Yorkshire Water

DWMP24

May 2023

Contents

Executive Summary

Our DWMP24 is the first iteration of our new strategic plan for drainage and wastewater.

We are proud to play our part in delivering ‘A thriving Yorkshire. Right for customers. Right for the environment.’ Today, every day and forever it is our job to make sure that everyone in Yorkshire has the water they need for their busy lives. And, when they have used it, it is our job to take it away and return it safely back to Yorkshire’s environment. Water is one of life’s most basic essentials and we do not underestimate the importance of taking care of it in the right way for everyone, all of the time.

Our plan describes how we will facilitate a robust drainage and wastewater network for our customers and the environment, in the face of future challenges such as climate change, population growth and environmental pressures, for the next 25-years and beyond. Our DWMP has been produced following an industry developed national framework and considers all aspects of our wastewater networks (foul, combined and surface water) as well as our wastewater treatment works (WwTW).

Our DWMP uses hydraulic models, established processes and statistical analysis of data alongside the latest guidance and scientific understanding to evaluate our levels of risk at present and the expected changes in the drainage and wastewater system performance by 2050. This helps us to assess the possible impacts of future challenges and plan what we need to do to manage our current and emerging risks.

We have evaluated risk under three key planning themes, as shown in Figure 1:

Figure 1: Our DWMP planning themes

Operation and impact of our storm overflows

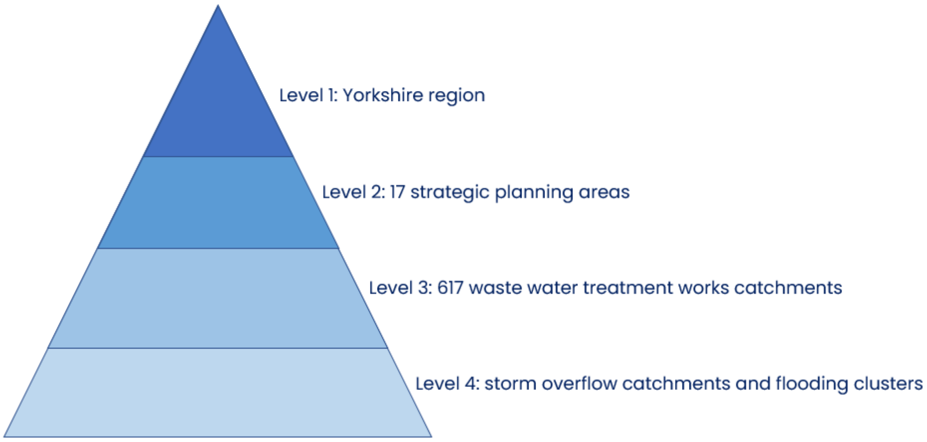
Managing internal and external hydraulic flood risk and the impact on customers properties

Maintaining compliance with our wastewater treatment works permits

We have also incorporated information relating to our business-as-usual activity in terms of asset health, maintenance activities and proactive activities, alongside innovation projects and pilots. We carry out these activities every day as part of the service that we provide to our customers and the activities that we undertake to minimise the impact we have on the environment.

The building blocks of our DWMP are shown in Figure 2:

Figure 2: Our DWMP building blocks



This hierarchy allows us to identify, focus and develop options for the catchments with the highest levels of immediate and emerging risk. The introduction of Level 4s for our final DWMP allows for a more granular approach to cost and benefit reporting compared to our draft DWMP.

We initially developed four scenarios for our draft DWMP to address the risks we have identified. Following our consultation, we have listened carefully to our customers and stakeholders and have adopted the preferred DWMP scenario that was identified through the consultation process. This scenario is detailed In Table 1 below and has been expanded to meet the requirements of the Storm Overflow Discharge Reduction Plan (SODRP). The SODRP is a statutory requirement that was published after our draft DWMP however has been incorporated within our final DWMP.

