Appendix

YKY08_Research and Development Innovation Strategy, Process and Objectives for PR24

YorkshireWater

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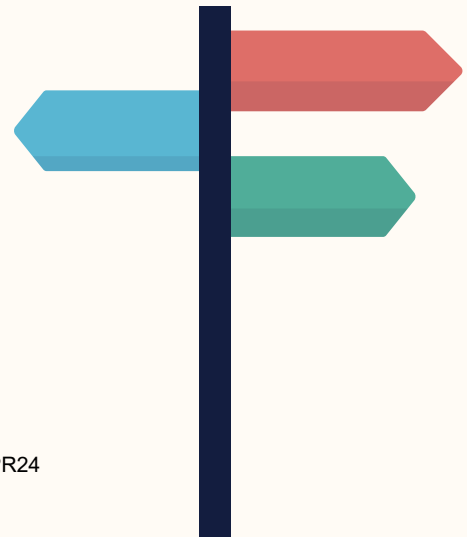
More detail on this subject can be found in **Chapter 1: Government / Regulatory Priorities and Targets**



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1. Introduction

1.1 R&D Innovation Context

This document describes the strategy for how the Innovation Programme delivers options for improvements in sustainable, resilient service provision in Yorkshire Water Services (YWS).

Innovation referred to in this document means **Research and Development** (R&D) Innovation. **Cultural Innovation** and **Supply Chain Innovation** are also described for context covering the whole meaning of "innovation" for the business.

The **R&D Innovation** budget resides within the Management and General (M&G) capital programme. The investment has no regulatory outcomes associated with it. The programme is governed by defined processes and Customer benefit is demonstrated through project outcomes. The strategy is to invest in a small number of high value projects informing transformational change whilst accommodating a programme of smaller projects designed to deliver incremental benefit.

1.2 R&D Innovation Programme

The programme covers five Price Controls (Household Retail, Water Resources, Water Network+, Wastewater Network+ and Bioresources), addresses current operational challenges and also considers wider challenges facing the industry such as population growth, climate change, affordability and customer expectations. **R&D Innovation** is driven and administered by a small core team drawing upon agile technical and project management support from inside and outside the company.

The strategy encompasses the end-to-end R&D Innovation process including input from external networks, capture of Business risks and identification of opportunities, programme creation and delivery, and calculation of return on investment. It informs how investment realises the articulated vision of R&D Innovation, which is:

> *"To deliver opportunities for resilience, improved service performance and business growth through a programme of Research and Development based on a clear articulation of risk and opportunity".*

OFWAT has clearly stated its intentions and expectations for innovation within the final methodology for PR24.

"The sector needs to be in a stronger position so that it can innovate and step up further and deliver against new expectations at PR24. It must seize the opportunities to move forward and deliver the resilient services that everyone deserves and to reach higher to achieve more stretching levels of customer service and environmental stewardship." It continues: *"Our methodology for PR24 sets out how we will drive companies to deliver more for customers and the environment. The methodology reflects our four key ambitions for the review:*

- *Focus on the long term*
- *Deliver greater environmental and social value*
- *Reflect a clearer understanding of customers and communities*
- *Drive improvements through efficiency and innovation*

*"Companies need to innovate constantly to achieve the best outcomes for customers, communities, and the environment at a cost that people can afford. PR24 will ensure that customers do not pay more than they need to, and reward only those companies that are ambitious and deliver great outcomes… **Innovation will be key**."*

YW's proposed programme of R&D Innovation in AMP8 is fully aligned to OFWAT's expectations of the PR24 Business Plan, in that it will deliver enhanced levels of customer service, in the near, medium and long term as well as being aspirational and ambitious.

1.3 Innovation Defined

Innovation is a term which can be used in many contexts. To establish a clear Innovation Strategy, it is important to define and contextualise terminology which can be related to, and recognised by, all colleagues. All positive business change, which is fundamentally what innovation is, relies upon the ability to articulate business risks and opportunities over a baseline level of performance.

1.3.1 Cultural Innovation

Cultural Innovation defines how creative, collaborative and process driven colleagues within the business are able to make positive changes to how the company operates and delivers its services. It is the day-to-day process of continuous improvement. Capable, trusted and aspirational colleagues and partners, who are open, and encouraged, to suggest or make those changes.

1.3.2 Supply Chain Innovation.

Once articulated, if a risk or opportunity cannot be mitigated or realised through process change by colleagues or partners, the Supply Chain should be stimulated through the Procurement process. This in turn is dependent upon the ability of the business to articulate and define a specification against which the supply chain can deliver. The procurement process should be two-way to allow innovative solutions to be offered over traditional solutions. R&D Innovation funding is designed to trial proven, at-market solutions only as a last resort if they cannot be fully evaluated through engagement with Suppliers and other end-users means. Supply Chain Innovation is described in more detail in Section 1.9.

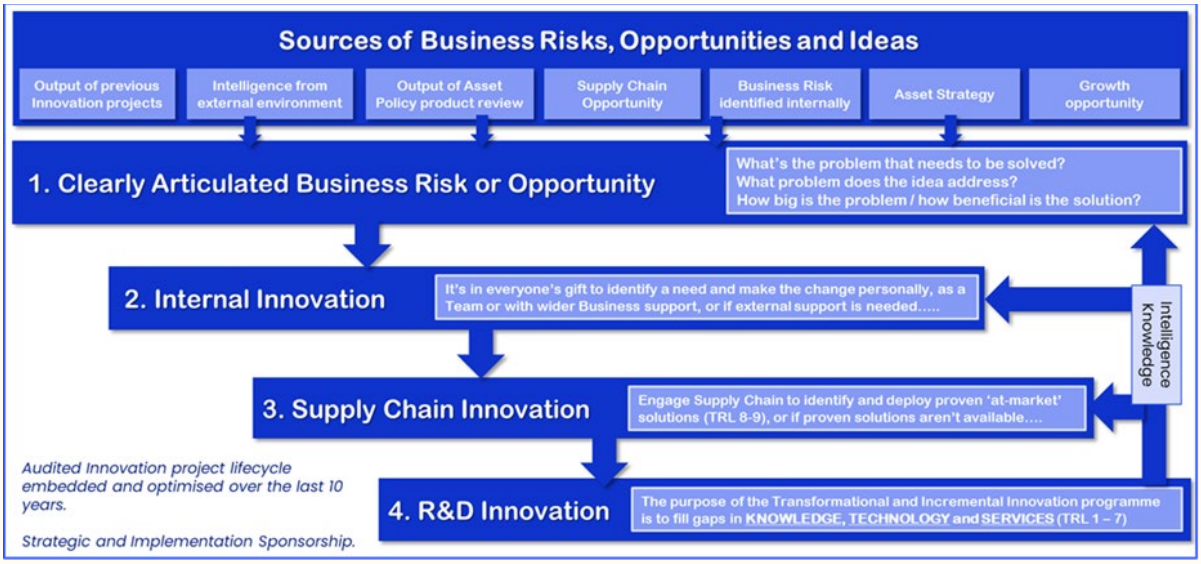
1.3.3 Research and Development Innovation

