Appendix 5
Innovation

Section 1

Introduction

1.1 To deliver our vision and strategy we will need to innovate. We have major challenges such as halving leakage, getting to zero pollutions, and re-plumbing London. These require a smarter approach if we are to achieve these outcomes and ensure our service remains affordable.

1.2 Our approach to innovation is precisely this: to organise and focus on solving our big challenges. Against this we construct a portfolio of ideas that we systematically manage to ensure a good return from our innovation investment. These ideas will have different risk profiles depending whether the ideas are improving existing processes, or are blue-sky concepts.

1.3 At a portfolio level there are some big innovation themes. If we can deliver against these themes we will solve one or more of our challenging problems. As an example deploying a smart water network with real-time insight about the performance of our assets will keep customers in supply and support halving leakage.

1.4 Collaboration is a key part of our portfolio approach. Partnerships with our supply chain, other water companies, and beyond are critical to tap into this expertise and plug into our business. Nearly all of our innovation themes will require a degree of partnership to be successful.

1.5 We define innovation broadly through the provision of more effective products, processes, services, technologies, and business models – or a combination of these.

1.6 We have a strong history of innovation. In the last 12 months we have further improved our capability and made it a much more prominent Executive responsibility. All Executives play an important leadership role in AMP7 and must inspire their teams to do the same. The intersection between Strategic, Planning & Investment and Digital is key. Strategic Planning & Investment defines some of the challenging problems we need to solve and works very closely with Digital to unlock the benefits of technology, and specifically the explosion of data, that are often the key to solving them.

1.7 To bring to life our track record on innovation and approach to how we will tackle some of our 'big challenges' we share 8 case studies. These are:

- Smart Water and Waste Networks – Intelligence Hub;
- Smart Sewer Management;
- Slow Sand Filters – Granular Activated Carbon Sandwich;
- Energy Recovery from Sludge;
- Resilient Water Supply – Water Re-use;
- Smarter Water Catchments;
- Protecting Vulnerable Customers; and

- Mogden Sewage Treatment Works.

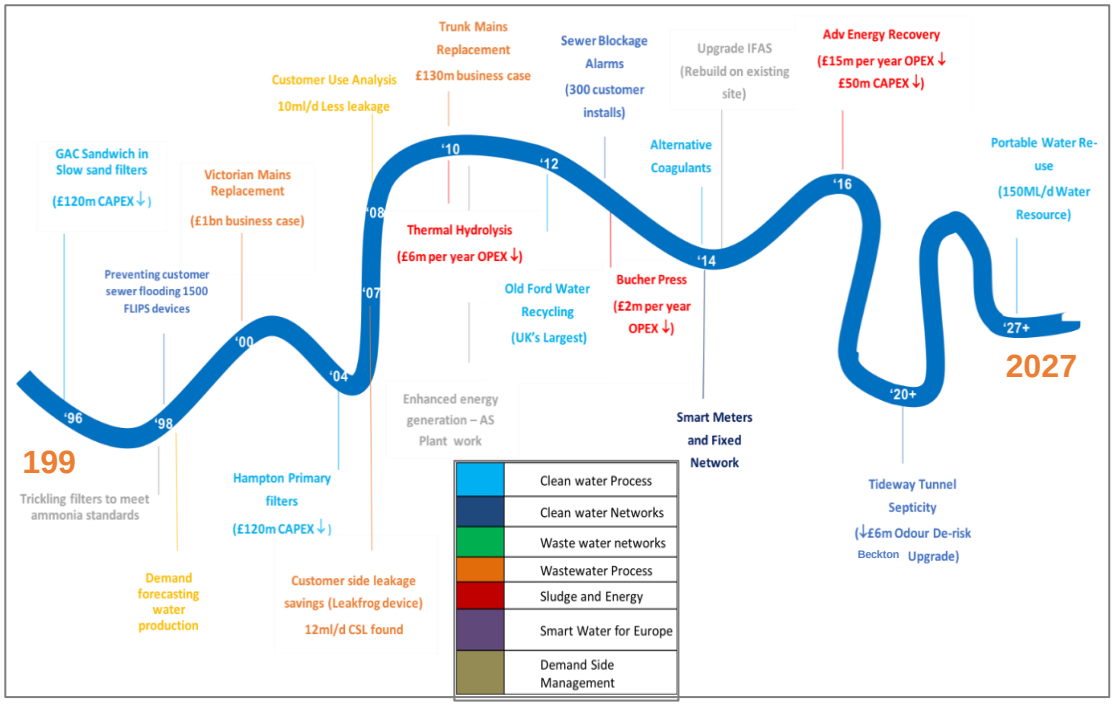
A Our Record of Innovation

1.8 Thames Water has a rich history of being an industry leader in Innovation and in AMP7 we will continue this. The Research & Development team is a key part of our innovation story and for many years has been recognised as industry leading. The innovation appearing in the case studies below remain as live projects and we continue to unlock even greater benefits from applying new technology, including powerful analytics or sensors.

1.9 Our track record of undertaking innovation projects, which has led to business wide implementation, is exemplary. A consistent pipeline of projects is managed by our R&D and Innovation teams and these work closely with all business functions. Since 1990 we have completed many successful innovation projects. Figure 1 demonstrates some of the highlights of the past 20 years and some of the projects due to complete in the coming years.

1.10 We want to be recognised as the leader in innovation in the global water industry and our pioneering work, both past and present, sets the standard for others to follow.

Figure 1: History and Future of Innovation – Innovation Managers



Source: Thames Water, Internal Document

1.11 We have invested in many different types of innovation. The diversity and range of innovation is vast impacting many areas including our customer service, asset performance and staff

health & wellbeing. The table overleaf briefly outlines some of our recent innovation highlights:

Table 1: Recent innovation highlights

Innovation	Description	Benefit delivery
Floating Photo-Voltaic	On our QEII reservoir we have developed and deployed the UK's first floating solar array.	By providing us with confidence in how to achieve this technically complex installation we are able to generate onsite power in areas where space was previously limited. We are now investigating our other sites to maximise this avenue.
Smart Bugs	We are testing a recently-discovered bacterium called *Anammox*, which has the potential to revolutionise nutrient removal in the wastewater. *Anammox* bacteria have the unique ability to convert ammonium directly to nitrogen gas.	This shortcut to ammonia removal halves the amount of oxygen and therefore the energy needed during the treatment process.
Lean manufacturing principles	Applied lean manufacturing techniques to multiple areas of our business	In various business areas we have deployed these methods. We are seeing benefits in some key areas including our find and fix activity for leakage.
Information Knowledge Exchange Champions	We initiated IKECs in our Eight20 alliance to find individual to champion innovation and share knowledge of ideas across different contractors and business functions	This has improved our efficiency in bringing the best ideas to wide spread adoption. Alongside solutions, we also shared our problems which in turn allowed new ideas to be developed to solve these.
Mental Health Training using Virtual Reality	We developed and introduced the world's first mental health training using VR technology. This enables us to put our people in the position of someone suffering the effects of negative mental stresses.	The outcomes of this enhanced education experience led to an increase in staff coming forward and seeking support; breaking the taboos and stigmas of mental health at work. For every 1 physical first aid intervention we have 5 mental health interventions.[1]
Personal Medical Assessment	For all employees that do not have medical cover we introduced a free, comprehensive, confidential medical assessment.	Over 10000 medical assessments have been delivered[2]. As a result numerous confirmed cancers were identified and now in treatment. With regular and comprehensive checking of the health of our staff they are then enabled to make better decisions about their diet and

[1] Thames Water, Internal Analysis
[2] Thames Water, Internal Analysis

		lifestyle.
Physio support	Free support to all staff for any injuries whether incurred at work or non-work. This provides support to recover from musculoskeletal disorders.	We have seen a very high volume of take up with the saving in terms of time of and sick days far outweighing the cost of the programme. This programme positively impacts the individual's personal life as well.
Agile software development	Introduced SCRUM methodology to introduce new work management software (started January 2018)	Reduced time to deploy shippable software by 50-60%[3]. Also user acceptance of new software is significantly higher. Agile is becoming the single standard for all software development at Thames Water.

[3] Thames Water, Internal Analysis

Section 2

Our approach to innovation

2.1 We have a methodical, portfolio-based, approach to innovation. We focus on the challenging problems that our business faces, with deliberate innovation efforts to part or completely solve these.

- A 'portfolio' approach to innovating against these challenging problems. This makes sure that we are attacking the problem from multiple angles, and investing wisely to ensure that at a portfolio level, the returns are good;
- A key part of this is being structured about the type of innovations we are pursuing, from continuous improvement (high certainty) to blue-sky (low certainty). We want to make sure we are not highly focused on only Blue Sky solutions to solve our challenging problems;
- Collaborating across and beyond our supply chain to bring the best expertise and to solve our challenging problems; and
- Building a culture of innovation and new ideas in our business – this requires Executive leadership in innovation and is supported by our new 'One Thames' structure.

