support tools to support improved investment in riparian and instream habitat activities and locations 4. Identify critical constraints to revegetation success and opportunities to improve vegetation outcomes 5. Improved understanding of instream habitat conditions, threats (including climate change) and processes across the region to inform works planning **Proposed New Key Research Area** 6. Develop remote sensing monitoring methods to better understand changes in vegetation condition and extent across the entire region	**Improved Habitat Suitability Models for instream values** – Developed improved stream network and associated environmental prediction information, including acquiring new vegetation and impervious surface data, to support the refinement of instream Habitat Suitability Models (HSMs) for aquatic macroinvertebrates, fish and platypus **Benefits of works-to-date and under climate change** – Used new climate change information for the region (e.g. VCP19 projections), data on works-to-date and proposed works through the HWS, and the instream HSMs to understand the potential implications for key environmental values across the region. **Climate resilient revegetation** – Modelled the risk of climate change to 31 key revegetation species to inform MW revegetation guidelines under a changing climate **Outcomes from riparian revegetation** – Developed and trialled a method for assessing the outcomes of riparian revegetation projects (ROMP) and has been adopted by the HWS MERI Framework **Remote sensing of vegetation extent and condition** – Investigated the ability of remote sensing monitoring methods to better understand changes in vegetation condition and extent across the region to complement more intensive field-based vegetation condition assessments that cannot be practically conducted across all 25,000km of waterways in the region **Species-level macroinvertebrate data** – Developing cost effective genetic approaches to identify aquatic macroinvertebrates to a species-level (as opposed to family level) for our aquatic macroinvertebrate MERI programs, that enable a deeper understanding of biodiversity patterns across the region and enable potentially more informative species-level Habitat Suitability Models **Managing deer impacts on vegetation and water quality** – Developed models to predict the distribution, density and vegetation impacts from deer across the region to support prioritisation of management interventions. Also reviewed options for non-lethal management of deer and assessed the success of particular control efforts **Incorporating instream vegetation in our strategies** – Conducting research on the relationships between flow, channel form and instream vegetation to	**Improved Habitat Suitability Models for instream values** – Continue to develop and refine instream Habitat Suitability Models (HSMs) for aquatic macroinvertebrates, fish and platypus to support the identification of the most cost effective waterway management actions, strategic target setting, the MERI framework and stakeholder strategy co-design in future Healthy Waterways Strategies **Climate resilient revegetation** – Forecast climate change impacts on a broader suite of vegetation species (including remnant native vegetation, common revegetation species and weeds), validate climate resilient revegetation approaches through establishment of climate plots across climatic gradients in Melbourne and develop a new management framework that builds resilience and adaptation of riparian revegetation to projected future climatic conditions **Impacts of climate change on fishway design –** Understand how climate change could impact the function and design of fishways to ensure that they continue to provide passage for target fish species in future decades **Outcomes from riparian revegetation** – Gain a deeper understanding of the outcomes of our riparian revegetation practices (ROMP) as well as the benefits for other environmental values e.g. riparian birds **Remote sensing of vegetation extent and condition** – Continue to test and establish cost effective remote sensing monitoring methods to better understand changes in vegetation condition and extent across the region, including impacts of vegetation clearing and outcomes from revegetation **Value and protection of headwater streams** – Understanding implementation barriers for headwater stream and wetland protection, including quantification of their water quality, ecological, social and cultural benefits, historical rates of loss, and the development of guidelines for protection from urban development **Integrated vegetation management to reduce chemical use** – Trial integrated vegetation management practices (e.g. alternative herbicides, heat, mowing) to reduce reliance on chemical use along waterways **Incorporating instream vegetation in our strategies** – Continue research on the relationships between flow, channel form and instream vegetation

	inform opportunities to manage and project instream vegetation habitat in the next Healthy Waterways Strategy **Channel form and floodplain protection** – Conducting research on the relationships between flow, urbanisation, floodplain connection and channel form to inform opportunities to protect stream channels from urban growth. Automated tools to extract channel dimension data (e.g. width, depth, slope, top of bank) across the region using Lidar were also developed to support a number of needs across Melbourne Water for channel dimension data **Direct seeding as a complementary revegetation tool** – Evaluated direct seeding as a cost-effective revegetation technique and developed guidelines for Melbourne Water for its use **Propagation of key vegetation species** –Developed methods for the propagation of critical native plants (*Gahnia*, *Pteridium*, *Lepidosperma*) for riparian restoration programs that are now commercially available from nurseries **Instream channel features needed to fully realise revegetation benefits** – Better understand the importance of retentive structures (e.g. instream wood, rocks, vegetation) for the retention of vegetation matter to realise the ecological benefits of organic matter inputs from riparian vegetation **Value and protection of headwater streams** – Investigated the role of small headwater streams in urban, rural and forested catchments for supporting waterway health, including stream flow, water quality and biodiversity benefits to guide strategies for the protection of headwater streams across the region	to inform opportunities to manage and project instream vegetation habitat in the next Healthy Waterways Strategy
