



INNOVATION

APRIL 2019

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DIRECTOR'S FOREWORD

Our customers quite rightly have high expectations of us.

As the only not-for-profit water company in England and Wales, we take the responsibility of meeting those high expectations seriously. We serve around three million customers, we own and maintain around 27,000km of water pipes, with another 36,000km of sewers, over 800 wastewater treatment works, and many other assets besides to enable us to provide our water and wastewater services.

To do the work we do, we need to earn the trust of our customers, every day. To earn that trust, we need to work in ways which allow us to maintain high quality services, but at an affordable price. As such, innovation is at the heart of everything we do — it helps us work more efficiently, at a lower cost, and with less impact on the environment and the world around us. That's why innovation is such a priority for us as a business, and for our customers.



Tony Harrington
Director of Environment

Our work over the past year, which we outline in this update, has built on our progress from recent years to encourage and develop new ideas. This can be seen across all areas of our business — in producing clean, safe drinking water of the highest quality, in removing and treating wastewater from homes and businesses across Wales and Herefordshire, in protecting the environment in all the areas we work in, and in protecting the health and safety of our 3,500 colleagues while they carry out their work.

Our Welsh Water 2050 vision sets out the big challenges facing our business and wider society, over the coming decades. These include a changing climate, more volatile weather events, new regulatory and policy priorities and demographic change — so we know our water and wastewater services will look very different by 2050. We have to balance these against a much lower cost base and the increased needs of customers. Engagement with our customers to

help us understand their priorities and what can be afforded will be key, and so we will need to develop more innovative ways of working, listening and planning.

I'm proud of the work we're doing in this area — over the past 12 months and beyond — but we know we have a lot more to do to achieve what our customers want us to and what we have set out on our 2050 vision. This is why we have published a new **Innovation Strategy** this year and associated Journey Plans. These set out the knowledge gaps we must fill through research and technology development. We hope these documents will be useful to help us engage with our partners, stakeholders and customers alike. It is, after all, by being open to new ideas, innovating and co-creating solutions that we will deliver what our customers need at a price they can afford.



IN BRIEF

OVER THE LAST
12 MONTHS...



WE'VE
INVESTED
£4.6M IN
INNOVATION

SINCE 2015...



467
IDEAS
REVIEWED BY
INNOVATION
FORUMS



123
PARTNERS
INVOLVED IN
PROJECTS



92
PROJECTS
COMPLETED



£39M
INVESTED
BETWEEN 2015
AND 2020



8
AWARDS
WON

WATER SERVICES

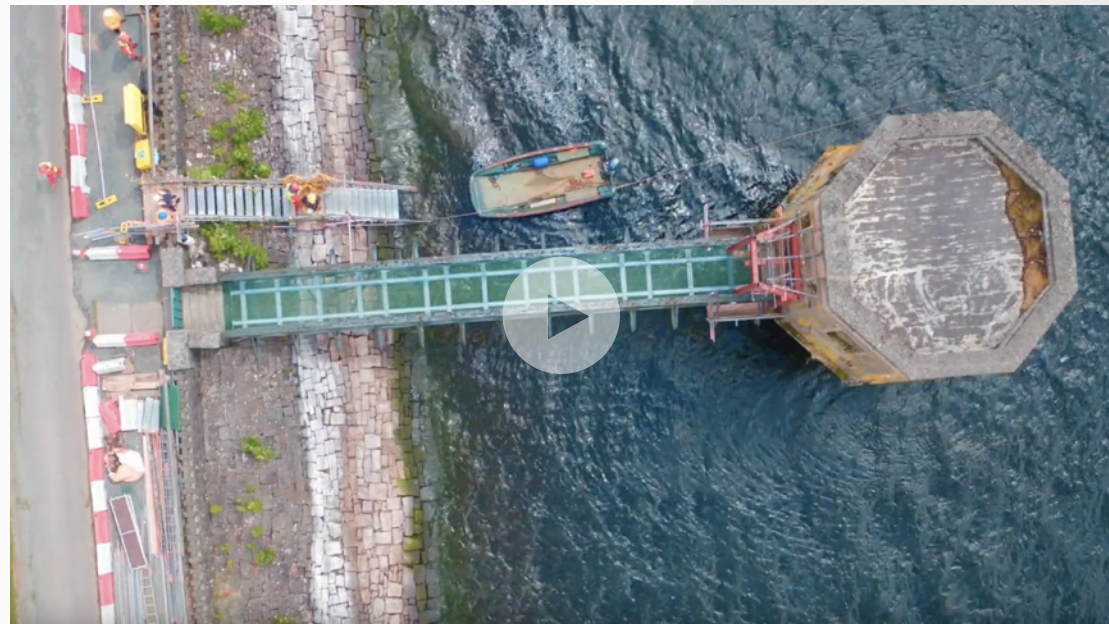
CUSTOMERS REGARD CLEAN, SAFE DRINKING
WATER AS OUR MOST FUNDAMENTAL DUTY –
WE ARE CONSTANTLY LOOKING TO REFINE AND
IMPROVE THE WAY WE DELIVER THIS VITAL SERVICE