A Problem Solving & Portfolio Approach

2.1 Our whole portfolio approach to identifying problems and areas to improve and then proceed to innovate around them, allows us to identify and drive the most promising solutions. An example of this is our investment in energy from waste and advancing slow sand filter usage is evidence of this approach; see Section 6. In addition, there is a portfolio based funding model to ensure we are investing smartly and probabilistically across a range of opportunities. This model tolerates failure but is rigorous in selecting ideas that are highly likely to succeed. A failure of a project is used to enhance our selectivity to further reduce the likelihood of failure. Similar to Venture Capital funds we look at overall success as the key measure of success and not the individual failed investment.

2.2 We assess the investment required for every idea against potential benefits and stage each project through clear gateways to maintain governance. Our process and governance provide customers with assurance that the investment is appropriate, and risks of failure minimised.

- Failing fast to learn quicker whilst considering the project outcomes; and
- Capture how or why a failure occurs to continuously improve how we select ideas to scale.

2.3 Innovation is a theme embedded in each of our strategic priorities.

- Brilliant customer engagement – we will need to use new digital, AI and Machine Learning technologies to get better insight about our customers and to make it easier for customers to get help;

- Invest in resilient assets – getting data and insights from our operations and assets is critical to making the best investment decisions we can;
- Protect and enhance the environment – deploying sensors deep in our waste collection network can radically reduce the number or severity of pollutions;
- Build a credible and capable team – we can innovate around how we collaborate across our teams and supply chains to improve responsiveness to customers. Also, applying new digital technologies to engage our employees in our vision is key to making Thames Water a 'great place to work'; and
- Use data to make better decisions – our business is a 24x7 real time business that is deeply integrated into society and the environment. There are few companies with 15m customers,[4] ~200k KM of distributed network and 500 production factories.[5] Exploiting this data is essential if we are to deliver our AMP7 plan.

2.4 As part of our long-term planning process we have identified our big challenges that we need to crack to successfully deliver in AMP7 and beyond. These are:

- Reducing leakage by 15% in this AMP with a plan to halve;[6]
- Reducing pollutions to zero;[7]
- Keeping all customers in continuous supply – and getting real time customer and network insight;
- Interact with customers in a smarter intelligent and personalised way, providing our vulnerable customers with world class service tuned to their needs;
- Re-plumb London – replace a 150 year old Victorian mains network with a modern, fit-for-purpose infrastructure;
- Ensure our people and supply chain partners are passionate and engaged in our business, and are hear for you; and
- Ensure we continue to strive for 'frontier efficient' outcomes, redefining what is possible in the industry.

2.5 Against these big challenges we have structured a 'portfolio' of potential solutions. These solutions fall into four categories:

1. Insight from within the business to improve processes and outcomes;
2. Best practices from global water industry applied to Thames Water;
3. Best practices from other industries applied to Thames Water; and
4. Blue-sky innovation.

[4] Thames Water, CSD021 - Annual Report and Annual Performance Report 2017/18
[5] Thames Water, WN1 data table and Thames Water, WWN4 data table
[6] Thames Water, TSD276-Shape Your Water Future Tool Analysis-Summary May 2018, Section 11
[7] Thames Water, PCD2-Wastewater Network Plus

2.6 This categorisation is important as it allows us to take a risk-adjusted approach to investing in ideas across all big challenges. Around these big challenges and innovation categories we have a structured process and governance for managing ideas from concept to value.

B Collaboration

2.7 Collaboration with all sectors of industry and academia is key to solving our biggest challenges. Thames Water's links with academic institutions across the UK is extensive and long established. Our collaborative working provides a whole systems approach to water industry issues. Since privatisation Thames Water has sponsored 86 EngDs & PhDs, 47 MSc and over one hundred other student placements.[8]

2.8 We partner with a range of stakeholders including other water companies and industry groups. Our network of collaboration includes, UKWIR, CCG, Isle's Technology Approval Group, Future Water and developing tools with key stakeholders including the Greater London Authority and Transport for London. In the last 12 months we have strengthened our relationships with technology firms as this will be a significant enabler in the future; we are partnering with Microsoft and SAP to co-innovate on long term objectives. For example we are co-innovating with SAP on the implementation of SAP C4C and Microsoft are funding innovation initiatives inside Thames. Each of these relationships is delivering advances in how we deliver for customers and protect the environment.

2.9 In Section 6, we have showcased eight of our projects to demonstrate how innovation has supported the business. Many of our projects started several years ago and delivered benefits and all continue to innovate further during operation. The case studies will demonstrate that we have achieved the following:

- Historical examples to resolve complex problems
- Implement incremental improvements in a wide range of disciplines
- Demonstrate ability, skills and a culture of innovation
- Show that we are future ready through our exploration and development of digital solutions.

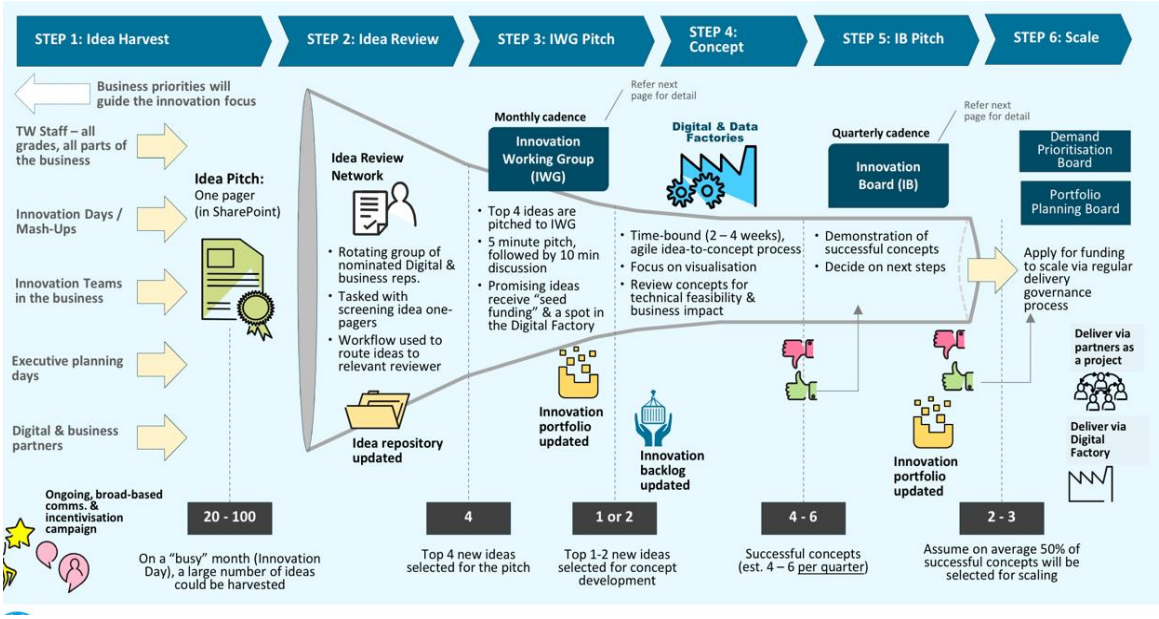
C Organisation and culture

Our innovation track record is built on a heritage of science and engineering but we have rapidly expanded that traditional focus to encompass all our business functions. We are developing better ways of capturing, developing and deploying our ideas for maximum impact

[8] Thames Water, Internal Analysis

to our customers and environment. The illustration overleaf shows how we capture ideas and move from concept to delivery:

Figure 2: Innovation Process



Source: Thames Water , Internal Document

2.10 One major change to support this was our recent 'One Thames' restructure where we created an Executive owner of Innovation (Strategy, Planning and Investment) – which houses Research, Development and Innovation – and a focus on developing and delivering digital technology and capability (Chief Digital Officer).

2.11 Most of our innovation teams use an Agile process – where cross-functional teams form to work in Sprints – with dedicated product owners. Agile and Sprint are recognised methodologies that provide fast and flexible development of a solution or product. The product owners are typically in the business function where the innovation is targeted. This approach increases success of the effort and supports a culture of innovation across the company.

Section 3

Big challenges & our innovation themes

3.1 We structure innovation around the difficult problems we need to solve as a company. For AMP7 these represent some of our most challenging performance commitments and ambitions. We have identified seven challenging problems that, if we are to succeed, we need new innovative solutions for. For each challenge some key levers are called out, however, most of these are used in each case: as a blend of people, equipment and technology are key to solving each challenge.