Stormwater management and flooding 1. Improve our understanding how system design to prevent flooding and protection of waterway health needs to alter to accommodate impacts of climate change 2. Improving the stormwater treatment performance and determine the optimal maintenance of WSUD systems 3. Understanding the costs and benefits of various stormwater management interventions for biodiversity, amenity and recreational outcomes 4. Develop improved technologies and systems to support stormwater harvesting and re-use 5. Identifying and addressing institutional and structural barriers to implementation of Integrated Water Management 6. Develop decision support tools to inform the most effective stormwater treatment systems and locations to protect waterway biodiversity, amenity and recreation **Proposed New Key Research Area:**	**'Smart' water storages for multiple benefits** – Implementing a distributed network of 'smart' rainwater tanks and urban lakes that enable real-time monitoring and control of water levels for multiple benefits – augmenting household non-potable water use, reducing the risk of localised flooding and environmental flows under a changing climate (Monbulk Creek Smart Water Network) **Measuring the performance of stormwater wetlands** – Includes developing efficient and effective indicators of performance, to support industry guidelines, improve future design and underpin asset maintenance prioritisation. More recent research is seeking to understand the treatment, harvesting, maintenance and environmental flow benefits of 'smart' stormwater wetlands that incorporate real-time monitoring and control of water levels and water quality **Ability of stormwater wetlands to remove microplastics** – Commenced research to understand to the performance of stormwater wetlands to remove microplastics prior to discharging water to downstream natural	**Barriers to the management of urban stormwater** – Understanding the barriers to the implementation of HWS stormwater Performance Objectives (e.g. policy, guidance, capacity and funding, sector willingness) and identify opportunities to overcome critical barriers. **Implications of climate change for stormwater management** – Better understand how flow changes associated with climate change will influence the threat of urban stormwater (e.g. increased storm intensity) and identify suitable interventions to mitigate the increasing threat **Real-time monitoring and control of WSUD assets** – Continue to investigate opportunities for real-time monitoring and control of WSUD systems, including rainwater tanks, urban ponds and stormwater wetlands, to improve treatment performance, increase harvesting suitability, prevent vegetation loss and provide environmental water for downstream waterways (including Groundwater Dependent Ecosystems)

7. Understanding and managing the threat of urbanisation to floodplain function, wetlands and headwater streams	waterways to understand the risks from microplastics and potentially inform future constructed wetland design and maintenance **Passively irrigated street trees** – Understanding the stormwater treatment and urban greening benefits of passively irrigated street trees, including testing a range of designs in contrasting contexts e.g. carparks, residential streets, median strips on main roads. **Managing stormwater in existing and new urban areas** – Assessed the benefits to stream health of a large-scale retrofit of stormwater control measures (rainwater tanks, raingardens) in an existing urban area (the Little Stringybark Creek catchment), as well as establishing a large-scale assessment of the benefits of the Sunbury IWM project that aims to achieve the HWS stormwater targets and protect the health of Jacksons and Emu Creek in the Sunbury Growth Area **Benchmarking and transitioning 'water sensitivity' of cities** – Developed a method to benchmark cities in regards to 'water sensitivity', set visions with stakeholders and implement transition strategies **Economic evaluation of Integrated Water Management projects** – Developed a comprehensive economic evaluation framework for Integrated Water Management projects and programs to support business cases **Tools and products to support Integrated Water Management** – Guidance documents and other tools and products to support integrated urban and water planning in new ('greenfield development') and existing ('infill development') urban areas	**Passively irrigated street trees** – Demonstrate the stormwater capture and infiltration potential of a fully functional 'leaky' streetscape with passively irrigated street trees **Impacts of urbanisation on wetlands** – Undertake research to better understand the impacts of urbanisation on wetlands and to define appropriate buffer distances and the measures required to maintain and improve values **Waterway setbacks for multiple benefits** – Explore opportunities to develop site specific waterway setbacks that protect floodplain functioning, including reduced localised flood risks, in urbanising areas **Measuring the performance of stormwater wetlands** – Continue to improve our understanding of the treatment of toxicants by stormwater wetlands, including emerging contaminants of concern, as well as the effect of toxicants on wetland performance e.g. biofilms, sediment bacterial communities **Managing industrial pollution with structural solutions** – Further develop and trial dry weather toxicant treatment assets in stormwater drains draining industrial pollution hotspots **Upscaling and mainstream Integrated Water Management** – Identifying approaches and opportunities to upscale and mainstream Integrated Water Management practices across the region
Pollution 1. Understanding the environmental impacts of pollutants, including contaminants of concern and litter, to inform risk-based management of waterways across the region 2. Quantifying ecosystem services in waterways for improving water quality to better account for the benefits of healthy waterways 3. Develop improved water quality indicators and monitoring methods to better understand the impacts of pollutants on waterway health 4. Developing tools and approaches to assist in strategic planning of pollution management to protect biodiversity, amenity and recreation in waterways across the region 5. Understanding and managing public health risks from recreation along waterways in the region 6. Understanding the impact of climate change on water quality and management implications for the protection of aquatic biodiversity, amenity and recreation along waterways **Proposed New Key Research Area:**	**Climate change and water quality** – Used new climate change information and water quality modelling (Port Phillip and Westernport Source Model) to understand the