Research & Innovation at Melbourne Water

31 projects showcasing technological and innovative excellence

2021

VICTORIA State Government

Melbourne Water

Enhancing Life and Liveability

Contents

Message from the Managing Director and Chair

Melbourne Water continues to be an industry leader through our commitment to excellence in research and innovation. This commitment underpins our vision of Enhancing Life and Liveability and supports our role in managing and protecting Melbourne's waterways and water resources to provide affordable services which are essential to the community, businesses and the environment. We strive to continuously improve the services we deliver through innovation and the application of high quality research outcomes, which are developed through targeted partnerships with universities, research organisations and the broader water sector. This collaborative model results in cost-effective access to academic excellence, while maintaining value for money for the community and ensuring that decisions regarding the delivery of services are supported by sound science and engineering.

Michael Wandmaker

John Thwaites

Specific challenges have arisen in 2019 and 2020 through the impact of devastating bushfires and the COVID-19 global pandemic. We have had to respond swiftly to a changing environment and have relied on our research relationships and in-house expertise to continue to develop innovative solutions to enable Melbourne Water to maintain operations and safeguard the health and wellbeing of our workforce.

Our excellence in innovation has again been acknowledged with Melbourne Water being named as one of the most innovative companies across Australia and New Zealand. Our development of a world-first Confined Space Entry simulator, through a collaboration between our Safety, IT and Asset Management Services teams and Deakin University's CADET Virtual Reality Training and Simulation Research Lab, was ranked in the top five in the Government, Education and Not-for-profit category of the AFR BOSS Most Innovative Companies list. This is the second year in a row that Melbourne Water innovation has been ranked in the top five.

We are proud to be sharing some of our current projects with you. These case studies represent a range of research and innovation projects that are underway or have been completed, and are now being implemented.

Our research and innovation outcomes allow Melbourne Water to achieve its goal of Enhancing Life and Liveability, as well as supporting our commitment to the United Nations Sustainable Development Goals. This snapshot highlights the quality of outcomes being delivered through Melbourne Water's research and innovation efforts.

Michael Wandmaker
Managing Director

John Thwaites
Chair

Why research is important

Our Strategic direction

Melbourne Water relies on informed strategic and operational decisions in order to deliver its vision of Enhancing Life and Liveability. Outcomes-based research underpins those decisions and supports the three pillars that represent our service to the community.

- **Healthy People** – strengthening the health and wellbeing of the community
- **Healthy Places** – Co-creating the world's most desirable places to live
- **Healthy Environment** – enhancing the natural environment

Research and development, together with innovation, are tools that assist Melbourne Water achieve its vision by:

- Understanding risk to enable confidence in planning and operational decisions.
- Investigating novel technologies for faster, or more cost effective-ways to do things.
- Ensuring Melbourne Water is aware of emerging issues nationally and internationally that require research to determine possible impacts on Melbourne Water's services.
- Contributing to the regulatory process and providing confidence that State and Federal standards and guidelines are based on the best available science.
- Sharing information across the business and the broader industry to increase organisational capability and common understanding.
- Contributing expert advice on specialised technical matters, including to Government agencies or Ministers.

Obligations

The need for research is supported by key legislative instruments, such as the Water Act (1989), The Victorian Safe Drinking Water Act (2003), the Safe Drinking Water Regulations (2015) and the Water for Victoria – Water Plan (2016). Research needs are also articulated across the whole business in Melbourne Water strategies, including those for Asset Management, Sewerage, Healthy Waterways and Drinking Water Quality.

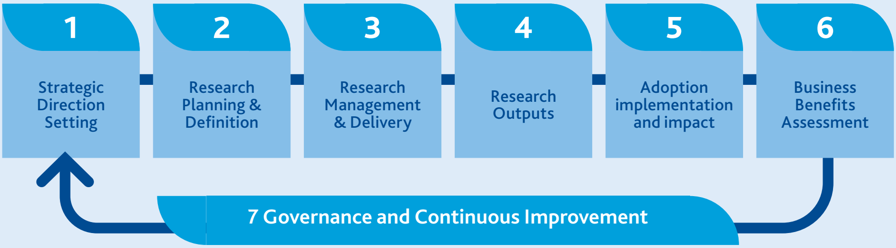
Mitigating risk

Melbourne Water's water supply, sewerage and stormwater systems are complex environments. To support integrated management of the water cycle and shared community assets, traditional approaches to managing risk for discrete systems have been replaced by a collective approach using multiples lines of evidence, drawn from research efforts. Research questions range from traditional issues relating to water and sewage treatment, through to understanding the impacts of climate change and emerging contaminants on the ability for Melbourne Water to maintain its levels of service and to maximise value for both core services and new initiatives for the community.

Driving efficiencies

Efficiency and innovation are necessary elements of any successful business. Research portfolios are developed based on identified needs for managing existing assets and improving operations, through to understanding the technical feasibility of novel approaches and reducing the impact of emerging issues. The outcomes of these projects result in the adoption of new measuring methods, upgraded or new treatment processes, modification to existing operations and more cost-effective ways of doing things. As the population grows and water resources are impacted by a changing climate, our ability to respond to these drivers is essential for delivering the best community outcome at the lowest community cost.

How research delivers value



Delivering Value

The benefits of research and innovation are tangible, and flow through directly to customers and community in the form of:

- Improved service reliability.
- Healthy People, Places and Environment.
- A more resilient city and region that is better prepared for the challenges of the future.
- Optimised investment of revenue from customers to more efficiently deliver on their priorities.
- More affordable services in both the short and long term.

Making research and innovation decisions

In order to ensure that research undertaken is relevant and of a high quality, we adopt a number of approaches to developing research portfolios and prioritising projects. Integral to this is identifying a need for information, consultation with customers and stakeholders, collaboration, and an understanding of recent developments both nationally and internationally. It's important that we carefully define the research questions, prioritise which ones should progress further, seek leveraging funds and measure the benefits of each project.

Collaborative Research partnerships

We know that working with others leads to better outcomes. Collaboration both within and outside our industry results in new ideas and expertise. This in turn leads to the exchange of ideas and experience, development of relationships, sharing of costs and fosters a culture of knowledge sharing. This efficient way of generating knowledge supports Melbourne Water's culture of innovation and encourages us to adopt new approaches to existing and emerging business risks.

Making research and innovation decisions

How does the need arise?	How do we prioritise?	Where is the funding from?	How do we determine success?
Customers	Strategic priorities	Regulated revenue	Feedback & reputation
Our strategic direction & environment scan	Clear beneficiaries	Co-funding from regulators & policy areas	Customer engagement
MW strategies	Risk impact	External granting bodies e.g. ARC	Degree of uptake
MW risk register	Operational outcome	Research institutions	Return on investment
Regulators	Leverage available	Co-funding from water utilities	Leverage
Policy makers	Reputation		Risk register change
Incidents	Deferred exposure		Influencing policy
Innovation program	Significance to regulatory/policy environment		Relationship development
Other sectors	Synergies with external programs		Capability development
			Requests for involvement in new projects

In 2019–20, Melbourne Water invested more than $6 million in over 60 individual research projects.

Collaboration is facilitated through membership of national and international research agencies, research brokers and industry organisations, or through the establishment of bespoke research partnerships.

Establishing research partnerships is a key element in Melbourne Water's commitment to deliver value in research outcomes. Partnerships enable us to leverage the broad expertise and agile thinking that is the mainstay of university research. It results in an association that benefits all parties and results in high quality science being applied to real-world problems. This approach builds capability within Melbourne Water and translates into defensible, published results that are used to support decisions. Our partnerships create a legacy of cooperative problem solving and represent best practice in delivery of research.

Current research partnerships include:

- The Aquatic Pollution Prevention Partnership (A3P) , with RMIT University.
- The Cooperative Research Centre for Water Sensitive Cities (CRCWSC), with Monash University.
- The Melbourne Waterways Research Practice Partnership , with the University of Melbourne.
- Arthur Rylah Institute for Environmental Research – Melbourne Water Integrated Research Program.
- The Nuisance and Harmful Algae Science-Practice Partnership with the University of New South Wales.
- The Walter and Eliza Hall Institute of Medical Research – Melbourne Water Centenary Fellowship for Water, Global Health and Innovation.

In 2019-20, Melbourne Water invested more than $6.7 million cash in over 64 individual research projects. The majority of these projects were collaborative, and included contributions from other partners such as the Australian Research Council, universities, water utilities and state and federal governments. We worked together with 33 Australian and 8 international universities, over 20 water utilities, 16 government agencies, 10 research agencies and 50 industry partners on multi-year projects totalling over $275 million. By working collaboratively, we are able to achieve far more than any one partner on their own.

FY 2019/2020

$275
Million budget

50
Industry Partners

10
Research agencies

41
Universities (inc. 8 international)

$37
Million in research

16
Government agencies

64
Projects

20+
Water utilities (10/18 in Victoria)

$6.7
Million in cash

31 projects showcasing technological and innovative excellence

→

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Using automation to improve service delivery at Patterson Lakes

1

Automating the operational aspects of our business is a key focus for Melbourne Water. In many instances, employing new technology that automates inspection and operational processes has proved not only cost effective, but also had the benefit of increasing staff safety and helped protect the environment and our communities.

One example of this is the operation of flood gates at Patterson Lakes, in Melbourne's outer south-east. These flood gates separate the tidal waterways and town centre marina from Patterson River and are designed to protect the area's 1,400 residents, their properties and local roads from flooding.

The tidal gates open during normal weather conditions so that boats can access the river, but close when river levels are high.

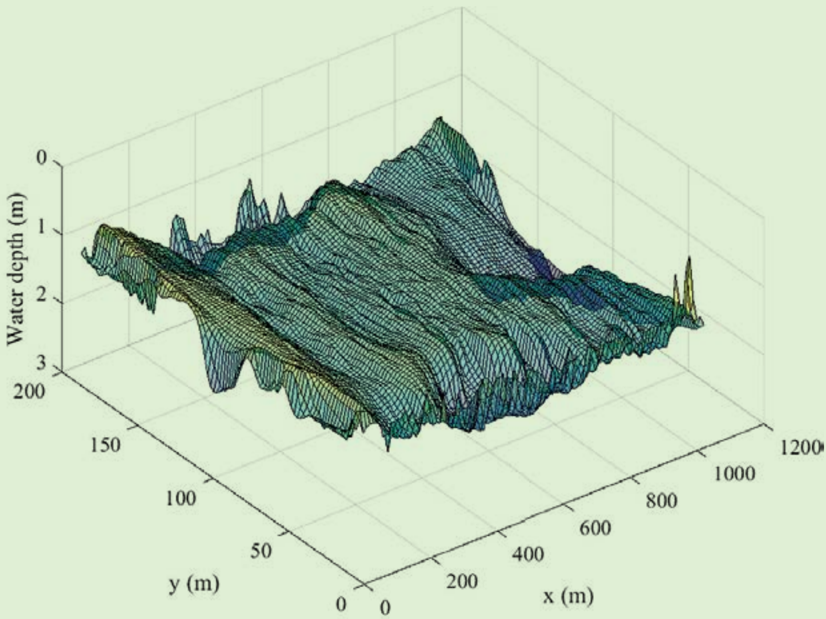
Traditionally, Melbourne Water personnel have had to attend the site manually to close the gates to prevent flooding, often in the dark and during bad weather. This process is not only potentially risky to our operators, but also costs valuable time while flood waters may be making their way upstream.

