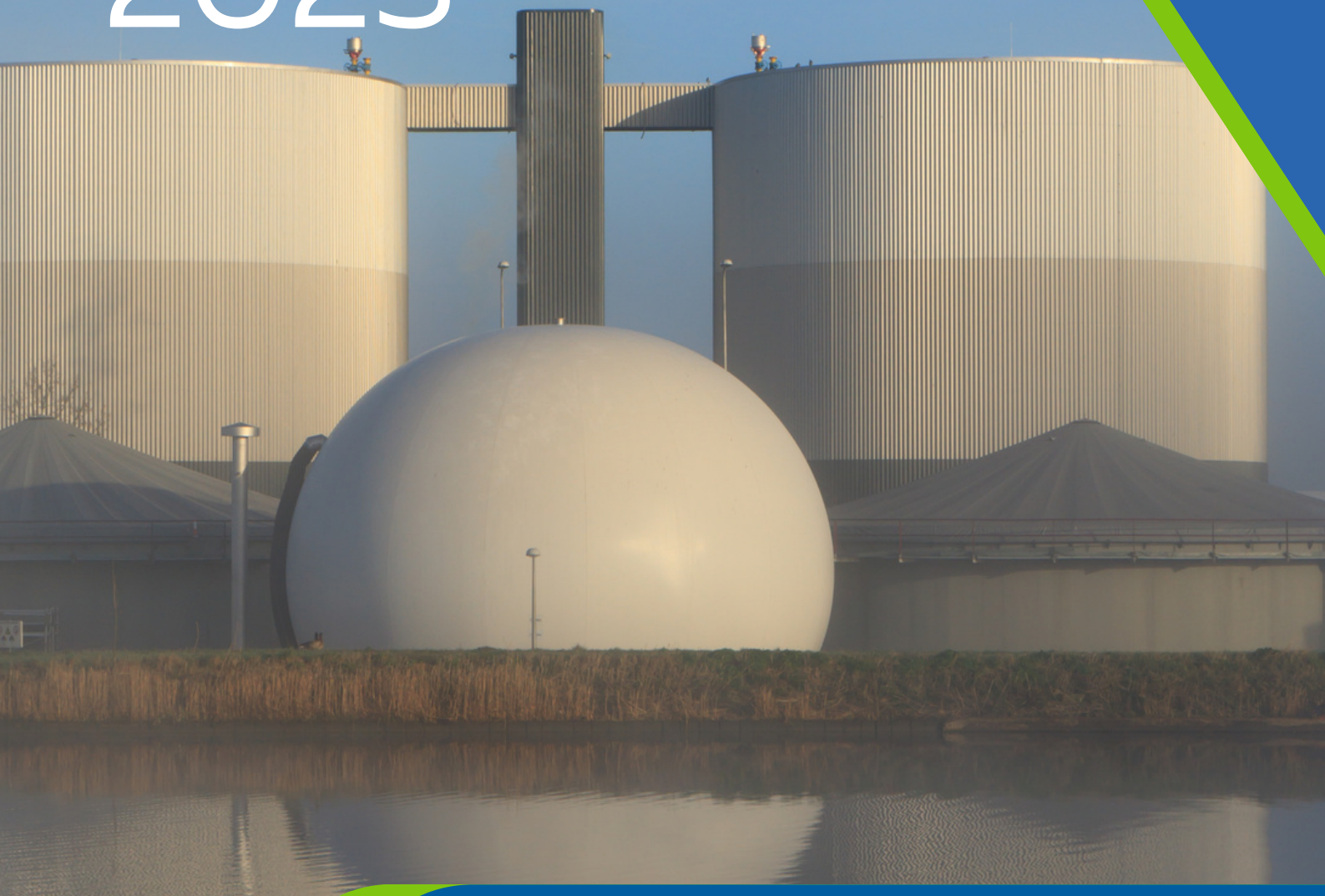
WATER SERVICES
ASSOCIATION OF AUSTRALIA

REPORT
RESEARCH, DEVELOPMENT AND INNOVATION
2023



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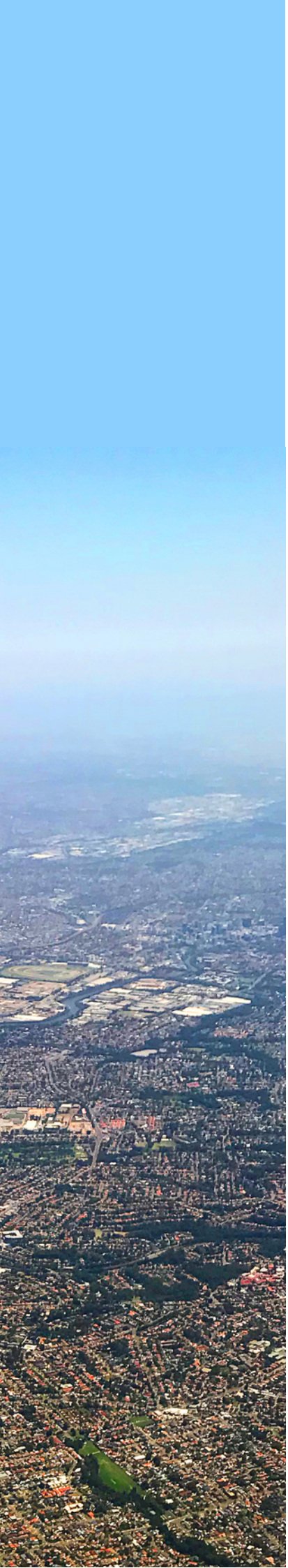

Foreword

Research, development and innovation are key tools for the water industry to lower costs, and enhance value for customers and communities. The urban water industry is making great progress as it seeks to meet challenges in ensuring services are accessible for everyone while playing a key role in helping communities be sustainable, healthy and resilient. The industry has identified **six key research priority areas** which drive collaborative research, development and advance innovation:

- Service Delivery - Making all options for safe, secure and reliable water supply available.
- Supply Optimisation - Making all options for safe, secure and reliable water supply available.
- Customers - Securing customer support to meet community expectations.
- Workforce - Building an industry of choice.
- Liveability - Expanding water's role in public and environmental health.
- Circular Economy - Closing the loop on resource generation and use.

This report provides a snapshot of our progress through some exciting case studies being undertaken by WSAA members, and celebrates the progress and connections made through this work.

I look forward to more of these reports, and hope they encourage future innovative collaborations.

Adam Lovell
Executive Director
Water Services Association of Australia

WATER SERVICES ASSOCIATION OF AUSTRALIA

Biochar 2 Batteries

Biochar can replace graphite in batteries for economic and environmental benefits

SUMMARY

Biochar 2 Batteries is an applied research project assessing the feasibility of using biochar made from different ratios of residential food and garden organic waste, and biosolids in energy storage devices, such as Sodium Ion Batteries (Na-ion) and super-capacitors. While the immediate aim is to test the technical feasibility, the bigger ambition is to unlock higher-value commercial applications for the Australian water-sector within the context of rapidly expanding opportunities across the Circular Economy.