potential impacts of climate change on water quality across the region **Synthesis of water quality issues and opportunities** – Summarised waterway pollution data across the region to understand key water contaminants, sources, pollution hotspots and management opportunities **Impacts of urban construction on sediment loads** – Quantified the amount and quality of sediment delivered to streams and wetlands during construction of urban residential areas in the South East of Melbourne to understand risks to waterway and bay health and opportunities for management **Emerging contaminants of concern** – Reviewed local and international literature and conducted risk assessments based on HWS key environmental values to identify potential emerging contaminants of concern, develop methods to sample and measure them across the region to identify priority pollutants for management	**Climate change and water quality** – Improve understanding of the likely implications of climate change (warming, drying, more intense rainfall events) on the levels and ecological impacts of contaminants in waterways **Quantitative passive sampling of contaminants** – Refine passive sampling methods for contaminants to enable assessments to move from presence/absence to quantitative assessments of chemicals **Low cost sensors for monitoring urban construction** – Development of low cost monitoring systems to increase the coverage and resolution of data to understand and manage the risk of sediments to waterways from urban construction e.g. construction sediment control, compliance monitoring, sediment pond maintenance **Chemical indicators of treated and untreated wastewater** – Validate chemical indicators of sewage and quantify risks to key environmental values from chemicals associated with wastewater, including recycled water and Emergency Relief Structure (ERS) overflows

7. Understanding and managing the impacts of treated and untreated wastewater on waterway health	**Impacts of treated and untreated wastewater** – Developed indicators of treated and untreated wastewater discharges to waterways to understand major sources of wastewater contamination to guide prioritisation of wastewater management activities across the region **Continuous improvement in chemical use** – Reviewed the chemicals frequently used by Melbourne Water on or near waterways and conducted an ecological and human health risk assessment and considered alternative chemicals or practices to reduce the ecological and human health risks of priority chemicals e.g. glyphosate used in vegetation management activities **Water quality benefits of gully revegetation and stock exclusion** – Tested the water quality benefits (sediments, nutrients, faecal microbes) of revegetation and stock exclusion along gullies on rural land in the Tarago River catchment **Managing industrial pollution** – Surveyed urban streams and drains in industrial areas across the region to characterise the types and concentrations of pollutants. Also tested the ability of different types of filter media to remove industrial pollutants from dry weather flows in stormwater drains e.g. Barry Road, Campbellfield. **Catchment studies to identify management priorities** – Developed and applied a range of complementary water and sediment quality survey methods (including passive samplers) as well as ecotoxicology tests to determine levels of pollution stress and diagnose priority pollutants for management in contrasting catchments (Kororoit Creek, Little Yarra River, Lang Lang River) **Low cost water quality sensors** – Developed and tested low cost water quality sensors (e.g. water level, salinity, temperature, turbidity) and modelling to isolate major sources of pollution in stormwater drains, including the Old Joes Creek (Bayswater) and Stony Creek (Yarraville) industrial catchments **Managing recreational public health risks along the Yarra River** – Conducted an assessment of the risks of different types of aquatic recreation along the Yarra River to inform opportunities to reduce public health risks **Managing the risk of bifenthrin use** – Understanding the levels and ecological effects of the synthetic pyrethroid Bifenthrin (e.g. used to control termites) on aquatic organisms in new urban estates to inform structural and non-structural mitigation measures	**Risks to waterways from recycled water use** – Understand risk to waterways from increased use of recycled water for environmental flow purposes and use in residential and agricultural areas. **Quantifying the benefits of rural land management** – Improved metrics used to estimate the effectiveness of site scale agricultural interventions to reduce sediment, nutrient and pesticide run-off to protect waterway health **Understanding the ecological threats from contaminants in rural areas** – Better understand threats from pesticides and other sediment contaminants for waterways where high values (e.g. macroinvertebrates, platypus) intersect with rural land use **Threat of litter entanglement to key environmental values** – Better understanding of the risk of entrapment from litter for environmental values beyond platypus (e.g. fish, birds) to inform priorities for litter management across the region **Non-structural tools for managing industrial pollution** – Investigate the benefits of non-structural strategies (education and enforcement) to manage pollution from industrial areas **Toxicant risk assessment framework** – Further develop and apply the A3P toxicant risk assessment framework to assist in the prioritisation of management actions to reduce impacts on key environmental values, including continuing to undertake a systematic approach for screening and managing pollutants at sites of environmental significance **Catchment studies to identify management priorities** – Continue to develop assessment tools (e.g. eDNA, metabolomics, habitat, hydrology) to strengthen the multiple lines of evidence framework to understand major stressors in subcatchments where key environmental values are declining e.g. Lang Lang River aquatic macroinvertebrates, River Blackfish in the Plenty River **Continuous improvement in chemical use** – Continue to review and refine chemicals used by Melbourne Water on or near waterways (e.g. wash down and pathogen control procedures, herbicides along waterways and drains) to reduce impacts to the aquatic environment and human health **Litter management prioritisation** – Develop a litter management prioritisation framework to guide litter management interventions e.g. litter trap installation, routine clean-ups