A new automated system currently being installed will allow the gates to close remotely as soon as we receive an alert about potential flood conditions.

This instant response will mean reduced chances of floodwater entering the tidal canal system as well as lowering our labour costs, improving staff safety, and helping to protect homes and businesses close to the river.

Patterson River Marina

Using autonomous remote operated vehicle technology for desludging lagoons



2

Water depth (m)

Mapping of the remaining WTP lagoons to be completed during 2020 to 2021

Lagoon-based wastewater treatment plants, such as Melbourne Water's Western Treatment Plant (WTP), provide a relatively low-cost way of treating wastewater.

The recycled water produced is vital for valuable agricultural industries during periods of drought, as well as reducing the demand on potable water supplies. But sludge accumulation in wastewater lagoons reduces the treatment efficiency of the lagoons over time.

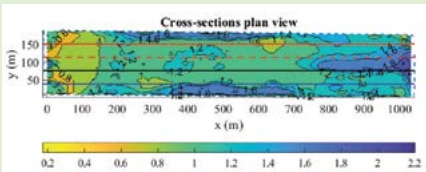
To de-sludge a lagoon, it must first be determined how much sludge has accumulated and where. The WTP's large-scale lagoon systems make this difficult, with the largest lagoon being over 1 million square metres in area. Methods to measure sludge height have traditionally been low-resolution and labour-intensive, such as a boat and a graduated pole.

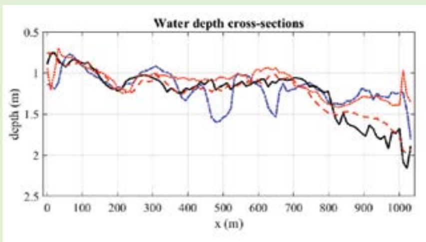
Recognising an opportunity for automation and the generation of high-resolution sludge-mapping data, Melbourne Water partnered with the University of Western Australia (UWA) to co-fund the development of remote operated vehicle (ROV) bathymetry mapping technology and its associated software.

To date, sludge bathymetry of 13 large WTP lagoons has been mapped, including nine of the 10 ponds which produce recycled water for the Werribee Irrigation District. This work is ongoing, with plans to complete mapping of the remaining WTP lagoons during 2020 to 2021.

The UWA is presently exploring ways to optimise the use of this technology so as to further reduce the time and cost of lagoon sludge mapping.

The results are helping prioritise the ponds for de-sludging which will help ensure that the recycled water meets its quality targets.





3

Using AI to reduce the high cost of vegetation monitoring in retarding basins

Artificial intelligence helping to map vegetation in retarding basins

Melbourne Water manages more than 200 retarding basins across Greater Melbourne, with another 40 to be added by the end of 2021. These retarding basins are vital for reducing flooding by holding heavy rainfall in low-lying areas of land reserved for this purpose.

Retarding basins are required to meet minimum design requirements, meaning it's critical that the vegetation health of newly established and existing retarding basins is monitored.

Currently, Melbourne Water uses a methodology consisting of both random sampling and on-the-ground field work. Our recent development of unmanned aerial vehicle (UAV) capabilities, however, has provided a unique opportunity to develop a more comprehensive and cost-effective way to monitor the vegetation in retarding basins. This new method can be used to replace the manual counting methods which have been used for many years.

In partnership with FrontierSI, a spatial data not-for-profit research organisation, we've used machine learning to develop a prototype algorithm for 'deep learning' tree detection and vegetation counting.

The algorithm can assess the presence or absence of vegetation, identify the type of vegetation and the number of different areas of vegetation. This is proving successful in interpreting images of Melbourne Water's retarding basins taken by the UAVs.

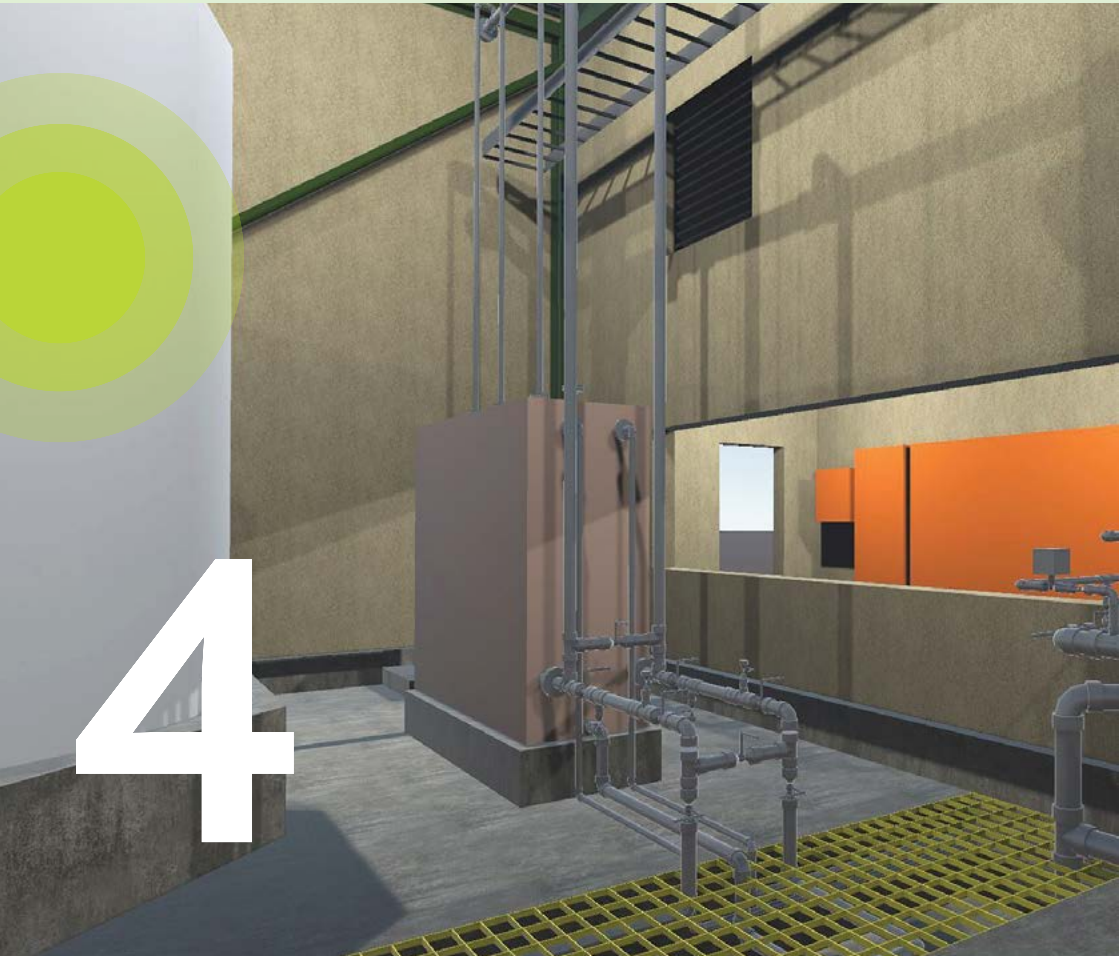
Our UAV program is exploring the potential for deriving additional valuable information from its captured UAV imagery of retarding basins. The aim of the prototype is to establish the viability and confidence we can place on this automated UAV vegetation detection algorithm, which has the potential to reduce the high cost of vegetation monitoring in retarding basins.

With recent major breakthroughs in the use of machine learning resulting in major reductions in the error rate, the technology is now better than the human eye for detecting features in UAV photographic images.

Bounding boxes determining the presence of vegetation and vegetation type in a Melbourne Water retarding basin

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

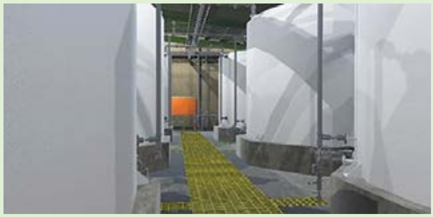
Using virtual reality to review engineering design



When a new facility and the associated treatment equipment are designed, a final step in the process is a workshop to review the drawings by those who will use the equipment or facility. This review was previously based on 2D paper or screen-based drawings. But these have now been replaced with virtual reality technology that enables a virtual tour of the planned facility.

This is now a mandatory process for all of Melbourne Water's major projects and the feedback has been extremely positive. By embarking on one of these virtual reality review tours, a technician can now simulate completing a task in the virtual world and explain to the designers whether or not there are access or design issues in the plant.

On average this approach has identified four times more design issues than the traditional workshops, and takes a quarter of the time to complete.



Virtual reality images

This approach has identified four times more design issues than the traditional workshop

Saving electricity by operating aerators intermittently at Sugarloaf Reservoir

$13,500

estimated direct power savings

5

Melbourne Water operates large aerators within our drinking water reservoirs to prevent stratification, which is the development of warm water layers with much colder layers below. Preventing stratification reduces the likelihood of toxic algae blooms and 'dirty' water events, which can be caused by iron and manganese present in the water column. While aeration ensures good water quality, it is expensive from an energy and maintenance perspective.

Historically, to ensure the reservoir was well mixed, aerators have operated continuously throughout the warmer months, usually from early November through to Easter.

However, a trial was undertaken to determine if intermittent operation of the aerators, which would save on energy and maintenance, could still achieve the same outcome as continuous aeration and produce good water quality.

A purpose-built 3D-hydrodynamic reservoir model was developed to test a number of scenarios ranging from continuous operation of the aerator, to six months of a 12-hour on/off cycle, and variations in between.

While the model showed that running the aerator intermittently for an entire six-month period would not adequately mix the reservoir, it did demonstrate that continuously running the aerators for three months, and then intermittently for another three months, gave the same outcome as running continuously for six months.

A successful live trial of this operating regime was then undertaken where mixing was adequately maintained throughout the three months of intermittent operation. The trial, which utilised an automated Vertical Profiling System (VPS) to sample the water, showed no stratification in the reservoir and no adverse effects on water quality.

Additionally, direct power savings were estimated to be around $13,500, maintenance and infrastructure replacement costs were reduced, as were GHG emissions. Following the success of the trial, automation of the intermittent aeration regime will be put in place in at least two of Melbourne's other reservoirs.