3.2 **Reducing leakage by 15%[9] in AMP7 and halving it in the long term:**

- **Process and Lean** – While some of the biggest changes to leakage will be enabled through technology, we still need to improve our operating processes. Specifically, we will develop more efficient find and fix methods and reduce time from find-to-fix.
- **IoT / Sensors –** Improving control and intelligence on our network. By deploying more sensors and moving to real time control we can prevent bursts occurring as well as respond to bursts more quickly. This reduces the number of incidents, the customer impact of them, as well as water loss.
- **Big Data analytics –** To supplement the sensors and loggers we will roll out, we will apply new big data techniques to identify leaks and to also predict where we may have bursts. Particularly, the output from **Smart Meters** is a significant contribution to the data set and helps target leakage and keep customers in supply**.**
- **Novel system solutions to prevent / reduce leakage or bursts –** Our 'systems thinking' approach will help reduce leakage by improving how we plan and design our systems. In complex networks – like our water and waste networks – this will help us better understand asset health, performance and network demand more accurately. Specifically we have kicked off a calm network initiative to run our water network in a mode of lower stress. Together with surge protection and the installation of variable speed drives we will be able to minimise bursts.

3.3 **Reducing pollutions to zero:** In waste networks and systems the technology that enables the change is similar to that in leakage but with differing algorithms and responses that move Thames rapidly towards zero pollutions.

- **IoT / Sensors -** As with leakage we will deploy more sensors and move to real time control. In waste networks the problems and challenges are different (for example we are working in a potentially explosive environment) but the enabling technologies similar.

[9] Thames Water, TSD276-Shape Your Water Future Tool Analysis-Summary May 2018, Section 11

- **Big Data Analytics –** As the number of sensors and data points grows exponentially we need to deploy a new computing and analytical capability. Through partnerships with a range of different companies we will access new techniques to process large quantities of semi-related unstructured and structured data.
- **Engaging the teams –** We continue to engage our field teams across all our challenges. Field teams are able to give us practical on-the-ground insight and feedback on a range of solutions and root causes. Also the behaviour and actions of our teams can play a role in creating or preventing pollutions.

3.4 **Keeping all customers in continuous supply – and getting real time customer and network insight.** We are deploying 'systems thinking' to ensure our plants and networks operate in harmony with the wider environment (e.g., when there are weather related issues). This will keep customer disruption to a minimum.

- **Modelling –** By using state of the art modelling technology combined with the IoT / Sensors and Big Data we can predict how our environment and networks will behave better than ever before. This knowledge allows us to tune our systems to deliver continuous output to the customer and helps link the full system from catchment area to tap.
- **Energy efficiency & resilience –** We are developing our energy resilience plan to ensure that we can support customers even when the national grid fails. In the next 5 – 7 years the national power network will come under increasing pressure and we need to ensure we are sufficiently resilient. This will involve generating more power onsite in new ways (e.g., solar arrays on reservoirs) as well as demand-response systems that store energy at site level to power it when needed (e.g., through the provision of batteries).

3.5 **Ensure we know who our vulnerable customers are and provide a personal service that meets their needs.** The innovation around consumer digital technology can be applied to all our customers and specifically those in vulnerable circumstances. We will use these tools to both communicate with these customers (where they adopt them) as well as allow us to know who they are so we can help them if there is a supply issue.

- **Horizontal / adjacent innovation** – In the adoption of consumer digital technology we expect that we will likely follow innovations from other industries. Our Net Promoter System – which will specifically help us get feedback from customers in vulnerable circumstance – will help us understand our customers expectation. In addition, our Digital team will continue to work with consumer-focused service businesses to apply new digital innovation to the water industry.
- **Sharing –** We will continue to share our data with other utilities and business to ensure we have the most up to date information that enable us to protect our most vulnerable customers (subject to appropriate regulations around data sharing and our customers' consent). This will allow us to provide an integrated response that will meet our customers' needs.

3.6 **Re-plumb London – replace a 150 year old Victorian mains network with a modern, fit-for-purpose infrastructure:**

- **Visualisation tools** – we are investing in better data-led 4D modelling and visualisation of our London trunk network. By analysing this data and identifying the key stress points in our network we will better identify the parts of the network that require more urgent replacement.
- **Novel construction** – given the construction challenge that replumbing London will demand it is essential to engage widely with and beyond the construction industry to ensure we tap into new and innovative ways of upgrading our network with minimum disturbance.
- **Materials science** – Traditional approaches in pipe replacement would represent a major barrier in dense urban environments that are typical in many parts of London. Therefore we will need to make use of new materials.

3.7 **Ensure our people and supply chain partners are passionate and engaged in our business, and are here for you.** Our people are passionate about what we do and our role in society. Talent will continue to be a premium and we need to make sure Thames Water continues to remain a brilliant place to work.

- **Building an Engaging Culture** – Our Net Promoter System will connect our people directly with customers. Specifically connecting our managers with our frontline should accelerate a customer-obsessed culture within our business.
- **Sharing our challenges widely** – One of the best sources of ideas is our people. They work in our business and know what delights and frustrates them. We will tap into them for ideas on how to make our business a better place to work. In addition, we will actively learn from some of our partners as to what has worked in their businesses and what can be applied to ours.

3.8 Ensure we continue to strive **for 'frontier efficiency' outcomes**, redefining what is possible in the industry:

- **Continue to innovate around process technology** – this includes all aspects of our operational processes from source-to-tap and drain-to-discharge – for example we can make use of 'designer bugs' to increase the effective capacity of aeration in our treatment works.
- **Continue to focus on energy optimisation and efficiency** – We have commissioned thought leading work on how we could achieve energy neutrality by 2025. This is developing our energy strategy and ideas as well as building on our proven AMP6 success, such as deploying floating solar.
- **Improve resource efficiency and effectiveness** – a major opportunity is connecting our customer to field team and obsessing about right-first-time. We are rolling out a new work management capability and the data from this should give fresh insight about on-going improvement opportunities.
- **Use digital to engage customers better and reduce cost to serve –** New technology is changing how our customers want to interact with us and we need to respond accordingly. We will apply consumer digital technology to not only improve NPS but also to reduce the cost to serve and prevent unnecessary customer contact.

Section 4

Innovation themes in AMP7

4.1 Against these big challenges we have identified a series of themes to help solve these problems. These innovation themes are:

- Developing and executing our plan for smart Water and Waste networks ;
- Improving our service to our vulnerable customers;
- Customer engagement to highlight, prioritise and resolve issues; and
- Enabling our people through engagement, training and resources.

4.2 These will be enabled by Data, Information and Insight into Action:

- Harnessing our current datasets to their full potential;
- Improving and developing those key datasets;
- Developing a targeted Internet of Things (IOT) to address key issues;
- Continuous Improvement on data and more practical issues/interventions; and
- Developing from predicting issues into optimised action and if appropriate to automated action.

4.3 This approach is powerful because our innovation themes help solve more than one problem. For example, Smart Water Network case:

- Reduces leakage because we will have more insight into where leakage is happening in our network;
- Keeps customers in supply as we will get real time insight about operational problems in our network; and
- Re-plumb London as we will be able to make smarter investment decisions based on data about the state of our assets and operations.

4.4 Problem solving and innovating around these challenges will help us deliver for our customers. Not just for AMP7 but consistently through future AMPs. Starting with our core capabilities of Water and Waste assets and operations we will accelerate change and alongside drive forward the digital capabilities. Here at Thames Water we take a long term view and a vision of how we can change.

Section 5

Summary

5.1 The volatility and uncertainty of our world has made innovation critical to success. Thames Water has to deal with one of the most dynamic cities in the world and will be dramatically affected by global megatrends. The megatrends of population growth and rapid urbanisation are already impacting our Thames Valley areas and London. As such we have committed to innovation for many years and have accelerated our work to unlock every bit of benefit, out of every idea, as quickly as possible.

5.2 Our customers understand that water is a limited resource, but leakage, flooding or polluting are not acceptable and need to be reduced or eradicated. Alongside this we constantly challenge ourselves to develop better ways of working with, informing and serving our customers. These challenges are complex, difficult to resolve, and will continuously evolve.

Section 6

Innovation case studies

6.1 These case studies demonstrate our past ability to deliver innovation within Thames Water in the context of our future aspirations. They demonstrate the categories of innovation, the various processes and techniques we undertake to deliver them, the skills we have and the culture to embed innovation into the day to day business of serving our customers and meeting our commitments.

6.2 Each case study has multiple elements to it. The impact on resilience is always a key factor as it is ensuring we serve our customers well alongside protecting the environment. The long-term benefit to resilience, water quality and low impact on the environment is well served by slow sand filters, smarter catchments and in the future Smart Water & Waste Networks. The financial benefits are complex to calculate in some cases but keeping our major process method, slow sand filters, in place rather than redesigning our whole process has had a significant financial benefit and we continue to make this a key factor in all our AMP7 plans.