Using biochar in Na-ion batteries can help reduce the use of graphite, commonly used in Lithium-Ion Batteries. Graphite is considered a critical mineral and is fossil-fuel intensive when mined or processed synthetically from by-products such as petroleum coke. There are also supply chain constraints and point-of-failure risks, for example, more than 90% of global raw graphite is processed in China. Current market estimates for graphite range between $8,000 - $20,000 per tonne, underscoring the potential commercial incentive of this project. Na-ion batteries, in contrast to Lithium ion, prefer 'hard carbons' (such as those found in bio-chars) due their inherent disorder allowing sodium to be intercalated.

Biochar 2 Batteries envisions the water-sector as a leading participant in developing next-generation battery materials, unlocking market potential, enhancing the circular economy by using a sustainable by-product from wastewater treatment, and stimulating partnerships across industry, academia, and government.

RMIT's ARC Biosolids Transformation Centre Deputy Director Professor Kalpit Shah were responsible for co-pyrolysizing multiple feedstocks (food, garden, and biosolids) to produce a carbon-rich biochar. The biochar was produced using RMITs patented PYROCO technology, a fluidized bed heat exchanger that significantly improves heat and mass transfer, and at lower cost. RMIT research revealed that carbon nanomaterial coated biochar can significantly improve carbon content and battery and super-capacitor performance. They also found that the biochar quality is important, particularly removing any impurities (such as silica) that can occur during feedstock harvesting. Deakin University Battery and Innovation, led by Professor Maria Forsyth, tested biochar in Na-ion batteries. One of the 'biosolids derived biochars' performed very similarly to current commercial anode material, validating its feasibility and demonstrating the potential.