Table 1: DWMP Scenario 2 summary

Element	Details	Timing
Deliver the requirements of the Storm Overflow Discharge Reduction Plan	Annual average of no more than 10 spills per storm overflow	
	Annual bathing season average of no more than 2 spills per storm overflow discharging to coastal bathing waters, to support achieving excellent bathing water classification	75% high priority sites achieved by 2035
	Annual bathing season average of no more than 1 spill per storm overflow discharging to inland bathing waters	100% bathing water sites achieved by 2035
	Installation of continuous water quality monitoring to assess any impact from storm overflows and wastewater treatment works discharge outlets	Monitoring installed by 2035
	Provision of screening at all storm overflows	Screens by 2050
	Ensure no local ecological harm from storm overflows	
Reduce Modelled Hydraulic Flood Risk	Reduce model predicted risk of internal and external hydraulic sewer flooding of properties up to a 1 in 30 return period, compared to the 2050 position	By 2050
Maintain WwTW Compliance	Ensure all of our wastewater treatment works remain compliant with current environmental permits and any future changes to permits	100% in AMP8

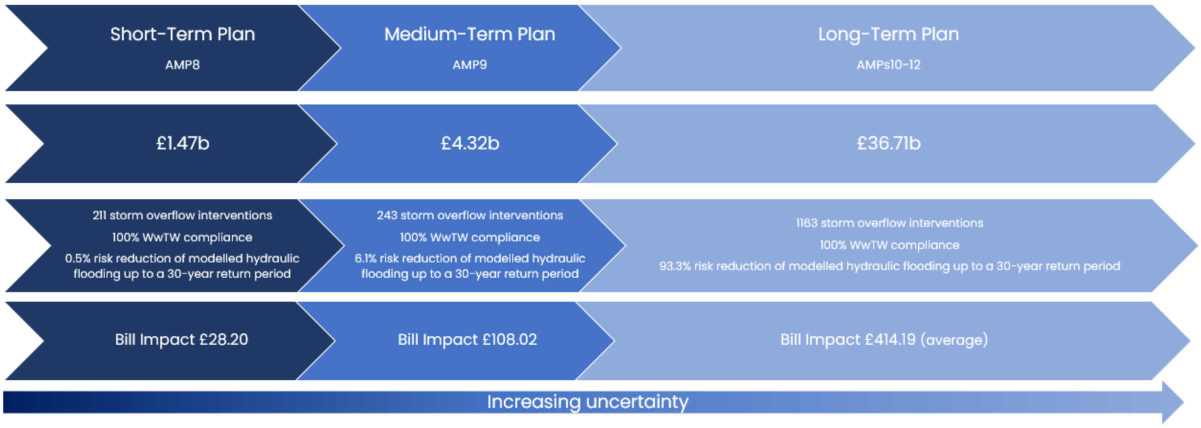
We have considered two main approaches to achieve our DWMP scenario targets, detailed below:

- **Reduce + Enhance:** Adopt blue-green solutions to manage and reduce the amount of rainfall entering our network to reduce our levels of risk (e.g., through the use of blue-green infrastructure and nature-based solutions or Sustainable Drainage Systems (SuDS) which look to manage flow in a cost-effective way whilst benefitting the environment and surrounding communities), then utilise traditional grey infrastructure solutions to meet the target if necessary.
- **Enhance:** Increase the capacity of our network through traditional 'grey' solutions, i.e., building bigger pipes, storage tanks and upgrading our existing assets.

If we did not invest in our wastewater assets by 2050 the forecast impact of population growth and climate change would result in an increase in storm overflow activations, the region would be at increased risk of flooding and levels of performance of our wastewater treatment works would be impacted.

We have created a preferred plan based on delivering our regulatory requirements for storm overflow assets in line with the Storm Overflow Discharge Reduction Plan and the relevant wastewater elements of the WINEP. It also incorporates solutions to reduce the risk of model predicted hydraulic flooding and to address the impact of growth at WwTW. The investment requirements and benefits delivered by this plan which addresses the increasing pressures we face on our drainage and wastewater network by 2050 are shown below in Figure 3.

