ASSET INTELLIGENCE AND INNOVATION

Innovation Strategy 2023

WONDERFUL ON TAP

SEVERN TRENT

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FOREWORD

Our customers expect us to have a positive influence upon their lives and the environment in which we all live and work. The impacts of climate change, water scarcity, population growth and rising energy prices, require more creative thinking and a move from the traditional thought patterns and ways of doing things. We must continually evolve and improve how we take care of one of life's essentials.

Innovation is key in helping us to improve our operational performance and deliver our ambitious sustainability goals, including improving river quality, and mitigating the impacts of climate change.

Innovation runs through our organisation; not limited to any individual team. So, we've created a central team who have the technical skills and experience to encourage, facilitate and accelerate innovation across our business.

We dig beneath the day to day and provide the heartbeat of latest ideas - using novel innovation techniques - to find solutions to the root causes of our current operational challenges - as well as those we expect to face in the future.

In AMP7, our 2020-25 business plan, we decided to combine our physical and biological innovation expertise with our digital and data innovation expertise. This was unique to the water industry and was designed to reflect the fact that we see it as being the future for innovation in the sector, with increased opportunities to drive value presented by the convergence of information technology (IT), operational technology (OT) and engineering technology (ET); understanding our assets, enhancing operational efficiency and safety, improving decision making and agility, and leveraging innovation.

Also, in AMP7, we've increased our total expenditure in innovation investment from circa £38 million in AMP6 to £61 million in AMP7 (not including the £566m of Green Recovery funding that has provided countless innovation and learning opportunities). Our investment includes the creation and development of our Resource Recovery and Innovation Centre (R2IC) at our Spernal sewage treatment works. This unique facility provides a multi-bay plug-and-play trial and laboratory facilities to allow the safe testing of emerging technologies, with the effluent returned to the work's inlet, preventing any risk to the environment.

We've delivered all this whilst keeping customers' bills low by reinvesting outperformance generated from across our company and creating a virtuous cycle of innovation. Outperformance gives us more freedom to take risks with innovation, which, if it delivers better outcomes, in turn generates more outperformance.

Our innovation approach has been designed to encourage and accelerate our creativity as well as leveraging all that exists around us and all that we've learnt is being incorporated into our 2025-30 business plan.

In this document, we explain:

- **Our innovation principles** – who we are and what we stand for.
- **Our innovation focus areas and needs** – our near and longer-term innovation plans.
- **Our innovation approach and ecosystem** – the tools and techniques that we use to capture and nurture ideas and who we rely on to help us.

The appendix contains:

- Case studies showcasing some of the innovation activities within our portfolio.

If you have an idea about how you can help us, or simply want to know more, we'd love to hear from you.

Contact us at:
www.severntrent.com/innovation/

RICH WALWYN

Head of Asset Intelligence and Innovation

OUR INNOVATION PRINCIPLES

Our company values define who we are and what we stand for at Severn Trent. They apply equally to how we do innovation as anything else:

Curiosity – great innovation starts with being curious and understanding business needs; we always start with outcomes in mind.

Courage – not every innovation will be successful; we learn from failure as well as successes and have a laser-focus on decision making at pace.

Care – we care about our customers; this means that we challenge ourselves to deliver positive service and environmental outcomes with every pound that we spend.

Pride – we are proud to be ambassadors for Severn Trent and we constantly think about our actions; we ensure that being trusted to take care of one of life's essentials aligns with everything we do.

IN ADDITION TO OUR CORE VALUES, WE HAVE FOUR ADDITIONAL INNOVATION SPECIFIC PRINCIPLES:

CULTURE

We believe that innovation isn't a department or a product, it's a mindset; we work hard to encourage and nurture innovative thinking from everywhere.

CATALYSE

We are a catalyst for change; we enable innovation to flourish at pace, no matter where the idea came from, this includes working with SMEs and start-ups to explore novel ideas.

COLLABORATION

We believe in building trust with our customers, colleagues, partners, investors, regulators and with the wider sector by being transparent and sharing what we are doing and what we are learning.

DESIGN THINKING

Our approach to innovation is human-centric, focusing on the people we're creating solutions for, which we believe results in better products, services, and processes.

We seek out people and organisations who share a belief in these principles. We believe that this is often more important than water domain experience which is why we welcome so many to our team from outside of the water sector. We believe that this enriches our creativity and helps us to learn faster.

OUR INNOVATION FOCUS AND NEEDS

We're focused on our customers and the environment. The Asset Intelligence and Innovation (AI&I) team work collaboratively to solve the challenges we face today as well as finding answers to those that we expect to face in the future.

Our innovation focus aligns to our corporate strategy which is to be "performance driven; sustainability led." This acknowledges our desire to continue to deliver the financial and operational performance that our stakeholders have come to expect, whilst also facing into the challenges and opportunities that the future will bring to us.

Our corporate strategy has four pillars:

- Delivering outcomes our customers care about.
- Running a business that goes hand-in-hand with nature.
- Caring for people in our region; and
- Being a driver for change.

Our innovation portfolio is organised around these pillars, which helps us to remain focused on delivering tangible value for all our stakeholders.

OUR INNOVATION FOCUS AREAS

PROJECT PORTFOLIO

We've built a portfolio of projects by working closely with our operational leadership teams, our Communities of Practice (CoPs) and capital delivery teams to target specific needs that require tactical problem solving.

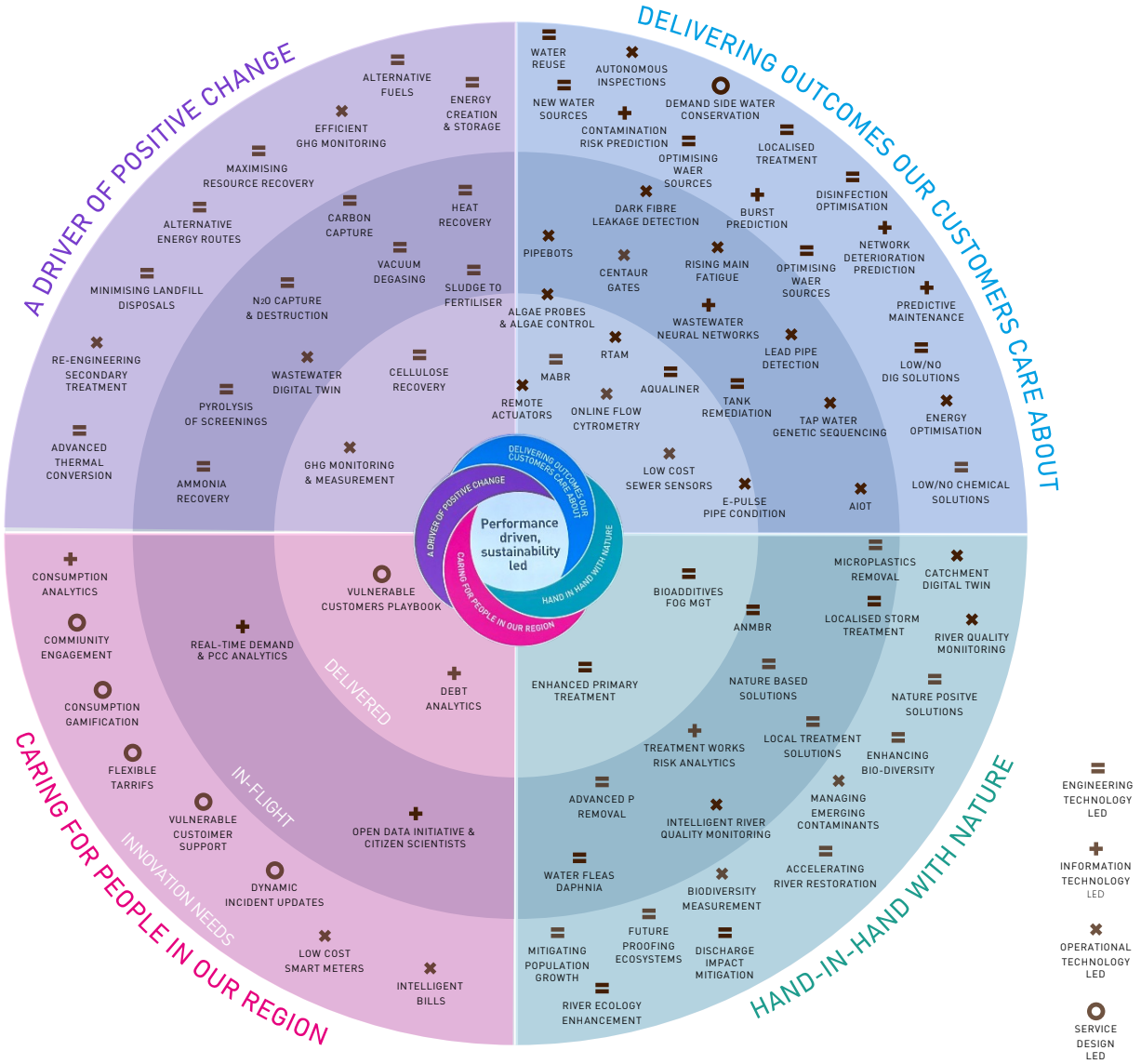
We believe that all innovation can be radical and/or disruptive, even if the technology has existed for years. This means that in addition to new and emerging technologies, our innovation portfolio includes exploring opportunities to use existing technologies and data in new and innovative ways. We embed successful projects into our standards and ways of working; and are helping to drive efficiencies in our forthcoming 2025-30 business plan and strategic enhancement investment projects.

INNOVATION NEEDS

We've also built a collection of needs based upon the emerging challenges and opportunities that we will face in the next AMP and beyond, by working closely with our asset strategy, regulation, legal and sustainability teams.

These needs align with the sector's innovation strategy and the UKWIR big questions, as well as the most material sustainability issues defined by our annual materiality assessment developed in consultation with customers, investors, colleagues, suppliers, regulators, government, and NGOs. Our sustainability report lays these out:

Severn Trent Sustainability Report



Examples of projects from our innovation portfolio.