The case studies are:

- Smart Water and Waste Networks – Intelligence Hub;
- Smart Sewer Management;
- Slow Sand Filters – Granular Activated Carbon Sandwich;
- Energy Recovery from Sludge;
- Resilient Water Supply – Water Re-use;
- Smarter Water Catchments;
- Protecting Vulnerable Customers; and
- Mogden Sewage Treatment.

A Case Study 1 – Smart Water and Waste Networks - Intelligence Hub Case Study

6.3 This case study describes how we have improved the way we manage our waste and water networks systems for better outcomes. The way we operate our networks today has not yet leveraged the full potential of technology and data. Our Smart Water and Waste Networks address our strategic challenges and some of our underlying problems that require to be solved for us to meet our commitments for AMP7. Smart networks deliver a range of benefits that impact our key goals.

Table 2: Case study 1

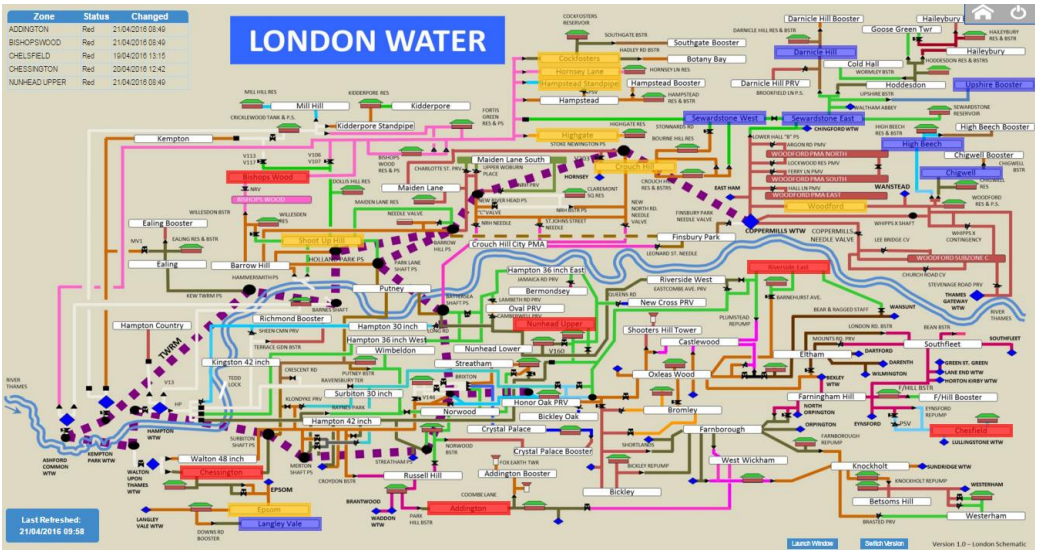
What it does	Key Challenge Solved
Reduces bursts or failures	Keeps customers in supply / reduce leakage
Real time network control	Keeps customers in supply / reduces failures in waste networks
Predict Issues and respond proactively	Supports customers and especially vulnerable customers
Provides insight to waste network performance	Prevents pollutions
Reduces energy consumption	Sustainability & resilience
Enable accurate asset health assessment	Targeted timely investment in assets and systems

6.4 **HOW:** Accurate, real time knowledge of our system prevents pumping too much at higher pressures. This puts unnecessary stress in the network. In turn we are using more energy than required and puts more stress on our pipes resulting in more bursts. Additionally with accurate asset level performance information we can identify the assets that are performing well and isolate those that are not thus enabling targeted replacement based on system wide performance.

6.5 As our smart networks evolve we will move towards investing in a targeted “internet of things” to enable a risk based prediction of asset failure and forecasting of emerging/imminent problems. This could avoid large capital investment to improve capacity/resilience through better management of current assets. A key aspect of this is establishing Calm water networks - the “Calm Network” concept is where we reduce the amount of stress operations put on the network and in turn we improve asset longevity, resilience, water quality, leakage and bursts.

6.6 To date we have embarked on developing the Intelligence Hub which offers an alternative solution to reactive maintenance and work activities. Our vision is to move from the historic position of reacting to events, to the position where we can see, manage and optimise performance in near real-time preventing problems before they happen. The Intelligence Hub (iHUB) programme was born from the strategy for AMP6 to make better use of our data and information right across the business. It blends different types of data such as real-time SCADA, transactional work and cost, geospatial, streaming customer contacts, structured risk and reporting information and third party actions.

Figure 3: London Water Map



Source: Thames Water, Internal Document

6.7 Legacy systems and data sets were developed to tackle different problems so do not align and are also very large. This meant that lengthy, skilled analysis was needed each time a problem about a potential incident was asked.

6.8 Our iHUB draws together real-time data from a range of sources to help us make better decisions about how to proactively manage catchments**.** For Wastewater, this includes: advanced weather radar that track storms across our catchments; data on levels in our sewers, and information about the energy use of our pumps. Together, this information makes us far better able to prioritise key issues, identifying potential flooding and pollution incidents. The insights iHUB provides have helped prevent several flooding and pollution incidents.

6.9 The near real-time insight provided by the iHUB enables us to understand issues before they impact customers, responding quickly if they do impact customers and give the ability to identify where best to invest for the future. The iHUB includes a visualised real-time mapping tool. It can be used for monitoring the performance of pumping stations, sewers and other assets, as well as monitoring of water extraction, supply and availability, using flow levels, rates and water quality parameters.

6.10 We used multi-speed data lakes in the cloud to integrate, analyse and visualise the widely varying data sources without having to modify the systems. The users also have a **real-time view of data quality** allowing them to either ignore or work round the issue. All other approaches to this problem have required lengthy data improvement exercises, system mapping and engineering exercises delaying delivery and going rapidly out of date.

6.11 We selected **integrated teams** from Operations, Control, Asset Management, and the Systems Integrators. They addressed high level problems, such as preparing for a storm and seeing emerging risk to water supply, then asked what information or tools (people or technology) are required to tackle the problem. An **"agile" delivery** model developed every 2-3 weeks provided a better version of the answer to the problem. This was then rolled out and stabilised using a lengthy "use and improve phase" in multiple phases to **embed the solutions** in the business.

6.12 The programme means that the Systems Operators (Central Control and Planning), Production, Transmission and Maintenance, have a common view of risk and performance against plan. Moving from weekly or monthly planning meeting to "in day" preparation or response to emerging risks.

6.13 Active monitoring of the network is critical to developing and improving the capability and performance of iHub. For example on the clean water network we have;

- Sensor technology – We have invested in 26,000 remote noise loggers[10] to listen for leaks and over 100 high frequency pressure loggers to study pressure transients within trunk mains;
- Domestic Smart Meters – Sector leading levels of 239,000 activated smart meters;[11]
- Trunk Main Monitors – Installed in high risk areas of our networks;
- Smart Valve Operation – Trailing new technology to detect valve movements;
- The SmartWater4Europe project has given us insights into Smart Water Networks; and
- Smart Network Pilots – demonstrating meters are able to identify system wide events such as bursts, pump trips, abnormal reservoir patterns and leading indicators for bursts.

These investments and pilot investigations are helping today and for iHub of the future where this data will be analysed in more detail and in an integrated way. This aims to improve service to customers and in particular our most vulnerable customers.

6.14 Two of the key problems addressed by iHUB were:

- Storm chasing: iHUB provided a real-time map and shows the availability & performance of our sewerage pumping stations. This enables us to prioritise activities to protect/repair assets based on risk and impact of failure ahead of and during storms. This is preventing approximately 35 pollution events per annum.[12] Other benefits include a reduction in energy and labour costs.

[10] Thames Water, CSD021 - Annual Report and Annual Performance Report 2017/18, page 9
[11] Thames Water, CSD021 - Annual Report and Annual Performance Report 2017/18, page 21
[12] Thames Water Analysis

- Water systems risk: Visualising in real-time our water extraction, transmission and storage availability and risk. This uses the levels, flow rates, water quality and predicted demands in our systems. The key benefits have been customer services and risk management by having the real-time visualisation and tracking of performance which gives a saving c. £1m of pumping costs per annum.[13]

Our Smart Water Network development programme has four main pillars that build on the iHub platform we implemented in 2016 and have further developed since then. iHub was a first-generation water data analytics platform to integrate information about our water network in one place for use in our control environment. This allowed us to respond faster and better to emerging operational issues across our water network. We are building on this in AMP7.