6 CLEAN WATER AND SANITATION

13 CLIMATE ACTION

Reducing greenhouse gas emissions using a temperate zone short cut nitrogen removal plant

6

Nitrogen removal, a vital step in the sewage treatment process at the Western Treatment Plant (WTP), reduces nutrients in the treated water discharged to Port Phillip Bay.

Conventional nitrogen removal uses bacteria that require large quantities of oxygen and carbon – and consequently has a high-energy demand.

Recent work has revealed a short cut for the nitrogen removal process that greatly reduces both the oxygen and carbon needed. Potentially the 'next big thing' in domestic sewage treatment, shortcut nitrogen removal has the potential to transform the way we treat wastewater, and provide cost savings for Melbourne Water and our customers.

Cultivating the right bacterial population, however, is not a simple science. Although shortcut nitrogen removal is well established in Europe and USA for processing concentrated digester side streams, it is only just starting to be implemented for treating the more dilute whole sewage flow. As WTP does not have a digester with a nutrient-rich side-stream, this presented a number of challenges to implementation.

A recently concluded trial of the process at WTP, however, has shown promising and significant results. The two-and-a-half year demonstration was able to continuously maintain the right balance of bacteria over the full range of expected conditions at WTP, thus representing a global first for continuous robust operation in temperate conditions.

The process also achieved a 35-45 per cent improvement in carbon efficiency, which will allow Melbourne Water to continue to achieve its nitrogen discharge targets without having to compromise renewable energy production.

Additionally, in translating the demonstration plant learnings to the renewal of the existing 55E Activated Sludge Plant, the risks of adopting this new process have been significantly reduced. The bioreactor volumes have also been reduced, thereby saving capital expenditure.

In addition to the direct outcomes, the demonstration plant has also significantly contributed to enhancing the skills of Melbourne Water staff. The plant allowed several members of the graduate program to gain hands-on experience operating a novel wastewater treatment process without the risk of failing our EPA discharge licence.

Findings have been presented internationally and nationally at several conferences in places such as Chicago, Shanghai, Singapore, and Brisbane, helping to establish Melbourne Water as an innovation leader on the global stage.

Shortcut nitrogen removal pilot plant at WTP

Thinking globally to reduce greenhouse gas emissions

7

Although Melbourne Water has made a substantial reduction in its Scope 2 (indirect) greenhouse gas emissions, reducing Scope 1 (direct) greenhouse emissions has proven more challenging.

Both the Western Treatment Plant and Eastern Treatment Plant produce a high volume of Scope 1 emissions and we are committed to reducing these in line with the State Government's target of zero emissions by 2030, as well as the United Nations Sustainable Development Goal 13 – Climate Action.

To tackle this problem, Melbourne Water launched the Scope 1 Emissions Innovation Competition, a highly competitive global contest aimed as identifying new solutions. We engaged Isle Utilities to manage the competition and offered a $10,000 prize to each of the top four participants to develop their ideas further.

These were then presented to an expert committee who selected the winning entry, with the winner receiving $160,000 to carry out a feasibility study.

From a quality field of proposals, the Cranfield University/AECOM/Royal Melbourne Institute of Technology University group was assessed as the best overall detailed solution, offering potential for both a high degree of reduction in direct emissions and also improving energy efficiency, relative to conventional treatment processes.

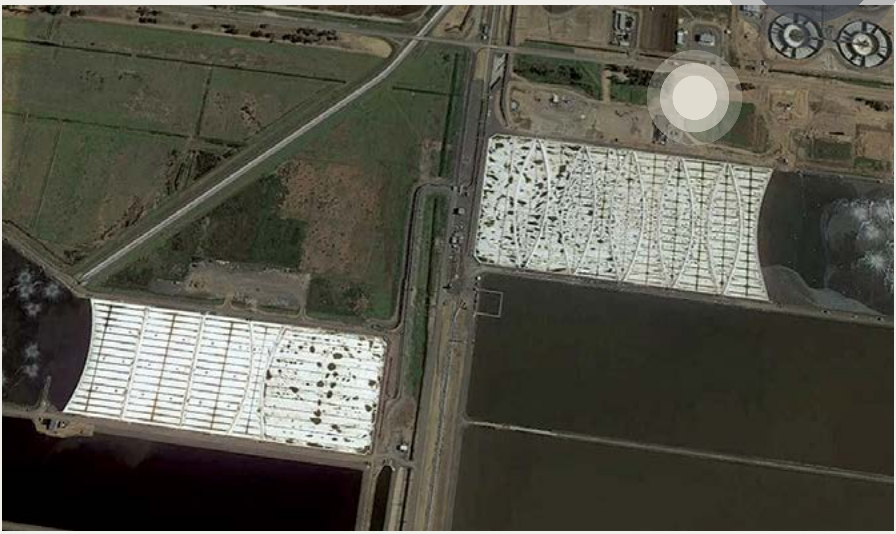
Their winning solution, which is being described as a new paradigm in wastewater treatment, combines established unit operations and mature technologies with newer elements in a way that reduces dependency on biological processes more prone to greenhouse gas emissions. Reductions in greenhouse gas emissions of up to 90 per cent are considered feasible.

Liveability Victoria co-funded the prize, which will be used to further develop and test key elements of the proposal at laboratory scale. This is expected to take around eight months. Beyond this, further design and pilot scale testing work would be required to assess potential feasibility for larger scale implementation.

6 CLEAN WATER AND SANITATION

13 CLIMATE ACTION

Managing anaerobic lagoons to enhance biogas production



Aerial view of the two covered anaerobic lagoons at the Western Treatment Plant

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Melbourne Water's Western Treatment Plant (WTP) operates some of the largest anaerobic lagoons (ALs) in the world.

Many lagoons have covers which capture biogas that can then be used for energy production. The lagoons require no external heating source as the treatment process occurs at ambient temperatures and generally produces biogas with a higher percentage of methane compared to conventional mesophilic anaerobic digesters. The effectiveness of this AL treatment process, however, can be impacted by the accumulation of scum and sludge under the floating covers, which creates stresses and can lead to damage.

Despite ALs being widely used, knowledge regarding biological dynamics and solids behaviour is limited and has led to uncertainty regarding appropriate sludge and solids management strategies.

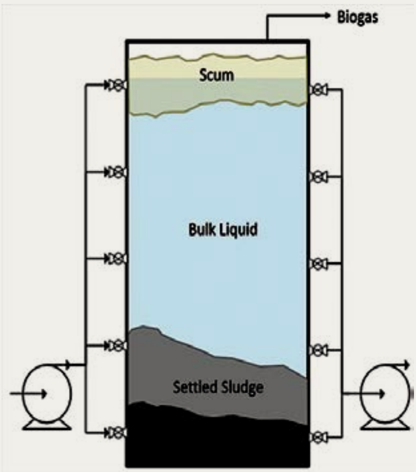
Melbourne Water is working with the University of Queensland, University of Melbourne and RMIT to develop a new, evidence-based operating protocol for the ALs to manage sludge and optimise biogas production. For the past three years, a pilot plant with a large glass window has been operating onsite at WTP, allowing us to see and understand the sludge dynamics in a way not possible in the large lagoons.

Ongoing testing of the pilot plant feed, sludge and effluent has facilitated the development of a biochemical-hydrodynamic model of the pilot plant and the full-scale lagoons. The model utilises computational fluid dynamics and will shed new light on the operation, including how to manage the solids and optimise biogas production.

So, what are anaerobic lagoons (ALs)?

ALs remove most of the organics from the wastewater, produce renewable energy in the form of methane-rich biogas and are used across Australia and internationally as a relatively cheap form of wastewater, sludge or manure treatment.

Diagram of cross section through the anaerobic pilot plant



Melbourne Water has a target of halving our greenhouse gas emissions by 2025

9

Delivering multiple benefits through coordinating pumping of our drinking water

The Melbourne water supply network is complex. With a total capacity of 1,812 billion litres stored across 10 reservoirs and 37 service reservoirs, water is treated by 14 treatment plants and transported via 1,069km of water mains and 221km of aqueducts.

This drinking water, ultimately, reaches more than 5 million people and many industries spread over an area of approximately 10,000 square kilometres. As the water predominantly runs downhill from the catchments, 14 turbines located in large pipes are used to generate electricity to reduce pumping and water treatment costs.

Melbourne Water has a target of halving our greenhouse gas emissions by 2025 and exploring a path to reduce them to net zero by 2030. In order to achieve this, many projects are being explored to reduce energy use, minimise greenhouse gas emissions by our wastewater treatment plants, and generate renewable energy.

While most of the water in the system is transferred by gravity, there is still notable energy use in pumping and water treatment. This pumping is complex and costly, both financially and in terms of greenhouse gas emissions.

In order to reduce energy use, Melbourne Water is implementing a new technology, called AquaAdvanced Energy. This technology will work together with our existing SCADA system to automatically sequence pumping and water distribution across the infrastructure network between our water treatment plants, and our supply points to the retail water companies.

The optimisation model within the software will help minimise pumping costs and maximise generation of revenue by the hydroelectric turbines in the network. It will also reduce the risk of outages at our treatment plants, the use of chemicals as it smooths the variations in flow of water, and enable better management of outages when they occur.

The first phase of this rollout of new technology has taken place at the Winneke Water Treatment Plant – Preston Reservoir system Future rollouts are planned for the Tarago – Cardinia system in early 2021 with the final stage planned for Silvan-Greenvale reservoirs in mid 2021.

Streamlining our sewer access approval system

10

The Sewer Transfer Operations Team are responsible for managing safe entry and exit to the 400 kilometres of Melbourne Water's gravity sewers.

They do this through the Sewer Transfer Access Approval process, which had long been facilitated via the manual entry of paper-based applications into a computer database purpose built for Melbourne Water in the 1990s.

This method entailed the following steps:

- Applications to enter the sewers would be received by the operations team via email, face-to-face requests or by fax.
- The operations team would have to type or 'copy and paste' the original information into the database that was available on only one computer which was based in the control room.
- The applicant was required to collect the hardcopy 'Sewer Access Permit' in person before heading out to site.
- Once on site, the applicant was required to phone the control room and quote the approval number to register their entry to the sewer.

This process ensured that a record was kept of each of the approximately 1,500 sewer access applications received each year, but it was also cumbersome. Finding information on who had entered or exited the sewer was time consuming, and access was limited to times when the control room was able to provide oversight as to who was in a Melbourne Water sewer at any given time.

To address this issue, the Sewerage Transfer Operations and Process Support teams, together with the Business Improvement Team, developed a new digital platform called the Access Request System for Sewerage Transfer.