Biochar 2 Batteries is a collaboration between leading research institutes RMIT and Deakin University together with Victorian water utilities Barwon Water and South East Water, as well as the Intelligent Water Networks, Department of Energy, Environment and Climate Action (DEECA), and The City of Greater Geelong.

KEY FINDINGS

- Biochar from biosolids can be used as the anode material in Na-ion batteries.
- The quality of the biochar is important to enhance battery performance.
- There is economic potential & environmental benefit for the Australian water-sector to produce and sell biochar for use in batteries.

PROJECT VALUE: $240,000
CASH: $150,000
IN-KIND: $90,000

PARTNERS
DEECA
Barwon Water
South East Water
Intelligent Water Networks (IWN)
The City of Greater Geelong
RMIT

VALUE
A world-first project that uses biochar from biosolids to power Na-ion batteries. Unlocking economic potential for the water-sector and expanding an advanced Circular Economy.

MORE INFORMATION

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eDNA Project

Environmental DNA monitoring in catchments to assess contamination risk

Photo: Yan Yean Reservoir. Credit: Shane Haydon

SUMMARY

Melbourne's water supply has a large component of its supply sourced from forested and protected catchments where human access is restricted. Most of this protected supply has chlorine-based disinfection which primarily targets bacterial pathogens. Unfortunately, illegal human access to the catchments and sometimes the reservoirs, does occur. To determine the level of the risk from this illegal access, requires an understanding of the number of people in contact with the water. Direct observation is difficult as most of the illegal access is surreptitious. A method, or methods, that do not require direct observation is needed. One option being trialed is targeting the level of waterborne human DNA in the water.

The methods used are derived from environmental DNA monitoring, which is usually referred to as eDNA. The methods were derived to determine the occurrence of animals in the environment, for example fish in a stream, without the need to actually catch the fish, as the DNA shed by organisms lasts for some time in the water. A water sample is collected and analysed for DNA, and the DNA compared to a DNA library to determine which species are present.

The first hurdle that had to be overcome is that humans are not typically the target for eDNA analysis, and as human interaction occurs in all parts of the process: manufacture of the kits, sample collection, handling in the laboratory, etc., managing contamination from those sources needs to be tested. This stage of the project has been done successfully. The current stage, which is almost complete, is to determine if the method is sensitive enough to determine if it can detect the difference between a water body with little or no human contact and ones with human contact. Preliminary data shows that the method can differentiate between the sites. The final stage of the project, which is yet to commence, will be to see if the method can produce the accuracy required to inform risk management decisions.

It is expected that this method, if accurate enough, will be used as one of a number of lines of evidence of the level of human contact with the water supply.

KEY FINDINGS

- eDNA technology can be used to detect human DNA in water without needing to observe people in real time.
- A trial to assess sensitivity of the technology for use in restricted water catchments is underway.
- If successful, this information will inform water quality risk management practices.

SOURCE OF FUNDING

Melbourne Water

PROJECT PARTNER

CESAR

MORE INFORMATION

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WATER SERVICES ASSOCIATION OF AUSTRALIA

Integrated investment approach to protect Adelaide's Coastal Waters

Translating science into decision making

SA Water

Government of South Australia

SUMMARY

Historical discharges of nitrogen and suspended solids from wastewater treatment plants (WWTP) have been identified as one of the drivers of degradation of Adelaide's coastal waters. A plan was adopted in 2013 to reduce all discharges from land and promote the return of the 'blue line of seagrass' closer to shore by 2050. Given the scale of investment, a program of scientific research was initiated to better understand the causes of seagrass loss and the factors that ensure its recovery. The aim was to explore both infrastructure and environmental solutions that meet community expectations whilst balancing prudent and efficient investment for customers. The program involved multidisciplinary science delivered through partnerships with leading research institutes and universities in a multi-pronged approach:

1. Understanding the past through novel integration of satellite, airborne, and drone remote sensing data of water quality and seagrass cover over time.
2. Predicting the effect of future interventions using coupled waves, hydrodynamics, biogeochemical, and habitat modelling.
3. Costing and ranking infrastructure and operational scenarios through multi-criteria analysis according to environmental and socio-economic benefits.
4. Testing the feasibility of assisted restoration options to promote seagrass recruitment and long-term recovery.