DAM SAFETY: TALYBONT-ON-USK

In October, we completed work on a £10 million modernisation of Talybont dam in the Brecon Beacons, using divers and remotely operated submersible vehicles across several months to upgrade the pipework inside the dam without impacting on drinking water supplies to over 30,000 households.

A specialist dive team was brought in to perform a complicated and challenging procedure to make sure the project went safely — removing parts of the pipe weighing several tonnes, in conditions of near-zero visibility. The operation involved the Dam Safety Team, working with the Capital Delivery Alliance with support from Lewis Civil Engineering, and the Caerphilly-based Edwards Diving Services.



SEE WHAT WE DID AT TALYBONT

FERRULE ISOLATION SPADE

On part of our distribution network, customer supply pipes are connected to our mains via an aqua ferrule fixture. In order to do any work on these customer supply pipes we have previously had to isolate the main as there is no point of isolation on the ferrule itself. This can lead to supply interruptions to customers, in some cases to over 100 properties for a short period of time.

To solve this problem, we developed an 'isolation spade' — which means we can isolate the supply pipe at the connection to the main, rather than the main itself. This prevents disruption to properties in the surrounding area.

The innovation involved using an existing slot in the aqua ferrule design to effect a temporary interruption to the flow using the 'spade'. The concept first devised by one of our operatives was developed in collaboration with the School of Engineering at University of Wales Trinity St David, in order to access improved design and fabrication equipment.

The product is now intended to be issued to our operatives in the field, with the aim of reducing disruption, normally caused by such work, to thousands of properties each year.

WE CAN ISOLATE THE
SUPPLY PIPE AT THE
CONNECTION TO THE
MAIN, RATHER THAN
THE MAIN ITSELF



FERRULE ISOLATION SPADE

SATELLITE LEAKAGE DETECTION

We have prioritised detecting and repairing leaks in recent years — halving leakage over the past decade alone. But with nearly 27,000km of water supply mains network, deterioration through natural ageing of the pipe material and the stresses caused by varying weather conditions, means the maintenance and repair of these assets provides us with a continuous cycle of work.

To address this, we are running a project designed to make it easier for us to find leaks in a more cost-effective and less resource-intensive way than traditional methods.

Using the Suez system, previously used to detect the presence of water on distant planets, we can use satellite-mounted sensors and overlay them on geographic information systems detailing our water mains. Using a unique algorithm that detects treated water, this can find leaks more efficiently over large areas — with each image covering a 3,500km² area of land — big enough to cover most UK cities, and thousands of kilometres of pipework.

This system has already provided us with a wealth of data which we are investigating and will hopefully enable us over AMP7 to reduce leakage by a further 15%.

UNDERWATER SURVEYS

As part of our Pipes in Dams work, we have also been working with Abyss Solutions to trial an advanced underwater drone, capable of gathering exceptionally high-resolution imagery in conditions of near-zero visibility. The remotely-operated vehicles (ROVs) use visual and acoustic imaging systems to conduct a baseline survey of Craig Goch Dam in the Elan Valley.