Research and Development Innovation's aim is to fill gaps in knowledge, services and products which cannot be provided by the Supply Chain or by process improvement. The programme establishes a small number of significant, high value projects informing transformational change. This is balanced by a programme which delivers options for incremental benefit. Utilising external networks, such as suppliers, academia and expert technical groups to introduce, "art of the possible" opportunities to the business is a key activity.

1.4 Innovation Process Flow in Practice.

Risks and opportunities can be identified from within all functional departments in the Business. These can be self-generated, informed by supply chain, through R&D Innovation or the external environment. Risks and opportunities are owned by the business function. They can reside in team documentation e.g. Team Hub processes, or corporate systems, for example the Corporate Risk Register or Corporate Risk Self-Assessment (CRSA) process. Once clearly articulated, opportunities or mitigation of risk can enter the Procurement or R&D Innovation processes.

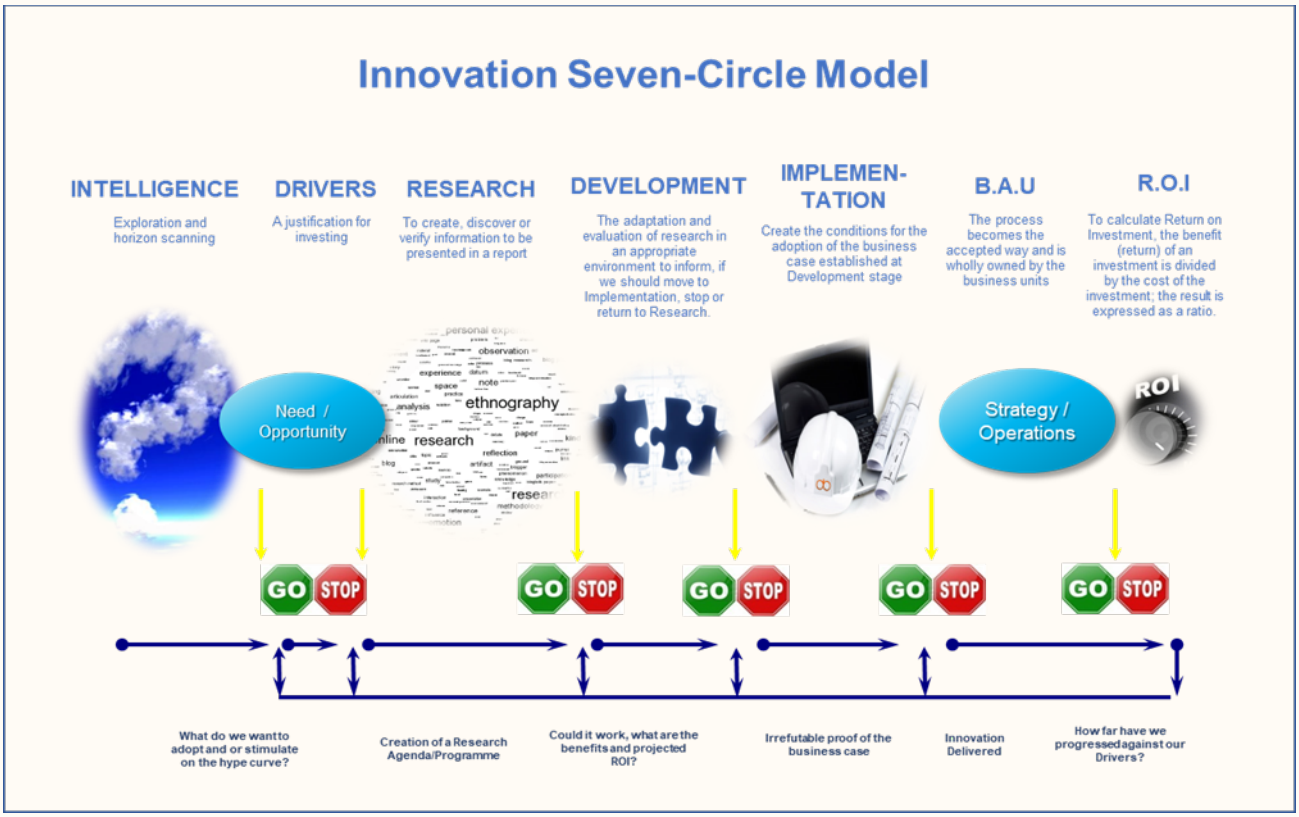
Figure 1.1: Innovation Defined



1.5 R&D Innovation Process

The R&D Innovation process has been mapped and audited. The process is highly governed through M&G Programme Management. A global standard “seven-circle” model of research, development and implementation has been adapted to articulate a production line mentality of projects as they mature. The most important elements of the flow are the “Stop” and “Go” stage gates. Through project governance and management, the flow of projects can be stopped or taken back a stage at any point in the life cycle.