Designed to reduce manual input, the new system offers a more streamlined process by removing the need for paper forms and untracked email requests, and instead allows more time for review of the works and easier tracking by phone, email or the system itself.

Electronic forms automatically record the global position system location of the requested work, the proposed date and contact details for the work leader. Once requests are approved, the new system automates emails and SMS approval notifications, replacing the signed piece of paper, which could potentially be misplaced.

After an applicant 'calls in', the control room can record 'live' sewer entries with a visible countdown to track when contractors are expected to be out of the sewer.

This has reduced potential human error through tracking and recording information and provided a safer outcome for managing potentially high-risk work in the sewer.

The new process also has the capacity to accommodate other areas of service delivery in the future.

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3 GOOD HEALTH AND WELL-BEING
6 CLEAN WATER AND SANITATION
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Keeping safe when entering a confined space

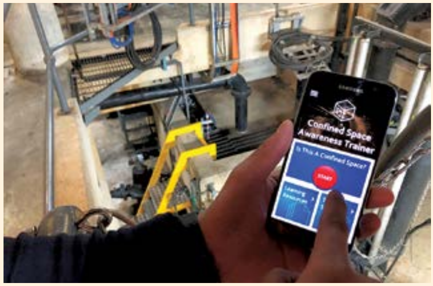
Many of the networks Melbourne Water manages have confined spaces that may be hazardous for humans.

A confined space is an area that is potentially unsafe to work in, due to its physical restrictions and atmospheric conditions. An example of this is our vast sewerage network, which usually has restricted entries or exits and is likely to have an unsafe atmosphere.

Even so, we found that many of our people were uncertain about what constituted a confined space, which would then lead to incorrect classification and application of hazard controls.

To address this issue, Melbourne Water, in partnership with Deakin University's CADET VR Lab, created an app. The app uses the traditional confined space assessment criteria from WorkSafe's Confined Space Compliance Code, and complements this with some common scenarios sourced from the operations staff in the sewerage transfer network, as well as basic refresher information on how to manage hazards that might be encountered.

The app is designed as a 'just in time' training tool that helps remind qualified and unqualified people about the real hazards of a confined space. By having the information at one's fingertips and in an easy to digest format, our aim is to improve safety and encourage learning outcomes by helping those using the app to remember the information for next time.



Because the WorkSafe Victoria Compliance Code is used, we demonstrated how the app works to WorkSafe. As a result, WorkSafe asked if they could place the app on the phones of their Work Place Inspectors. This is expected to occur sometime during 2020. It is intended that the app will also be made available industry wide.

The app has improved the understanding of our staff and contractors regarding what comprises a confined space and resulted in tasks being completed with more practical safety controls.

Our staff feel safer knowing that they are able to make an informed decision with the app to back them up. They can now focus on appropriately managing the hazards of the space rather than being distracted by uncertainty.

3 GOOD HEALTH AND WELL-BEING

Improving staff health and wellbeing

For many years, 'wellbeing' at Melbourne Water had been perceived as 'nice to have' rather than an integral component of our personal health and safety ethos.

Whereas good physical health and safety is culturally accepted – and considerable time and effort devoted to it – the importance of wellbeing has generally received less attention.

Melbourne Water wanted to change this, so we set out to deliver a series of dynamic wellbeing initiatives designed to not only improve our health and wellbeing program, but also to change perceptions.

To do this, we asked our workforce what they thought was important. Our approach and the feedback gathered was underpinned by the following principles:

- Focus on real risk. For example, our crews are exposed to UV while working outdoors, so melanoma is a real risk.
- Accessible for everyone – activities to be run at even the smallest Melbourne Water sites.
- Simple and practical.
- Has an element of 'whole of life' – this acknowledges the 24-hour person rather than treating work and home life as distinctive areas, as we believe that people carry negative and positive behaviour from one area to the other.

Family members at a Family Fun Day at the Western Treatment Plant

Key activities of the new wellbeing program include:

- Skin cancer checks offered to all our employees and contractors. Close to 1,000 of the 1,100 Melbourne Water employees attended the checks, with over 30 people diagnosed with some kind of skin cancer.
- Twenty minute voluntary health checks, which include a mental health questionnaire that gives a score for stress, anxiety and depression. Those with high mental health scores have been referred to our Employee Assist Programme and followed up. Over 350 people have attended a health check.
- Extending flu vaccinations to contractors as well as staff.
- Pharmacy vouchers were offered to people who couldn't attend a flu vaccination at our sites.
- Offering a series of 'Family and Friends' after-hour sessions on first aid and mental health topics, to which employees or contractors could invite their family members or friends.
- Mental health topics focused on building strong relationships, how to speak to teenagers and other communication skills.
- Organising family fun days across Melbourne Water sites.
- Workers could invite family members to their place of work on a Sunday for lunch and fun activities.
- A selection of assistance programs including traditional counselling, financial advice, manager assistance, lifestyle advice including nutrition, conflict assistance and family assistance.
- Since offering these initiatives, we've received dozens of emails sharing positive feedback about the program, demonstrating that a focus on wellbeing does make a real difference in people's lives. Importantly, this can strengthen relationships not only within the Melbourne Water community, but also with our contractors and partners.

3 GOOD HEALTH AND WELL-BEING

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Using virtual reality to train for high-risk maintenance jobs

13

An astonishing 350 million litres of sewage is treated each day at Melbourne Water's Eastern Treatment Plant.

To make sure the highest quality recycled water is produced, the treatment process includes state-of-the-art ozone treatment. Ozone is a highly reactive form of oxygen which cleans wastewater by stripping the electrons off organic matter. Because of its reactivity and the large quantities of ozone required to treat such large volumes of water, we generate this ozone onsite.

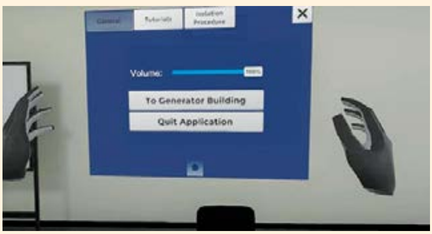
But like any machinery, ozone generators sometimes need to be isolated for maintenance or repairs. This 40-plus step process is one of the riskier ones that Melbourne Water carries out and, although familiarity with the equipment is important for maintaining safety and developing operator confidence, training cannot be done routinely.

To address this issue, Melbourne Water's Safety Team created a virtual reality ozone generator. The generator employs hand-tracking technology that allows users to interact with the virtual menu and 'walk' through the plant to find and fix potential hazards, operating and locking isolation valves as required.

The virtual reality software also allows a number of users to interact in the same virtual reality environment, irrespective of where they are located in the world. This means that we can access experienced technical support from anywhere in the world to support our operators.

The virtual reality ozone generator is an extension of Melbourne Water's virtual reality program where we build replicas of new equipment to help familiarise our staff with new technology before being called on to maintain it.

Hand-tracking technology



A significant number of households took action as a result of the pilot trial

14

Educating the community: a flood resilience pilot study

Floods have long been an inevitable part of life for Melbournians. With the impacts of climate change, it is highly likely that more Victorian homes will flood in the future.

Currently in Melbourne there are an estimated 232,000 properties at risk of flooding, yet only 44 per cent of households in flood-prone areas are aware that they are at risk – and preparedness for a flooding event is low. To date, more conventional community education methods have had little effect on increasing awareness of flooding and the preparatory actions required.

To address this issue, in 2018 Melbourne Water commissioned Brian Cook and his team of researchers at Melbourne University to work with the Victorian State Emergency Services (VICSES) volunteers and the community in the flood-prone areas of the City of Whittlesea. The outcome was a community education program that drew on and enhanced the more traditional VICSES methods of door knocking and outreach.

Community Engagement for Disaster Risk Reduction (CEDRR) takes an innovative and effective approach to community education. The door-to-door engagement assesses residents' preparedness for floods, while also asking residents to help by engaging with their friends, neighbours, and others who could benefit. The aim is to better understand community perceptions and actions, while acting as a prompt to residents to take action and help others in their community.

Melbourne University researchers and VICSES volunteers engaged with flood-prone residents over three visits. The first visit involved gathering data about current levels of flood awareness, the second aimed to understand changes in activity after the first visit, and the third to understand what changes in activity took place after the second visit. In each instance, VICSES got to know the community and hear their views, and could offer household-specific advice if asked.

Initial findings from this research show a significant number of households took action as a result of the pilot trial. Additionally, the CEDRR approach pioneers a form of engagement that stimulates a 'ripple effect' in which the community takes ownership and leads the sharing of flood preparedness information.

As a result of the CEDRR pilot in the City of Whittlesea, Melbourne Water is looking at ways in which this approach can be incorporated into our overall flood preparedness program.


15
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Sewage monitoring for COVID-19 helps management of the pandemic

In response to the 2019/20 COVID-19 (also known as SARS-CoV-2) pandemic, Melbourne Water, in collaboration with a number of other partners, initiated an authorities about potential clusters of people infected with the virus, and timelines of potential outbreaks.

The Australia-wide ColoSSos Project – Collaboration on Sewage Surveillance of SARS-COV-2 – aims to track and monitor the presence of the COVID-19 virus through a partnership coordinated by Water Research Australia. This partnership includes 12 water utilities, six health departments and ten research organisations. The program of work is also supported by the Water Services Association of Australia (WSAA).

The project has the potential to identify emerging or re-emergent outbreaks, better characterise the extent of asymptomatic infections and community transmission, identify the true peak in infected individuals (compared with confirmed cases) within a sewer catchment, and confirm 'clearance' of the COVID-19 virus from an area.

Sampling commenced at different sites across Melbourne and elsewhere in Australia while a sensitive and accurate method was simultaneously being identified. More than 1200 sewage samples have been taken since commencement of the program in April 2020. This includes samples from Victoria from several sewage treatment plants, including the Western Treatment Plant and Eastern Treatment Plant, as well as a number of sewerage system hotspots.

This important initiative is in its early stages, but is a promising methodology that may yield important new information to help inform disease control measures, such as social distancing, to flatten the curve.

Aerial view of Western Treatment Plant lagoons

6 CLEAN WATER AND SANITATION

14 LIFE BELOW WATER

Monitoring receiving water quality through 3D-modelling

Melbourne Water's Eastern Treatment Plant at Bangholme receives and treats over 350 million litres of wastewater per day. While some of the treated water, called Class A recycled water, is used on site or provided to nearby customers, the rest of the high quality recycled water is released into the ocean via the South Eastern Outfall (SEO) at Boags Rocks, Gunnamatta.

This outfall is a shoreline discharge and the second largest ocean outfall in Australia. Under the Environment Protection Authority (EPA) Victoria guidelines, Melbourne Water is required to demonstrate that this discharge to the ocean does not have a negative effect on the local marine environment. A multiple lines of evidence approach is the preferred way of demonstrating this.