The inspection gave us information on the structure — which dates back to Victorian times — which would traditionally have involved drawing down the level of the reservoir, and use of divers — which involves numerous health and safety considerations, impact on the quality of information we receive, as well as much higher costs.

The system was able to capture images of the key features of the dam, such as the outlet tower gates, culvert inlet, coffer dam wall and scour outlet valve headstock using the on-board sonar.

The data we received allowed us to build a digital “twin” of the dam — identifying faults using machine-learning principles and tracking change over time.

UNDERWATER DRONE



DATA SCIENCE

E-DIARY

Teams across Water Treatment Works in Welsh Water have traditionally relied on written records of work carried out on our sites — such as chemical deliveries, equipment failures or maintenance.

However, this system restricts the availability of important detail to just those teams — and there is benefit for teams across the company having access to these records, and without the need to travel to access them.

As a result, the Data Science Team and Water Production teams worked together to devise an eDiary to use at works to address these challenges. The online diary ensures data can be easily recorded by colleagues, is consistent, can be collected in a

structured format, which means it can be analysed more easily and where necessary, shared with our regulators far more efficiently.

The trial was introduced across four sites in West Wales last year, and further developments have been made to the system in readiness to be distributed for the second phase of trials at two sites in each region.

The final eDiary will have a report functionality that can be used by any authorised person to pull data from the eDiary from any location so that site visits to copy the paper diary aren't needed, and enabling better analysis for the entire organisation.

THE USE OF DATA IS A
HUGE OPPORTUNITY FOR
US TO IMPROVE THE WAY
WE WORK TO BENEFIT OUR
CUSTOMERS, AND OUR
EMPLOYEES



WASTEWATER SERVICES



TREATING WASTEWATER
AND RETURNING IT TO
OUR ENVIRONMENT SAFELY
SHOULD BE 'OUT-OF-SIGHT
AND OUT-OF-MIND' – THIS
IS WHAT WE AIM TO PROVIDE
ALL YEAR ROUND

ULTRAWAVES

A challenge across our sludge treatment assets is maximising energy production in our digesters, particularly at our Cardiff East Wastewater Treatment Works – which processes the sewage of around 300,000 homes across South Wales.

Our partnership with The Wales Centre of Excellence for Anaerobic Digestion (University of South Wales) identified that the digestion process at Cardiff Wastewater Treatment Works is not operating at its full potential due to high levels of ammonia inhibiting the gas production process.

To overcome this we have trialled a technology which used high power ultrasonic waves to treat the sludge.

In a lab-scale trial, the use of this system seemed to increase the amount of biogas produced. This increases our renewable electricity and heat production and the increased solids degradation reduces the amount of residual sludge left over to be disposed of.

Projections based on this pilot suggest that we could increase gas production by around 40%, which together with a reduction in the sludge to dispose of, would save around £635,000 per year.

The process is subject to many natural variations and it is difficult to isolate these from the impact of the ultrasound.



HIGH POWER

ULTRASONIC WAVES

TREAT THE SLUDGE

MECANA FILTRATION

The presence of phosphorus in our water sources presents a big challenge to water quality — so using innovative measures to remove it from our water sources can be of huge value to the company. It usually reaches these bodies from soil from fertilisers, through run-off from land or discharges from our treatment works. It is cited as a major reason that UK rivers are not achieving 'good' status under the Water Framework Directive (WFD).

To tackle this, we introduced a new system that enhances existing processes to achieve compliance of our works — the Mecana filtration unit. This was initially introduced at Hirwaun and Caerwent wastewater treatment works, with further units installed in Cowbridge and Llangennech.

The Mecana media filter was introduced as a tertiary treatment in place of sand filters to aid the removal of phosphorus.

The system has prompted savings (against traditional sand filters) of up to 19% on our capital spending. It's also significantly reduced maintenance requirements.



MECANA MEDIA FILTER



WHITCHURCH WASTEWATER TREATMENT WORKS

SAND CYCLE

Conventional sand filters used in wastewater treatment processes are meant to remove suspended solids from wastewater treatment plants by percolating water through a sand bed. However, the rate that the sand filter beds turnover is important to their performance. If the movement rate is too high, this will cause the sand filter to underperform and will be difficult to meet the plant consents.