WORKSTREAM 1

- Ensure full visibility of our water network assets and that these assets are linked in with our visualisation systems and tools;
- This will provide the specific location of every valve on our network, whether it is on or off, which way it turns and if we turn the valve what happens to water flow;
- This information will be available on the engineer's field device and in the control room so that we respond as efficiently as possible for bursts and supply incidents;
- We will do this by partnering with our mapping provider to build a 3D model of our entire infrastructure; and
- By 2021 an initial version of this capability will be in place.

WORKSTREAM 2

- Measure the degree of operational stress that the network is under and use this to predict potential bursts to run the network in a calm way;
- This will involve taking real-time pressure and flow feeds in to the control room and identifying network stress and alerting controllers;
- We will correlate this with 'high burst areas' to ensure we optimise the running of the network and to increase resilience; and
- We expect the first version of this 'calm network' capability to be deployed in 2020 and be rapidly developed thereafter.

[13] WCCO Report, July 2017, Quantified benefits of the iHUB

WORKSTREAM 3

- Ensure availability of real-time supply, demand and storage data in our control room across our 93 water systems by integrating our SCADA and meter data into our analytics platform;
- This will allow us to identify immediate changes in demand, or losses in supply, that impact our customers and either prevent them or mitigate the effect on customers; and
- We intend to have the first 10 systems delivered by 2019, with the remainder following in 2020 and 2021.

WORKSTREAM 4

- Integrate customer and operational data in a single visualisation platform to allow us to model the impact of operational issues on customer supply. This will ensure our operations teams have visibility of customer calls, messages, tweets about supply interruptions, and if available, local CCTV feeds;
- This tool will be critical to managing incidents as it will identify priority customers and make sure we have the correct bottle water station coverage; and
- Taken together, the delivery of these work streams will give us a differential level of insight as to what is happening in our water systems; this will help us respond faster and better. The data will also underpin the modernisation of our control environment and operational performance.

B Case Study 2 – Smart Sewer Management Case study

Table 3: Case study 2

What it does	Key Challenge Solved
Reduces pollutions	Protect our environment
Real time network control	Smart management of flows to prevent pollution
Efficiently deploy teams	Reduce cost and Supports all customers.
Provides insight to waste network performance	Prevents pollutions
Reduces energy cost	Sustainability & resilience

HOW: By providing real time, accurate information on sewer depth we are able to proactively manage flows across the entire network and prevent many cases of over flow. In cases where we see abnormal conditions emerging we can deploy the team proactively to investigate; in the past we would only do so once a problem had occurred and customers impacted.

6.15 This case study demonstrates the start of this journey to improve our processes and outcomes in our Waste Water network. Our ambition is to develop a Smart Wastewater network to prevent flooding and pollution to the environment.

6.16 We have taken a holistic approach to sewer flooding by collaborating across the business and with industry. We are using the latest technology and data analytics as well as engaging with our customers. We have developed incremental improvements, used big data and utilised our innovation culture for collaborative working.

6.17 We began work in 2016 to drive down Sewer Flooding Other Causes (SFOC) incidents. We worked in partnership with departments across the organisation on the following projects, with the one aim of reducing flooding incidences:

- Customer Education 'Bin it – don't block it' campaign;
- Development of modelling risk maps;
- Data led prioritised targeting of solutions (see TSD043);[14]
- Sewerbatt targeting of cleaning;
- Customer Sewer Alarms;
- WRc Best Practice - Blockage clearance & planned maintenance;
- Investigating & reducing blowbacks and improving response times; and
- Temporary sewer depth monitors.

This initiative won Utility Week Awards 2016 IT Winner.

6.18 As part of our innovations programme we engaged in a novel way with the public on illustrating the extent and nature of the problem of fats and other materials in the sewer system. To do this we worked closely with the media and national press to raise awareness of the 'fatberg' issue, and what can be done to prevent it. A programme titled 'Fatberg Autopsy' was aired on Channel 4 earlier this year and a piece of the Whitechapel fatberg was displayed at the Museum of London. This coverage provided a great opportunity to educate the public and draw attention to our 'Bin it - don't block it' campaign.

[14] Thames Water,TSD043- SFOC Big Data

Figure 4: London Museum Fatberg, Customer Education billboard & Media amplification

Sources: Thames Water, Internal Document

This initiative has driven down SFOC numbers for 2 consecutive years, ensuring that we are now under the penalty band and continuing to improve.[15]

6.19 Additional benefits of this initiative recorded in AMP 6 are:

- Using a Big Data computing model with over a billion data points including flooding history, elevation, property age, type and use. This solution identified the key factors that lead to a particular reactive job's likelihood of flooding. The tool enables faster decisions and better quality prioritisation;
- Sewerbatt had been supported by Thames Water since its university concept through EPSRC grants and in-kind support. This initiative saw the technology being used at operational scale; and
- Customer sewer alarms developed by the R&D team with the specific intent of customer service, providing warning for those properties that suffer repeat flooding incidents. It is estimated 64 floods per year[16] are prevented by these alarms. The trial of mobile depth monitors helped us reduce the number of repeat sewer flooding incidents significantly, this tool allows us to monitor complex faults in our network while we make arrangements to undertake repairs.

6.20 Now and into AMP 7 we will continue to drive this initiative. We will continue to develop this approach to further reduce SFOC numbers.

6.21 We will continue to develop our intelligent waste network to improve our understanding of where blockages and hydraulic flooding pinch points occur and how to optimise our operation:

- We have already invested a lot in hydraulic models and in AMP 6 have integrated real-time weather and groundwater data to alert us to potential flooding (ICMlive);

[15] Thames Water Published Annual Returns for 2017 and 2018 (AR17, AR18)
[16] Thames Water, Internal Analysis

- Harnessing Work Management Data on historic blockage work orders into insight, we are currently building a "virtual" blockage alarm (I^3) which predicts problem areas and can then proactively clean a further 273km of sewer.[17]
- Developing and installing more sewer level monitors and customer alarms on the ground. By the end of 2018 we will have 1000 additional depth monitors which alarm.[18] In AMP7 we will expand coverage and develop machine learning to improve the virtual blockage model.
- Linking the monitors to ICMlive models. The reports generated will be sent directly to the operational control centre.
- Developing further the digital twin (ICMlive) and data visualisation (iHUB) of our network assets.

6.22 The real time data and models of our sewer system will contribute to the understanding of our network and enable us to take a more proactive approach to sewer flooding. The digital twin will form part of our wider digital strategy to map and monitor our assets, using predictive models and artificial intelligence to respond to issues before they develop into an event. The digital twin will be integrated with our iHUB system to ensure a consolidated approach is in place.

C Case Study 3 – Slow Sand Filters – Granular Activated Carbon (GAC) Sandwich Case Study

Table 4: Case Study 3

What it does	Key Challenge Solved
Provides excellent water quality – All SSF	Protect our environment, reduces energy, reduces need for chemicals
Keeps our teams safe – (filter attachment)	Responsible, leading employer
Enhances capacity (underwater skimmer)	Keep customers in supply

6.23 **HOW:** The underwater skimmer will allow us to reduce the length of time that a SSF is out of our system for the maintenance task of removing the top layer of sand. This process currently takes several days and requires complex co-ordination of teams to perform it. Carrying out the task whilst full will require the SSF to be out of our system for hours rather

[17] Thames Water, Internal Analysis
[18] Thames Water, Internal Analysis

than days. This generates extra capacity from our system and assists with periods of high demand which can result in customers having low pressure or losing supply.

6.24 The introduction of a regulation for pesticides in drinking water in 1989 meant Thames Water would either have to augment its Victorian slow sand filters with a new process or find a way to improve them. The R&D team reviewed what would be required to achieve the required standard. A number of ideas were trialled including testing of ozone treatment and different granular activated carbon media to evaluate their combined effectiveness for pesticide removal. Options were then tested and optimised at a larger scale during our £7m "Water Factory of the Future" Advanced Water Treatment trials programme.[19]

6.25 Several non-slow sand filter treatment sites were refurbished with GAC absorbers to deliver compliance; these included Farmoor and Swinford Water Treatment Works (WTWs). The initial pilot testing programme for London's slow sand filter sites looked at whether GAC absorbers should precede or follow slow sand filtration. Despite the pilot trials providing excellent results the GAC sandwich concept was born in a session of blue skies thinking and then incorporated into the 7-year Advanced Water Treatment trials programme. Following successful pilot and full-scale tests, and with scientific and managerial approval, the GAC sandwich was installed at London's largest slow sand filter sites. A patent was granted to Thames Water which enabled carbon suppliers to offer the innovation to other water companies across the globe with a royalty fee paid back to Thames Water.

6.26 The GAC sandwich provided an innovative solution to the worldwide industry for pesticide removal from drinking water. Since its installation, optimisation of its performance and maintenance has been a key objective to meet increasing demands on supply.