DELIVERING OUTCOMES OUR CUSTOMERS CARE ABOUT

WATER THAT'S GOOD TO DRINK AND ALWAYS THERE

Ensuring our customers have a continuous supply of brilliant high-quality water, and that we all understand the importance of, and value this precious resource.

Our water resilience innovation focuses on detecting and dealing with potential risks to the quality and availability of the water we supply to our customers as well as keeping their bills low. To ensure its quality, we are implementing novel solutions to manage and improve raw water quality, optimise our treatment processes, and remove risks associated to legacy assets. To ensure its availability, we are trialling solutions to operate and renew our assets in the most cost-effective way, optimise abstraction and production, reduce consumption and losses, and identify technologies to treat water that we've not been able to use previously.

We have applied monitoring tools previously used in the medical sector and forensic investigation techniques in combination with artificial intelligence, and machine learning tools to help us to predict and prevent failure of our assets. In additional we are trailing new technologies to increase our resilience to hotter, drier summers through our green recovery investment, including floating wetlands and ceramic membranes which will reduce chemical and energy consumption.

We are actively working with our ecosystem to identify and pilot trials of new technologies. Once we've proven feasibility, desirability, and viability, we move to trialling the solutions at scale at our Water Resilience Hub prior to embedding them into our design standards.

Aqualiner

Smart Valves

Dark Fibre Leakage Detection

Algae Probe & Control

Works & Borehole Analytics

Separation & Smart Storage

Treatment Enhancement & Optimisation

Asset Resilience & Health

Optimise Assets

DELIVERING OUTCOMES OUR CUSTOMERS CARE ABOUT

WASTEWATER SAFELY TAKEN AWAY

Making sure that we prevent any disruption to our customers service and keeping our bills low.

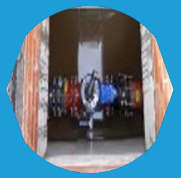
Wastewater innovation focuses on providing a wastewater treatment service that is not harmful to our environment or disruptive to our customers. This improves our network monitoring, maximises the utilisation of our existing network through smart control, continues to improve the efficacy and efficiency of our treatment processes, and identifies ways to engage with local communities on improving our performance.

Our green recovery investment includes making bathing quality stretches of the River Leam and River Teme using solutions, such as, ozone treatment of final effluent. Our flood resilience work in Mansfield town centre has demonstrated the wider catchment opportunities for novel Sustainable Drainage Systems (SuDS). We are exploring nature-based solutions, improving river ecology at wastewater treatment works to provide a sustainable, chemical free and future-proof approach to managing phosphorus levels in rivers.

Our data scientists are working on emerging technologies, such as neural networks and generative AI, to predict network blockages and ingress to prescribe proactive interventions to optimise treatment and storage capacity. We've also trialled and implemented new small scale and localised treatment facilities to reduce harm within the catchment.

We are actively working with our eco-system to identify and pilot new technologies. Once we prove feasibility, desirability, and viability, we move to trialling the solutions at scale at our Zero Spills Hub prior to embedding successful solutions into our design and operating standards.

anMBR



Rising Main Sensors

Enhanced Treatment

Waste Neural Networks

Centaur Smart Control

A DRIVER OF POSITIVE CHANGE

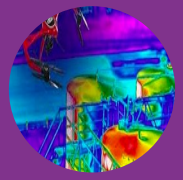
NET ZERO EMISSIONS FROM OUR ACTIVITIES

Climate change is an existential threat to humanity. We are leading by example to reduce the impact of our operations on the climate by significantly reducing our carbon footprint.

Our carbon and climate change innovation targets new ways of measuring and quantifying the actual greenhouse gas (GHG) emissions from our processes. We're not waiting to be mandated to invest through regulation and are trialling new and emerging technologies to help us to drive down, capture or eliminate process emissions.

We designed our Net Zero Hub to transform our Strongford Treatment wastewater treatment works into the world's first carbon neutral site. We're implementing a range of technologies to capture and convert greenhouse gas emissions. This includes a catalytic cover across our activated sludge plant to convert nitrous oxide into its constituent parts and a digital twin that is using the power of AI to minimise what we produce. The learning from these technologies and the site is feeding into our future investment plans.

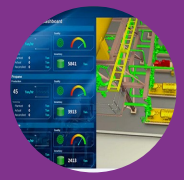
We are actively working with our ecosystem to identify and pilot other new technologies. Once we prove their feasibility, desirability, and viability, we will move to trialling the solutions at scale at our Net Zero Hub prior to embedding successful solutions into our design and operating standards.



Emissions Monitoring & Measurement

Cellulose Recovery

N2O Cover & Convert



Process Digital Twin

Digestion optimsation

A DRIVER OF POSITIVE CHANGE

EMBRACING THE CIRCULAR ECONOMY

Global demand is placing a huge strain on the availability of natural resources and traditional linear economic models generate significant amounts of waste, leading to environmental pollution and the depletion of landfill space.

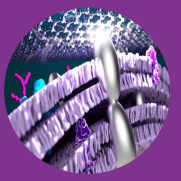
Our circular economy innovation, targets ways of recovering the valuable resources within the wastewater we receive at our treatment works, such as cellulose, phosphorus, and ammonia. In addition, we're exploring opportunities to implement modular solutions to extend asset lives and to reuse, repair and recycle the existing assets that we have.

We are actively working with our eco-system to identify and pilot new technologies. Once we prove their feasibility, desirability, and viability, we will move to trialling the solutions at scale at our Zero Waste Hub prior to embedding successful solutions into our design and operating standards.


Sludge to fertiliser


Ammonia Recovery


Heat recovery from FE


Microbial Fuel Cells

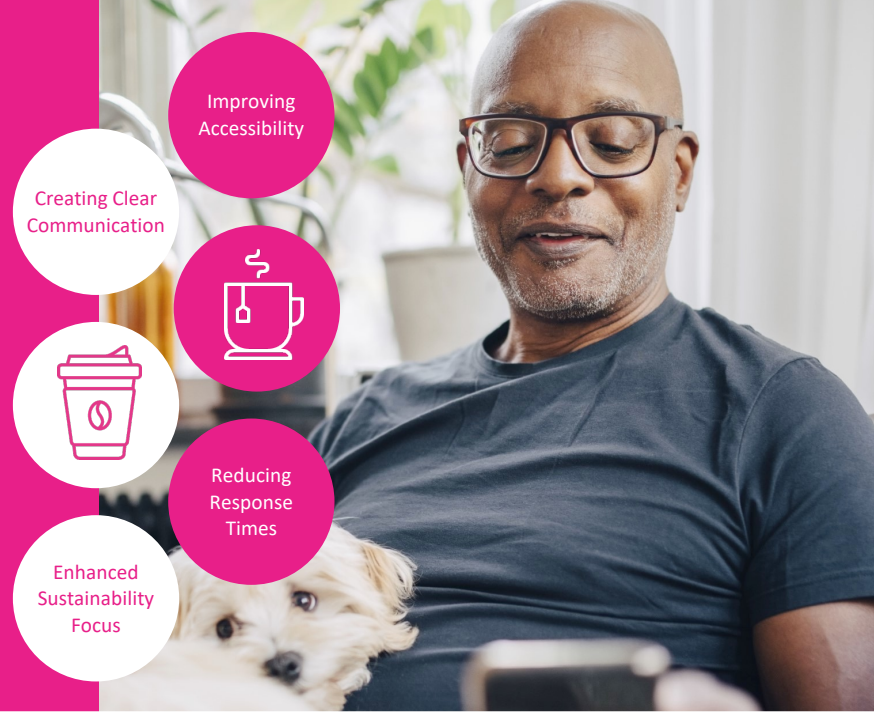

CO2 Capture

UNDERPINNING FOCUS AREAS: CARING FOR PEOPLE IN OUR REGION

AFFORDABILITY AND ACCESSIBILITY

We recognise the impact the pandemic, inflation, and the cost of energy is having on our customers. We offer a wide range of support options for our customers to help, as well as making sure that we look after vulnerable customers when operational incidents occur.

All of our innovation activities will look at ways of connecting with and helping our customers when they need it, making it easier for them to interact with us, and reducing the cost of the services we provide. Our service design and behavioural science team are working to improve access, reduce consumption, and create more understandable billing solutions.



HAND IN HAND WITH NATURE

ENHANCING NATURE

Ecosystems across the world are deteriorating due to the impacts of climate change. In our Great Big Nature Boost, we have made commitments to protect and improve biodiversity in our region. In addition, we want to proactively understand the substances that enter the water cycle and impact the environment without waiting for regulation to enforce their detection and removal.

We will include identifying ways of accelerating the development of nature-based solutions. Improving river ecology at works outlets to provide a sustainable, chemical free and future-proof approach to managing phosphorus levels in rivers.

OUR APPROACH TO INNOVATION

We have brought together some of the most experienced, creative, engineering and scientific minds from across our business. Coupled with dedicated operational technology, information technology and service design delivery experts, we will accelerate trials from concept to value realisation. Our expertise covers the full spectrum of digital, data, physical, biological, chemical, product and service design skills. This enables us to trial, test, and scale new operational, information and engineering technologies to address the challenges we face and realise new business opportunities.

JOHN O'KELLY
Strategy and Architecture
Digital, data, physical and biological innovation strategic direction and architectural practice.

RICH POWELL
Relationship Management
Business analysis, forensic root cause analysis and design thinking practice.
Innovation ecosystem and partnership management.

DARREN DUNCAN
Technical Expertise
Digital and data technical expertise, data science and AI delivery, data asset management.

JESS ALCE
Technical Expertise
Physical and biological technical expertise, drones and autonomous machines management.

PAUL DENNISON
Programme Delivery
Programme and portfolio management.