The approach was successful in uncovering the value of past investment, including approximately 11,000 ha of seagrass gain since the early 2000s. The improved understanding of system behaviour also allowed identification of current roadblocks to further recovery. Region-wide barriers, such as wave dynamics and sediment resuspension, suggest that investment in WWTPs alone would not be sufficient to bring the blue line of seagrass closer to shore, and innovative alternatives across government need to be explored.

Source of funding
SA Water, EPA, Department for Environment and Water, City of Onkaparinga.

Value of initiative
Research investment was approximately $3M over 10 years.

Links to additional information

- SA Water - Our research
- Adelaide Receiving Environment Model (deltares.nl)
- Habitat suitability modelling to improve understanding of seagrass loss and recovery and to guide decisions in relation to coastal discharge - ScienceDirect
- Landsat historical records reveal large-scale dynamics and enduring recovery of seagrasses in an impacted seascape

KEY FINDINGS

- The drivers of historical seagrass loss are not the same as current barriers to recovery.
- Reduction of nitrogen and suspended solids discharges has led to widespread seagrass recovery in deep waters, but the nearshore remains bare.
- This study informed negotiations with regulators promoting action across government to address roadblocks, to achieve environmental outcomes.
- SA Water continues to support this world class research exploring feasibility of seagrass restoration.

RESEARCH PARTNERS

Airborne Research Australia
Aurecon
Damco Consulting
Deltares
Edith Cowan University
Flinders University
South Australian Research and Development Institute
The University of Adelaide

MORE INFORMATION www.wsaa.asn.au

WATER SERVICES ASSOCIATION OF AUSTRALIA

Developing a novel taste and odour removal treatment process

Moving Bed Biofilm Reactor for drinking water treatment

SUMMARY

Taste and odour (T&O) compounds can be a significant aesthetic issue in drinking water leading to customer complaints. Where removal by traditional methods such as the use of Powder Activated Carbon (PAC) can result in significant increases in treatment costs, manual handling risk, and potentially upgrade costs in the millions of dollars to add conventional T&O treatment to water treatment plant assets.

This research project aimed to determine effectiveness of a wastewater treatment process Moving Bed Biofilm Reactor (MBBR) in a drinking water treatment context.

T&O compounds are biodegradable and can be successfully removed using biological filtration. Biological filtration has long been used in drinking water treatment but at later stages of the process where nutrients that would encourage biological growth have been removed. However, putting the traditional biological filters at the front of the plant would result in high head loss.

MBBR has the potential for Seqwater to:

- Reduce/remove dosing of PAC for T&O removal
- Reduce coagulant dose required
- Reduce manual handling risks

After successful bench scale testing, MBBR was tested at three Water Treatment Plants using 50L reactors.

Findings

- T&O removals varied across the three different source waters between 44% and 83%
- Differing microbial communities accounted for the differences in removal rates from the different treatment plants
- Removal rates were altered by hydraulic retention time (HRT) and sudden changes to water quality from inflow events
- Removal of hydrophilic small molecular weight organics resulted in reduced coagulant dose
- Manganese (Mn) removal was seen when present

This project has shown that the MBBR can result in multiple water quality benefits in addition to T&O removal. Low level DOC removal resulted in downstream alum dosing reductions and lower sludge production. Under suitable conditions the biofilm is capable of Mn removal. The biofilm composition is highly dependent on the feed water characteristics.

The next phase of this project has installed a 1,000L pilot at one location to further test removal rates and operational parameters before going to full scale.

KEY FINDINGS

- MBBR can successfully remove T&O compounds.
- Manganese removal is possible.

VALUE/IMPACT

- Effective replacement of labour-intensive PAC dosing for T&O removal.
- Reduced costs and manual handling due major reduction in PAC dosing requirements.

NEXT STAGES

- 1,000L pilot at a single site.
- Full scale testing following successful pilot.