Sand Cycle uses the same technology for tagging animals, like cattle and pets. The tags, move with the sand bed through the continuous sand filter. An antenna detects the passing of the tags, and sends it to the Sand-Cycle processing unit where it is turned into data used to power the Sand-Cycle dashboard. The filter operator then has near real-time access to the health of the filter process.

Our trial at Whitchurch Wastewater Treatment Works in Shropshire indicated a number of benefits, including near real-time bed time over rates, automated logging of filter turnover, as well as the site effluent meeting the consent. We are looking at full implementation across all four of our sand filters at Whitchurch.

MERMAID QUAY

The commercial area of Mermaid Quay in Cardiff Bay embodies the challenge we face when materials are wrongly washed or flushed away into the wastewater system. We are investing £2 million to upgrade the sewer system in the area, after reports of local internal flooding caused by people putting fat, oil and grease down the sink that has now built up in the sewer. More frequent cleaning to clear these materials can wear out old sewers quicker than we would like — and that is what happened in Mermaid Quay.



WATCH OUR
MERMAID
QUAY STORY

In its initial work phase, we have removed around 800 tonnes of fat, oil and grease from the collapsed sewers — the equivalent of more than 130 African elephants. This has been done in a busy commercial area with a number of restaurants and bars, which has meant we have worked very closely with business owners to minimise disruption caused by our work.

Part of this has been a new approach to working with the community — with a permanent presence on site with an information hub, acting as a liaison between businesses, residents, visitors and our workers to keep people informed about the latest work, and to deal with any queries they may have.

CAPITAL ALLIANCE

OUR RECORD CAPITAL
INVESTMENT MEANS WE ARE
PROVIDING EVER BETTER
ENVIRONMENTAL AND OTHER
BENEFITS FOR OUR CUSTOMERS
AND THEIR COMMUNITIES

XYLEM CONCERTOR PUMP

This project centred around a sewage pumping station, where there had been a particularly acute problem of 'ragging' — where the pump becomes clogged with rags, meaning costly call-outs. There were 40 such callouts over the course of a year to the same pumping station, costing the business around £20,000.

We trialled the Flygt Concertor at the pumping station — introducing integrated intelligence into the pumping system at the site. This meant cleaning of the wet well was automatically carried out, and flowrates optimised for reduced power for the levels of flows to the site. As a result, there were significant benefits in terms of reduction of costs, energy savings of around 15%, protection of the environment around the station through reduced risk of spills, reduced maintenance callouts and health and safety benefits.

As the pumps bring significant benefits in how they operate, Welsh Water maintenance teams and the Capital Delivery Alliance has gone through detail to ensure it is safe to operate, reliable and can be retrofitted in to existing applications as well as used in new applications.

THERE WERE
SIGNIFICANT
BENEFITS IN TERMS OF
REDUCTION OF COSTS



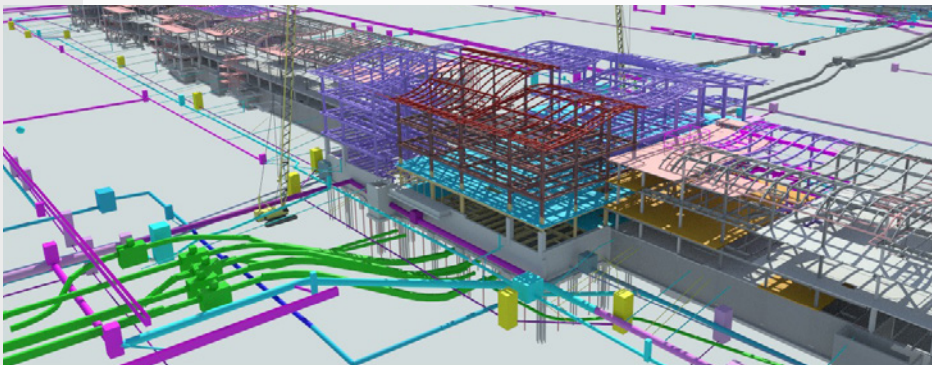
XYLEM CONCERTOR PUMP

SYNCHRO 4D

Working with our construction partners, Skanska, we have introduced software which allows us to better map each stage of a construction project, meaning our impact on the communities we are working in can be minimised.