6.27 The R&D team continued to study the GAC sandwich concept in operation for pesticide removal effectiveness and other issues. It sponsored Steele's PhD studies at the Centre for Environmental Health Engineering at Surrey University with field trials on Thames Water sites.[20] In addition, the R&D team developed in house analytical tools called SandMan, WatchDog and GACtram to assist in the operational management of GAC sandwich filters.

6.28 This GAC sandwich example demonstrates many different types of innovation from R&D to practical elements. We are still improving how we operate the slow sand filters;

6.29 **Evolution 1**

- Our mechanical skimming machines still required our technicians to dig the dirty sand away from the edges of the filters by hand to unblock them, introducing risk to them;

[19] Rachwal, A.J., Foster, D.M. and Holmes, M. (1992) Combining ozone/advanced oxidation and biological filtration processes for organics removal from water. Proceedings of AWWA / WQTC conference, Toronto, 543-560.

[20] Steele M (2004) Investigating best operational practice procedures for granular activated carbon enhanced slow sand filters. PhD thesis. University of Surrey.

- The local Health and Safety advisor worked with the R&D team to investigate how to reduce the risk of injury. After the safety advisor suggested a hand operated snow plough idea the R&D team developed the concept of attaching a suitable adaptation to the side of the skimmer. It was notable that our skimmer technician's participation was key to stimulating the innovative thinking that developed the solution;
- We shared our new cleaning design concept with the skimmer manufacturer who then made an attachment which avoids the hazardous manual labour and saved time;
- The prototype attachment was trialled by the filter technicians on a skimmer. Some improvements were suggested and implemented so that the final product delivered resulted in a 90% reduction in manual handling tasks and saved time for the end to end process;
- We rapidly adopted this innovation; it was popular with the technicians and remains in daily use.

Figure 5: Slow Sand Filter cleaning

Source: Thames Water Image

6.30 **Evolution 2**

- Working with the same team of Thames Water personnel we have commenced an ambitious project to again lead the world of slow sand filters;
- Could we find and deploy a remote controlled robotic slow sand filter skimmer that allows us to skim the filters without draining them first?
- Having engaged manufacturers from around the world we concluded, alongside the suppliers, that a vehicle does not exist that can work fast enough or give sufficient control of the process;
- This project requires us to design and build a new submersible vehicle using the best of all the devices we reviewed;
- This project will work quickly to understand if it is possible to achieve. The outcome will restore 90Ml/d of water otherwise lost through downtime of the slow sand filters by enabling more reliable and quicker turnarounds following cleaning.

6.31 These are practical aspects to running and optimising our performance and we have the skills, experience and culture to tackle these problems as demonstrated above.

D Case Study 4 – Energy Recovery from Sludge Case Study

Table 5: Case study 5

What it does	Key challenge solved
Removes contaminants from waste	Protects the environment
Reduces energy cost	Sustainability & resilience
Provides Thames with onsite power generation	Resilience
Stores energy on site	Resilience

6.32 **HOW:** We continually develop and enhance our processes to extract more energy from waste. Our process engineers review the operation of each unit and find the most productive conditions to generate energy.

6.33 We have an established history of innovation in sludge treatment. Sludge is a resource and we are driving advances in its management. Through the development of leading technology with industrial partners and universities, the optimisation of current processes and the identification of innovative technologies to begin to unlock the full potential of sludge are possible.

6.34 We are pioneers in sludge treatment and energy recovery, having worked in partnership with Cambi on the development of Thermal Hydrolysis Process (THP) since 1998. This is now the process of choice for treatment works around the world. THP has been, and continues to be, rolled out at sites for sludge conditioning ahead of anaerobic digestion.

6.35 Intermediate THP (ITHP) was identified as a process to optimise energy recovery. ITHP increases biogas generation by up to 17% and provides 15-17% improved de-waterability of sludge compared with conventional THP.[21] The implementation of this process lowers haulage costs and helps to maintain a high-quality product for farmers.

6.36 Our specialist bioresources pilot facility in Basingstoke has played a pivotal role in the development and optimisation of our sludge treatment. ITHP, Bucher press and other technologies have led to improved dewatering, on some sites this is enough. The roll out of

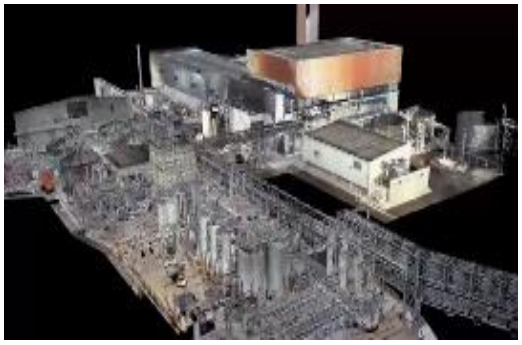
[21] Thames Water, TSD305-Corporate Responsibility and Sustainability Report, Case study, March 2017, page 2

ITHP is planned for AMP7+ as asset capacity requires investment. Some technologies have been from other industries including the Bucher press from the Cider industry.

6.37 The Sludge and Energy team identified that that further improvements may be possible. The Advanced Energy Recovery (AER) process of low temperature drying and pyrolysis of digested sludge may enable considerable increases in energy recovery. Further savings in cake disposal and the possibilities for mineral recovery are all being studied. The first major installation of this new innovative technology is currently being commissioned at Crossness sewage treatment works.

6.38 At Crossness, a digital asset was created via laser scanning. The scan was used to create a 3D model and simulate a real time build. This enabled digital rehearsals with stakeholders to identify risks or issues before the build. Encouraging greater collaboration; HoloLens was used to review the design in a real-world setting, enabling the new build to be 'augmented' on top of the current facility; Operations could see the designs via a headset. Digital delivery has reduced design cost, health and safety incidents and minimised re-work.

Figure 6: Crossness digital asset



Source: Eight2O[22]

6.39 Our journey to AER from sludge demonstrates how we have embraced early stage technologies. THP has now reached full maturity and been rolled out and we aim to optimise THP (ITHP). This demonstrates how we are able to convert long term research programmes into large scale, industry leading facilities to meet our energy demands.

[22] Thames Water, TSD038-Crossness Video

E Case Study 5 - Resilient Water Supply Case Study – Water Re-use

Table 6: Case study 5

What it does	Key challenge solved
Reduces need to remove water from the environment	Protects the environment
Recycles water and uses it for secondary purposes	Sustainability & resilience
Reduces need to pump water around our wider network	Reduces energy consumption
Stores water on site	Resilience

6.40 **HOW:** With a closed cycle of water use we remove the need to pump it around our systems. This provides benefits in reduction of energy and stress on our asset base. By using waste water that would go through our sewer network we then further reduce energy and pumping costs as it stays in close proximity to its original use point.

6.41 Population growth and climate change increase pressure on our water resources. If we don't take action, there's predicted to be a shortfall of around 360 million litres of water per day by 2045; equivalent of 2 million customers' needs.[23] We have investigated options of using wastewater to support water resources and help tackle the shortage of water supply. These include planned indirect potable reuse, non-potable reuse and environmental flow augmentation. These options would increase our resilience.

6.42 Over the last three decades, we have successfully gained experience in implementing and operating non-potable systems learning from international experience. The OFWRP (Old Ford Water Reuse Plant), located on the Queen Elizabeth Olympic Park (QEOP), is the UK's largest wastewater recycling facility. It was jointly funded with the Olympic Delivery Authority to reduce potable water consumption across QEOP by 40%.[24] The plant supplies non-potable water for toilet flushing and irrigation. It serves as a research platform for assessing the feasibility of non-potable reuse (NPR) at urban scale. Other schemes include the greywater water recycling plant at the Millennium Dome (O2 Arena, London), the blackwater recycling plant at Beddington Zero Emission Development (Bedzed, South London), and the recent installation of a greywater recycling plant at a mosque/community centre in Wapping. The

[23] Thames Water, TSD308-Shape Your Water Future, Draft WRMP 2019, page 3
[24] Thames Water, TSD306-The Old Ford Water Recycling Plant and Non-Potable Water Distribution Network, page 1

R&D team also participated to the implementation of various blackwater or greywater recycling systems in the UK and across the world.

Figure 7 – Old Ford Water Recycling Plant

Source: Thames Water - R&D

6.43 We have assessed the feasibility of Indirect Potable Reuse via two pilot plants. The Deephams pilot plant (2008-12) was assessing the use of microfiltration, reverse osmosis and advanced oxidation processes to treat final effluent. Since December 2016, at the OFWRP we have been evaluating two treatment trains in parallel, both treating Membrane BioReactor (MBR) effluent from the OFWR using reverse osmosis followed by advanced oxidation process and GAC followed by advanced oxidation.