TERESA FRANKLIN
Programme Office
PMO, commercial and legal management.

OUR APPROACH TO INNOVATION

TACTICAL

We are embedded in the operational teams to understand their short-term tactical needs and problems. Our tactical problem solving involves forming rapid action/scrum teams from across our business analyst, data scientist, product & service design, technical experts, and subject matter expert teams into targeted hacks and trials.

We use forensic investigation methodologies and analytical neural networks to test root cause hypotheses and build effective driver trees to diagnose our problems. This helps us to create a systematic approach to experimentation and objectively measure success. We apply design thinking principles to assess the technical feasibility, user desirability, and financial viability of candidate solutions that we've identified through technology scouting.

Our human centric approach to design thinking helps with the embedding of change and continuous improvement because solutions are designed around the people who are going to use them.

STRATEGIC

Our strategic portfolio and technology roadmaps are created by our architecture team, who have over 150 years of combined experience across the operational, information and engineering technology domains. Supported by our ecosystem, their analysis of the emerging sector challenges and opportunities ensures we have roadmaps of solutions at varying technology readiness levels to meet future needs. These are researched, developed and, ultimately, tested for their technical feasibility, user desirability, and financial viability.

Recognising the importance of cross sector collaboration and knowledge sharing, architects are continually assessing options to work with external bodies and cross sector companies so that we collectively benefit from innovation activities. The support of our external-funding team helps to facilitate this through the pursuit of grant funding opportunities to jointly develop and investigate emerging technologies.

We undertake proof of concept and pilot trials of new technologies across our estate including at our Resource Recovery and Innovation Centre (R2IC). If the feasibility, desirability, and viability are proven, we move to trialling the solutions at scale. We've developed four scale trial hubs each focussed on a specific strategic challenge. The four hubs are:

- Net Zero Hub
- Circular Economy Hub
- Zero Spills Hub
- Water Resilience Hub

In addition to its strategic focus, each hub is being designed to ensure that we also work hand-in-hand with nature and care for the people in our region.

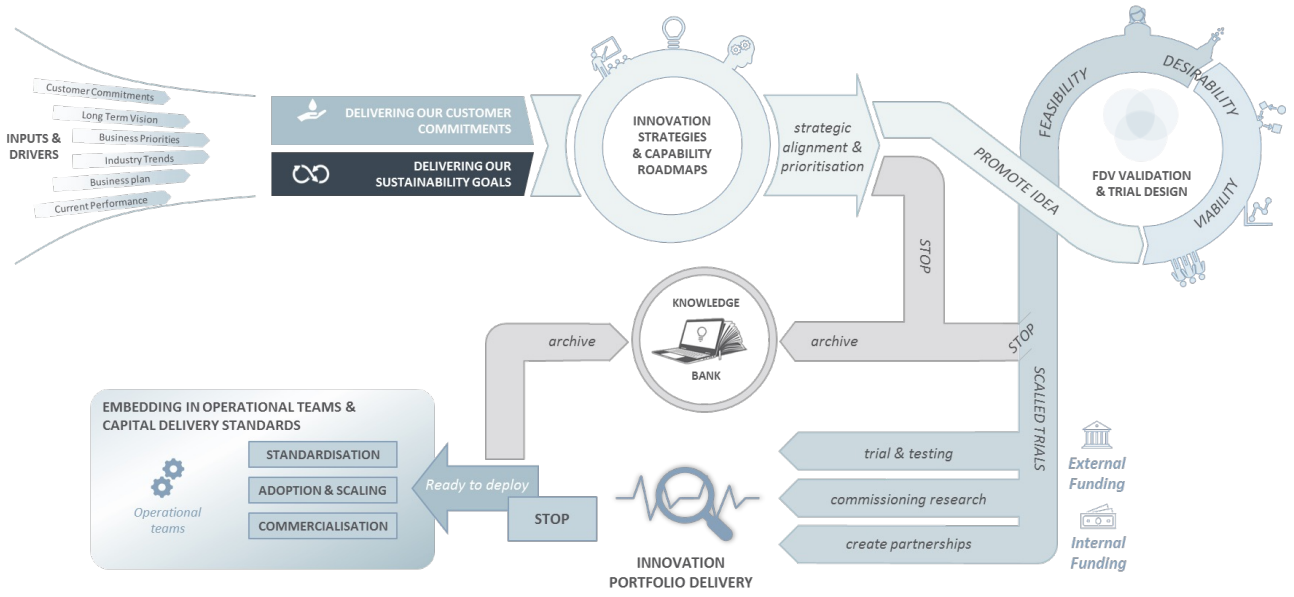
If scaled trials are successful, we bake them into our design and operational standards as well as our future investment plans and price reviews.

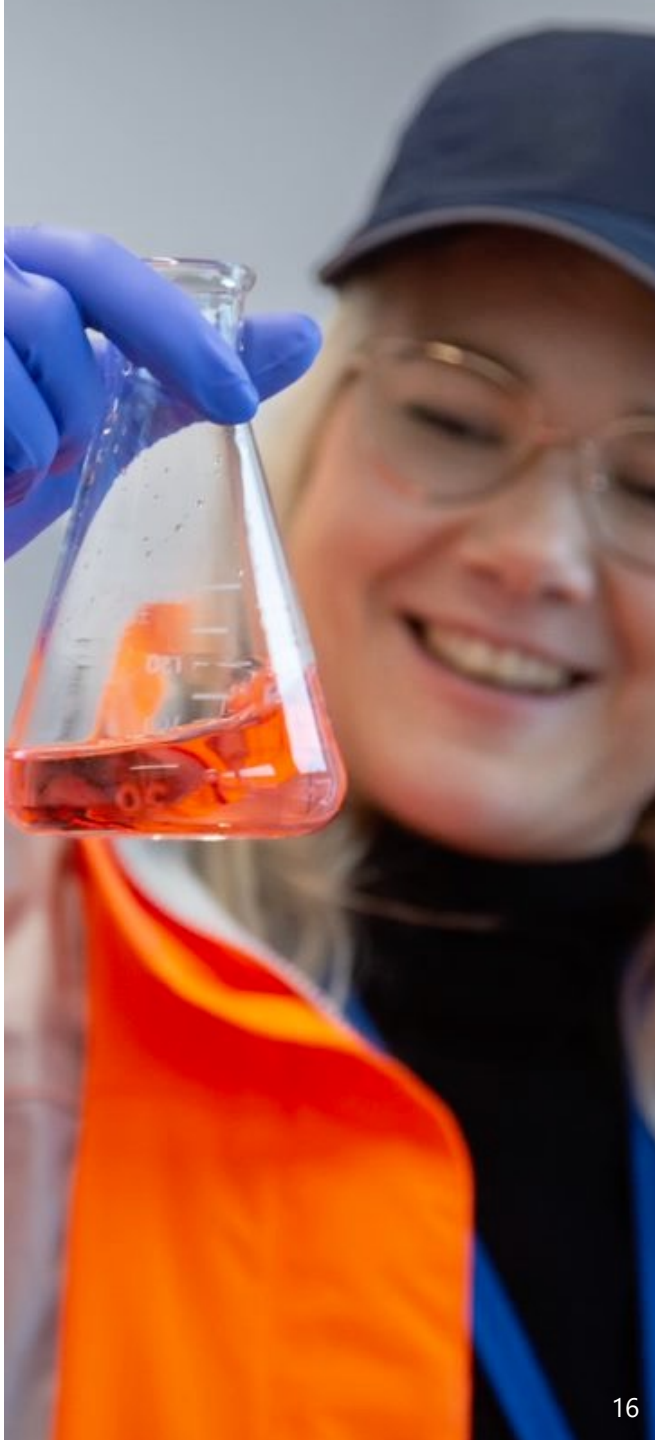
OUR APPROACH TO INNOVATION

Our expert team identify solutions to meet business needs using a structured approach that drives us towards value realisation at pace.

All ideas are tested for their technical feasibility, financial viability, and colleague/customer desirability. We set the success criteria for each of these at the start and design our experiments and trials to quickly prove or disprove them.

Any ideas that don't match our needs or that don't pass these tests are stored in our knowledge bank for future reference, should things change.





OUR ECOSYSTEM

The unprecedented and sector wide nature of some of the challenges our team are working on mean that they are best solved through collaboration and knowledge sharing. We have established our innovation ecosystem to help and encourage us to push out beyond our boundaries. Our ecosystem is diverse and brings creative people and organisations together from multiple sectors, across the globe.

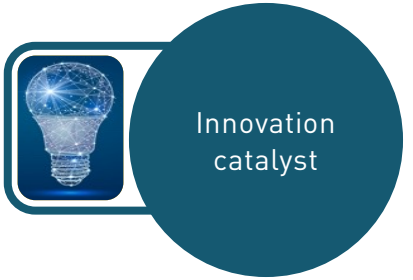
OUR ECOSYSTEM

TECHNOLOGY SCOUTING ECOSYSTEM

We scan the globe for solutions to our needs to ensure when a new technology emerges or someone develops a new use for an existing technology, we know about it and can adapt our plans accordingly. Doing this means that we are at the leading edge of technology development and deployment within the UK's water sector.

World Water Innovation Forum - the forum has been established to bring together likeminded water companies to share their learnings through collaboration and knowledge-sharing on trials, research, and ground-breaking technology.

Innovation Catalyst – launched in December 2021, we set ourselves the challenge to look outside of what we already know to learn from knowledge and experience across the globe. Basing ourselves in global technology hotspots, we engage scouts within those regions to seek out new technologies that are applicable to our needs. Our first was in the Nordics with North America next.



Innovation Partners – we are utilising the diversity of our supply chain partners to identify opportunities for mutual support to secure grant funding and to accelerate ideas through the trial process. In addition, we are extremely supportive of the new Ofwat Water Discovery Challenge and see this as an opportunity to identify and quickly deploy new and emerging technologies.