Hydrology and Environmental Flows 1. Developing improved approaches to flow data collection and data management to support flow management decisions 2. Understanding and mitigating climate change effects on the hydrology of waterways, estuaries and wetlands	**Climate change and stream flows** – Used new climate change information for the region (e.g. VCP19 projections) and water quality modelling (i.e. Port Phillip and Westernport Source Model) to understand the potential impacts of climate change on flow across the region	**Climate change and stream flows** – Improve understanding of the likely ecological implications of climate change (warming, drying, more intense rainfall events) on the hydrology of waterways across the region

3. Improving our understanding of the responses of key environmental values to flow regimes to refine our environmental flow objectives 4. Developing tools and frameworks to assist improved decision-making in the management of flows to meet environmental flow objectives 5. Investigate opportunities for managing stream flows in urban catchments to protect and improve aquatic biodiversity, amenity, recreation and reduce flooding 6. Improved understanding of the hydrology of floodplains, wetlands and estuaries, including groundwater-surface water interactions to protect and improve aquatic biodiversity 7. Improved understanding of the flow requirements of estuaries to develop and refine environmental flow objectives 8. Explore opportunities to integrate methods for determining ecological flows objectives in urban and rural streams to improve approaches to objective setting across both stream types	**Benefits of billabong watering along the lower Yarra River** – Worked with the Wurundjeri Woiwurrung Narrap team to assess the vegetation and broader ecological benefits of watering billabongs along the lower Birrarung (Yarra River) to inform environmental watering regimes **Benefits of watering regimes in the Yellingbo Conservation Nature Reserve** – Assessed the vegetation and broader ecological benefits of watering regimes in the Yellingbo Conservation Nature Reserve that supports threatened species including the helmeted honeyeater and Leadbeater's possum **Upstream migration of threatened Australian grayling** – Assessed the relationship between the upstream migration of the threatened Australian Grayling and environmental conditions, including flows in the Bunyip River catchment **Fate of infiltrated stormwater from biofiltration systems** – Measured the volume and underground flow path of water infiltrated by the Wicks Reserve (The Basin) biofiltration system to understand the potential for this asset type to restore dry weather flows to adjacent waterways	**Incorporation of flow stress predictors in our Habitat Suitability Models** – Incorporate further hydrological predictors to refine instream Habitat Suitability Models e.g. farm dam flow stress metric **Multi-species interactions associated with environmental flows** – Better understand the benefits of environmental flows when multi-species interactions (meta-community perspective) are accounted for in environmental flow plans **Traditional Owner-led billabong management** – Further investigate historical wetting and drying cycles, vegetation communities and fire regimes to enhance future Wurundjeri-led management of Birrarung's billabongs
Liveability, community engagement, and social research 1. Refining our conceptual models and developing tools to support investment in waterway works for recreation and amenity 2. Defining public health and wellbeing benefits of waterway, stormwater and urban cooling programs to support investment decisions 3. Understanding the compatibility between social and environmental values and whether management actions are required to balance potentially competing objectives 4. Understanding demographics, preferences, values and water awareness of our customers to inform waterway works planning and delivery 5. Understanding, involving and supporting volunteers in waterway management to facilitate shared waterway objectives 6. Increasing community awareness and connection to waterways so we have informed, engaged partners 7. Understanding aboriginal cultural values of waterways and establish a framework to better integrate these values in waterway management decision-making	**Litter monitoring methods** – Developed and tested new litter monitoring methods to identify litter hotspots, understand major types and sources of litter, prioritise areas for management, and in future Healthy Waterway Strategies to set strategic targets and track progress towards those targets **Community engagement with waterways before, during and after Covid-19 restrictions** – Used a combination of community surveys and mobile phone human movement data to understand the levels of community engagement with and perceptions of, Melbourne's 'blue' and 'green' spaces (e.g. waterways, local parks) before, during and after the Covid-19 pandemic. **Managing WSUD on private land** – Assessing the performance, levels of maintenance and household perspectives of water sensitive urban design (WSUD) assets (e.g. rainwater tanks and raingardens) on private land, using contrasting management scenarios e.g. Aquarevo, Little Stringybark Creek catchment, Coburg Hill. **Impact of digital technology for citizen science** – Surveyed citizen scientists involved in the Frog Census and Birdlife Australia programs in the region to understand reasons for their involved in these programs, the pros and cons of using digital technology to participate in these programs (e.g. Frog Census App) and opportunities to increase participation, retention rates and participant satisfaction **Knowledge sharing with Traditional Owners** – Drafted knowledge sharing protocols between Melbourne Water and three Traditional Owner (TO) groups in the region, to support TO-led research and waterway management capacity building	**Human wellbeing and wetland health as a potential new social value in the next Healthy Waterways Strategy**– Better understand the relationship between human wellbeing and wetland health to inform the potential adoption of wellbeing as a social value in future Healthy Waterways Strategies **Strengthening our understanding of the links between social conditions and values** – Undertake further investigations to better understand these causal links between conditions (e.g. litter and access) and how that impacts social values (perceptions and realities) to improve Healthy Waterways Strategy conceptual models that underpin prioritisation of actions to increase social values across the region **Threat of recreational access to key environmental values** – Better understand the threat of recreational access to waterways on key environmental values, including riparian birds to better balance social and environmental values protection across the region