Figure 1.2: Innovation Seven-Circle Model



1.6 R&D Innovation Resource

The R&D Innovation Programme Managers are accountable for the R&D Innovation process and delivery of business plan targets. Three Programme Managers are each responsible for clearly defined elements of the overall Programme, ie. Water, Wastewater and, Commercial and Governance. Four Innovation Technical Specialists are responsible for supporting the Business in articulating business risks and innovation opportunities, and providing technical expertise, along with other relevant experts from within the wider Business, during the project development and delivery process. Three Project Managers are responsible for development, approval and delivery of projects ensuring objectives are achieved and outputs are disseminated. A Strategy Sponsor and an Implementation Sponsor ensure governance from an internal client perspective. The Strategy Sponsor ensures projects are aligned with the relevant business strategy and the Implementation Sponsor provides an ‘operational’ perspective to facilitate implementation of solutions into normal business activity. Technical resources are also secured from internal or external sources as capability or capacity dictates.

1.7 R&D Innovation Metrics

The R&D Innovation Programme lead measures (Forecast Return on Innovation Investment (ROII) and Forecast Spend Profile) ensure the pipeline of projects is affordable and has the potential to deliver the desired return on investment. The necessary lag measures are:

- 8:1 Return on Innovation Investment is measured from the completion of the project/programme of work for a ten-year horizon;

- 50% Leverage, meaning financial and in-kind support equal to the value of the customer funded programme is sought from external sources, such as the Ofwat Innovation Fund or other grant funding bodies;
- 50% Effectivity ensures that a balanced approach to risk is taken and the programme is sufficiently aspirational. This allows for 50% of projects to deliver a positive, utilisable outcome. The remaining projects, whilst successfully delivering an outcome, may not be technically or economically viable at the current time and with therefore not be progressed further.

1.8 R&D Innovation Risk, Controls and Governance

Programme risk and appropriate controls are managed through Capital Delivery Programme Services with M&G Programme Board the accountable body. This utilises the Company's well-articulated Risk and Control process and is captured in the Corporate Risk Self-Assessment (CRSA). Corporate policies underpin all activities. Consultation with Programme Services, Group Risk and Internal Audit, Group Legal and the Procurement and Contract Management departments ensure adherence as part of the Project Management lifecycle.

Project delivery risks and controls draw upon support from a wide range of resources from across the business, including but not limited to Regulation, Finance, Health and Safety and Engineering. This is prescribed through the Innovation Project Management lifecycle. Responsibility for delivering scorecard measures lies with the Innovation Programme Managers. Accountability for administering and reporting the Innovation budget, resides with the Programme Services Manager. Monthly reports to the M&G Programme Board along with Quarterly reports to the Board Investment Committee (BIC) and YW Board provide updates on programme content and performance.

1.9 Supply Chain Innovation

Supply Chain Innovation is introduced through both the internal and external environments. Internally through the clear articulation of business risks and / or opportunities, and externally from a multitude of sources including academia and consultants, along with suppliers ranging from multi-nationals to start-ups and individual inventors. The internal process of implementation is largely dependent on whether an Opex or Capex solution is required. Both processes are dependent upon a clear articulation of risk and opportunity being established by the client (Yorkshire Water).

The processes described below rely on the availability of new, yet tried and tested (proven) at-market, technologies and processes. Where these are not available through the supply chain, or the specification and performance of the solution is unproven, further investigation will be required through the Research and Development Innovation process and programme.

1.9.1 Procurement and Contract Management

If a risk or opportunity cannot be mitigated or realised through process change by colleagues or partners, the Supply Chain should be stimulated utilising the Procurement and Contract Management process.

All Supplier and Contract Partner tendering processes incorporate a requirement for the successful organisation to identify, offer and implement innovative technologies and processes to deliver improved service at lower cost.

Where a risk and / or opportunity is identified by the client (YW), the Contract Management process should present an articulated requirement or specification to the relevant Partner or Supplier. If incumbent suppliers are unable to fulfil the requirement, the Procurement process should present the issue to the wider ‘external’ Supply Chain.

Critically, Supply Chain Innovation should be a two-way process which requires a mature and willing client to consider alternative, new, potentially radically different solutions. Similarly, it is incumbent upon suppliers to understand the needs of their client and to proactively articulate and present opportunities for improvement.

Where a new product or technology is identified, this will be assessed by the relevant teams and individuals within the business to ensure technical and financial viability, and compliance with relevant standards. Formal processes are in place for these evaluations and for the development of new, or deviations from existing standards, where necessary and appropriate.

1.9.2 Asset Management

Where opportunities are to be realised and / or risks mitigated through capital investment, these are delivered through the Capital Delivery Directorate.

Prioritised business risks are progressed for resolution through Framework Consultant and Delivery Partners. Solutions are required to comply with relevant standards as described previously. It is incumbent on design and delivery partners to offer innovative solutions to drive cost efficiency across the capital programme.

1.10 Innovation Context Summary

Innovation in YW relies upon a culture that identifies the need for, and drives and manages change, one that welcomes disruptive, transformational change derived through the Supply Chain or through R&D Innovation. It is dependent upon clear articulation of risk and opportunity and a strong internal and external, collaborative network. The delivery of Great Customer Service, Resilience, Affordable Bills through Innovation is enabled by a clear vision, strategy and a receptive culture which is capable of implementing sustainable and resilient solutions.

1.11 Ofwat Innovation Fund

1.11.1 YW's approach

YW has a long history of collaboration with other Water Companies to share learning and deliver innovation projects for the benefit of the participating companies and industry as a whole.

Bids into the Ofwat Innovation Fund are coordinated, led and supported by YW's R&D Innovation team. The team works with the wider business, other water companies, and the supply chain to identify and prioritise project opportunities which are then presented at the Executive Innovation Board for approval to progress.

The Innovation Board also provides the governance and assurance for YW's approach to other funding opportunities (such as the successful £3.25m Department for Digital, Culture, Media and Sport 'Fibre in Water' bid), and the wider internal Innovation Programme.

1.11.2 YW fund engagement to date

Given the complexity of the Innovation Fund bidding process, and that the bid success rate (across all water companies) is relatively low, YW has taken a targeted approach that is manageable with existing resource levels.

YW has led a small number of industry critical project bid and supported a much larger number of projects that have been led by other companies.