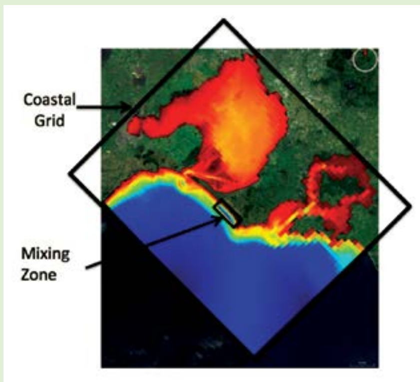
A 3D hydrodynamic model has been developed for the SEO discharge environment at Boags Rocks to compliment traditional monitoring, which is based on taking and analysing water samples. The model uses the Aquatic Ecosystem Model 3D modelling platform, which simulates the behaviour of water over time based on environmental forcing – that is, the effect of the wind, waves and tides. It also shows the fate and transport of the discharged water once it leaves the SEO.

In order to capture the dynamics of the water movement around the discharge point, it was important to incorporate a significant section of coastline in the model domain. Therefore, a small-scale nested grid is also included to ensure the nearshore environment is adequately modelled. To force the model, the best available data from the Bureau of Meteorology, including wind, waves and tides, is used.

The modelling platform is one familiar to specialist modellers within Melbourne Water, so assessing the impacts of changes in discharged water quality and quantity can be done in-house.

The model will be used to assess the "current and future impacts of the outfall" on the near-shore environment and associated aquatic ecosystems, and inform biological monitoring programs and research activities. It will also help to demonstrate Melbourne Water's compliance with the mixing zone requirements, as set out in its discharge licence.

While the objectives of the project included developing a detailed and calibrated model that could be used by Melbourne Water as a decision support tool for strategic planning and scenario assessment, its ultimate goal is to ensure that the area around the SEO continues to enjoy good water quality, thus maintaining the biodiversity of the area.




Floating polymer covers are larger than the MCG
17

Using photogrammetry to detect changes in large polymer covers

Photogrammetry is the science of making measurements from photographs. Often these are 2D aerial photographs which can be used with computers to calculate actual measurements. These 2D photos can even be used to determine measurements in 3D.

A 3D image generated from this process can then be sent to a 3D printer and the 3D printouts of proposed, or new works, can be used as models when sharing these ideas with stakeholders and the community.

With this process in mind, we wanted to know if 2D aerial photographs of the floating polymer covers at the Western Treatment Plant (WTP) could be used to generate a 3D shape for identifying distress 'hot spots' in these floating covers.

These 10-hectare covers collect biogas from the anaerobic digestion of wastewater. This biogas is then used to produce renewable electricity, providing almost 100 per cent of the energy requirements of the entire treatment plant.

Currently, field personnel at the WTP need to walk over the covers in order to detect defects or take measurements to determine the amount of solid scum under the covers. Scum slowly moves under the covers and can result in their tearing, making the inspection of the covers risky.

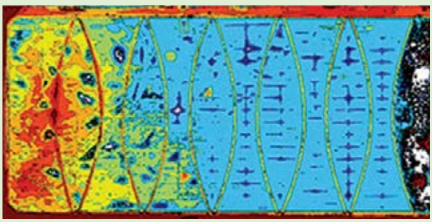
Melbourne Water and Monash University have been utilising photogrammetry to develop a safer inspection method that will enable more accurate scheduling of maintenance and ensure that the covers operate safely for the longest possible period.

Of immediate and additional benefit to operators is that photogrammetry can be used to identify and quantify the volume of scum and biogas between the underside of the covers and the surface of the lagoons, how and where this changes with time.

By applying 'filters' to the collected data, we can also monitor the occurrence of wrinkles and arrange for timely and relevant action.

The results are showing that photogrammetry offers a viable alternative technique for the monitoring and assessment of the floating covers. Work continues to automate as much of the process as is practicable.

Photogrammetry showing areas of stress (red-yellow) in the cover



Melbourne Water's Eastern Treatment Plant treats over 350 million litres of sewage each day

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Improving sludge pipe design through artificial neural network software

Melbourne Water's Eastern Treatment Plant treats over 350 million litres of sewage each day.

Treatment results in separation of the solids from the liquid, creating a dilute sludge that is pumped to and from digesters. Designing pipelines for pumping sludge, though, is complex and problematic. Sludge behaviour in the pipeline is unpredictable and dependent on the concentration of the sludge, the size of the particles, and the way they settle out if the sludge is not continually mixed.

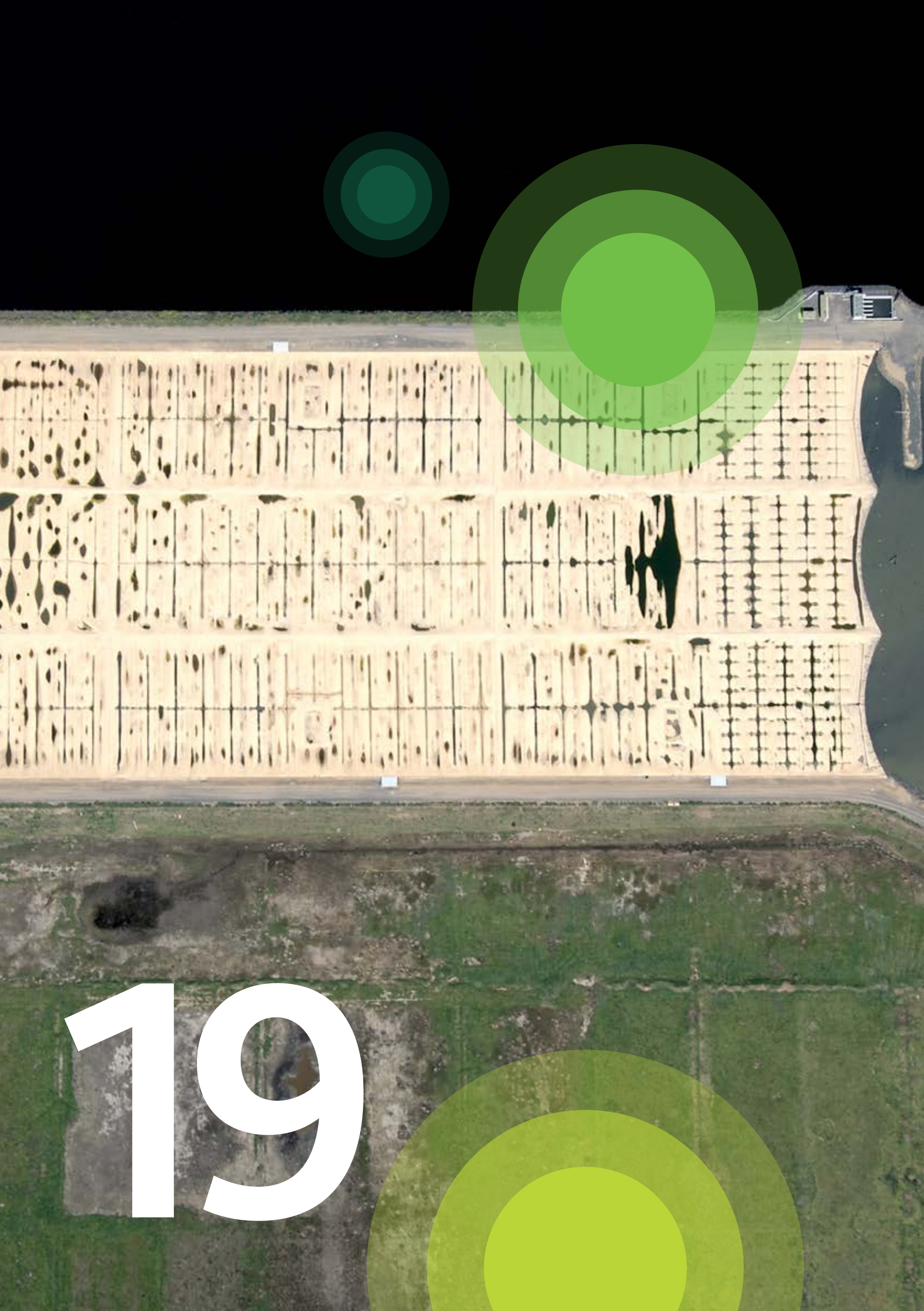
This settling out of sludge particles can lead to blockage of the pipeline, which is then difficult to clear.

While there are a number of methods for designing sludge pipelines, most do not offer effective or economical design solutions. Hence, sludge pipelines have tended to be overdesigned.

To find a more effective solution for the Eastern Treatment Plant's sludge pipelines, Melbourne Water is collaborating with RMIT University and the Perth-based Water Corporation.

The project team collected data over 12 months on the properties of three different types of sludge at Eastern Treatment Plant to develop a software platform for sludge pipeline design. The result is the artificial neural network software, which can predict the performance of the sludge and can be used to design and optimise sludge pipelines, as well as allowing visualisation of the sludge flow.

Work to further expand the use of this software platform is ongoing.



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Collaborating to better manage risks in sewage

Melbourne Water, City West Water, South East Water, and Yarra Valley Water work together to manage the quality of Melbourne's sewage.

In doing so the aim is to:

- Ensure the safety of those working in the sewers and at the wastewater treatment plants.
- Protect the sewage pipes, pumps and other equipment.
- Protect the wastewater treatment processes, including production of biogas by the microorganisms.
- Comply with regulation and licence requirements including the protection of the air, water and soil.
- Facilitate water recycling and the beneficial reuse of biosolids, which are a by-product of wastewater treatment.

A key component of this work is assessing the risk from expected changes in the raw sewage entering our sewers, which typically come in the form of industrial trade waste discharges.

Existing methodologies have proven challenging to use and it was identified that a more streamlined collaborative process would help determine sewage quality risk more effectively.

The Sewage Quality Risk Assessment Toolbox (SQRAT) is a centralised 'single source of truth' digital platform for assessing sewage quality risk. The platform, which was developed collaboratively between the four water businesses, contains a set of tools that can be used to streamline the risk assessment processes.

It also ensures easy access to the latest risk assessment methods, full transparency about how risk assessments are conducted, and that all risks are appropriately prioritised.

Significant work has been undertaken to digitise existing methodologies as well as incorporate outcomes from Melbourne Water's long-term research project, the Sewage Quantitative Risk Assessment for chemicals of concern. This has proved beneficial by compiling knowledge previously challenging to use, into a 'business as usual' process that supports operational requirements.

The SQRAT is not a static system. Rather, it is modular, allowing updates or replacement of existing methods as better ones become available. This ensures that all decisions about managing the quality of sewage are supported by the best available data and knowledge.