	Indigenous-led approaches to urban water design – Commenced research led by the Boon Wurrung Foundation and Monash University to learn about ways to repair urban landscapes for their cultural values	
Wetlands and Estuaries 1. Developing strategic decision-making tools and frameworks for the prioritisation of management interventions for wetlands and estuaries 2. Improving our understanding of management techniques that are most effective for protecting and improving the ecological health of wetlands and estuaries 3. Developing improved monitoring, assessment and reporting methods to understand environmental conditions and values of wetlands and estuaries **Proposed New Key Research Areas:** 4. Understanding the potential impacts of climate change on wetland health and mitigation options 5. Develop remote sensing monitoring methods to better understand changes in wetland condition across the region	**Habitat Suitability Models for wetland values** – Developed improved waterbodies spatial information layer and associated environmental prediction information to support the development of wetland Habitat Suitability Models for frogs, fish and birds that will enable predictions of current condition, condition under future urban growth and climate change and setting environmental value targets for wetland assets in future Healthy Waterways Strategies (equivalent to how the instream HSMs were applied in the current HWS) **Developing environmental DNA (eDNA) methods for aquatic biodiversity monitoring** – Further developed and applied eDNA monitoring methods to support the HWS MERI framework, including protocols for detecting frogs, birds and aquatic plants in wetlands and for detecting threatened or invasive species (e.g. threatened invertebrates, freshwater mussels, Australian mudfish, smooth newt)	**Habitat Suitability Models for wetland values** – Continue to develop and refine wetland Habitat Suitability Models for frogs, fish and birds that will enable predictions of current condition, condition under future urban growth and climate change, and develop decision support tools like zonation to aid in prioritisation of management scenarios for wetlands and setting environmental value targets for wetland assets in future Healthy Waterways Strategies. Further develop the environmental data library to include wetland Habitat Suitability Model predictors we expect to be influential, such as measures of impervious cover within the catchment areas of waterbodies. **Remote sensing of wetland loss and condition** – Continue to investigate cost effective remote sensing data collection techniques for wetland extent and condition assessments (e.g. inundation, vegetation cover) to support Habitat Suitability Model development and final strategy evaluation of wetland condition and loss. Further develop the wetland remote sensing change detection methodology to determine its accuracy and applicability to flag wetlands where substantial changes in open water may have occurred and could be subject to follow up investigations **Predicting climate change impacts on wetlands** – Consider other approaches to assessing potential climate change impacts on wetlands (e.g. extreme events such as fire, heatwaves, 'rain bombs', floods, and storm surges) that complement the wetland Habitat Suitability Models **Review our suite of regionally significant wetlands** – Once the wetland Habitat Suitability Models are finalised, conduct further analysis of regionally significant wetland representativeness across the region with respect to key environmental values, as well as investigating the potential for waterbodies or regions to be refuge areas for particular species during dry conditions **Managing the impacts of invasive fish species** – Identify opportunities for reducing the risk of invasive fish such as carp and mosquito fish in areas of high environmental value
Other Aquatic Biodiversity 1. Improving our understanding of critical ecological processes and ecology of key species to improve our conceptual and quantitative models 2. Understanding the unintended consequences of our management activities on aquatic biodiversity to inform works planning and programming to reduce impacts on environmental values 3. Understanding areas of high biodiversity significance (e.g. Melbourne Water's Sites of Biodiversity Significance, Ramsar)	**Risk of pollution to sites of environmental sensitivity** – Conducted risk assessments and screened for pollutants at 40+ environmentally sensitive waterways sites in the region, to understand the threat of aquatic pollution and identify priorities for management **Status of threatened aquatic macroinvertebrates** – Used a combination of traditional and eDNA survey methods to assess the current status of threatened aquatic macroinvertebrates in the region, including the Donna Buang and Kallista stoneflies and the Dandenong and Sherbrooke amphipods	**Waterway function as a new key environmental value in the next Healthy Waterways Strategy** – Investigate and develop monitoring methods and metrics to enable the inclusion of waterway function as a key environmental value in future waterway strategies, as well as helping to prioritise waterway management interventions and setting of strategic targets that can be part of the HWS MERI Framework **Status of threatened aquatic macroinvertebrates** – Increase our understanding of the distribution of threatened aquatic

and appropriate management responses to manage key threats to environmental values **Proposed New Key Research Areas:** 4. Understanding the impacts of barriers to dispersal across the landscape on key values 5. Developing methods, metrics and strategic management frameworks for waterway function as a key environmental value	**Status and management opportunities for less understood aquatic life** – Reviewed ecological, distribution, threats and management opportunities information for aquatic fauna where information was lacking, including river blackfish, freshwater mussels and freshwater crayfish	macroinvertebrates, including clarifying taxonomic uncertainty of the amphipods **Water quality, hydrology and riparian birds** – Strengthen our understanding of the relationship between water quality, hydrology and riparian birds to help update our conceptual models and prioritisation of management interventions **Increasing our knowledge to protect threatened platypus** – Investigate the relationship between platypus populations, water quality and macroinvertebrate communities (abundance and diversity), as well as increasing our understanding of the carrying capacity and minimum habitat patch size required to support a self-sustaining platypus population. **Potential risks from anti-microbial resistance to waterway health** – Understanding the risk of Antimicrobial Resistance (AMR) to waterway health from agricultural sources to inform the need for management interventions **Barriers to the dispersal of key environmental values** – Understanding the impacts of barriers to dispersal across the landscape on key values (including under a changing climate and following disturbances) to evaluate the need for interventions that increase population connectivity (e.g. barrier removal, road underpasses, translocations)