OUR ECOSYSTEM

IDEATION ECOSYSTEM

Despite the creativity, experience, and knowledge of our people, we know we don't have all the answers. We source ideas from all our stakeholders, including customers, colleagues, academia and our supply chain. In addition, we are extremely active in UKWIR, collaborating to maximise our investment in this valuable research resource.

Innovation Vanguard – launched in May 2023, we identified leading companies, industrial specialists (from inside and outside the water industry), and pioneering academics to stretch our thinking, push the boundaries of the possible as well as providing evidence to support our business planning. Our first Vanguard event focused upon water reuse and emerging contaminants in Singapore; our second was on advanced thermal conversion in Germany; and our third will be on smart waste networks and leakage management in Denmark. Our intention is to run a series of Vanguard CPD events at our purpose-built academy based upon what we have learnt. We will make this available to anyone to join.

Challenge Cup - we run an annual innovation ideas campaign called the 'Challenge Cup' where we invite our 7,000 employees to generate and share their ideas on new products, services, or processes that could help improve our service. The Challenge Cup encourages employee engagement and generates over 100 inspiring new ideas every year.

OUR ECOSYSTEM

UKWIR & SPRING – we believe in the importance of collaborating on research projects of common interest with the rest of the UK water sector. This removes duplication and enables us to get even more value for our investment. We have several of our people actively involved in UKWIR's "Big Question" initiatives, which have been established based upon the key challenges that the sector faces. We are active members of the Spring Development Group and have led the first of the Accelerator Initiatives which was focused on innovations to reduce carbon emissions.

Wavemakers – this is a brand-new annual ideas challenge that seeks to nurture talent and stimulate innovation in the community that we serve. Having completed one successful round of this in 2022, we are planning to launch the second edition in 2023. We're delighted to have been able to offer one of our Wavemakers from the community a role within our innovation team.

OUR FUNDING STRATEGY

To keep our customers' bills low and to trial more innovative solutions that have not necessarily been applied in the water sector before, we work with partners from our supply chain and academia to target relevant grant funding from various sources.
Our approach has six key steps:

STEP 1
Continually seek out potential funding sources and align our strategic needs to them.

STEP 2
Identify partners to work on developing proposals. These can be start-up companies that have approached us directly, other water companies, organisations from our supply chain, academic institutions, and others from our international ecosystem.

STEP 3
Network and build relationships with the potential funders to get clarity on the goals and objectives of the fund, to increase our chances of securing the funding.

STEP 4
Develop a comprehensive grant proposal that aligns its planned outputs and outcomes to our strategic needs and defines the activities that will be required to deliver.

STEP 5
Work with partners to ensure that we have the skills, resources, and commitment to deliver the activities as well as defining the associated costs and programme plan.

STEP 6
Follow-up with the funding organisations to ensure that our proposal is being considered, and if it isn't why not, so that we can learn for future submissions.

In AMP7, we are working on £42m of externally funded or part-funded projects through Ofwat, UKRI, BEIS, Innovate UK and Horizon Europe.

The Ofwat Innovation in Water Challenge has provided a brilliant mechanism to grow innovation in the sector as well as driving increased collaboration between companies to realise beneficial outcomes for our customers, society and the environment.

We are committed to working with others to maximise the value to be gained by this investment and have entered and been successful in every round thus far.

OUR FUNDING SUCCESSES

INNOVATION IN WATER CHALLENGE (CATALYST STREAM)

Leak detection using dark fibre

Using unexploited optical fibre strands in existing telecoms cables to detect and prevent leaks in water networks.

Supporting customers in vulnerable circumstances

Using behavioural science to engage with hard-to-reach customers.

Tap water forensics

Using genetic sequencing in drinking water treatment to improve the accuracy of water quality investigations.

Catalysing a net zero future

Using bacteria to remove toxic ammonia in our existing treatment process without producing N20.

A HERU for screenings

A pyrolysis-based waste recovery system to process waste screenings on site, recover bio-gas and reduce the impact on landfill.

INNOVATION IN WATER CHALLENGE (TRANSFORM STREAM)

Artificial Intelligence of Things - autonomous waste catchments

Using IOT, AI and ML to monitor and control waste catchment in real-time.

Carbon capture machine

Capture unavoidable carbon dioxide in exhaust emissions from CHP engines for reuse as a sequestration product.

Net Zero Hub

Transforming a large, carbon intensive wastewater treatment works into the world's first retro-fit carbon neutral site.

NEXTGEN – H2020

AnMBR

Assessment of AnMBR as a key building block to achieve energy neutral wastewater treatment.

HORIZON EUROPE 2022E

Microplastics

Developing techniques and operational solutions for chemical free and energy efficient removal of microplastics from wastewater effluent.

BEIS

Sludge to Fertiliser

Converting digested sludge, recovered ammonium hydroxide and CO2 into dry pelletized fertiliser with a high degree of energy efficiency.

REWAISE - RESILIENT WATER INNOVATION FOR THE SMART ECONOMY

Aqualiner

Trial of polypropylene structural insertion lining for its suitability as no dig leakage repair technique.

Smart Metering / Devices

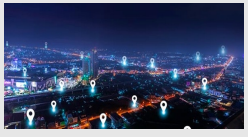
Deliver a smart meter and comms trial to explore the use of data to enhance operational decisions.

Robotics

To work with FIDO to develop a an in-pipe robotic technology coupled AI and ML for lead detection.

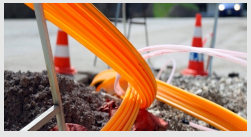
Remote Valve Actuators

Trial of a re-deployable remote value actuator to reduce response times during incidents.



Smart Networks - Waste

Using sensors and analytics to manage the waste network by optimising existing latent storage.



Fibre Optics in Water

Trial fibre in water to detect leakage, asset health and pressure; as well as comms and revenue benefits.

Ammonia Recovery

Trial of thermal scrubbing to recover ammonia from dewatering liquors and its conversion to hydrogen.

APPENDIX: case studies

An overview of past and future projects driving forward progress towards meeting customer commitments and sustainability goals.

Innovation in action: delivering performance

DELIVERING OUTCOMES OUR CUSTOMERS CARE ABOUT

CASE STUDY: E-pulse - Ultrasonic pipe condition assessment

STRATEGIC THEME: Delivering outcomes our customer care about
Water that's always there and good to drink

OVERVIEW

Traditionally to assess the need for asset renewal the conditions of the metallic main water pipeline need to be understood.

The remaining life of the pipe can be assessed by taking samples of the pipe wall (coupons), or via ultrasonic measurement of the wall thickness on exposed 1m sections. Both techniques are expensive and time consuming, but only give information at the point of measurement.

The ePulse condition assessment technology uses acoustic signals and advanced computer algorithms to determine the average pipe wall thickness for the tested pipe section and assigns a grade of good, moderate or poor based on the actual condition of the pipe segment.

This information can then be used to optimise the mains renewal programme to ensure investment only targets pipes that require replacement.

CHALLENGE

STW covers a large area with numerous districts metered areas (DMAs) and associated mains. This can make it difficult to understand the condition of our DMA mains and target rehab effectively.

ACTIVITY

The aim of the trial was to determine whether ePulse could be used to optimise the replacement schemes proposed in 3 Birmingham DMAs (District Metered Areas) to minimise disruption to our customers.

15.5km of mains within 3 Birmingham DMAs were surveyed and the following was identified:

- the average wall thickness
- % pipe wall loss
- remaining service life (RSL) based on the rate of wall loss, pressure, and criticality of the pipe.

OUTCOME

The surveys allowed the prioritisation of workload which suggested significant TOTEX savings within 2 of the 3 DMAs surveyed, whilst also minimising customer disruption.

The trial proved that ePulse is a non-invasive tool 'in the box' that can provide additional information on metallic pipe condition.

VALUE

The ability to rapidly assess the condition of underground assets helps to prioritise network refurbishment schemes and reduce TOTEX.

CASE STUDY: Aqualiner - No Dig Pipe Refurbishment

STRATEGIC THEME: Delivering outcomes our customer care about
Water that's always there and good to drink

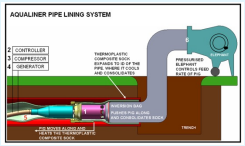
OVERVIEW

Severn Trent has a vast network of pipes that supplies water and wastewater to its millions of customers. A network of this scale needs continual repair and maintenance, to make sure it can deliver a reliable and high-quality product to customers, as well as minimising leakage.

However, this level of maintenance has significant cost, which ultimately is passed on to customer bills. A cheaper, more accessible method to maintain and repair the pipes is needed.

STW has worked with an external company, Aqualiner, who had developed an innovative lining material that can be installed with very little disruption. The lining material is a glass-reinforced polypropylene; and is currently the only Regulation 31 approved, fully structural lining available to the industry.

This project has been funded by Horizon 2020 REWAISE



CHALLENGE

A network on STW scale needs continual repair and maintenance, to make sure it can deliver a reliable and high-quality product to customers, as well as minimising leakage. Current techniques are costly and impact our customer's bills.

ACTIVITY

A piece of 9-inch pipe that was at the end of its workable life located in Rhostyllen in Wrexham (Hafren Dyfrdwy) was used to trial the lining material. The cast iron main had been taken out of supply due to its poor internal condition generating significant water quality complaints.

The Aqualiner process was undertaken by pulling the new liner through the old pipe and heating it to 200°C with an electrical heating element built into a pig. The pig is moved along the pipe at a controlled speed by an inversion bag, which also moulds the new liner against the wall of the host pipe. As the heating element does not touch the wall of the host pipe, it can line any material including plastic pipes.

OUTCOME

The lining material became fully bonded to the host pipe and the team onsite deemed the pipe to be structurally sound. Pre- and post-chemical samples demonstrated an improvement to water quality and removed risks associated with the pipe.

VALUE

Deployment of this technology is not only more cost effective that tradition pipe refurbishment, but also is less destructive to the public and significantly extends the life of existing network assets.