SOURCE OF FUNDING

Seqwater

VALUE OF INITIATIVE

$350,000

seqwater WATER FOR LIFE

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

MORE INFORMATION

WATER SERVICES ASSOCIATION OF AUSTRALIA

Water Corporation - Ceramic Membrane Pilot Trials

Trialling ceramic membranes for wastewater recycling and drinking water treatment

SUMMARY

The Water Corporation has an established track record of applying UF membranes to treat high Natural Organic Matter surface waters, secondary treated wastewater for recycling and pre-Reverse Osmosis treatment of seawater for desalination. The greater durability of ceramic membranes (>20 years), with optimal ozone and coagulant dosing, may offer potential capital and operating cost advantages over polymeric UF membranes. The Water Corporation has collaborated with PWNT to undertake Ceramic MF pilot trials for surface water treatment (2020-2022) and water recycling applications (2017 -2019) in Western Australia. In both scenarios, the combination of ozonation, coagulation and ceramic membrane microfiltration resulted in sustainable high fluxes (300LMH for surface water (450LMH feasible), and 150LMH for treated wastewater (250LMH feasible)). The robustness of ceramic membranes has also been demonstrated with chemical clean in places able to recover permeability to as new, following severe organic and inorganic fouling events in both trials. Overall, the research has demonstrated the feasibility of the ozone, coagulation and CeraMac ®process with the Metawater membrane in both recycling and drinking water applications.

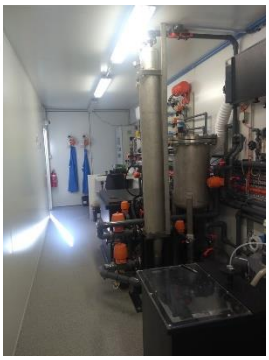
The next step for Water Corporation is to consider trialling ceramic membrane filtration as RO pre-treatment in desalination. It is anticipated that as competition in the ceramic membrane market increases, capital costs drop, and utility confidence in the technology matures, ceramic membranes will likely become more widespread in both drinking water and recycling applications.

KEY FINDINGS

- Ceramic membranes successfully trialled as an alternative longer- life option to polymeric membranes.
- Trials were completed for processes related to both surface water treatment and wastewater recycling.
- The robustness of ceramic membranes was demonstrated.

Link to additional information

Preliminary findings of Recycling trial:
Water Practice and Technology (2019) 14 (2): 331–340



SOURCE OF FUNDING

Water Corporation Research and Development Program

VALUE DELIVERED

- Ceramic membranes were proven as viable options for both water and wastewater treatment.
- Future technologies will be determined by commercial bids, but as a result of this research ceramic membranes will be considered.
- Ceramic membranes are more robust and have longer lifespans than polymeric counterparts.

MORE INFORMATION

WATER CORPORATION

pwnt

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WATER SERVICES ASSOCIATION OF AUSTRALIA

Sotto® leak detection sensors

Development and field trials of low-cost leak detection sensors

SUMMARY

Sotto® is a key innovation in South East Water's critical work to reduce non-revenue water losses due to hidden leaks on the water network, more effectively manage leak repair and reduce sudden bursts with resultant consumer disruptions. South East Water's R&D team, together with product development partners and manufacturers, built an industry-first, low-cost miniaturised leak detection sensor designed to be deployed economically at scale.

The Sotto® vibration sensor is small enough and cost effective enough to be packaged within a digital water meter. While digital meters will identify leaks on the consumer's property, Sotto® is instead tuned to detect water leaks on South East Water's infrastructure.

Sotto® was developed with Melbourne product development house Planet Innovation. After development of multiple prototypes with related testing and tuning against water leak signals, real-world trials began. Around 5000 units were installed across Port Melbourne where Sotto® sensors successfully detected 88% of leaks up to 4 to 5 months ahead of traditional detections.

Data was sent to a back-end heat map system allowing for quick visual identification of 'hot spot' areas.

Trials were highly successful identifying many leaks well in advance of water coming to the surface and confirming Sotto's ability to monitor consistently growing leaks leading to sudden bursts.

An independent assessment has estimated that South East Water could save up to 1.63 GL/annum in water by deploying Sotto® sensors.