6.44 Holistic approaches were associated with all the UK schemes and include risk assessments to understand impacts on the environment and public health, technology assessment to mitigate these risks and public perception study. We have learned a lot from the research carried out including:

- Understanding the effects on the environment and society associated with these options, to ensure we comply with regulations such as the Water Framework Directive and the Water Supply (Water Quality) Regulations, by developing risk assessment methodologies;
- Assessing how these risks could be mitigated via treatment or non-treatment barriers; and
- Understanding governance and stakeholders' perception for planned IPR and NPR options.

Our revised draft Water Resource Management Plan 2019 (rdWRMP19) options

6.45 The various projects described above have helped us to ascertain if options using wastewater to support water resources should be included in our investment plan. During the WRMP19 process, three options were assessed:

- **Non-potable water reuse (NPR)** – A recent study we commissioned as part of the WRMP19 process, found that up to 33 Ml/d of water could be saved through the implementation of

NPR, by harvesting rainwater/stormwater and/or recycling greywater (combined source).[25] Options for London's opportunity area are included in the WRMP19 Demand Management Options screening report. We identified the recycling of greywater with rainwater/stormwater harvesting as the most cost effective and carried it forward to the rdWRMP19 preferred plan's Integrated Demand Management model. The preferred plan of the rdWRMP19 includes a demand reduction by 0.5 Ml/d in AMP7[26]

- **Indirect Potable Reuse (IPR)** – Five sub-options were identified with a combined maximum deployable output of 816.5 Ml/d.[27]The preferred plan of the rdWRMP19 includes the implementation of an IPR scheme at Deephams STW by AMP8.
- **Environmental flow augmentation** – We have evaluated the feasibility of using wastewater to support upstream freshwater abstraction. A flow augmentation option was established to support the enhanced Teddington Direct River Abstraction option. The deployable output of such option could reach up to 268 Ml/d.[28] However, we have concluded that the Teddington DRA option is not feasible and therefore it does not feature in our rdWRMP. We will continue to undertake research to investigate the potential to mitigate the effects of the scheme on ambient river temperature as well as other impacts such as salinity and flow pattern that could affect the River Thames ecosystem.
- With increasing demands on water resources re-use has an important part to play in our future resilient water service. We are using global experience and investigating the options now and assessing them through studies and pilot trials to ensure an optimal, seamless service is provided in the future.

F Case Study 6 - Smarter Water Catchments Case Study

Table 7: Case study 6

What it does	Key challenge solved
Prevents flooding	Recues impact to customers of flooding
Protects vulnerable water sources from pesticides	Sustainability and environment
Works with the environment to protect water resources	Resilience, environment and customers

[25] Thames Water, TSD307- WRMP19 Non-Potable Water Reuse Feasibility Report June 2017
[26] Thames Water, TSD308- Shape Your Water Future-Draft WRMP 2019, Section 11
[27] Thames Water, TSD3082- Shape Your Water Future-Draft WRMP 2019. Appendix L
[28] Thames Water, TSD308- Shape Your Water Future-Draft WRMP 2019. Appendix L

6.46 **HOW:** By managing our interaction with the natural and built environment we understand how to control it better and respond to it. It recognises the wider system implications of everything in our natural environment and how our urban environment interacts with it.

6.47 Thames Water has a long history of catchment projects and programmes, ranging from pioneering work in the 1990s to protect drinking water sources from pesticides used on rail lines, to our award-winning recent programme to install sustainable drainage in schools, managing flood risk and creating new nature reserves in urban catchments.

Figure 8: Train programmed to spray herbicides and avoid vulnerable water sources

Source: JSD Rail Image

6.48 When developing our Smarter Water Catchments Programme we considered that, to date, the successful catchment management projects in England and Wales have each focussed predominantly on tackling single issues. We recognised that further benefits and better value can be achieved by tackling multiple challenges together, regarding the environment as a system. The value that can be offered by harnessing natural processes, and capitalising on opportunities of greater scope and scale. This is the premise of our Smarter Water Catchments initiative.

6.49 We have developed a holistic approach to catchment management. Our catchment spans rural, upland areas to London. This is the most challenging and complex of all of our urban catchments and will be particularly important in helping identify long-term solutions to the pressure rapid population growth is putting on the capital's wastewater infrastructure.

6.50 We commissioned several pioneering projects as part of our programme. One of our first successful catchment management projects, protecting vulnerable drinking water sources from herbicides used to control weeds on railway lines. We were a founding partner in this project, delivered in collaboration with Network Rail and its predecessors, which became a national agreement administered by the Environment Agency. It is the largest, longest-

running catchment management project in the country, protecting 75 vulnerable water sources in our region, and 550 more elsewhere.[29]

6.51 More recently award-winning Sustainable Drainage Systems (SuDS) schemes such as the Herne Hill and Dulwich Flood Alleviation Scheme. We worked with the EA and London Borough of Southwark to solve surface water and sewer flooding which is based around SuDS and includes flood relief measures in three parks. As well as reducing flood risk, it has created a new wetland habitat and wildflower meadow, improved the existing play area and provided children from six primary schools the opportunity to learn more about the project. This is a good example of a scheme to address a problem benefiting the customer and environment.

Figure 9: Herne Hill after flooding in 2013

Source: Thames Water Image

Figure 10: The £4.3m Herne Hill flood alleviation project, which protects 200 homes from flooding, has improved a children's play area, including making use of flood alleviation features

Source: Thames Water Image

[29] Thames Water, TSD310- External Publication, Smarter Water Catchments, page 4

6.52 Our Smarter Water Catchments initiative is a step change in the level of ambition and investment in catchment management. Pilot projects will be used to learn, capture and transfer knowledge.

6.53 Further benefits can be achieved by tackling multiple issues rather than tackling single issues, such as pesticides, phosphorus or nitrates, recognising the environment as a system and there is a value to be offered by harnessing natural processes. The expertise, collaboration and drive to innovate across this area will be key to the future success. London 2100 is a key example of thinking big and the longer-term, involving key stakeholders and universities to identify challenges and opportunities.

Evenlode Catchment Case Study

6.54 The Smarter Water Catchments programme for 2020 – 2025 includes six partnership projects with key stakeholders that will join up existing and new activities, addressing a range of issues and providing multiple benefits. It will build detailed evidence of the costs and benefits of this new approach, helping us and others assess the potential to adopt catchment management on a larger scale. Evenlode catchment was selected as one of six cases due to a range of water quality issues in a rural catchment.

6.55 To develop a sustainable approach to reduce the high levels of phosphorus in the Evenlode River needed to meet 'good' ecological status under the Water Framework Directive. We are working closely on several schemes in the Evenlode Catchment Partnership (ECP), local organisations and farmers to develop a holistic approach to reducing river pollution.

Figure 11: Trees being planted to slow farmland run-off, as part of the 'No Till and Cover Crops' scheme

Source: WS Atkins Image

6.56 The schemes at Evenlode include:

- **Catchment Fund** to provide grants for new infrastructure and changes in farm management practices;
- **Advice service** to help farmers take advantage of existing agri-environment schemes, as well as support in completing applications for our Catchment Fund; and
- Programme of 'No Till and Cover Crops' in reducing the loss of soil and phosphorus to watercourses, and in improving soil health.

6.57 We aim to continue developing relationships and collaborating with partners and stakeholders within the catchment programme, for example, through the development of farm management procedures and trials. Data capture, analysis and sharing across the organisation from this work will help understand the effectiveness of the different interventions and will allow for the expansion of the project.

G Case Study 7 – Protecting Vulnerable Customers

Table 8: Case study 7

What it does	Key Challenge Solved
Better understanding of our Customers	Supports vulnerable and priority customers
Increased Customer awareness	Improved Customer service
Standardised and improved services	Efficiency of service delivery

6.58 **HOW:** We are using 'co-creation' to optimise the service we provide to vulnerable customers. Partnering with charities, Non-Profit Organisations (NPOs), industry peers and vulnerable customers to design a Priority Service that is best in class. We are also networking with the utilities industries and the third sector to share best practice and create a more consistent experience for the consumer.

6.59 Thames Water cares about protecting and assisting vulnerable customers and has invested in designing a priority service that is industry leading. Our Retail team has used new technology, collaborative ways of working and data analysis to improve the engagement and relationship we have with our customers. We have implemented innovative approaches to protect vulnerable customers and in addition are working closely with the wholesale team to focus on what additional benefits can be brought using smart metering.

New Industry Leading Priority Services

6.60 To protect vulnerable customers a Priority Register was created:

- Co-creating marketing and sign up material with customers and stakeholders;

- Tapping into energy sector vulnerability registers and share our data with them. This includes multi utility sign up processes and shared marketing campaigns;
- An Industry wide data share with explicit consent between water and energy companies;
- Establishing vulnerability panels with experts and seek their input for internal training materials, service propositions and emerging themes for service development; and
- Collaboratively promoting our support services through partnerships with local charities and other organisations such as Age UK, Money Advice Trust, Fire & Rescue.