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Enabling more Victorians to experience our water assets in new ways

6 CLEAN WATER AND SANITATION

Taking a virtual tour of the Western Treatment Plant

The Western Treatment Plant has been contributing to the health and liveability of Melbourne since it first began treating sewage in the 1890s.

This innovative site produces its own electricity, creates recycled water and is home to rare bird and frog species. It also has important Aboriginal and European cultural heritage values.

Tours of the plant are available to school and community groups. In response to the ongoing success of these tours, we developed an immersive virtual tour of the plant to enable more Victorians to experience our water assets in new ways.

The interactive, self-guided tour provides information and resources to support the current tour program, as well as increase access for those unable to physically visit the plant.

In doing so, the aim is to increase awareness and understanding of water-related issues, encouraging advocacy and water resilience through the development of informed water citizens. The tour provides a bird's eye view of this important Melbourne Water asset, by exploring the:

- Raw sewage inlet.
- Sewage treatment lagoons.
- Agricultural areas.
- Outfall to Port Phillip Bay.
- Conservation wetlands.

A variety of media – including 360-degree drone footage, video, audio and narration – offers an immersive experience that aims to entertain, engage and inspire.

The project also fulfils Melbourne Water's mandated obligation to provide water literacy education, and supports key strategic directions in our Education Digital Strategy.

6 CLEAN WATER AND SANITATION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

13 CLIMATE ACTION

From piloting to full scale nitrogen removal from wastewater

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As population rapidly increases, growth in flows and loads to the Western Treatment Plant (WTP) are increasing.

These increased flows impact the treatment plant's existing ability to meet regulatory obligations around discharge of treated effluent to Port Philip Bay. It has been important, then, to find a way of improving treatment capacity that maintains an appropriate quality of effluent discharged, and thus protects the bay's environmental and recreational values while still ensuring customer affordability.

This ultimately led to the 2018/19 construction of the innovative 160S Nutrient Removal Plant (160S NRP), which has seen a vital improvement in the sewage treatment process at WTP. But the journey to reach this goal was no less innovative and included an atypical procurement strategy and the application of cutting edge global technologies and design.

The project was divided into two phases. The first phase, design development, saw three teams work closely with Melbourne Water between September 2014 and May 2016 to test designs informed by bench-scale testing or pilot/demonstration plant trials and computer modelling.

Three processes were shortlisted:

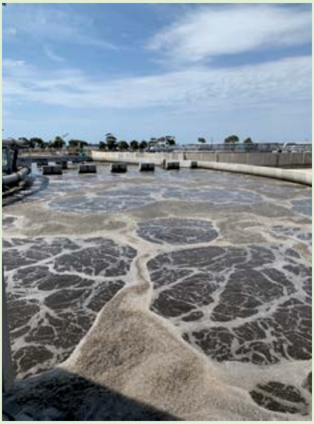
- an aerobic granular sludge process (Nereda®);
- a hybrid mixed liquor/fixed film process (Organica Food Chain Reactor); and
- a step-feed process incorporating advanced control.

This testing phase was critical for reducing risk from the use of new treatment technologies, to both Melbourne Water and the consortium chosen to design and build the plant.

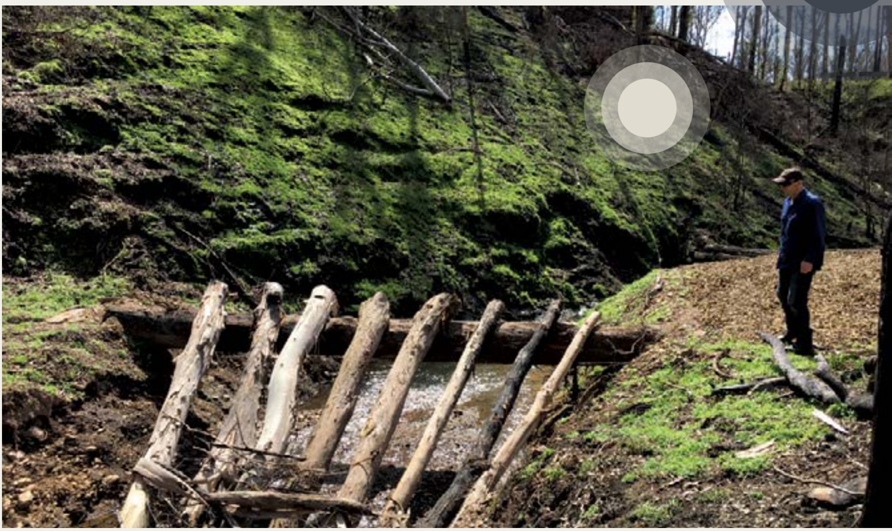
The outcome of this phase informed the subsequent second phase – the detailed design and construction of the 160S NRP, which is capable of treating up to 140 megalitres of wastewater per day (equivalent to 56 Olympic-sized swimming pools).

The new plant was built with the latest advanced monitoring and control systems. It is more energy efficient than the current plant and future benchmarks established by Water Services Association of Australia. It also incorporates sustainable design principles, including a smaller footprint and combined circular reactors and clarifiers, which have reduced the amount of concrete and steel normally required in a 'conventional' separate rectangular bioreactor and clarifier, typical of most treatment plants.

While the delivery approach facilitated a bespoke, cost-effective design and delivered the lowest capital and whole-of-life cost solution, the project overall is an example of cutting-edge technology and design that will benefit both the community and the environment.



Protecting our water supplies from debris flows after bushfire



Because Melbourne's water supply is naturally high quality and low in turbidity and colour, it largely remains unfiltered. But the absence of filtration can also pose a risk to water quality through events such as fires and the resulting debris flows.

The probability of a debris flow increases after bushfire and the risk remains high until vegetation has re-established. Although most debris flows can occur 12 months up to two years after a fire, debris flows may be a risk for many years after a fire effects an area.

In February 2019 a significant fire burnt approximately 6,300 hectares of the forested Thomson catchment in the area close to Bells Portal, the structure that controls the transfer of water from Thomson Reservoir via a tunnel to the Upper Yarra Reservoir.

Should a debris flow occur in this area, approximately 1,200 tonnes of sediment would be released. And, given the burnt area's proximity to Bells Portal, the risk is heightened.

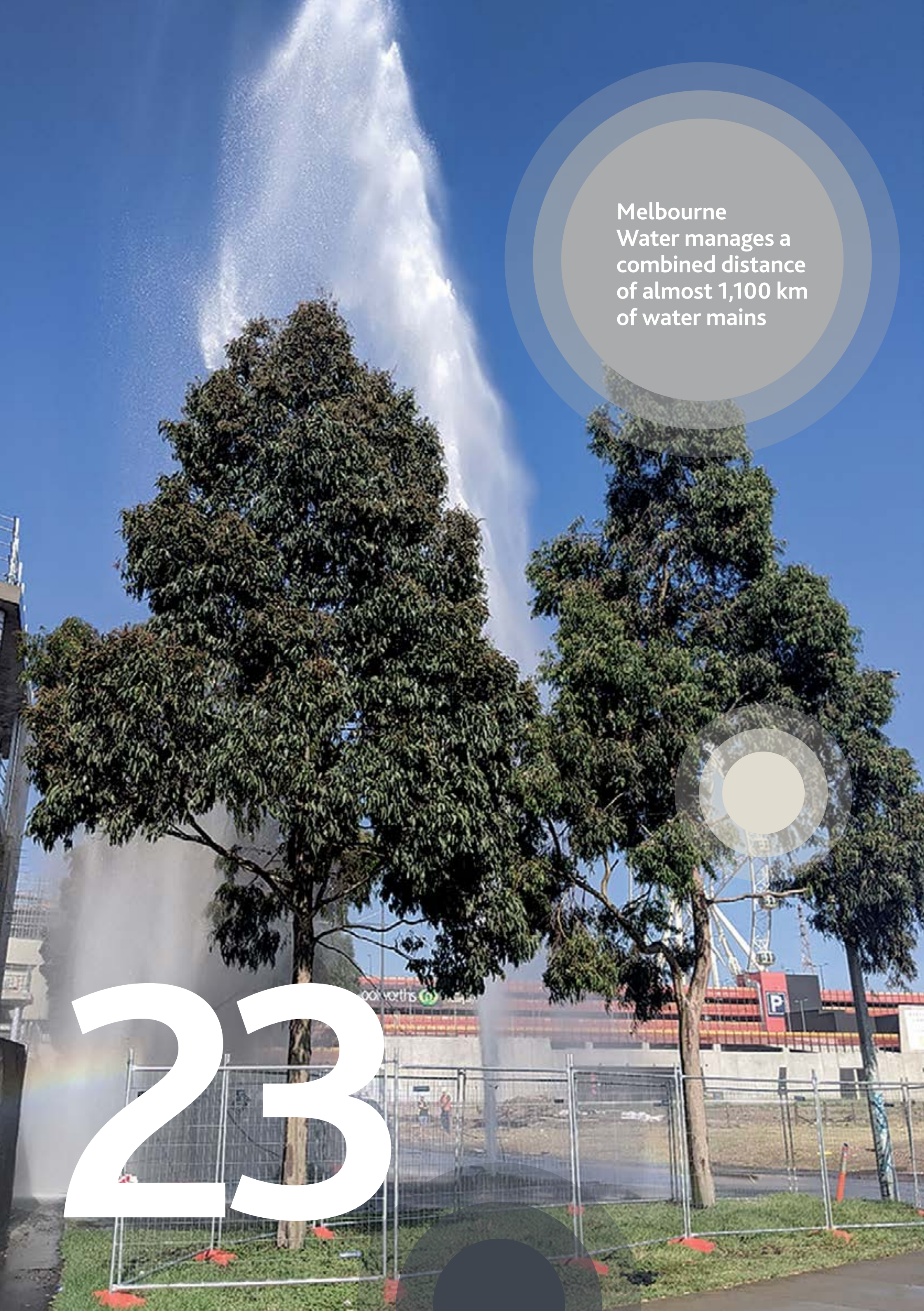
To address issues such as the Thomson catchment fire, Melbourne Water had previously carried out research to identify the processes that put a burnt catchment at higher risk of a debris flow after fire. This research led to the development of a model that identifies high-risk debris-flow locations, as well as structures that can mitigate debris flows.

To date, trial debris flow mitigation structures have been installed at some high-risk locations, and monitoring for the effectiveness and refinement of the designs is being carried out as needed.

So, what is Debris Flow?

A debris flow is essentially an avalanche of soil and rock that flows down a gully and is initiated by rainfall. The initiating rainfall event does not have to be exceptionally large, as relatively small events of around 25mm an hour can cause them.

Debris flows tend to occur on steep slopes covered in dry eucalypt forests, rather than in the wetter forests which grow at higher altitudes. They can deliver many thousands of tonnes of sediment to streams or reservoirs, which may result in water turbidity that lasts for many months.