DELIVERING OUTCOMES OUR CUSTOMERS CARE ABOUT

CASE STUDY: Demand intelligence and consumption analytics

STRATEGIC THEME: Delivering outcomes our customer care about
Water that's always there and good to drink

OVERVIEW

We have a critical need to better understand water demand across the entire network in order for our water resources teams to appropriately plan ahead and ensure sufficient water is available for customer supply.

There are various factors that can influence customer demand to fluctuate, such as day of the week, general weather, school holidays etc. Our ambition is to utilise the field of machine learning through our internal data science capability to build a predictive model which can accurately forecast demand across our network over 7 days. This insight is critical for us as a business to know how much water we will need to supply to our customers.

Our data science experts will use innovative machine learning techniques to build a predictive model that will accurately forecast demand across out network over 7 days. This will offer critical business insight into how much water is needed to supply to customers at any given time.

CHALLENGE

We require insights to understand how much water demand we will experience across our network over the next 7 days. This will support us to optimise water resources in order to meet expected customer water demand.

ACTIVITY

Demand intelligence – We have built a machine learning model which predicts demand over 7 days based on various factors such as weather etc. Phase 1 focused on demand across our entire network. The subsequent phase will build more granular models for each of the 100+ water control zones across our estate.

We have also built a PCC (per capital consumption) machine learning model which classifies customers into various categories and supports our Retail/Marketing team to target specific customers for water consumption and efficiency campaigns.

OUTCOME

Automated Power BI dashboards have been built to visualise model outputs to show predicted water demand over the next 7 days.

VALUE

The ability to accurately predict water demand and storage requirements is critical to effectively manage our water treatment and distribution networks. During recent hot weather periods, these models ensured that our operational response was enhanced to keep customers in supply.

CASE STUDY: Remote Valve Actuators

STRATEGIC THEME: Delivering outcomes our customer care about
Water that's always there and good to drink

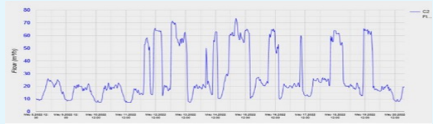
OVERVIEW

STW has a vast network of pipes that supplies water to its millions of customers. To optimise, repair, maintain or rezone our network, it's often required to operate valves in difficult locations to ensure the various activities can be carried out.

Generally, these valves must be manually operated by a distribution service technician (DST) as the valves are in areas where traditional methods of actuating valves (which involves building large chambers, grid connections for power and telemetry, often at great expense to the business) are not possible.

The aim the trial was to review a smart solution that allows automation of these valves in difficult to reach areas.

This project has been funded by Horizon 2020 REWAISE.



CHALLENGE

Events on the network such as bursts or high demand require us to operate valves to rezone the distribution network to ensure customers remain on supply; incurring costs and delays to event resolution.

ACTIVITY

Severn Trent approached R2M Ltd. about their remotely operated, battery powered 3S actuators. These run completely standalone with a battery and have a much smaller installed footprint meaning cost reductions of over 80% compared to the costs of traditional actuation methods. Also, the actuators can be retrofitted to most existing valves or directly flanged onto an ISO top flange. Trial was progressed in 2 stages:

- Phase 1- Controlled Testing: training and optimisation of the valves
- Phase 2- Live Trials: to monitor the effectiveness of the actuators in the field and assess the benefits.

OUTCOME

During phase 2, three valves were installed in Nottinghamshire and are now being regularly used by the operations team. Benefit assessment showed:

- Resource saving due to reduced DST time associated to valve operation.
- Each valve operation will reduce scope 1 emissions from operational vehicles- for one of the installed valves the carbon benefit of a single valve operating once a week for a year is 34.41 tonne CO2e.

VALUE

Remote control of valves during operational incidents allows the network to be managed centrally, avoiding time consuming field visits and supply interruptions and a faster restoration of customers' water supply.

DELIVERING OUTCOMES OUR CUSTOMERS CARE ABOUT

CASE STUDY: Algae probes & Algae control

STRATEGIC THEME: Delivering outcomes our customer care about
Water that's always there and good to drink

OVERVIEW

There have been algae related issues at several STW sites (Whitacre, Draycote, Melbourne and Church Wilne). At times, the algae can cause water extracted from reservoirs to be untreatable at the water treatment works (WTWs). At times, algae blooms have left water untreatable all summer.

Algae Probes
Trial of a sonde was undertaken to identify and accurately record algae concentration levels to allow for better proactive decision making with regards to water treatment and water production volumes.

Also, as algae can stratify in a reservoir, this will allow the option to use different draw off locations within a reservoir if available.

Algae Control
Mecana filters are 'pile cloth' filters, used in wastewater treatment for removal of phosphates. Trial to understand if the same equipment can be used to remove algae at a WTW.

CHALLENGE

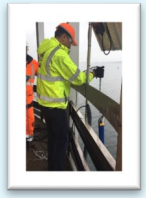
Historically algae issues cause significant problems for various WTWs particularly in the summer months when demand is at its highest which can result in reduced water into supply. Climate change has only exacerbated this problem.

CHALLENGE

An algae probe has been installed at Draycote reservoir draw off tower.

With an additional probe to be located at Chuch Wilne.

Mecana trial unit installed at Whitacre to understand seasonal variation of algae removal.



OUTCOME

Algae Probes: Data is showing that there are several peaks in algal activity over the first months of the trial. Ongoing sampling across a range of depths within a reservoir will show how water quality varies with depth in relation to algae.

Algae Control: Mecana data shows that there is a significant removal of algae from the raw water from Lower Shustoke reservoir during the winter months.

VALUE

Initial trials suggest that removal of algae from raw water can increase the volume of water that can be treated by up to 16MLD; mitigating the need to develop new raw water sources at £1.5m per megalitres per day (MLD). Saving up to £20m of capital investment.

CASE STUDY: Dark fibre leakage detection

STRATEGIC THEME: Delivering outcomes our customer care about
Water that's always there and good to drink

OVERVIEW

The water industry is facing a significant supply demand deficit due to population growth, climate change and the need to balance customer's needs.

In response to these challenges, the water industry is striving to reduce, and ultimately eliminate, leakage from the water supply network.

Also, leakage from the network can result in catastrophic failure of pipes, leading to loss of supply to customers. This can cause severe disruption and endanger public safety through flooding and the downstream loss of water for essential activities - including the loss of mains water for use by the fire service.

The use of fibre leak detection has been successfully demonstrated within the water industry, but uptake of this technique has been prevented by the cost and disruption of laying new fibre either above or within water mains. This project investigated the use of unused optical fibre strands ("dark fibre") within the existing cable networks for leak detection and provided additional information about our network - including monitoring the creation of voids around leaks or damaged sewers.

CHALLENGE

Leakage from the network can result in failure of pipes and loss of supply to customers, causing severe disruption and endangering public safety through flooding.

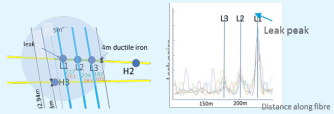
OVERVIEW

The trial took place in phases:

- Phase 1: controlled environment where fibre optic cable was fitted, and 7 different leak types were simulated.
- Phase 2: A live environment where the equipment was installed on a main road.

2 types of leak detection using fibre were used:

1. Direct detection for nearby leaks, by picking up resultant sounds in the fibre.
2. Indirect detection by monitoring changes in the water saturation of ground near the fibre.



OUTCOME

The trial successfully proved that leaks can be monitored using dark fibres. For direct measurement, leaks could be found with a range of +/- 0.5m from the dark fibre and a detection range of up to 5m via the indirect method.

VALUE

The use of third-party fibre networks provides low cost, rapid and accurate leak detection; reducing cost of find and fix and quickly returning customer to supply.

DELIVERING OUTCOMES OUR CUSTOMERS CARE ABOUT

CASE STUDY: Tap water genetic sequencing

STRATEGIC THEME: Delivering outcomes our customer care about
Water that's always there and good to drink

OVERVIEW

This project will develop the use of genetic sequencing in drinking water treatment to improve our ability to understand treatment process effectiveness and investigate water quality failures. Unlike current tests, genetic sequencing can determine all the bacterial species present in water.

A library of genetic sequence "finger-prints" will be generated from water treatment and distribution and combined with data from flow cytometry analysis to provide additional insights.

This library can then be used to provide an accurate assessment of the bacterial population in the water sample, improving our ability to optimise treatment processes and identify potential sources of contamination.

This project has been funded by the OFWAT Innovation Fund through the Water Breakthrough Challenge Round 2.

CHALLENGE

In 2020 English and Welsh water companies had 192 regulatory failures for bacteria in water. Based on typical costs for the reactive investigations, it is estimated that this costs £6-12m/year (excluding CRI penalties).

ACTIVITY

The project is currently in scoping phase to build the library of water quality "finger-prints". Activities to be completed include:

- Sample preparation methodologies for different stages within the water treatment process. This includes understanding what sample volume will provide sufficient material to fully sequence the microbiome.
- Collection and analysis of over 1,100 samples covering normal and abnormal conditions within water treatment and distribution networks. This will identify patterns that point to different sources of water quality failure.
- Build analytical models that can train Artificial Intelligence (AI) software to automatically pick out patterns from large and complex data sets and compare to the "fingerprint library".

VALUE

If proven, this technology will significantly improve the speed and accuracy of water quality investigations and enable targeted interventions..

CASE STUDY: Enhanced primary treatment

STRATEGIC THEME: Delivering outcomes our customer care about
Taking waste safely away

OVERVIEW

Micro-flotation technology such as the Enviplan are an evolution of a dissolved air flotation plant (DAF) used in primary wastewater treatment.