The Synchro 4D project was trialled first at a major investment programme at Prioress Mill, near Newport. The software was used to improve understanding and sequencing of the excavation of a large hole — in an area constrained tightly on all sides by a river, pressurised pipe mains, an existing pumping station and an environmentally-sensitive area.

The programme gave a visual representation of key stages of the work — including logistics and deliveries, improved health and safety on site and better operations and customer engagement — as we can demonstrate how things will be done and the impact it will have.



NIVUFLOW INSERTION FLOWMETER

Magnetic flow meters have traditionally been used to measure flow rates through pressurised sewer pipelines. However, these systems are expensive, particularly larger pipe sizes or in to existing pipelines, and the accuracy can be affected if there are gases in the pipe.

To tackle this, we introduced a trial of the Nivuflow system at Gowerton Wastewater Treatment Works. This system works on 'time-of-flight' principles — the time taken by an object or wave to travel a distance through the pipe — using sound waves. As it is an insertion type flowmeter, the flow of the pipe doesn't need to be stopped or the pipe isolated to install or maintain the device. This makes the installation cost and the cost of ownership lower while still providing the same accuracy of information as the traditional solution.

This also ensures health and safety concerns are significantly reduced — as pipes do not need to be drained or taken out of service, and no lifting equipment is needed. Reducing any down time by being able to maintain the flowmeter without taking the process offline gives better resilience.

We are now examining the case for rolling out the systems on certain pipes — both for new installations and for retrofitting existing pipework.

HEALTH AND SAFETY



OUR ULTIMATE
RESPONSIBILITY TO
OUR 3,500
EMPLOYEES IS TO
ENSURE THEY CAN
DO THEIR JOB SAFELY,
AND AS EFFICIENTLY
AS POSSIBLE, AND SO
THEY CAN GO HOME
SAFELY AT THE END OF
THE DAY

HAVWEAR

As such, our 'safety-first' culture means we are working towards reducing the number of work-related injuries and illnesses to zero.

A simple idea to help achieve this was the introduction of 'HAVWEAR' wrist-worn devices for workers — originally introduced by our contractor partners; Morgan Sindall. These measure the level of hand-arm vibration (HAVs) — recording data and triggering alarms construction workers using certain machinery reach a threshold which could endanger their health.

These are intended to replace the traditional practice of time limitations on machine use, by using more sophisticated measures of the magnitude of the vibrations and exposure across longer time periods, allowing us to monitor vibration data at an individual or group basis, identify equipment which could be generating more vibration than it should, and producing real-time data to protect workers from over-exposure and permanent damage.

CUSTOMER SERVICE



OUR NOT-FOR-PROFIT
VISION MEANS OUR ULTIMATE
PRIORITY IS ALWAYS TO
EARN THE TRUST OF OUR
CUSTOMERS, EVERY DAY

WATER RESILIENT COMMUNITIES

Sitting alongside one of our largest investments (£23 million) in our programme to cleanse and renew water pipes in areas which suffer repeated interruptions during 2015-2020, the Rhondda Fach Water Resilient pilot project was designed to maximise the benefit of our presence in one of Wales' most deprived communities. It focussed on key areas of our work on a comparatively small geographic area with the intention of leaving the legacy of a "water resilient community."

Our work in the Maerdy-Porth zone is our single largest investment in the programme: 54 kilometres of new water

mains are being laid in the south Wales Valleys. This investment addresses issues linked to the appearance, taste, odour of local drinking water supplies, as well as improving its reliability.

Engagement with the local community was essential while we completed work to explain what we are doing and manage customer expectations. However, this project has pushed us further by identifying areas where we can maximise the benefit we can bring to an area while investing in our own assets, as well as involving, working with and listening to the community to make these changes for long-term benefits.