Port Phillip and Western Port 1. Undertake priority research projects identified in the Port Phillip Environmental Management Plan 2. Undertake priority research projects identified in the Western Port Environment Science Review and synthesis report 3. Undertake priority research projects identified in the Ramsar management plans for the Port Phillip and Westernport region	**Amounts and sources of sediment to Western Port** – Measured and modelled the amounts and major sources of sediment to Western Port to understand the locations and types of management interventions (e.g. riparian revegetation, rural land management, coastal protection), that are most likely to protect and improve critical seagrass habitats in Western Port **Restoration of seagrass meadows** – Developing and trialling methods for seagrass propagation and planting, along with tools to predict locations where seagrass restoration is likely to be most effective, to accelerate recovery of critical seagrass habitats in Western Port **Restoration of mangroves** – Developing and trialling methods for mangrove propagation and planting across Western Port and Port Phillip to restore critical mangrove habitats to support ecosystem health and coastal protection **Restoration of coastal vegetation under a changing climate** – Mapping past, present and predicted future distribution of coastal vegetation (mangroves, saltmarsh) across Western Port, to identify opportunities to protect coastal vegetation under sea level rise **Risks from and major sources of toxicants to Western Port** – Screened waterways, including stormwater wetlands, across Western Port to understand the types and concentrations of toxicants and evaluate the risks	**Amounts and sources of sediment to Western Port** – Increasing our understanding of the amounts and major sources of sediment to Western Port to support the prioritisation of interventions to reduce sediment loads to Western Port under urban growth and climate change and to meet the SEPP sediment target **Restoration of seagrass meadows** – Refining propagation and planting methods to support scaling-up and mainstreaming of seagrass meadow restoration in Western Port and Port Phillip **Risks from and major sources of toxicants to Western Port** – Complete the development of locally relevant tests to assess toxicity of priority pollutants (based on a risk assessment of chemicals detected across Westernport streams and wetlands) to early life stages of fish **Amounts and major sources of microplastics to Western Port** – Complete research to understand the levels and major sources of microplastics discharged from waterways into Western Port to evaluate the risks from microplastics to the health of the bay

	to waterway and bay health – including the development of locally relevant tests to assess toxicity to early life stages of fish **Amounts and major sources of microplastics to Western Port** – Commenced research to understand the levels and major sources of microplastics discharged from waterways into Western Port to evaluate the risks from microplastics to the health of the bay **Using environmental DNA (eDNA) to survey benthic biodiversity in Western Port** – Sampled sediment across >100 sites across Western Port and used eDNA techniques to determine spatial patterns in benthic biodiversity (microbial and invertebrate)	

Appendix 4 – Short list of projects identified by Melbourne Water teams during the June 2023 Melbourne Waterway Research-Practice Partnership workshop

Project ID	Title	Description
MWRPP_1	Understanding Traditional Owner priorities for waterway protection and improvement across the region	Working with Traditional Owners to understand opportunities for TO-led management of waterways across the region. One example is our Australian Research Council Linkage project grant application investigating historical wetting and drying cycles, vegetation communities and fire regimes to enhance future Wurundjeri-led management of Birrarung's billabongs. Opportunities with other TOs could also be explored.
MWRPP_2	Investigating streamside and instream habitat restoration activities and outcomes for key environmental values	This project would assess outcomes from management activities where Melbourne Water invests substantial funds and for which there is a lack of confidence about the outcomes for environmental values e.g. vegetation, riparian birds, fish, aquatic macroinvertebrates. A likely focus would be our riparian revegetation practices but could potentially include instream habitat improvement works (e.g. channel naturalisation).
MWRPP_3	Real-time monitoring and control of Water Sensitive Urban Design (WSUD) assets for multiple benefits	This project would investigate opportunities for real-time monitoring and control of WSUD systems (including rainwater tanks, urban ponds and stormwater wetlands) over a range of scales, to improve treatment performance, increase harvesting suitability, prevent vegetation loss, reduce nuisance flooding and optimise water quality and flow regimes in downstream waterways (including Groundwater Dependent Ecosystems). The project will be based primarily on three sub-projects, funded in part by the Australian Research Council (Monbulk Creek Smart Water Network, Activating Lazy Wetlands (Troups Creek) and the Laureate Fellowship project on creating a "smart rainwater network" (including social and economic aspects).
MWRPP_4	Measuring changes in waterway vegetation condition and extent across the region using remote sensing methods	This project would continue to investigate the ability of remote sensing data (both free and proprietary) and methods to better quantify and understand changes in vegetation condition and extent. This will complement more intensive field-based vegetation condition assessments that cannot be practically conducted across all 25,000km of waterways in the region. It would go beyond just assessments of tree cover and consider assessments of vegetation clearing and outcomes from revegetation programs. As well as along rivers and creeks, could potentially include vegetation in wetlands and estuaries.