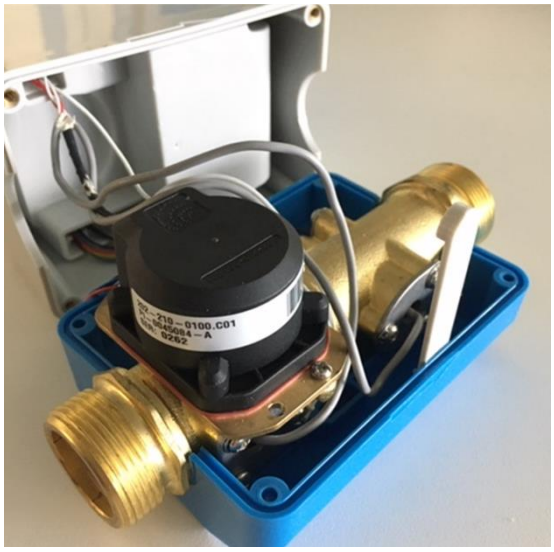
Sotto® has changed the way South East Water, and other utilities, can manage their infrastructure. For the first time, water network operators can see how their buried infrastructure is performing with daily data delivered by Sotto® at a price that can be deployed at scale.

Source of funding
Self-funded

Link to additional information
https://iotaservices.com.au/products/network-leak-detection/

KEY FINDINGS

- For the first time, a cost-effective leak detection device leveraging the capabilities of an IoT Digital Meter has enabled South East Water to have a daily view of the performance of its hidden infrastructure.
- Reduced water losses, customer disturbances and costly burst repairs.
- South East Water now installing 30,000 units distributed around critical infrastructure.



MORE INFORMATION

South East Water

www.wsaa.asn.au

WATER SERVICES ASSOCIATION OF AUSTRALIA

Revolutionising Regional Wastewater Treatment

Integrated High Rate Anaerobic and Algae Treatment

SUMMARY

Urban Utilities led a collaborative research program on the development of a fit-for-purpose solution to transform inefficient regional sewage treatment lagoons into self-contained environmental assets. This benefited regional communities, unlocked future potential for growth, and increased resilience. The three-year project had a total partnership contribution of $5.2M. This included commonwealth funding of $1.4M from the Cooperative Research Centres Projects fund. The project brought together a strong partnership of key contributors to achieve this outcome.

Currently more than half of all Australian treatment plants are lagoon-based. The technology developed in this CRC-P project mitigates issues currently experienced in the operation of lagoon systems including poor nutrient removal, cyanobacterial blooms, long retention times, sludge accumulation, and associated odour and greenhouse gas emissions.

At the heart of the research project was the use of an Upflow Anaerobic Sludge Blanket (UASB) reactor technology, integrated with High-Rate Algae Pond (HRAP) technology. The research program included over 30 months of pilot operation at Urban Utilities Innovation Precinct and delivered two full-scale demonstration plants. One at the Helidon Resource Recovery Centre, Queensland and the other at the Leanyer-Sanderson Wastewater Treatment Plant, Northern Territory.

Ongoing monitoring and performance optimisation under real-world conditions will be performed over the next 12 months with the aim to expand to full-scale application and explore commercial opportunities across Australia.

While research and technology development occurred, the partnership achieved a great deal in parallel; a deep understating of industry and community challenges, upskilling of numerous contractors and operators, creating significant national and international impact via an array of publications, and extensive educational achievements including the development of a UQ IWES course.

Links to additional information

- Urban Utilities Innovation
- IWES: Regional Wastewater Treatment

KEY FINDINGS

- Increased treatment efficiency with additional reliability
- Two function proof of concept regional demonstration scale systems delivered
- Reduced greenhouse gas and odour emissions
- Retro fit opportunity to increase treatment capacity of existing STP's
- Recovery of Nitrogen and Phosphorus from embedded algae biomass

FUNDING

CRC-P, Australian Commonwealth Government and Project Partners

Total $5.2 million

PARTNERS

Cooperative Research Centres Program

Lockyer Valley Regional Council

Power and Water Corporation

Urban Utilities

The University of Queensland

The University of Western Australia

Aquatec-Maxcon

Australian Government Department of Industry, Innovation and Science | Business Cooperative Research Centres Program

Lockyer Valley Regional Council | PowerWater | UrbanUtilities

The University Of Queensland AUSTRALIA | The University of Western Australia | AQUATEC MAXCON

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