[WATCH OUR RHONDDA FACH STORY](#)

Among the benefits we sought were to influence customer behaviour through our 'Let's Stop the Block' and water efficiency campaigns; and working with customers to understand the barriers they may face that prevent them from accessing one of our social tariffs, or registering for the Priority Service Register.

IN BRIEF

£120,000 saved for customers through social tariffs

2,000 children received lessons in the area

23 groups and organisations have worked with us to change the way we do things

TRAILBLAZERS

One of our big priorities is making sure that our background customer service work is as efficient as possible — so customers can receive the best service possible, and we minimise waste.

A new delivery approach piloted in the last year — covering Field IT, Developer Services BPM, Mobile Apps, Office 365 and Retail Services' Digital Programme — has put in place a delivery framework enabling us to work in a more flexible way using short 'sprints' to complete tasks.

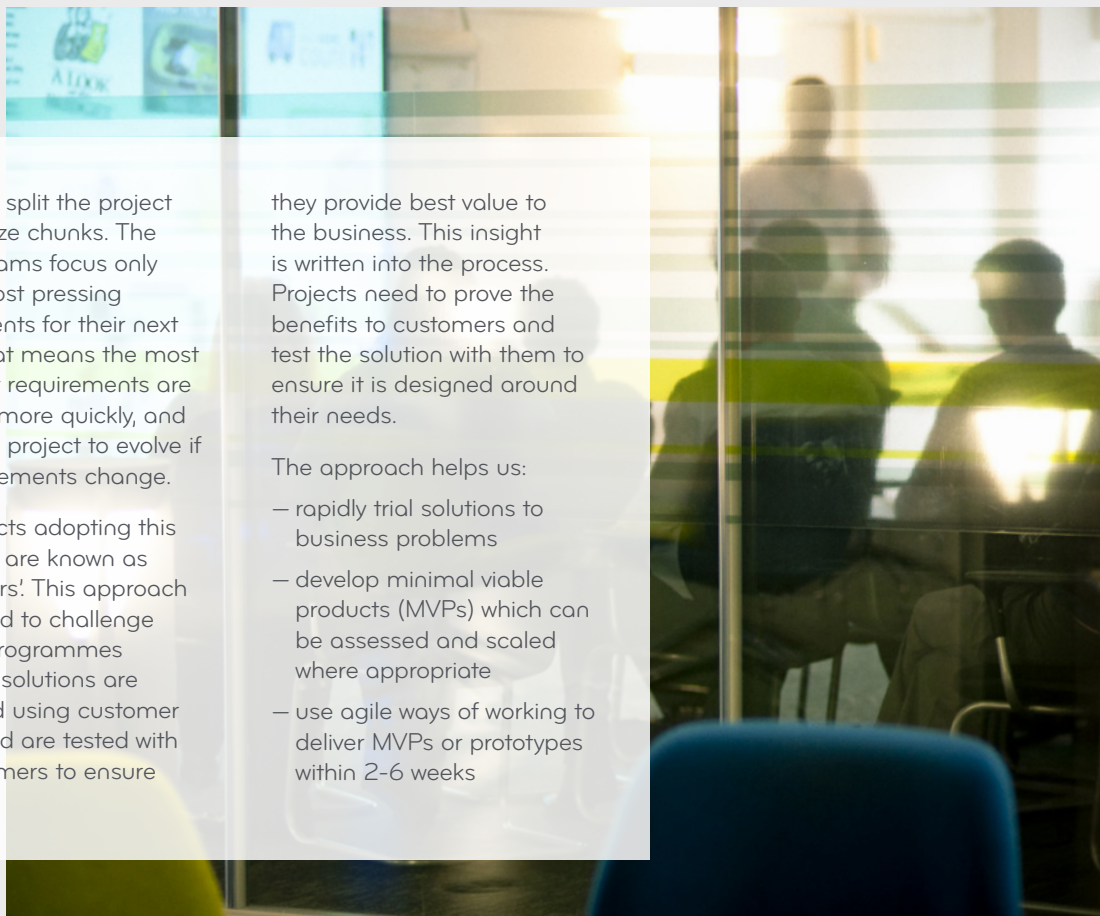
They help split the project into bite-size chunks. The project teams focus only on the most pressing requirements for their next sprint. That means the most important requirements are delivered more quickly, and allows the project to evolve if the requirements change.