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Melbourne Water manages a combined distance of almost 1,100 km of water mains

6 CLEAN WATER AND SANITATION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Monitoring the health of water pipes and air pollution

Melbourne Water manages a large network of water transfer pipes having a combined distance of almost 1,100 km. This network supplies water to the Greater Melbourne area, so it's vital to know where corrosion of pipes is occurring to avoid water main leaks and spectacular breaks.

Traditionally, transfer pipe inspections have been carried out manually. But we've been trialling a new matchbox-sized piece of technology to identify where corrosion is occurring. Around 200 of these devices, developed through a collaboration between Melbourne Water, the Environmental Protection Authority Victoria (EPA) and Green Technology Services, are being installed in special corrosion protection stations positioned alongside transfer pipelines.

The devices alert Melbourne Water staff when action is needed, making them potentially more time efficient as well as improving field staff safety by reducing time spent on pipeline inspections.

But more than this, these unique pieces of technology also include an air particle counter, which means that they can detect the presence of smoke – from bushfires, for example.

Air-pollution data collected from these devices is sent to the EPA, which is responsible for ensuring that air quality in Melbourne does not cause health issues.

6 CLEAN WATER AND SANITATION
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES

Trialling natural reed beds for drying waste alum sludge

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The Tarago Water Treatment Plant has been trialling reed bed technology to reduce the volume of treatment sludge sent to landfill.

The plant treats around 70 million litres of water per day from the Tarago Reservoir and the treatment process results in a large volume of waste sludge. Further treatment is then required to reduce the amount of sludge and turn some of it into dried solids, which is then sent to landfill. The existing treatment uses a sludge thickening process and centrifuges, resulting in a sludge comprising 17-20 per cent dried solids.

Reed bed sludge treatment was developed to treat both drinking water and wastewater treatment sludge. It incorporates reed beds into sludge drying pan technology, whereby a reed bed is planted in the drying pan. As sludge is deposited in the pan, it drains through the bed with the roots and movement of the reeds enhancing thickening of the sludge. As reeds and their roots are a natural home for microbes they also facilitate sludge treatment through biological activity.

For our trial at Tarago, we were keen to know if this reed bed technology would not only improve the sludge treatment process but also minimise operational costs, be more environmentally friendly and use less energy than the existing sludge drying system.

The pilot plant consisted of ten 1m^2 reed beds. One reed bed at a time was filled with unthickened sludge and allowed to ‘rest’, the sludge drying through evaporation as well as by reed transpiration.

At the end of the trial the dried sludge was harvested and achieved a dried solids content of 30-50 per cent, roughly double that achieved by the current process. These results suggest that if the full-scale reed bed system were to be implemented at Tarago, the sludge volume sent to landfill could be reduced by 73 per cent and electricity consumption potentially reduced by 16MWh per annum.

The Tarago trial also demonstrated the ability of reed beds to produce a much better quality treated water (filtrate), in all cases better than that produced by the centrifuges, and in most cases as good as, or better than, the water recycled from the sludge thickener. In addition, the removal of contaminants such as suspended solids, nutrients, pathogens, algae and metal coagulants also occurred at higher rates. This suggests that the reed bed filtrate could then be readily returned to the water treatment process stream with a lower probability of issues caused by the recirculation of problem contaminants.

Based on the success of this trial, Melbourne Water is considering using reed bed treatment to treat up to 50 per cent of the sludge produced at the Tarago Water Treatment Plant.

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Reducing heavy sampling loads by using light weight filters

Understanding the quality of the water is critical to ensuring the 25,000 km of waterways that Melbourne Water manages in the Port Phillip and Western Port regions are healthy and able to support biodiversity and other beneficial uses.

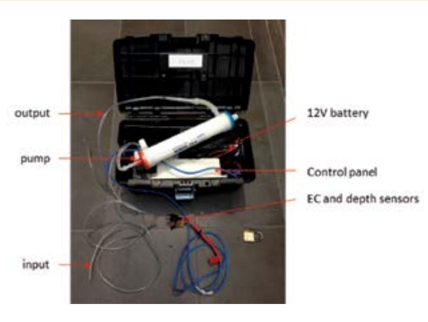
Traditional sampling techniques often require large volumes of water to be taken from the waterway. This poses logistical and health and safety risks to samplers, as well as offering only a limited snapshot of water quality in a constantly changing and dynamic system.

To reduce risks and provide better data, Melbourne Water has partnered with Monash University to validate and trial continuous-flow ultrafiltration samplers. These samplers, deployed in safe locations away from the waterway edge, draw water from the waterway via a small tube. The water is then passed through a filter which traps contaminants.

To provide a representative sample, the rate of pumping is matched to the flow in the waterway of interest, and the pumping rate is adjusted over time to compensate for clogging of the filters. Once the sampling period is completed, the filters are then collected and contaminants removed from the filters for analysis.

To date, both laboratory and field results are proving promising for microbes, with good consistency for E. coli, and MS2 bacteriophages. Nutrients and metals are posing more of a challenge, but early work indicates that this can be managed through multiple washes of the filter.

Importantly, from a health and safety point of view, samplers are no longer required to carry or transport heavy water samples as each ultra-filter, which contains the 'sample', weighs in at only 200 grams.



15 LIFE ON LAND

How citizen scientist ‘frog champions’ are helping us understand billabong hydrology

Regulation of the Yarra River and its large-scale diversion of water has resulted in floodplain billabongs between Templestowe and Kew becoming disconnected from their natural river environment.

With the river banks no longer experiencing regular flooding, many of these billabongs are unable to function as reliable breeding grounds for wetland and aquatic animals such as frogs, which depend on these regular flooding events.

To address this issue, Melbourne Water carried out a number of billabong watering trials throughout 2018/19 to progressively improve the hydrology (movement of water) and aquatic habitat of some of these billabongs – and potentially also improve the Yarra's water quality.

Photographer: Richard Akers

Monitoring was undertaken to understand how changes to the hydrology of billabongs influence the distribution, variety and population size of frogs along the floodplain. To support this effort, citizen scientist frog monitors were enlisted through Melbourne Water's Frog Census program.

Since its inception in 2001, the Frog Census program has collected significant amounts of data in the lower Yarra area. More recently, the introduction of the Frog Census app has enabled citizen scientists to record frog calls and input other data into their phones. This information is then sent to Melbourne Water and checked by ecologists using the baseline data against which the new data is compared.

The monitoring program has delivered positive results. Early data show that watering of the billabongs increases the abundance of frog calls. It has also highlighted the increase in abundance of the banana box frog, first detected in the area in the early 2000s. This assessment was largely due to citizen scientists conducting a number of site visits to billabongs before and after watering, particularly after high-rainfall events, to collect data.

To increase awareness of the importance of frogs to our environment, and to introduce the wider community to the benefit of environmental watering of billabongs, community group members have also helped stage 'Frog Nights' at the billabongs before and after watering.

Boroondara City Council has strongly supported these initiatives with two engagement events, each attended by over 100 people, held at Willsmere Billabong in Kew.

3 GOOD HEALTH AND WELL-BEING

15 LIFE ON LAND

Reimagining Arnolds Creek

Improving biodiversity and providing urban cooling outcomes for the Melton West community

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Reimagining Your Creek is an innovative urban design program that is transforming Melbourne's stormwater channels and underground pipes back to beautiful, natural waterways.

The program aims to improve the quality, accessibility, visual amenity and ecological value of our urban waterways, which are recognised as important ecological and social arteries that connect habitats and communities alike.

In 2017, Melbourne Water selected three sites for the pilot program – Arnolds Creek in Melton West, Blind Creek in Boronia and Tarralla Creek in Croydon. Arnolds Creek was the first to be 'reimagined' in early 2020.

Located in a highly urbanised catchment joining the Werribee River, Arnold's Creek was characterised by a concrete channel that ran up either side of a grassy reserve. Additionally, this area had around one third of the area of open space per person compared to the wider Melton Council area, which has a lower socio-economic demographic generally and the fastest growing population rate of all local government areas.

An important aim of the Reimagining Your Creek program is to create engaging spaces for community enjoyment, recreation and wellbeing. The restoration of Arnolds Creek will create a health and wellness hub by delivering a series of walking paths, boardwalks and bridges that connect the community to nature and each other, and improve pedestrian and cycling connections with other transport links.

The transformed creek will also meander through urban forest, while revegetation along the creek will create additional shade and rejuvenate the waterway. The revegetation will also improve biodiversity and provide urban cooling outcomes for the Melton West community.

To create these public open spaces, it has been essential to work alongside external stakeholders and the local community. For the Arnolds Creek restoration, we held a number of public engagement events and workshops in and around the site, as well as through Melbourne Water's online portal Your Say. In this way, communities were able to share their thoughts and ideas on the proposed design, which could then be further developed in response to community needs.

Reimagining Your Creek is based on the application of innovative urban design concepts and principles to provide a unique experience for the community, whilst adapting a pre-existing service to deliver multiple community benefits. The design and engagement process occurred iteratively and has resulted in the community re-connecting with their waterway.

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15 LIFE ON LAND

Desilting stormwater wetlands

Stormwater is a growing concern across Melbourne. As urban development increases and climate change brings more extreme weather events, it is critical that we continue to work on improving the quality of stormwater discharged to Port Philip Bay and Western Port. One of the ways Melbourne Water has been doing this is by building and managing stormwater wetlands.

Melbourne Water's stormwater wetlands network includes sediment ponds. The role of these ponds is to ensure contaminants carried by the stormwater can settle out, after which they are processed for disposal. In 2014 a survey of these ponds showed that 55 percent of the ponds had accumulated sediment to such an extent that it was impairing their ability to trap sediment.

Sediment is made up of waste material classified as 'prescribed' (higher risk) and 'non-prescribed' (lower risk), with the prescribed waste material being more costly to dispose of. Investigation of the sediment indicated that over 60% percent of these ponds were producing sediment in the higher-risk, prescribed waste category, or otherwise known as Category C.

In response to the growing problem, Melbourne Water initiated the Dredging and Sediment Separation System Project. The project utilises equipment with a greater efficiency in removing and managing sediment and which separates the sediment into prescribed versus non-prescribed material.

During field trials it was identified that equipment modifications were required to effectively isolate small particles of <0.3-5 mm in diameter from the larger particles. Once this was achieved, it was confirmed that metals linked to these smaller particles are largely responsible for the contamination of wetland sediment. The trial project has resulted in a reduction of the amount of prescribed waste sent to landfill, which represents significant cost savings.

Melbourne Water is currently implementing the project outcomes in its sediment management program and will continue to work to ensure our management of stormwater continues to align with State Environment Protection Policy guidelines.