1.12 UKWIR and Spring

YW actively participates in and supports UK Water Industry Research (UKWIR) and Spring, at all levels. YW's Director of Wastewater Service Delivery is an UKWIR Board member and colleagues from across the business lead and support the UKWIR research programme, and provide technical input and guidance on individual projects. YW has supported the development of Spring and continues to work with R&D Innovation Leads from across the industry to ensure Spring effectively achieves its objectives of promoting, facilitating and accelerating the adoption of innovation within the water industry.

2. AMP7 Analysis

2.1 Overview

R&D Innovation projects are selected through expert analysis of risk and opportunity. The expertise which resides within the Team comes from many, many years of experience within the water industry. The Team has a clear view of known business risks and emerging challenges, such as potential regulatory changes.

The benefit of each project delivered through the R&D Innovation process is clearly understood through the articulation of risk and opportunity. In many, if not all, cases projects deliver multiple, aggregated primary and secondary benefits. A 'Leakage' project for example can also potentially contribute to the 'Supply Interruptions' and 'Water Quality' PCs and be a driver of Net Zero.

Table 2.1articulates a number of key programme areas, with associated drivers, which are being delivered in AMP7.

Table 2.1: AMP7 programme areas with associated drivers

Project	Approximate spend	Programme Sub-Area	Primary Service Measure	Proposed Solution and Outputs
Galvanic Corrosion Risk from Ion Exchange	£100k	Raw Water Catchments and Production	Water Quality	Evaluate the increased galvanic corrosion risk from the change in water chemistry instigated by the installation of a new ion exchange process.
Flow Cytometry for water quality	£300k	Raw Water Catchments and Production	Water Quality	Trialing of particle counters and flow cytometry instruments to supplement current turbidity monitoring to identify failures in the treatment barriers
AMP7 Reservoir mgmt for algae control	£500k	Raw Water Catchments and Production	Water Quality	Developing a greater understanding of algal growth in reservoirs through intensive monitoring of mixed and un-mixed reservoirs, reducing water quality risks, customer contacts and reliance on ozone and carbon-based treatment solutions.
Iron compliance and discolouration modelling	£530k	Raw Water Catchments and Production	Water Quality	Iron monitoring, hydraulic modelling, optimised DMA flushing and profiling DMA discolouration risk.
Land Use and Catchment Monitoring	£1,200k	Raw Water Catchments and Production	Raw Water Quality	Long term research project to understand the impact of land managament preactices on raw water quality.
Plumbosolvency	£500k	Distribution	Water Quality	Delivering a greater understanding of the mechanisms behind phosphate control of plumbosolvency. Highlighting the other factors that impact on lead corrosion and solubility that can lead to elevated lead at customer properties.
Smart Water Networks	£940k	Distribution	Leakage	Following on from Smart Water Network pilots in AMP6. Demonstrating LoRaWAN as a cost effective data transmission solution and delivering integration with existing technology and systems.
Supply Pipe Leaks Improving detection	£190k	Distribution	Leakage	Temperature sensor trials to detect and quantify service pipe leakage.
Fibre Optics in Water Mains - (Govt. Funded)	£1,121,157	Distribution	Leakage	Project to deliver a pilot installation of fibre optics in water mains for commercial broadband supply and leakage detection. Collaboration between multiple stakeholders and part-funded to c.£4m by UK Govt.
Designer Liner Phase 1 and 2	£3,500k	Distribution	Leakage	Ofwat Innovation Funded projects to specify and develop and new cost effective, sustainable liner for water mains.
Valve actuators 4G upgrade	£44k	Distribution	Interruptions	Developed, installed and tested a 4G compatible valve actuator enabling remote control of water main isolation values, to reduce water supply interruptions and improve drinking water quality compliance.
Spray lining of Laterals	£560k	Wastewater Networks	Internal Sewer Flooding	Develop a new generation of spray liner focussing on access and deployment from the main sewer reducing the need to access customer properties.
Smart Waste Water Networks Pilot	£1,900k	Wastewater Networks	Waste Network Service	Delivering technology and process pilots incl. asset mapping and surveying sewer flow and level monitoring, river water quality monitoring, smart water butts and data analytics solutions. Stepping stone towards a 'Systematic approach to wastewater', full end-to-end network visibility and automated hydraulic control, Reducing flooding, pollution, CSO spills. Improving river water quality, contributing to bathing water compliance and delivering operational efficiency. Developing and demonstrating a model for the use of Smart technology to enable smart decision making: - Understand the network - Optimised monitoring - Predict performance - Visualise the data - Premium 'pre-emptive' Response.
Lateral Sewer CCTV	£370k	Wastewater Networks	Internal Sewer Flooding	Trial of lateral sewer CCTV enabling an increase in asset surveys and reducing access to customer properties.
Future Rising Main Rehab	£326k	Wastewater Networks	Pollution	Assessing risng main survey and cleaning technologies
Low Cost Sewer Monitor	£300k	Wastewater Networks	Internal Sewer Flooding	Development of an 'ultra-low cost' sewer monitor to identify blockages in lateral sewers.
Satellite and Aerial Asset Risk Assessment	£200k	Wastewater Networks	Waste Network Service	Utilising satellite and aerial survey technologies to assess and quantify asset risks.
P Removal CCm Technologies Pilot	£650k	Wastewater Treatment	TOTEX Efficiency	Development of an N&P recovery process for sustainable fertiliser production and creating process headroom enabling lower CAPEX P compliance.
Process Emissions Modelling and Mitigation	£180k	Wastewater Treatment	Carbon Reduction	Increased understanding of process emissions across the water industry and informing an effective approach to GHG emissions monitoring, modelling, reduction and mitigation.
AD Transformation (Phase 2)	£600k	Bioresources	TOTEX Efficiency	World-leading microbiological research programme to increase the efficiency of the anaerobic digestion processes, increasing sludge throughput and creating headroom within the existing asset base to provide long-term resilience and TOTEX efficiency.
Static Sludge Thickener	£660k	Bioresources	Opex Efficiency	Piloting of a new sludge thickening solution which has no moving parts and uses no polymer.
Sludge Insect Bioconversion	£90k	Bioresources	TOTEX Efficiency	Research to evaluate the production of insect protein grown on sewage sludge, creating a commercial opportunity and reducing volumes of sludge for disposal.