The projects adopting this approach are known as 'Trailblazers'. This approach has helped to challenge existing programmes to ensure solutions are developed using customer insight and are tested with our customers to ensure

they provide best value to the business. This insight is written into the process. Projects need to prove the benefits to customers and test the solution with them to ensure it is designed around their needs.

The approach helps us:

- rapidly trial solutions to business problems
- develop minimal viable products (MVPs) which can be assessed and scaled where appropriate
- use agile ways of working to deliver MVPs or prototypes within 2-6 weeks



SMART



THE USE OF
DATA IS A HUGE
OPPORTUNITY
FOR US TO
IMPROVE THE
WAY WE WORK
TO BENEFIT OUR
CUSTOMERS,
AND OUR
EMPLOYEES

The use of removable media devices, such as USB sticks, is commonplace within the workplace. However, there are inherent risks associated with their use, one being the potential vehicle for introducing malware and viruses into systems and environments, which in the context of our operating environment, could result in loss of confidentiality, integrity and availability of systems potentially impacting primary operational processes. It is therefore important that appropriate security controls are in place to reduce the risk of malware and virus infections and potential impacts.

In order to align with Welsh Water security policies and standards, and due to the complex nature, technical challenges and constraints of Operational Technology and the environment, an innovative approach to this risk is required. The Welsh Water InfoSec team, with direct support from other Welsh Water business areas, and leveraging upon existing concepts, have designed, developed and trialled a sheep-dip solution.

A sheep-dip traditionally is a fixed, isolated computer dedicated to performing anti-virus scans of USB devices prior to use within a network to reduce risk of infection. Welsh Water took this concept and developed a mobile sheep-dip solution enabling in-field personnel to perform anti-virus scans of USB devices before and after use within our environments thus reducing both the risk of infection and onward infection.

The solution is a secure laptop hosting anti-virus software. The sheep-dip, utilising 4G connectivity, is monitored via a cloud based portal sheep-dip enabling the health of the sheep-dip to be monitored, and notification and incident response investigations should malware be discovered.