MWRPP_5	Methods for the effective management of key invasive plants and animals to reduce their impact on instream and riparian vegetation communities	Recent research by the MWRPP has focussed on the impacts of deer on riparian vegetation and water quality, preference for certain vegetation types, possible relationship to fuel moisture and associated fire risk, and opportunities for management. Deer is still a priority for research, particularly methods for managing impacts, although consideration could also be given managing the impacts of other introduced species (e.g. fish, weeds, rabbits).
MWRPP_6	Effective engagement of stakeholders to support Heathy Waterways Strategy objectives	This research projects aims to understand the best ways of engaging different stakeholders, particularly 'hard to reach' groups that are important to delivering Healthy Waterways Strategy objectives. It will map strategic partnerships and where there are critical gaps in our ability to deliver effective collaborative partnership programs across urban and rural waterways. It will be important to identify the groups we need to target and for what purpose we are engaging with them, in order to understand (from those groups) how we can effectively engage with them.
MWRPP_7	Effectiveness of rural land management interventions to reduce sediment, nutrient and pesticide run-off to protect waterway health	This research will seek to quantifying the benefits of key rural land management activities as part of Melbourne Water's Rural Land Management Program, including improved metrics used to estimate the effectiveness (and prioritisation) of site scale agricultural interventions to reduce sediment, nutrient and pesticide run-off to protect waterway health. In the first instance this project could start with the creation of tools based on prior research conducted by the Partnership e.g. vegetated buffers along gullies, rural biofiltration systems.

Project ID	Title	Description
MWRPP_8	Models and decision support tools to model the status of wetland environmental values, explore threats and likely future conditions and prioritise management interventions most likely to protect or improve wetland values	This project will further develop and refine the spatial environmental data library for wetlands (and waterways) in the Port Phillip and Western Port region as they are vital inputs for instream and wetland biota Habitat suitability models. This project will continue to develop and refine wetland Habitat Suitability Models for frogs, fish and birds that will enable predictions of current condition, condition under future urban growth and climate change, and response to management actions. It will also develop action planning scenarios for analysis via decision support tools like Zonation to aid in prioritisation of management scenarios for wetlands and setting environmental value targets for wetland assets in future Healthy Waterways Strategies.
MWRPP_9	Opportunities to incorporate instream vegetation into future Healthy Waterways Strategies	Conducting research on the relationships between catchment characteristics (e.g. imperviousness, tree cover), flow, channel form and instream vegetation to inform opportunities to manage and protect instream vegetation as a value in the next Healthy Waterways Strategy.
MWRPP_10	Optimum combination of centralised and decentralised stormwater control measures (SCMs) to achieve Healthy Waterways Strategy stormwater harvesting and infiltration targets and protect headwater streams	Will investigate the optimum combination of centralised and decentralised approaches, at multiple scales from the lot, street and public open space, to achieve the Healthy Waterways Strategy stormwater management performance objects, including stormwater harvesting and infiltration, and the protection of headwater streams. This research is expected to provide prioritisation tools to assist in spatial prioritisation of stormwater control measures in new and existing urban areas.
MWRPP_11	Better understanding of relationship between hydrology and key environmental values to help set environmental flow objectives	Will investigate the environmental flow requirements of key environmental values in rivers, wetlands and estuaries where there is a lack of confidence in flow objectives in environmental flow planning e.g. macroinvertebrates, frogs, platypus, and native fish. The identification of critical knowledge gaps will be supported by the Healthy Waterways Strategy key value conceptual models and consultation with teams involved in environmental watering programs.
MWRPP_12	Managing the impacts of climate change on remnant vegetation, revegetation and weeds	Will continue work to forecast impacts of climate change on a broader range of plants, including remnant vegetation, revegetation and invasive weeds, to inform climate resilient vegetation management programs. It could also monitor climate resilient revegetation approaches through establishment of climate plots across climatic gradients in Melbourne and develop a new management framework that builds resilience and adaptation of riparian revegetation to projected future climatic conditions. As well as streamside vegetation, could include consideration of estuarine vegetation (saltmarsh, mangroves).
MWRPP_13	Managing the impacts of climate change on the health of estuaries and wetlands	Will investigate the likely impacts of climate change (e.g. extreme events such as fire, heatwaves, 'rain bombs', floods, and storm surges) on the health of estuaries and wetlands, and management options. It will aim to identify species, communities, ecosystems at greatest risk from climate change, including groundwater dependent ecosystems (GDEs). Could consider risks to a range of environmental values, including vegetation, fish, frogs and birds, and could be supported by scenarios using the wetland Habitat Suitability Models, including an analysis of refuges across the landscape. Rather than just understanding the likely impact of climate change on the health of estuaries and wetlands, it will important to understand management opportunities.
MWRPP_14	Understanding and managing the threat of urban stormwater to waterway health under a changing climate	Will aim to understand management opportunities in the face of the combined impacts of urban growth and climate change. It will seek to better understand how flow changes and extreme events associated with climate change will influence the threat of urban stormwater (e.g. increased storm intensity), including infill urban development on the capacity of existing waterways and drainage infrastructure, and how interventions can mitigate these compounding threats (e.g. smart tanks).