2.2 Return on Innovation Investment

Return on Innovation Investment is a key measure of overall programme success.

The ROII calculation methodology is defined in a documented process. This process assesses individual project benefits, collated in Benefits Tracker and rolled up in an overall programme ROII Calculator.

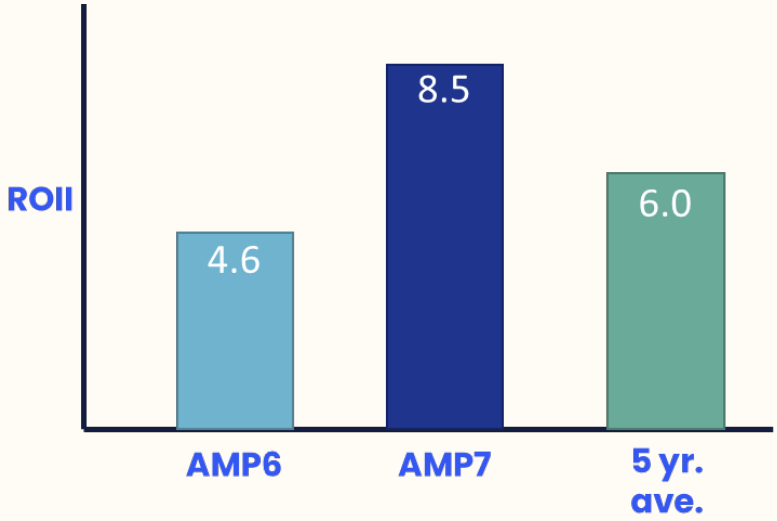
Calculation of a meaningful ROII value is notoriously difficult and therefore a pragmatic approach is required. Full assessment of benefit is only carried out on projects of significant value. Whilst this may not include the lower value benefits associated with a number of projects, or those projects that delivered no benefit, it gives good approximation of overall programme value.

Project value is based on predicted '*net benefit over 10 years'* from completion of the project. Benefit is calculated at the end of the project and reviewed after 3 years.

ROII is defined as the '*sum of net programme benefits'* divided by the '*total programme spend'* on a rolling 5-year basis.

Figure 3 below shows the current assessment of ROII across AMP6, AMP7 and the 5 year rolling average.

Figure 2.1: Current Assessment of Return on Innovation Investment



3. Proposed AMP8 R&D Innovation Programme

3.1 Overview

Our AMP8 R&D Innovation investment plan is aligned with our overarching business vision, “A thriving Yorkshire, Right for Customers, Right for the Environment”.

In AMP8, R&D Innovation will be an essential element in delivering compliance with ever tightening Customer Outcomes and service Performance Commitments across all operational functions. Where appropriate, out-performance against those regulatory service measures will also be enabled.

In addition to achieving compliance with Performance Commitments, the AMP8 R&D Innovation programme will deliver opportunities for enhanced levels of asset, service and commercial Resilience along with the identification, creation and provision of Growth opportunities to secure long-term income streams.

3.2 AMP8 R&D Innovation Programme Costs

The proposed AMP8 programme totals in the region of £18.25m. This will be enhanced by an additional £18.25m of external leveraged funding delivering an overall Innovation programme of £36.5m. This recognises the economic pressures facing customers and a need to keep bills low. The directly funded programme is an increase of c.£6m on the c.£12m we are forecasting to invest in Innovation during AMP7.

Proposed Opex associated with the Innovation Team has increased from £2m in AMP7 to £6m in AMP8. This accounts for increases in UKWIR Subscriptions, contribution to Spring and additional Opex for accounting of additional non-Capitalised research.

Table 3.1 Proposed AMP8 R&D innovation capex and opex spend

Draft PR24 Innovation Plan

	CAPEX	OPEX
Innovation Programme	£36.5m*	£2.5m
Internal Resource (non-Capitalised)	-	£1.25m
UKWIR / Spring	-	£2.1m
Other: subsistence, travel and subscriptions	-	£150k

*** 50% YW funding and 50% external leverage funding**

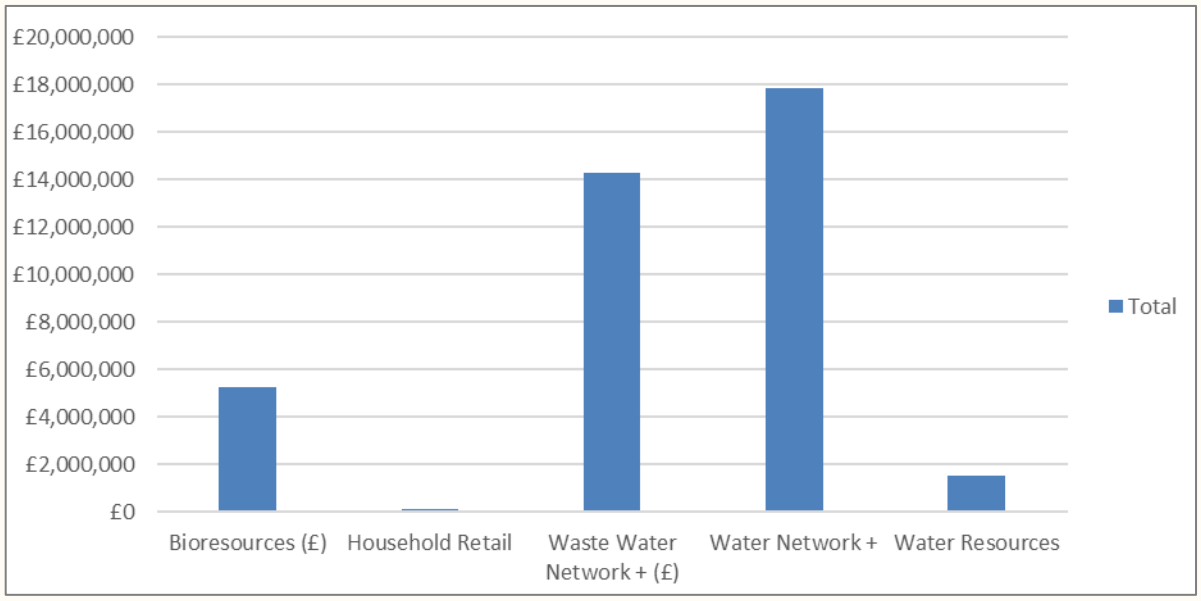
For the purpose of this Business Plan submission, all costs are based on the directly funded proportion of the programme.