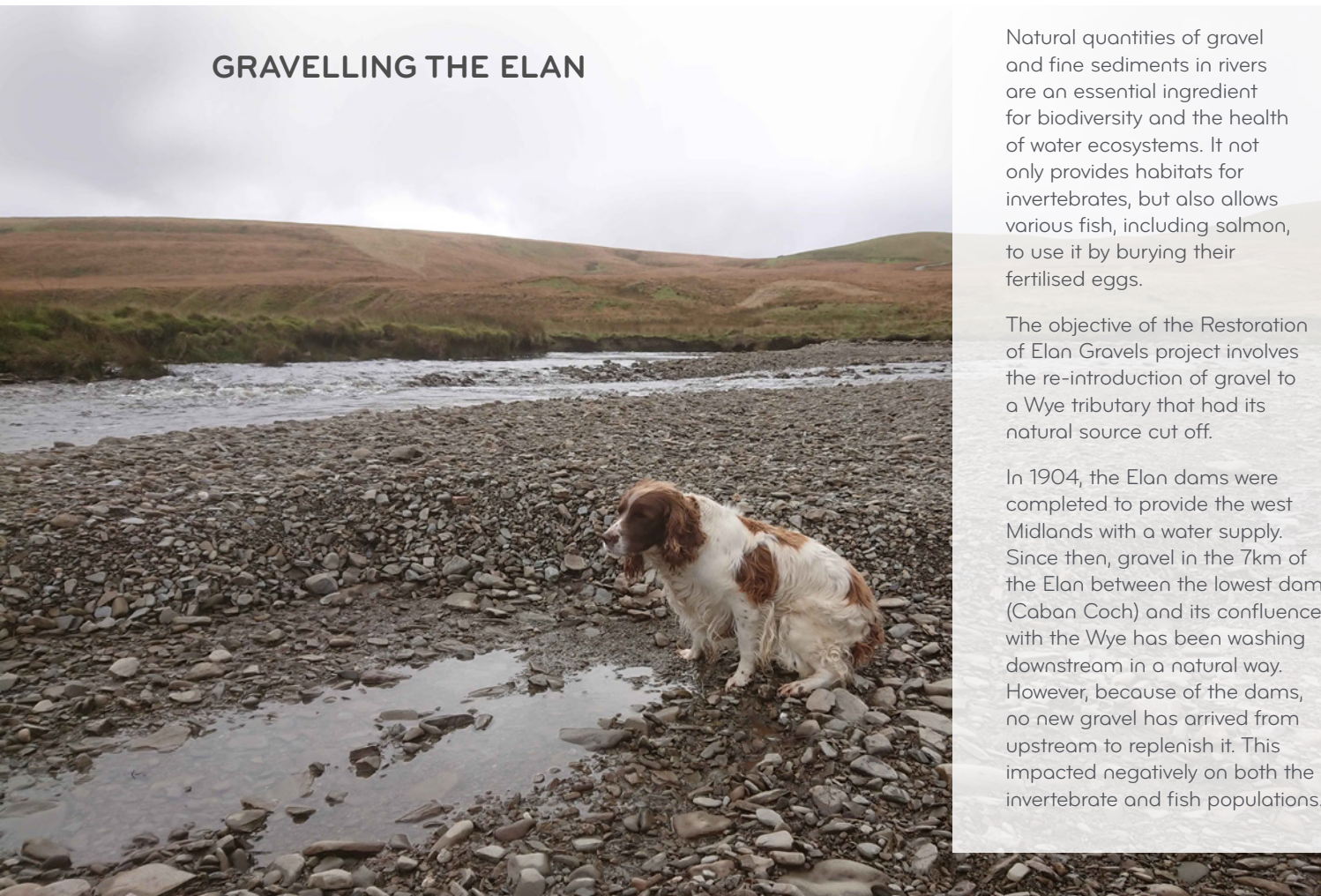
The solution has been trialled by the user community, who have recognised the risk and expressed their appetite for such a solution. Further to their positive response about their experiences, this solution is now being considered for refinement and deployment across the wider user communities.

ENVIRONMENT

WE WANT TO NOT ONLY
MINIMISE THE IMPACT WE
HAVE ON THE ENVIRONMENT,
BUT TO WORK WITH THE
COMMUNITIES WE SERVE TO
SUPPORT AND IMPROVE THE
WORLD AROUND US



GRAVELLING THE ELAN



Natural quantities of gravel and fine sediments in rivers are an essential ingredient for biodiversity and the health of water ecosystems. It not only provides habitats for invertebrates, but also allows various fish, including salmon, to use it by burying their fertilised eggs.

The objective of the Restoration of Elan Gravels project involves the re-introduction of gravel to a Wye tributary that had its natural source cut off.

In 1904, the Elan dams were completed to provide the west Midlands with a water supply. Since then, gravel in the 7km of the Elan between the lowest dam (Caban Coch) and its confluence with the Wye has been washing downstream in a natural way. However, because of the dams, no new gravel has arrived from upstream to replenish it. This impacted negatively on both the invertebrate and fish populations.

The area our partners — the Wye and Usk Foundation — and we worked on is downstream of our Elan Valley reservoir network, and focussed on restoring the spawning habitat of the upper River Elan. The project concentrated on transferring gravel from the upper catchment (above the dams), replacing large boulders with gravel.

We financed the first year of the project (2016) along with our environmental regulator, Natural Resources Wales, and we saw gravel replaced that had been winnowed from the Elan over the previous 113 years. We have since part-financed a further two years of the project.

After thousands of tonnes of river gravel being moved from a sustainable location in upper Wye catchment, in August 2018, juvenile salmon and trout were recorded for the first time since early 1970s. The project illustrates just how successful multi-stakeholder initiatives like this, which involve the local community can be.



dwrcymru/innovation