Separation is delivered by flotation of solids and colloids through the action of micro-bubbles (30 to 50 microns). The micro-bubbles have a high affinity for solids and do not coalesce so that when they are dispersed throughout the wastewater, they form a uniform air blanket which causes solids to rise to the surface. At the surface, they form a sludge blanket which is scraped away by a simple chain scraper.

The systems have the potential to deliver higher biological oxygen demand (BOD) and solids removal efficiencies than conventional primary sedimentation and should therefore be considered for deployment where additional primary settlement capacity is required. It is estimated to have a lower whole-life cost, requiring significantly less footprint, and producing comparable reduction and drier sludge than primary settlement tanks (PSTs).

CHALLENGE

Population growth will create more demand on existing assets that may not be able to cope with current projections. This will require investment into new infrastructure at a high capital cost to the business. It is also a carbon intensive process.

ACTIVITY

A pilot scale trial of the Enviplan Micro Float system was conducted at the Resource Recovery & Innovation Centre (R2IC) at Redditch, Spernal STW. The assessment programme consisted of three phases:

- Process Optimisation: to establish the best combination of flow and pressure settings, to maximise COD and TSS removal rates at lowest energy use.
- Flow Variation Tests: to establish the unit's performance under diurnal, storm and intermittent flow conditions.
- Alternative Use: to examine the system's performance when chemically dosed for phosphorus reduction as a sludge thickening device and in the removal of dissolved metals.

OUTCOME

Outputs of the trial showed that the Microfloat unit yielded load reduction comparable to a standard PST. It also showed that the retention time needed was approximately 30-45 minutes, so a lower physical footprint is needed when compared to PSTs for comparable performance.

The unit also produced sludge of up to 8.5%DS on average, without chemical addition which is thicker than conventional PST primary sludge.

Performance was not adversely impacted by sudden flow changes and there is potential that chemical dosing improves load removal and phosphorus removal performance.

VALUE

Proving this technology provides our capital delivery teams with a cost-effective retrofitting solution to upgrade the capacity of existing treatment works; allowing for significant savings in capital investment and avoiding the embedded carbon.

DELIVERING OUTCOMES OUR CUSTOMERS CARE ABOUT

CASE STUDY: Centaur – Waste Network Flow Management (IWAN)

STRATEGIC THEME: Delivering outcomes our customer care about
Taking waste safely away

OVERVIEW

CENTAUR® is an intelligent, autonomous system for urban flood risk and consented sewer overflow (CSO) spill reduction. It senses the prevailing situation in the sewer network and uses artificial intelligence to decide whether to hold flow back or pass it forward. In this way, escapes are avoided or reduced. The technology fully leverages the capacity of existing infrastructure rather than building more.

Each CENTAUR system involves the installation of water level sensors within the waste network which communicates these levels back to the CENTAUR Hub. The system then uses artificial intelligence to dynamically control the pass-forward flow at the CENTAUR gate to prevent wastewater network escapes.

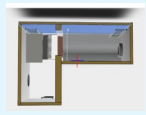
CENTAUR® is self-managing, ultra-reliable and easily deployed. It is orders of magnitude less costly than alternative capital- and space-intensive solutions.

This project has been funded by Horizon 2020 REWAISE.

CHALLENGE

Climate change and rapid urbanisation have led to an increase in flows in STW combined sewer network. This results in an increase in discharges of untreated wastewater from urban drainage networks into the local environment and watercourses.

ACTIVITY



STW has over 1000 Sewage Treatment Works, each with a unique sewerage network. A staged approach has been followed to refine catchments to those which were most likely to benefit from using multiple CENTAUR system to manage flows.

- A coarse filter using existing STW data sets to rapidly remove unsuitable catchments.
- A detailed filter that identified sites with the most potential to utilise latent storage within existing networks.
- Final catchment selection and modelling to identify specific locations within the catchment suitable for a CENTAUR System.

OUTCOME

Modelling has identified that three gates would maximise storage and reduce the CSO spill frequency and volume in the Derbyshire catchment of Alfreton.

Overall, the modelling work has calculated that the impact of the scheme will reduce spills at these CSOs by up to an average of 46% per year.

VALUE

The implementation of centaur gates across our waste network, coupled with smart monitoring and control, will reduce the likelihood of CSO discharges into the watercourse. This solution will also mitigate the need for future capital investment.

CASE STUDY: AnMBR – anaerobic membrane bio reactor

STRATEGIC THEME: Delivering outcomes our customer care about
Taking waste safely away

OVERVIEW

The Anaerobic Membrane Bioreactor (AnMBR) combines anaerobic digestion with physical separation membranes, resulting in maximum organic load removal and biogas. Historically the technology has been used in warmer climates, such as Brazil where anaerobic treatment has been successfully implemented to treat wastewater from millions of their local population.

STW has been working with partners Cranfield University to see how anaerobic treatment works in more variable climates and have built "Europe's Largest AnMBR" at Resource Recovery & Innovation Centre (R2IC) at Redditch, Spernal, STW.

This project has been funded by the EU Horizon 2020 Next Gen programme.

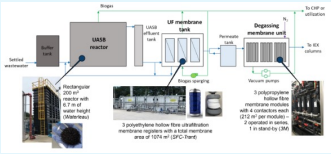
CHALLENGE

Secondary biological treatment at a WWTW is key to ensure final effluent quality when discharged to a water course. However, this essential process has an incredibly high energy demand and hinders the path to Net Zero wastewater treatment.

ACTIVITY

The AnMBR installed at Spernal consists of 3 distinct work packages:

- A UASB (Up-flow Anaerobic Sludge Blanket) reactor: a methane-producing digester, which uses an anaerobic process and forms a blanket of granular sludge.
- A submerged membrane ultrafiltration (UF) plant that ensures adherence to site permits.
- A membrane degassing unit to remove any dissolved methane.



OUTCOME

Results show there is potential to recover biogas to a similar quality of conventional digestion and that pH and alkalinity are compliant with discharge requirements for recycled wastewater.

The nutrient recovery performance tested by Cranfield provided promising evidence that ammonia and phosphorus recovery from AnMBR effluent is possible at lab scale.

VALUE

Once proven, AnMBR has the potential to be the future standard for waste treatment, reducing the capital investment of future works by £20-30m.

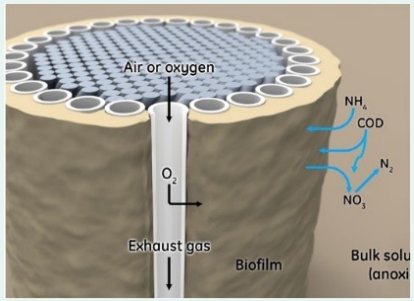
HAND IN HAND WITH NATURE

CASE STUDY: MABR – Membrane Aerated Biofilm Reactor

STRATEGIC THEME: Hand in hand with nature
Enhancing nature

OVERVIEW

Membrane Aerated Biofilm Reactor (MABR) is a wastewater treatment technology that uses a membrane to aerate the wastewater, and a biofilm to break down pollutants. In the MABR process, the wastewater is pumped through a membrane where it is aerated and mixed with a biofilm.
The biofilm, which is made up of microorganisms, breaks down the pollutants in the wastewater; cleaning it.



CHALLENGE

Population growth, tighter quality consents, and CAPEX/OPEX affordability are increasingly requiring ST to treat more sewage to higher standards without increasing the process footprint or greenhouse gas emissions, while reducing operational and capital costs.

ACTIVITY

Competing technologies (10 Oxymem units and 5 Suez units) were installed in two separate ASP lanes at Spernal WWTW which serves a 100,000 PE to evaluate MABR performance, and specifically, ammonia reduction capability. The observed outcome met the expected outcome of a 10% ammonia reduction across each trialed anoxic tank. Throughout the duration of the 12-month trial, the lanes were continually monitored for ammonia reduction, nitrification and the impact on sludge production.

OUTCOME

The trials demonstrated that MABR increased the capacity for ammonia removal across the anoxic zones, denitrification and nitrification peak lopping along with reducing energy consumption in the ASP lanes. It was also found that retrospective MABR units installation in anoxic zones can be completed without significant capital construction or site interruptions at a significantly lower cost than upgrading the lanes.

VALUE

Proving this technology provides our capital delivery teams with a cost-effective retrofitting solution to upgrade the capacity of treatment works using existing asset footprint; saving significant capital investment and avoiding the embedded carbon of redeveloping works.

CASE STUDY: SWARM – Waste treatment works risk matrix

STRATEGIC THEME: Hand in hand with nature
Enhancing nature

OVERVIEW

We're committed to using better data to find and fix problems quicker than ever before.

The risk of a waste treatment works exceeding its discharge and final effluent compliance is important to understand, so that it can be proactively managed. Historically this has been done through a manually intensive spreadsheet with limited data dependent variables and only updated monthly.

Using our data science and analytics expertise we can develop a predictive risk analytics capability to access dynamic insights of risks. Including these three desired capabilities:

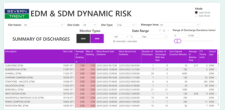
- Real time detection of potential overflow non-compliance,
- Real time detection of potential issues with monitor performance or calibration,
- Future prediction of both compliant and potentially non-compliant overflow operation.

CHALLENGE

Severn Trent have committed to five Get River Positive Pledges which include ensuring storm overflows and sewage treatment works do not harm rivers.

ACTIVITY

We are building a model that compares historic site overflow data against contributing factors such as rainfall, to predict where overflows are likely to occur in future. It creates a prioritised list of sites at risk of failure to proactively manage. The model uses machine learning to improve its predictions over time.



OUTCOME

During the first phase of SWARM, a tool for predicting sensor overflow spills has been developed and is being trialled by the operational teams.

Additionally, a data pipeline has been set up, allowing our teams to monitor the performance of their sites and detect where sensor and monitor errors may be occurring – previously this would not have been highlighted until the end of the year!

VALUE

The ability to predict the likelihood of any operational issues at a treatment works and allows interventions to be prioritised; avoiding spill events and reducing their impact on water courses.