3.3 AMP8 R&D Innovation Programme Development

The programme has been developed by the R&D Innovation Team from intelligence gathered during engagement at all levels across the Yorkshire Water business along with the external environment and wider water industry. The proposed AMP8 programme represents a balanced approach considering near, medium and long-term risks and opportunities that will deliver multiple benefits and directly aligns to OFWAT's key aspirations of long-term, customer-focussed, social and environmental value, and performance improvement.

The programme as a whole will deliver benefits across the four ‘operational’ Price Controls, Water Resources, Water Network+, Waste Water Network+ and Bioresources, and to a lesser extent Household Retail (Figure 3.1).

Figure 3.1: Proposed AMP8 R&D Innovation Investment by Price Control



3.4 AMP8 R&D Innovation Programme Objectives

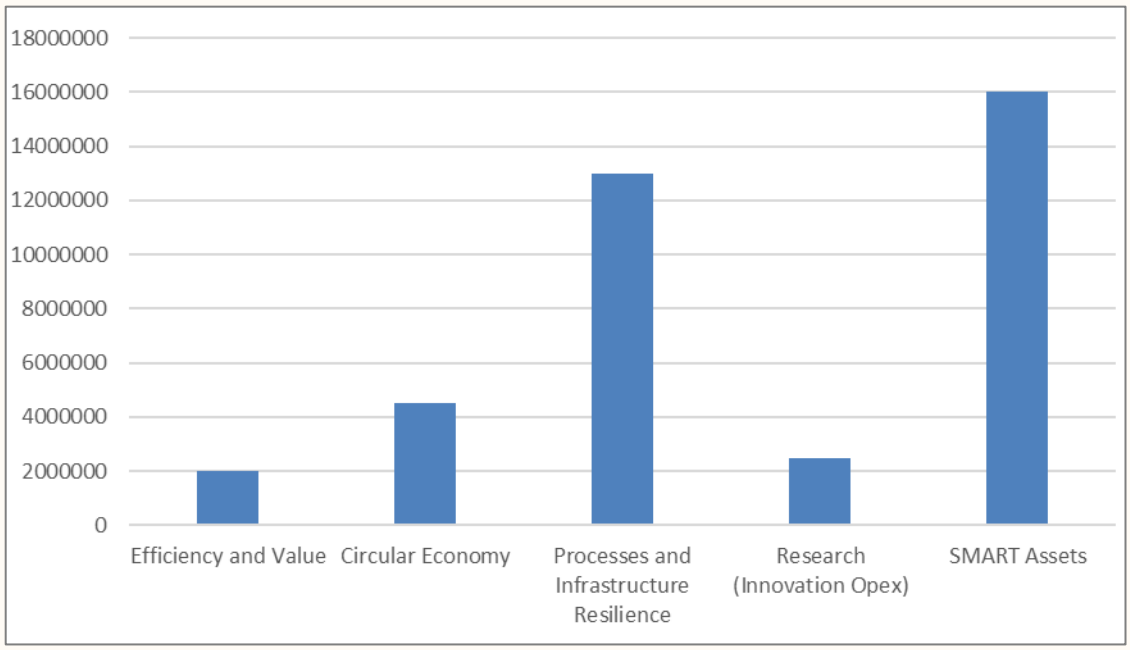
The long-term 'strategic' elements of the programme will focus on exploring and demonstrating the opportunity presented by the circular economy with resource recovery and reuse increasing environmental sustainability, operational efficiency, and growth. The evaluation and deployment of ‘smart’ technology will transform asset management processes and service performance, initially enabling proactive asset interventions and in the longer term delivering ‘autonomous’ assets which monitor, manage and maintain themselves. Understanding, reducing and mitigating process emissions will reduce climate change impacts and contribute to Net Zero ambitions for YW, the Water Industry and the UK as a whole.

The incremental elements of the programme will deliver immediate and 'near-term' service performance improvements.

The programme reflects the current view of future risks and opportunities. The flexible nature of the R&D Innovation programme management process means focus and priorities will be monitored and the programme will be adapted accordingly. This will consider intelligence gathered from within the business and from the external environment through AMP8.

As described previously, the programme will deliver both transformational (long-term, strategy) and incremental (near-term) innovation and this will be across 5 Streams (Figure 3.2). The majority of the investment will be in 3 key areas, ‘Process and Infrastructure Resilience, ' ‘Smart Assets’ and ’Circular Economy'.

Figure 3.2: Proposed AMP8 R&D innovation investment by stream



- **'Process and Infrastructure Resilience'** will deliver opportunities for long-term asset and process resilience, meeting current, emerging and new pressures such as climate change, population growth, affordability and, customer and stakeholder expectations of significantly improved environmental performance.
- **'Smart Assets'** will build on the Smart Water and Wastewater Network initiatives delivered in AMP6 and AMP7. In AMP8 YW will explore and demonstrate new approaches to asset and catchment management through the deployment of smart technology, moving towards the concept of 'autonomous' assets which monitor, manage and maintain themselves. A concept which will deliver significant improvements in service performance across all operational assets.
- **'Circular Economy'** will expand on the ground-breaking work done at Esholt and other wastewater treatment works in AMP6 and AMP7. This stream utilises the principles of the Circular Economy to maximise the value of operational process flows through resource recovery and reuse to inform new land management strategies. The work at Esholt presented opportunities to recover and commercially supply heat, power, potable and non-potable water, and nutrients for both industrial and domestic use.