Project ID	Title	Description
MWRPP_15	Impacts of barriers to the dispersal of key environmental values across the landscape	The research project aims to understand the impacts of barriers (e.g. roads, dams, weirs, pipes, levees) to dispersal of key environmental values across the landscape (including under a changing climate and following disturbances such as bushfires). It will also evaluate the likely benefits of interventions that increase population connectivity (e.g. fish barrier removal, road underpasses, translocations). Initially, this research could draw on Melbourne Water's comprehensive environmental DNA dataset and other historical biological monitoring and research data underpinning our Healthy Waterways Strategy Monitoring, Evaluation, Reporting and Improvement Framework.
MWRPP_16	Quantifying the true cost of urban development with regard to waterway degradation and restoration	This project will quantify the full cost of urban development to society, including waterway degradation (e.g. bed stabilisation, grade control, riparian vegetation management, litter collection) and associated increase in levels of management to support business cases for catchment and waterway protection policy and guidelines in the context of urban development.
MWRPP_17	Increasing our knowledge to protect threatened platypus	Platypus were recently listed as a threatened species in Victoria given steady contraction in the distribution and population densities across the State. This project will investigate the relationship between platypus populations, water quality and macroinvertebrate communities (abundance and diversity), as well as increasing our understanding of the carrying capacity and minimum habitat patch size required to support a self-sustaining platypus population.
MWRPP_18	Effective engagement with the general public in 'catchment thinking' to inform waterway management activities	This project aims to understand how we effectively engage the general public in 'catchment thinking' and how it might inform waterway management activities and their communication. For example, does the community understand the link between rivers, stormwater and sewerage? This project seeks to understand ways to increase catchment and water literacy, as well as community drivers, for the purpose of behaviour change to protect or improve waterway health, including volunteering. Example programs where we are currently seeking community engagement for waterway health outcomes and could for case studies include the Monbulk Creek Smart Water Network, Stream Frontage Management Program and Rural Land Management Program.
MWRPP_19	Increase our understanding of the distribution of threatened aquatic species	The Healthy Waterways Strategy Monitoring, Evaluation, Reporting and Improvement Framework outlines the need for Melbourne Water to understand the current status and trajectory of threatened aquatic species. Initially, this research could draw on Melbourne Water's comprehensive environmental DNA dataset and other historical biological monitoring and research data to increase our understanding of the distribution of threatened aquatic species, including clarifying taxonomic uncertainty where required e.g. amphipods.
MWRPP_20	Relationship between physical form and ecological health of waterways	This research will seek to better understand the relationship between physical form, instream habitat types and ecological health, including the role of sediments in streams and benefits for reducing incision. This research will also consider the relationships between physical form and floodplain connections to inform opportunities to protect stream channels and floodplains from urban growth. It could explore the incorporation of physical form environmental predictors in Habitat Suitability Models for instream environmental values (e.g. fish, aquatic macroinvertebrates, platypus) and the refinement of physical form condition metrics and targets in the next Healthy Waterways Strategy.
MWRPP_21	Understanding the barriers to achieving Healthy Waterways Strategy stormwater harvesting and infiltration objectives	The mid-term review of the Healthy Waterways Strategy identified that we are off track for achieving our stormwater harvesting and infiltration targets. Achieving these targets is critical for the protection and improvement of waterways across the region under urban growth and climate change. This research will seek to understand the major barriers to the implementation of HWS stormwater Performance Objectives (e.g. policy, guidance, capacity and funding, sector willingness) and identify opportunities to overcome critical barriers.

Project ID	Title	Description
A3P_MWRPP_1	Develop methods, metrics and strategic management frameworks for waterway function as a key environmental value	Investigate and develop monitoring methods and metrics to enable the inclusion of waterway function as a key environmental value (e.g. nutrient and carbon processing) in future waterway strategies, as well as helping to prioritise waterway management interventions and setting of strategic targets that can be part of the HWS MERI Framework. One aspect that A3P could incorporate is the threat of toxicants to waterway function.
A3P_MWRPP_2	Measuring pollutant treatment performance of Water Sensitive Urban Design (WSUD) assets	In addition to stormwater wetland performance project above, this project aims to develop efficient and effective indicators and approaches to monitor the pollutant treatment performance of other WSUD assets (e.g. biofilters, green roofs, raingardens, passively irrigated street trees) to inform improved designs, appropriate maintenance regimes and long-term sustainability.
A3P_MWRPP_3	Understanding the treatment of toxicants by stormwater wetlands as well as the effect of toxicants on wetland performance	Includes developing efficient and effective indicators of performance, to support industry guidelines, improve future design and underpin asset maintenance prioritisation. Research will be based on contaminants that Melbourne Water are most concerned about (e.g. zinc, pesticides, microplastics), extent to which these chemicals are removed by wetlands, implications for maintenance and disposal costs, and wetland treatment performance (e.g. biofilms, sediment bacterial communities). Includes economic, social and environmental risk assessment of pollutant accumulation.
A3P_MWRPP_4	Understanding the threat of climate change to water quality in waterways to inform mitigation opportunities	This project will seek to understand the threat of climate change to water quality in waterways and key environmental values most vulnerable to changes in water quality. In particular, it will look to determine critical thresholds for relevant species, in response to changes to temperature, dissolved oxygen, salinity and flow. This information could be combined with modelling approaches to predict impacts of climate change across the region and likely benefits of management interventions.