HAND IN HAND WITH NATURE

CASE STUDY: Water Fleas – Daphnia – Micropollutant removal

STRATEGIC THEME: Hand in hand with nature
Enhancing nature

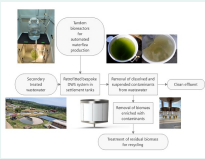
OVERVIEW

Daphne Water Solutions (DWS) uses an unconventional biological agent, the water flea (Daphnia), to non-selectively absorb, concentrate, and remove organics and inorganics from wastewater, including chemicals on the priority lists set in international regulatory frameworks.

The system consists of modular interconnected bio-filtration devices that provide passive, chemical-free, tertiary treatment of wastewater through a self-sustaining culture of Daphnia. The modularity allows the system to be retrofitted with minimum modifications to the existing wastewater treatment plant.

The bio-filtration unit is supported by on-site, side stream bioreactors that sustain a culture of Daphnia using algae as the feedstock. This culture acts as a seeding process for the biofilters to optimise performance, or a source of re-seeding in the event of the live environment being knocked out in a shock event.

Ref: https://www.dwsol.co.uk/



CHALLENGE

Emerging contaminants in wastewater are increasing in concern, requiring new methods of removal or treatment.

ACTIVITY

Severn Trent Innovation is working with Daphne Water Solutions, a spin-out company from the University of Birmingham, to trial a pilot-scale Daphnia filtration system on wastewater at the Resource Recovery & Innovation Centre (R2IC) at Redditch, Spernal, STW.

The 16-week trial will explore the impact of working in a live wastewater environment on the activity and longevity of the water fleas.

The pilot-scale Daphnia filtration unit will treat the equivalent of final effluent from a population of 6,000 to monitor how it performs in removing:

- Pharmaceuticals
- Microplastics
- PFAS / PFOS
- BOD
- Suspended solids
- Nutrients (ammonia and phosphorus)

OUTCOME

The outcome of this trial will be:

- Established removal rates for targeted micropollutants, nutrients and BOD / SS.
- Growth rates of Daphnia in the live wastewater system at winter and spring temperatures.

VALUE

The development of a nature-based solution for the removal of emerging contaminants provides us with a sustainable and environment friendly means of enhancing nature and protecting the health of our customers.

CASE STUDY: AIOT – autonomous wastewater catchments

STRATEGIC THEME: Hand in hand with nature
Enhancing nature

OVERVIEW

Artificial Intelligence (AI) is changing the way the world works. It has the potential to transform the way the water sector delivers for our customers, society and the environment. To drive transformative change and realise the benefits we need to share data, best practice, and innovative solutions within the sector.

Our cross-sector coalition proposes to pilot an autonomous waste catchment in Alfreton, Derbyshire. This will combine emerging technologies for comprehensive testing, and create a shared blueprint that is tested, proven and ready to be scaled across the UK.

The blueprint will allow water companies to:

- Minimise the risk of flooding and pollutions in real time
- Minimise the risk of asset failure by integrating prescriptive, condition-based maintenance of sewage pumping stations and rising mains.
- Reduce energy consumption and process emissions, and maximise resource recovery by maintaining steady-state conditions to the sewage treatment works.
- Protect the system from cyber threats and malicious attacks

CHALLENGE

Sewage pollution and flooding causes our customers unacceptable stress and damage. The negative impact on the environment can be catastrophic in both the short and long term.

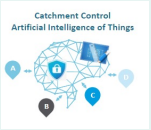
ACTIVITY

Physical
Currently in the process of understanding what upgrades are needed at pumping stations so that they can send key data to our digital models in real time.

Digital
Process of understanding how to build digital models to:

- Predict future storms
- Predict the flow into pumping stations and the treatment works
- Simulate how potential changes in weather will impact the catchment.

Trials
Once the above are complete we will link our pumping stations with the digital models to test real-time control of the pumps.



OUTCOME

The desired outcome is that, ahead of a storm, the network will automatically create capacity in the sewerage network by emptying large tanks. During a storm, the network will automatically store storm water in the pipes and tanks that have available capacity.

VALUE

AIOT will ensure that the use of latent storage across the waste catchments is optimised; creating a steady state flow to treatment works and mitigate the need for future capital investment in storage solutions.

HAND IN HAND WITH NATURE

CASE STUDY: Advanced Phosphorus Removal

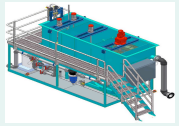
STRATEGIC THEME: Hand in hand with nature
Enhancing nature

OVERVIEW

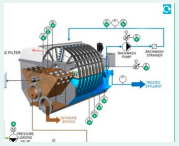
Under the WINEP Phosphate Reduction Programme there are tighter limits related to total phosphorus permit limits, particularly at larger sewage works (>100,000PE).

Two technologies have been reviewed to assess if these limits can be reached:

The WesTech RapiSand™ Ballasted Flocculation techniques uses flocculation techniques and adds a dense ballast to deliver much higher settling rates.



The Veolia Discfilter process is set up for phosphate removal by using chemical dosing to precipitate the soluble orthophosphate, flocculating these solids together with the incoming suspended solids and removing the flocs on the filtration surface of a discfilter.



CHALLENGE

The WINEP Phosphate Reduction Programme has introduced new ultra-low total phosphorus permit limits, particularly at larger sewage works (>100,000PE); significantly lower than current limits.

ACTIVITY

For both the trials with WesTech RapiSand and Veolia Disc Filter the aims of the trial were to:

- Evaluate compliance against ultra-low permit levels in terms of total phosphorus, total iron and total suspended solids.
- Ensure that the process can handle wide fluctuations in inlet parameters.
- Ensure that the process can provide a smaller installation footprint

OUTCOME

Both trials were located at our Resource Recovery & Innovation Centre so that final effluent from a live WWTW could be directed to both technologies and be as representative of site scale as possible.

Both the WesTech RapiSand and Veolia Discfilter technologies were able to meet total phosphorous limits below (<0.3 mg/l)

VALUE

Deployment of this solution at environmentally sensitive sites will ensure that tighter P consent levels can be met in AMP 8 and that we continue to reduce the impact of wastewater treatment on river health.

CARBON & CLIMATE CHANGE

CASE STUDY: Advanced models & digital twins – GHG reduction

STRATEGIC THEME: A driver of positive change
Net zero emissions from our activities

OVERVIEW

Identifying the highest-impact opportunities to reduce emissions is challenging, because we don't have a complete picture, i.e., a 'real-time' digital model of the end-to-end treatment process.

Digital models help by combining different data sources to create a 'connected digital twin' of the physical infrastructure. This will allow us to safely simulate different methods for operating the treatment works to ensure the lowest possible GHG emissions and to meet relevant permits.

While there are currently a range of Commercial Off The Shelf (COTS) products within the market, none have the capability to combine the models, undertake the engineering analysis, run complex simulation scenarios and present the findings in a timely, cost-effective way.

The Digital Twin will, over time, learn set points / operational conditions to suit the conditions coming up (e.g., bad weather or more effluent coming in). It will also identify the ideal conditions to enable carbon emissions to be reduced to as low as possible in near real time.

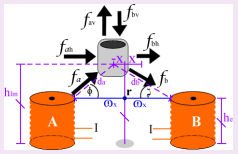
CHALLENGE

There are billions of variables to consider when trying to run a treatment works.
The sector's journey to net-zero has highlighted that operator experience alone will not be enough to consider all these variables and manage the required trade-offs to hit zero emissions.

ACTIVITY

The activities that will enable the creation of a Digital Twin are:

1. Understanding the most appropriate position for N_2O and CH_4 monitors.
2. Complete a design of a system to host the models.
3. Complete a Mechanistic Model of the "as is" and "to be" end-to-end treatment process.
4. Integrate the GHG data with the mechanistic model.
5. Identify at least three user scenarios that will directly reduce emissions.
6. Successfully test user stories within the digital models.



OUTCOME

The outcomes of the Digital Twin will be:

- A clear, definitive mathematical relationship between process and GHG production
- Plant wide optimisation for emissions, given limits for energy, chemical and final effluent compliance

VALUE

Wastewater treatment digital twins will allow operations to optimise works for treatment compliance, power and chemical consumption, process emissions and resource recovery; reducing operating cost and environmental impact.

CARBON & CLIMATE CHANGE

CASE STUDY: GHG Monitoring & Measurement

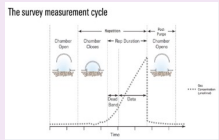
STRATEGIC THEME: A driver of positive change
Net zero emissions from our activities

OVERVIEW

An accurate baseline is fundamental to a credible reduction. The industry standard is to use the UKWIR Carbon Accounting Workbook (CAW) calculations to estimate GHG emissions using an industry-standard factor.

STW has embarked on an industry-leading monitoring programme, which has improved our understanding and reporting of process emissions from the treatment of sewage and sludge.

STW has also created the Net Zero Partnership (NZP) with Arhaus Vand and Melbourne Water to share learnings and best practice and this includes GHG emission monitoring.



CHALLENGE

Severn Trent has committed to achieving Net Zero Green House Gas emissions by 2030.

ACTIVITY

Industry leading activities to monitor and identify way to reduce GHG process emissions include:

N2O Monitoring:

- A commitment to install continuous monitoring on sites making up 40% of our N2O emissions.
- Installing Unisense monitors measuring dissolved N2O in ASP and estimating emissions.
- Data science helping us draw insights from data to better understand what happens in the process to lead to N2O production and what levers we can pull to control it.
- Spot sampling emissions from assets omitted from the incumbent carbon accounting method (PST, FST, Cake, reed beds etc).

CH4 Monitoring:

- Monitoring in place at Minworth (point sensor network and dispersion modelling) at cake and landfill site.
- Exploring environmental and operational factors that lead to cake and landfill emissions.
- Committed to installing continuous monitoring at sites making up 40% of our methane emissions.