  This Concept brings together existing, new and emerging technologies to fully integrate the wastewater treatment works with the surrounding environment to create a system which can be replicated in whole or in part at other Yorkshire Water sites.
- **'Efficiency and Value'** will deliver operational efficiency and value by informing and enabling improved ways of working through the exploitation new technology solutions. Exploration, evaluation and demonstration of the technology, data, systems and process which will facilitate the deployment of high-speed wireless communication technologies across Yorkshire will enable true remote working, asset monitoring and intervention within Yorkshire Water and enabling wider social and economic development.
- **'Research Opex'** will fund fundamental research projects supporting the generation of intellectual capital informing the future direction of water industry operational activity and investment plans. This may for example include Academic studies, such as PhDs, or 'problem understanding projects' which do not meet the criteria for capitalisation.

Operational performance ('Performance Commitments'**)** will be addressed across the programme with the themes described above and will directly and indirectly deliver

improvements in customer, and environment, impacting service measures including Pollution, Flooding, Leakage, Water Quality and Supply Interruptions.

3.5 Programme Validation

The AMP8 Business Plan for Innovation presents a programme value that is appropriate given current economic pressures that our customers face and impending challenges that the water industry will face. In addition, the programme has been subjected to an internal and external quality assurance.

4. Key Areas of R&D Innovation Focus AMP8

Outlined below are the key areas of R&D Innovation focus across the main functional areas in AMP8. These indicative activities will address current and emerging risks and will be refined as necessary in AMP8. In each case the primary business driver is indicated.

4.1 Water Catchment and Production

Table 4.1 Indicative Activities SMART: Catchments and Abstractions

	Description	Benefit
Targeted Peatland restoration methods for water quality improvement	A radical review of catchment restoration methods to determine the best techniques for delivering water quality benefit.	Raw Water Quality
Developing Best Practice guidance for cutting vegetation on peatlands and heathlands	Develop a set of progressive best practice guidelines taking advantage of the long-term monitoring data set already built up in Yorkshire (10 years in many areas).	Raw Water Quality
Applying genomic techniques to manipulate trophic cascade in drinking water reservoirs to reduce water quality risks associated with cyanobacteria	Deliver an understanding of how dominance of algae or macrophytes relates to T&O risk and whether altering the trophic state can change this dominance. Applying high tech eDNA genomic methods to design a low carbon “catchment solution” in response to climate change impact.	Water Quality
Developing a data platform and model to incorporate both quality and quantity into our raw water source selection	Develop a model or decision tree and data platform that will facilitate the expansion of an automated source selection solution which was first implemented at Chellow in AMP7 (avoiding the need for an ion exchange plant).	Raw Water Quality
Innovation solutions for WRMP indirect potable reuse and aquifer recharge	Carry out a review, feasibility and trial of innovative solutions to address predicted changes to where and how YW abstracts it raw water. Could include aquifer storage or indirect potable reuse	Raw Water Quality

Table 4.2 Indicative Activities SMART: Water Treatment

	Description	Benefit
Quantifying the water quality risks from climate change to inform long term strategic planning	Understanding the impact of increased air temperature and changes in rainfall patterns on dissolved organic carbon, nitrate and algal related risks, mitigating the need for high capex and carbon intensive solutions	Raw Water Quality
Phosphate disengagement strategy	Understanding the implication for water quality once all lead service pipes are removed and phosphate dosing is turned off. Considering geographical differences and specifically, implication for Yorkshire Water customers	Water Quality
Integrated approach to water treatment optimisation:	Understand how multiple measures such as turbidity, particle counting, flow cytometry and zeta potential can be integrated and analysed in an automated way to give greater insight into operation performance, specifically to reduce the risk of compliance failures.	Water Quality
Identifying and enabling new sources of raw water	Attenuated surface water, water recycling, non-potable supplies, raw water recharge with final	Water Resources

	effluent, advanced next generation reverse osmosis and ultrafiltration for seawater treatment	

Table 4.3 Indicative Activities - Managing water treatment process waste within the circular economy

	Description	Benefit
Recycling nitrate waste from ion exchange and Electro Dialysis Reversal (EDR)	Review the future nitrate risk in Yorkshire, considering customer demand and climate change, and determine the feasibility of recycling nitrate rich waste into agricultural fertilisers through utilisation of processes such as EDR	Resource recovery and reuse / carbon
Recycling DOC waste from Ion exchange	Trial and evaluation of HUMVI which can recover humic acids from MIEX regenerant waste to convert a tankered waste stream into high value fertiliser product.	Resource recovery and reuse / carbon
"Toward Informed Decisions on Ecologically Adaptive Land management for mitigating UK FIRE":	Continuation of the NERC funded project determining the environmental costs and benefits of widely applied fuel management tools (burning, cutting, rewetting and managed succession) on habitat quality, biodiversity and the carbon balance in fire prone UK landscapes	Carbon

4.2 Water Distribution

Table 4.4 Indicative Activities Water Distribution

	Description	Benefit
Improved understanding of asset life	Develop a multi-faceted, multi-data approach to determine the remaining life of an asset.	Asset Health
Identifying trends in existing data	Using existing data in new ways to understand issues linking production and networks (big data type project).	Asset Health
Renewal rates	Optimised asset investment models, what investigation process and techniques should we use to verify and determine the most cost effective repair / rehab. solution. Learning from previous renewal / relining programmes eg. YW Section 19 relining vs other company's mains replacement programmes	Leakage, Bursts, Customer Contacts, Totex efficiency
Impact of road infrastructure and traffic volume on water infrastructure and bursts	Understanding and quantifying the impact of traffic volume and road infrastructure on asset health, informing asset renewal models, informing mains laying processes and standards (increased bedding to reduce impact of traffic)	Asset Health, Leakage, Bursts
More cost-effective repair solutions	Utilising new solutions, such as internal pipe clamps to reduce the 'Economic Level of Leakage' and 'Socially Acceptable Level of Leakage'. Developing and using new tools and techniques, such as pressure, to dynamically locate and pinpoint leaks.	Leakage, Capex efficiency
Identifying and replacing lead pipes (YW and customer side)	Water Quality (Lead) a) Develop a formal process for identifying and removing lead in the network. b) Develop cost/liability strategy for water company to replace customer side lead pipes.	Water Quality