6.61 Sharing of best practice is evidenced through the industry development of shared data and tools to identify customers in vulnerable circumstances. The work underway includes:

- Development of a geographical view of open source data that indicates where Priority Service Register marketing should be aimed. This will enhance the tailoring that we and other utilities can provide to each customer in vulnerable circumstances;
- We are leading one of the workstreams within the Water UK facilitated data sharing approach with the energy sector to grow our register;
- Expanding the pilot of our joint branded PSR leaflets with UKPN and SSE to share the effort in growing our registers, and to learn lessons in preparation of full data share; and
- Designing the low income social tariff for customers with a consistent eligibility criteria across water companies in the South East to prevent duplication of administration for both customer and Water Company.

6.62 We are making two performance commitments to give weight to our ambition:

- Reaching more than 400,000 customers on our Priority Service Register.[30]
- Improving NPS for our customers on our Priority Service Register.[31]

6.63 Signposting affordability services will contribute towards performance commitment of 200,000 households benefiting from a social tariff.[32]

H Case Study 8 - Mogden STW: Using Less

Table 9: Case study 8

What it does	Key Challenge Solved
Better understanding of operational performance	Resilience

[30] Thames Water, CSD005-AR04-Number of customers on the priority services register
[31] Thames Water, CSD005-AR04- Customers recommending Priority Services
[32] Thames Water, CSD005-ER03-Households on our social tariff

Increased Customer awareness	Cost reduction
Reduces energy consumption	Cost reduction

6.64 **HOW:** By working in our 'One Thames' model we are able to understand how each team works and unlock benefits. Central to this example is how to harness data and translate that into action at site level. We were then able to demonstrate the benefits gained. This example has provided evidence of a repeatable process for us to implement elsewhere.

6.65 Mogden STW is Thames Water's second largest sewage treatment works serving over 2 million customers.[33] It treats the incoming sewage via an activated sludge process, which involves aerating the sewage to speed up biological breakdown of organic components. Large blowers are required to bubble air through the sewage and these use a lot of energy with each one rated between 600-1000kW.

6.66 In Spring 2017, Mogden STW had a new blower house built onsite with 4 new blowers that were to supply air to batteries A & B and take half the aeration demand off the old power house which would continue to supply air to batteries C & D.[34] This was intended to improve energy consumption onsite because these blowers were more efficient. However the energy consumption at the old power house didn't decrease as expected.

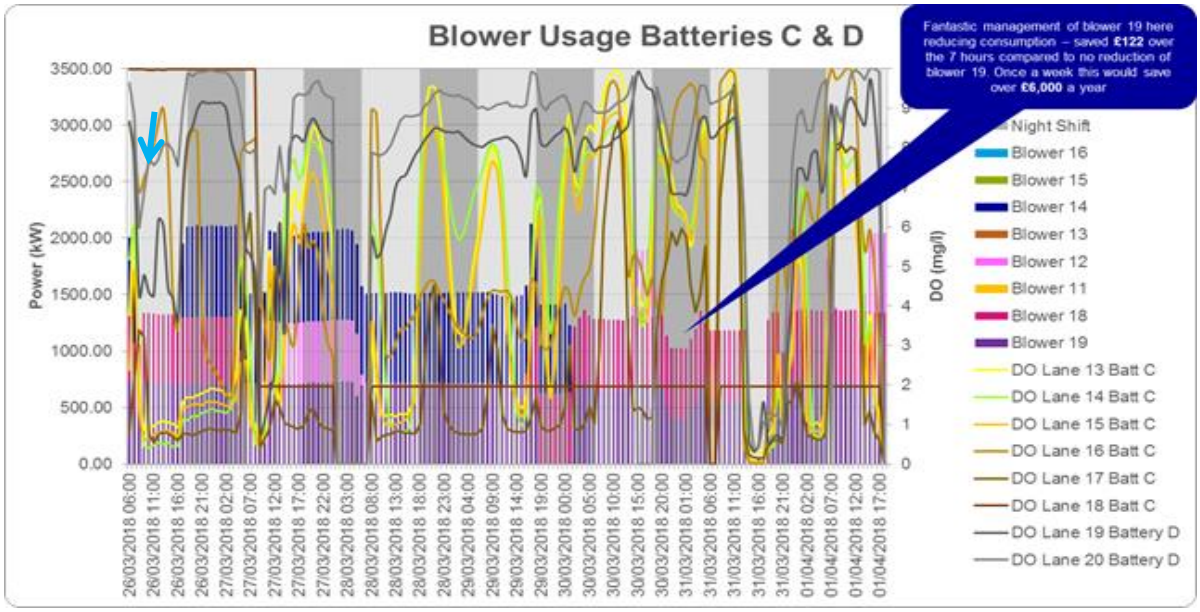
Implementing the strategy

6.67 Thames will implement the strategy using 'data, information, insight, action'. We used sub-metering power data and operational DO data to understand how the blowers in the old power house were being used. We found that there was no change in operation since the new blower house was commissioned and more air was being used than required. We then talked to the Process Controllers (PCEs), who operate the site and found that the operation of the blowers was manual. The PCEs would turn blowers on and off as they thought was required.

6.68 We then engaged the PCEs with their energy use and helped them to operate the blowers more effectively and closer to the required DO. Through weekly meetings with the PCEs and managers where we shared insight to the data we had gathered (see graph below) we worked together to use less energy at the old power house.

Figure 12: Blower Usage Old Power House

[33] Thames Water Analysis
[34] Thames Water, Eight2O Design Development Report C728 Mogden Air Main AMP6



Source: Thames Water, Internal Document

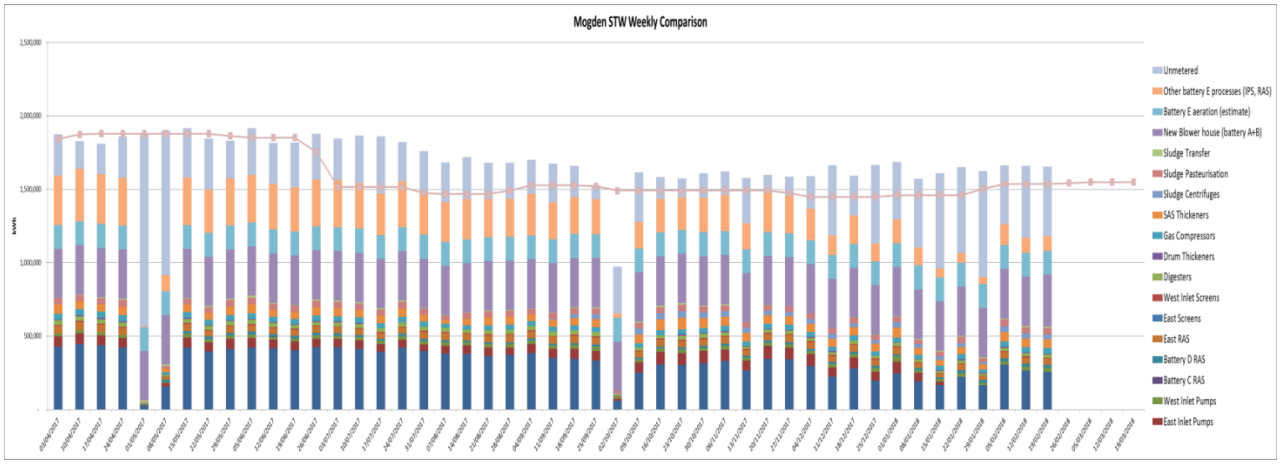
6.69 We also attend weekly management meetings to help the management understand where their energy usage is going onsite using sub-metering data. We can then identify areas where there de-ragged and energy consumption has since decreased. de-ragged and energy consumption has since decreased.

Benefits

6.70 So far by engaging weekly with the PCEs we have saved over 4,000,000 kWh or roughly £348,000 at the old power house since June 2017. Furthermore by helping management understand where their energy use is going onsite and using data to understand how different projects onsite are affecting energy consumption, a further 7,700,000 kWh or £663,500 has been saved from their energy consumption. In total Mogden's energy consumption has reduced by 12% in the last year – a saving of 11,000,000 kWh.[35]

Figure 13: Mogden STW Weekly Comparison

[35] Thames Water, Internal Analysis



Source: Thames Water, Internal Analysis

Next steps

6.71 We are continuing to support operational staff at Mogden on a weekly basis providing the data and insight to help projects onsite understand how they are impacting their energy. We are also rolling out analysis on the new blower house onsite to help the PCEs manage these blowers more effectively.