Drone Detection

- Surveying our sludge sites with our drone and optical gas imaging camera to locate and fix leaks.
- MSc by research project to quantify some of these emissions detected using the drone.

OUTCOME

Current data analysis combined with a review of the available international science, shows that process emissions are substantially higher than the previous CAW calculations and has had a significant impact on our baseline forecast.

VALUE

Development of cost effective and reliable GHG monitoring technologies has established our baseline emissions and has informed the programme of activities required to remove and reduce their environmental impact.

CASE STUDY: Advanced Thermal Conversion

STRATEGIC THEME: A driver of positive change
Net zero emissions from our activities

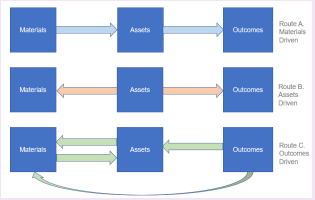
OVERVIEW

Severn Trent treats over 200,000 tonnes of sewage sludge every year. Our current bioresources strategy is centred on anaerobic digestion of the sludge, supplemented by thermal hydrolysis processes at four of our largest sludge treatment centres. All the biogas is used either to generate renewable electricity through CHP or it is upgraded to biomethane and injected to the gas grid. All the digested sludge is recycled to agricultural land to sustainably return nutrients to the land.

However, with the regulatory landscape for recycling of treated sludge to land likely to change, our current approach to treated sludge disposal may no longer be viable.

Furthermore, there are emerging contaminants such as microplastics, pharmaceutical residues and PFAS all exerting pressure on sludge to land.

Advanced thermal conversion (ATC) technologies are an option that that will support in addressing both the carbon and regulation challenges and position Severn Trent favourably in a competitive bioresources market.



CHALLENGE

Severn Trent has committed to achieving Net Zero Green House Gas emissions by 2030 and our bioresources operations has significant potential to both reduce and offset our process emissions.

ACTIVITY

Severn Trent has engaged with a consultant, Stoic Limited, to complete a strategic assessment of ATC technologies to complete the following:

- Outcome 1 – Technology Assessment
- Outcome 2 – Demonstrator Plans
- Outcome 3 – Business Case and Recommendations

OUTCOME

The review has established the next steps towards investment in ATC that will help reduce our carbon impact and address future regulatory challenges. These include:

- A timeline for commercial and technical due diligence of the short-listed technologies identified in report.
- Engagement with Scottish water companies who already dry sludge for testing within ATC.
- Establishing STW “hierarchy of needs” for given scenarios and select an appropriate number of technologies to focus on fulfilling those needs.

VALUE

Advanced thermal conversion provides a viable route for the disposal of digested sludge from waste treatment works while also providing a circular economy by-product.

CARBON & CLIMATE CHANGE

CASE STUDY: Cellulose recovery

STRATEGIC THEME: A driver of positive change
Embracing the circular economy

OVERVIEW

There is a significant amount of cellulose in sewage (originating from toilet paper - toilet paper is approximately 80% cellulose). In the ST region alone, we receive approximately 100,000 tonnes of cellulose per year.

Cirtec, a Dutch company, have developed a process where the cellulose fibres can be recovered. This recovered cellulose can be used as a structural material to substitute virgin cellulose - it has been used in asphalt, concrete and other building materials as well as bio-composite materials. It can also be used as a feedstock for chemicals including acetic acid and polymers.

Life cycle analysis has estimated that cellulose recovery can improve the of a sewage treatment works and help to reduce its carbon footprint by up to 15%.

CHALLENGE

Severn Trent has committed to achieving Net Zero Green House Gas emissions by 2030.

ACTIVITY

The trial was conducted for 8 weeks and split into the following programme:

- One/two weeks of optimisation and calibration.
- Spernal influent trial: 5 weeks (3 weeks mixed influent, 3 weeks unmixed Influent).
- Strongford influent Trial: 2 weeks (1 weeks mixed influent, 1 weeks unmixed Influent).

The plant ran in 1hr intervals and created on average 4.5kg-6kg of cellulose per day. The material was dried to 97% dry solids as this is required for Cellulose testing and on average took around 3hrs.

This final material was sent to ReCell in the Netherlands for comparative Cellulose testing to other similar recovery trials held in the Netherlands & Italy.

OUTCOME

Proof of concept trial is now complete, and material has been tested by ReCell for chemical composition and is suitable for use in a number of products including asphalt and as a chemical feedstock.

Microplastic analysis confirms the process can also remove 99% by mass of microplastics from the influent and is concentrated in the sludge stream and not the cellulose product.

VALUE

Cellulose recovery not only provides revenue from a valuable construction and manufacturing raw material, it also improved works treatment capacity and is a route to the removal of microplastics from wastewater final effluent and digested sludge.

AFFORDABILITY & ACCESSIBILITY

CASE STUDY: Vulnerable customers – engaging the hard to reach

STRATEGIC THEME: Caring for people in our region
Affordability & Accessibility

OVERVIEW

Extreme weather such as the 'Beast from the East', the 2018 hot summer and numerous storm events have highlighted the need to improve our understanding of, and response to, customer vulnerability. COVID-19 and the subsequent economic challenges have also resulted in a significant impact on the levels of customer vulnerability.

Without adequate insight of vulnerable customers' needs the sector risks not delivering the right level of support during planned and unplanned events. This is complicated by several overlapping barriers including English not being a first language, making such customers harder to reach. Distant customer relationships present a risk that vulnerable customers may not be aware of available support. Consumer Council for Water (CCW) emphasise that more needs to be done to increase awareness of support available and the number of households on the Priority Service Register (PSR).

This project will facilitate a step change improvement in engagement of hard-to-reach customers and communities to improve clarity on the support they need.

The insight and improved engagement resulting from this project will put water and wastewater companies in a better position to support vulnerable customers during planned and unplanned events and in accessing affordability support.

CHALLENGE

Vulnerable Customers are individuals that are more likely to require a more tailored experience from us. Hard-to-reach customers are a subset of vulnerability.

They are someone, who due to their circumstance, is likely to miss or not fully understand communications from us. Knowing who these customers are matters.

ACTIVITY

Using behavioural science and design thinking methodology, the project will determine the relationships between the types of communication methods used to connect with consumers, and their effectiveness.

Research and trials, focussing on a demographically diverse pilot location in Leicester, will test and ascertain how the right campaigns and support can be directed to those most in need. The insights obtained will be used to tailor customer journeys and communication channels to be more appropriate and effective, facilitating a step-change improvement for the water sector in the engagement of hard-to-reach customers and communities.

OUTCOME

We've learnt a lot through this project; there are complex reasons why customers can be hard-to-reach, particularly if they are vulnerable.
It requires tailored and thoughtful approaches to ensure they know about the support that is available to them.
We've shared what we have learnt in a new playbook, which is available to download here.

VALUE

We have developed new techniques and strategies that present us with the opportunity to better serve our customers and help them understand the support available to them.

APPENDIX:
innovation hubs

Our collaborative approach to tackling the challenges we are facing across the sector

Innovation in action: collaborative learning

Preparing for AMP 8

Expanding the Innovation Hubs

Building on the Net Zero Hub, we plan to adopt this approach to tackle the challenges that we face as a water sector. The hub approach provides an environment and way of working that supports:

- Multidisciplinary teams working together across and beyond Severn Trent.
- Diverse internal and external stakeholders to share knowledge, resources and expertise.
- Platforms to trial and prove integration and interoperability of Engineering, Operational and Information Technology solutions.
- Access to infrastructure, mentorship, partnerships and networking opportunities to support innovation.
- Opportunities for training and education to promote learning, knowledge sharing and skill-building.
- Collaborative culture that supports the development and implementation of new ideas and solutions.

During AMP 8, using this model, we will work with water companies, third party suppliers and academics on four hubs which are aligned to our strategic objectives of being performance driven and sustainability led. The hubs will provide a platform for proving technologies that support the delivery of the commitments outlined in our AMP 8 base plan, ODIs, and UMEs. Each hub will be underpinned by a strong focus on improving customer experience and deploying nature-positive solutions.

Zero Spills Hub - Where we'll deploy solutions, at scale and in combination, to ensure that we take **wastewater safely away,** reducing and removing overflow spills and flooding by understanding the catchment as a system. We will bring together artificial intelligence (AI) and machine learning (ML) with physical technologies, new sensor technologies, open data and automation to optimise the network through multivariate modelling and simulation. Through this we will be able to maximise the use of existing network capacity and increase the viability of nature-based solutions and other low carbon, high amenity solutions.

Net Zero Hub – Where we'll deploy solutions at scale and in combination to reduce, remove and sustainably offset process emissions at a wastewater treatment works to **achieve carbon neutrality**. We will bring together artificial intelligence (AI) and machine learning (ML) with physical technologies and automation to optimise the works through multivariate modelling and simulation. This will ensure our environmental commitments are delivered, whilst minimising process emissions and energy consumption as well as maximising energy production and resource recovery.

Water Always On Hub - Where we'll deploy solutions, at scale and in combination, to ensure that water is **always there and is good to drink,** ensuring that all the water we supply is of the highest quality and that what is consumed is necessary and when it's necessary, it's always on. We will bring together artificial intelligence (AI) and machine learning (ML) with physical technologies, new sensor technologies, smart metering, and open data to address raw water quality deterioration, prevent microbial contamination, prevent disinfection by-products, water discolouration, target asset health improvements, drive down supply interruptions, improve our operational resilience (power and chemicals), reduce operational losses and leakage, as well as supporting customers to reduce consumption.

Zero Waste Hub - Where we'll deploy solutions, at scale and in combination, to reduce and remove the loss of valuable resources from our value chain. This will include wasted resources, embedded value, capacity and lifecycles, including water reuse. We'll also develop the artificial intelligence (AI) and machine learning (ML) tools to enable the prediction of flow and load into our resource recovery factories to optimise production.

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