	c) Customer and Stakeholder engagement to change perception of the issue and stimulate action. d) 'Push' devices to locate lead supply pipes and find leaks without impacting WQ.	
Summer breakout	Understanding this new risk, not in current leakage models. Soil moisture deficit and ground movement significantly increased in 2022 and will increase with climate change. Yorkshire Water hasn't yet experienced the impact of soil drying due to climate change yet, unlike Anglian and the South East. Infrastructure that is resilient to shrinkage, swell and thermal expansion and contraction.	Leakage, Bursts, Totex efficiency, Customer Contacts, Demand Management
Next generation SMART Networks	Smart pressure management, dynamic networks, virtual DMAs, virtual smart water system, smart DMA control.	Leakage, Demand Management, Bursts, Totex efficiency
Sensing devices integrated in smart meters eg. pressure and water quality	What is the optimum blend of devices in water mains to achieve the most effective digital twin	Leakage, Demand Management, Water Quality
Reducing Discolouration	Continuation of work with Sheffield University. Validation and expansion of auto-mains conditioning pilots. Sampling programme of SREs / dead-ends / distribution mains to understand where the flushed sediment is ending up. Sediment build up modelling / digital twins. Intelligent tools to inform flushing programme	Water Quality, Customer Contacts
Smart tariffs	Investigating the use of water tariffs / smart tariffs / block tariffs for increased usage (economics NOT behavioural change) as a driver of PCC and NHH demand reduction using examples of water tariffing from around the world to incentivise reduced usage.	Demand reduction

4.3 Wastewater Networks

Table 4.5 Indicative Activities Wastewater Networks

	Description	Benefit
Systemic Approach to Wastewater - Full catchment end-to-end asset rationalisation, network control, process optimisation and land management	Building on the Smart Networks project in AMP7 this concept will see us move into asset rationalisation, network control and process optimisation across an entire catchment. Identifying opportunities for asset rationalisation and taking control of a catchment using AI and machine learning combined with a series of actuated penstocks and pump controls this will allow us to maximise the storage on our existing network whilst minimising spills from CSOs and flooding to properties. To enable this level of control more monitoring of the network will be required so further advances in this area will also be necessary. This extra control in the networks will also help the treatment process by delivering a more consistent product and volume for treatment enabling us to reduce energy costs and greenhouse gas emissions. This full catchment approach also presents the opportunity to manage land differently, attenuating surface water and reduce run-off to improve river water quality. Also planting trees on floodplains to	Storm Overflows, Carbon, Totex efficiency, Flood prevention

	increase water uptake, increase biodiversity, and produce biomass for energy generation	
System separation	One of the biggest areas of focus over the next few AMP cycles is going to be the reduction of storm overflow events. To enable us to reduce these events and operate our network in the most efficient way possible we need to prevent foul water from mixing with surface water in our combined sewers. To enable this we need to understand and untangle the existing networks including the inputs from highways drainage. We also need to look at innovative ways to reduce the cost of separation by incentivising customers to do this at a property level or where we have to install new foul or surface water systems reducing costs by laying broadband in the same trench or removing lead supply pipes	(Storm Overflows, Carbon, Totex efficiency, Flood prevention)
Network mapping & asset health	A key enabling activity for both catchment control and system separation is network mapping. With the transfer of private to public in 2011 it was estimated we took on an additional 26,000km of sewer network. Recent studies by other water companies estimate that this could have been underestimated by up to 200%. This transferred network has the greater share of incidents associated with it of internal and external flooding. To get to the root cause of these issues we need to better understand our network. Both its location and condition. Building on ideas explored in AMP7 this will create the tools, systems and processes required to rapidly map, survey and condition grade our network at an affordable price	ISF, Pollution
Energy from sewers	Recognising Yorkshire Waters commitment to reach net zero by 2030 we need to explore how sewers and sewerage could play a part in achieving this. Heating buildings accounts for 19% of overall greenhouse gas emissions in the UK and the majority of these properties are connected to the sewer network. With advances in heat pump technology and the relatively high temperature of the liquid passing through the sewers this combination could help reduce the carbon released by heating buildings. There is also an opportunity to harness some of the energy produced by large volumes of water passing through the gravity network and alongside full catchment control look at utilising the network as a large battery able to generate electricity when required.	Growth, Carbon

4.4 Wastewater Treatment and Bioresources

Table 4.6 Indicative Activities Wastewater Treatment and Bioresources

	Description	Benefit
Treatment of emerging substances of concern	River health is under increasing scrutiny with chemical and ecological status remaining stubbornly low. There is a growing need to identify candidate technologies for removal of organic pollutants such as PFAS, pharmaceuticals and AMR, and other contaminants such as microplastics from wastewater to inform a response to pressure from customers, stakeholders, regulators and central Government. Assessing the process efficacy and consequences (ie. chemical destruction or accumulation in sludge), carbon impact and cost.	WwTW and Sludge Compliance

Net zero (carbon and process emissions)	A large part of achieving net zero goals will be curtailing process emissions. Building on work in AMP7, further work to measure wastewater process and fugitive emissions, particularly nitrous oxide and methane, characterising all treatment and sludge processes and developing tailored mitigation strategies. Demonstrate successful mitigations and enable accurate reporting of greenhouse gas emissions through the carbon accounting workbook. Auto-monitoring and plant control to optimise balance between final effluent compliance, sludge quality, process emissions/carbon and energy/chemical use	Carbon
Ammonia recovery	Ammonia production to support agriculture consumes 3% of global energy, with its destruction to protect water health consuming another 2%. Explore ways in which ammonia can be made more sustainable such as piloting domestic and/or 'commercial-scale' urine separation and source reuse, technologies to recover ammonia from sludge liquors. Investigate carbon and energy balance of various alternative approaches and explore market viability of each. (Resource recovery and reuse)	Carbon
Sludge transformation and productisation	It is expected that sludge to land recycling will become non-viable and as a result, beneficial use of sludge could stall. Identify and assess technologies and approaches to extracting and recovering substances of value from sludge to support circular economy goals. Additional work to ensure that markets to receive sludge products are available and sustainable.	Sludge compliance
Small works	Process and technology opportunities to deliver operationally efficient and compliant small, rural wastewater treatment works.	WwTW compliance