DNA barcodes: Improving the way we monitor waterway health

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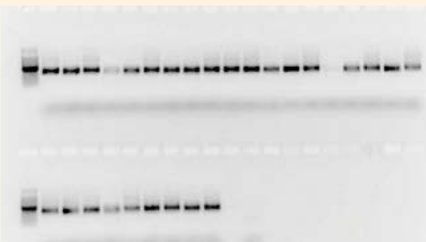
As a manager for waterways and major drainage systems in the Port Phillip and Western Port region, Melbourne Water has been undertaking aquatic macroinvertebrate (water bug) surveys across the region since the 1990s.

Understanding the types of macroinvertebrates present in our waterways is vital for assessing the health of our rivers and creeks and for identifying major threats. It also provides an evidence base for priorities in our new Healthy Waterways Strategy, with ongoing aquatic macroinvertebrate surveys integral to assessing progress towards our strategy targets.

Traditionally, these surveys are carried out by collecting aquatic macroinvertebrates in the field, preparing them in the laboratory, then identifying and counting them using a microscope.

Identification is usually done to a family level, largely for practical reasons, such as processing time, cost and expertise of laboratory staff in high-resolution identification to genus or species level. But also because it aligns with legislated biological objectives in state environmental protection policies.

Sample



While family level identification may help us broadly understand the health of waterways, it does not tell us about biodiversity, such as changes in the number of species present within each family, or the occurrence of threatened or invasive species.

To streamline sample processing, reducing both time and cost, while improving the usefulness of the data we generate, Melbourne Water has invested in research led by The University of Melbourne, in collaboration with the Australian Research Council, Royal Melbourne Institute of Technology University and Ecology Australia.

Through this project, we have developed a method for undertaking aquatic macroinvertebrate surveys using a technique known as DNA meta barcoding. This process of extracting DNA from aquatic macroinvertebrate samples in the laboratory replaces the traditional method of manually identifying and counting them using a microscope. So far the results are promising.

Based on a survey of 47 sites across Melbourne in spring 2018, we found that DNA identification of animals compared favourably with animals identified to a family level using a microscope, both in terms of data quality and cost.

Importantly, for a similar or lower cost, the new DNA approach provides additional value by generating more detailed (species level) data for, on average, 70 per cent of animals within the samples.

Further work over the coming year on the DNA database underpinning the identifications is likely to substantially increase this percentage, at which point it is anticipated that this new method will be ready for integration into Melbourne Water's routine monitoring program.

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Understanding the health of Western Port

Western Port has experienced extensive changes over the last 200 years, including clearing of the catchment, draining of large areas of swampland and progressive agricultural, urban and industrial development.

Despite this, the area is recognised as an internationally important habitat for wildlife and contains three of Victoria's 13 marine national parks. Western Port's varied and important natural habitats include mudflats, seagrass meadows, mangroves, saltmarshes and rocky reefs.

Yet little research had been carried out on Western Port until 2011, when a major scientific review on the area was undertaken by Melbourne Water, the now Department of Environment, Land, Water and Planning (DELWP) and the Port Phillip and Westernport Catchment Management Authorities. The resulting report identified priority research projects grouped into five themes: physical processes, nutrients and sediments, seagrasses, toxicants and iconic species.

Since then, Melbourne Water, in collaboration with other state agencies and universities, has carried out a series of high and medium-priority research projects on Western Port, with many either being completed or well underway. The 2018 Melbourne Water report Understanding the Western Port Environment 2018 presents a synopsis of the research carried out, highlighting key findings across the priority research themes and providing links to the individual research reports.

Just as importantly, it also identifies current research needs – including finer resolution mapping of erosion in the catchment, options for erosion control, determination of water quality targets for sediments and nutrients that support plant communities in the system and the recovery of seagrass.

In this way, the Western Port environment research program continues to provide value to Melbourne Water – and the Victorian government more broadly – by helping inform priorities such as Melbourne Water's Healthy Waterways Strategy 2018 and the new sediment load targets for Western Port in the revised State Environment Protection Policy (Waters).

3 GOOD HEALTH AND WELL-BEING

11 SUSTAINABLE CITIES AND COMMUNITIES

15 LIFE ON LAND

Chain of ponds – breaking new ground in delivery of waterway management

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The Moonee Ponds Creek is a major tributary of the Yarra River that begins at the edge of suburban Melbourne and runs 35 kilometres through the outer and inner suburbs of the city's north.

The creek drains an area of approximately 145 square kilometres and its extensive catchment is now largely urbanised. Until the latter part of the 19th century, the lower reaches of the creek comprised a chain of ponds draining into the West Melbourne Swamp (also known as 'Batman's Lagoon').

Since then, the creek has undergone wide-ranging drainage and infrastructure works including significant realignment, so that it now joins the Yarra at Docklands. Extensive urban and industrial development has also impacted the creek's waterway health.

Despite these developments, the creek is still highly valued by the community. In an historic move, 15 organisations committed in October 2018 to developing a new vision for the creek, one that would see it transformed into an iconic waterway for all Melburnians.

Known as the Chain of Ponds Collaboration, the group's signatories are working together to deliver co-designed projects focused on challenging traditional business-as-usual approaches and empowering communities to be part of the decision-making process.

One of the Collaboration's strategies has been to change the way we view stormwater. Rather than seeing stormwater as water that needs to be rapidly transported away by a 'concrete drain', why not see it as water that creates and maintains this much-loved creek?

To realise this objective, a range of methods are being explored, including promoting green infrastructure solutions such as stormwater wetlands, addressing water quality issues, revitalising the creek corridor as a linear park, improving access and connectivity, revegetation and naturalisation (where possible) and other amenity improvements to celebrate this unique space.

By identifying shared issues and priorities, the Collaboration has developed principles for working together and established working groups to address priority catchment challenges.

This is already resulting in more cohesive and efficient outcomes. The Collaboration's efforts were recognised at a state level, being awarded the 2019 Stormwater Victoria Awards for Excellence in the category for 'Excellence in Strategic or Master Planning'.

The Chain of Ponds Collaboration is a great example of how doing something differently can be risky and time consuming, but in the long run can have outcomes that exceed expectation.

Brosnan Crescent waterfall

Current and Future Research and Innovation

Research and innovation at Melbourne Water are core to our vision of enhancing life and liveability.

Melbourne Water has undertaken formal bespoke research and development for more than 25 years, providing value in delivering safe and reliable services and understanding and responding to current and emerging risks.

Our research portfolio covers all areas of our business from drinking water to waterway health, and from wastewater treatment to asset management. The eight research programs aim to deal with existing issues such as flood mitigation or pollutants as well as ensuring we are prepared for potential future issues such as bushfires, climate change or the global Coronavirus pandemic of 2019/20.

Current and Future Research and Innovation

Research and innovation are critical to Melbourne Water's themes of customer and community, safe and inspired people, continuous improvement and business sustainability. All our research programs show a commitment to improvements in one or a number of these themes.

Melbourne Water has a proud track record of significant achievements in this field. Our investment in high quality research has led to significant benefits. Undertaking research and development involves a degree of risk and uncertainty and as such, it is often difficult to assign a tangible financial benefit to R&D outcomes. Research success can be measured by a number of criteria – including:

- Improved reputation or customer satisfaction.
- Avoided risk.
- Improved community engagement.
- Degree of uptake of outcomes within Melbourne Water and the water industry.
- Financial return on investment.
- Organisational capability improvement.
- Better regulation.

Additionally our research ensures that decisions made at Melbourne Water are based on the best available evidence and stand up to external scrutiny. This is key to our core value of integrity.

Our investment in research is also an investment in the expertise of our people, who provide technical advice that is critical for management of risks. This technical knowledge is required by statutory obligations and ensures that Melbourne Water is able to protect the health of all Victorians and our environment.

For these and many other reasons, Melbourne Water will continue to invest in research and innovation. A list of our current research themes, together with some key projects is shown below. For more information on these or any other issues raised in this booklet, please contact Melbourne Water at melbournewater.com.au or phone us on 131 722.

Water recycling & integrated water management research

- Integrated water management and storage.
- Environmental and health risk assessment.
- Novel treatment processes.
- Emerging chemical issues.
- Managing risks from pathogens and blue-green algae in alternative water sources.
- Increasing the use of recycled water.

Energy and greenhouse research

- Macro algae for nitrogen removal in sewage treatment.
- Characterisation and quantification of greenhouse emissions at Eastern Treatment Plant and Western Treatment Plant including direct greenhouse emissions monitoring.
- Simultaneous nitrogen and methane removal from sewage.
- Greenhouse gas reduction challenge.

Our research portfolio covers all areas of our business from drinking water to waterway health.

Asset management research

- Corrosion and odour control in sewers.
- Dam safety (earthquakes and storms).
- Water pipes (coatings and cathodic protection).
- Stormwater drainage pipe networks.
- Non-contact strain measurement of floating polymer covers.
- Self-healing concrete.
- Improved materials for pipe and pavement longevity.
- Impact of climate change on storm patterns and floods.
- **Waterways and wetlands research**
- Water Sensitive Cities Cooperative Research Centre (CRCWSC).
- Water resources strategic planning tools
- Native vegetation management.
- Urbanisation and stream ecology.
- Environmental flows.
- Waterway improvement techniques.
- Ecology and condition of estuaries and wetlands.
- Westernport environment research.
- Climate change and biodiversity.
- Biodiversity conservation.
- Water sensitive urban design for managing stormwater quality.

Drinking water research

- Catchment sources of pathogens.
- Reservoir modelling.
- Bushfire research.
- Environmental E.coli management.
- Smart monitoring for microbial risk assessment.

Climate change and variability research

- Megadrought risk and climate change impacts on water resources.
- Water Research Australia planning guidelines for climate change adaption.
- Climate change impacts on environmental water planning, sewage and waterway strategies.

Wastewater treatment technology, marine and biosolids research

- Wastewater treatment plant discharge environment studies.
- Port Phillip Bay nutrient modelling.
- Improving the performance of Western Treatment Plant anaerobic lagoon operation.
- Improving sewage sludge drying efficiency.
- Scope 1 greenhouse gas emission reduction.
- Environmental impact of microplastic pollution.
- Improved transport of wastewater sludge.
- Emerging contaminants in sewage systems.
- Detection of SARS-Cov-2 virus in sewage.

Aquatic pollution research

- Monitoring & assessment of aquatic ecosystems.
- Environmental impacts of sewage.
- Emerging contaminants of concern.
- Litter and microplastics in waterways.
- Effects of chemical use around waterways.
- Integrated catchment management framework.
- Ecotoxicology of urban streams, wetlands and estuaries.
- Aquatic Biomarkers.
- Pollution Management Research.

For further information on these and other projects at Melbourne Water visit

melbournewater.com.au

or phone us on

131 722

VICTORIA State Government

Melbourne Water
Enhancing Life and Liveability