Figure 3: Preferred Plan costs, benefits and bill impacts



Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£1.47b	£4.32b	£36.71b
211 storm overflow interventions 100% WwTW compliance 0.5% risk reduction of modelled hydraulic flooding up to a 30-year return period	243 storm overflow interventions 100% WwTW compliance 6.1% risk reduction of modelled hydraulic flooding up to a 30-year return period	1163 storm overflow interventions 100% WwTW compliance 93.3% risk reduction of modelled hydraulic flooding up to a 30-year return period
Bill Impact £28.20	Bill Impact £108.02	Bill Impact £414.19 (average)

In the early years of the plan (AMP8), nearly all the proposed activity is required to meet the statutory requirements of the WINEP and the SODRP. Throughout the planning period, the requirements of the SODRP are met. In the long-term (AMPs 10-12), interventions include those planned to deliver a significant reduction in the modelled risk of hydraulic flooding. This risk is significantly increased in the future by climate change, population growth and urbanisation.

The DWMP is a long-term strategic plan and whilst the actions and costs presented in the plan are produced using robust data and evidence, it is noted that whilst there is a high degree of certainty associated with the AMP8 components of the plan, uncertainty increases in AMPs 9-12. Confidence will progressively increase as further cycles of the DWMP are completed.

Delivering the activities identified in our plan will have an impact on customer bills. The benefits delivered within our preferred plan will result in an increase of £28.20 on the average bill each year in AMP8. The bill impact is forecast to increase significantly over the planning period and in further cycles, we will work to reduce this impact by further optimisation of interventions and applying the benefits of experience gained in the early part of the planning period, along with the efficiencies gained through deployment of technology and innovation.

Throughout the creation of our DWMP we have engaged with customers and key local stakeholders including Lead Local Flood Authorities, The Rivers Trust and the Environment Agency. We will look at how we can deliver solutions in partnership with other agencies wherever possible, use sustainable nature-based solutions and provide the best value for our customers and the environment.

We will use the DWMP findings to inform both YW's long-term delivery strategy and our business plan submission for PR24.

Following on from publication of our fDWMP24 we will commence work on the next cycle of DWMP development, which will start in Summer 2023. This will make use of newly available datasets, including climate change and growth projections and we will incorporate learning and feedback from the completion of our first DWMP. Our learning will be combined with wider industry learnings, and we will continue to work with our regulators as we move through into cycle 2. Through continued engagement with our customers and stakeholders and partnership working we will ensure that we deliver the best value solutions to communities, customers, and the environment.

Technical Summary

1. Overview

The Drainage and Wastewater Management Plan (DWMP) is a new strategic planning framework. It is a collaborative long-term strategic plan that outlines the needs and requirements of drainage, wastewater and environmental water quality for the next 25 years and beyond. This is the first 5-year cycle of the DWMP (DWMP24).

The DWMP framework was published in 2018 by Water UK and ensures that plans are co-created by water companies and stakeholders with an interest in integrated catchment management. As such, DWMPs will facilitate an increased level of partnership working across relevant stakeholders including Lead Local Flood Authorities (LLFAs) and the Environment Agency (EA) to support and develop long-term plans for drainage, flooding and protection of the environment.

The DWMP is underpinned by the need for consistency, transparency, and collaborative approaches to long-term planning across the industry. We have worked with the national DWMP Implementation Group, and a number of task and finish groups supported by Water UK to finalise framework details. We have worked with our stakeholders and customers to share our progress.

We are proud to play our part in delivering 'A thriving Yorkshire. Right for customers. Right for the environment.' Today, every day and forever it is our job to make sure that everyone in Yorkshire has the water they need for their busy lives. And, when they have used it, it is our job to take it away and return it safely back to Yorkshire's environment. Water is one of life's most basic essentials and we care deeply about taking care of it in the right way for everyone, all of the time.

How we do that really matters; the resources we use and recycle, the way we look after land, our broader support to local communities and the partnerships we develop, will make a considerable difference to getting it right for Yorkshire's people and places.

The 5.4 million people who live in Yorkshire and the millions of people who visit each year rely on our services for their basic health needs and lifestyles. 140,000 businesses use our water to provide goods and services that support the economy, not just of Yorkshire, but the whole of the UK.

Yorkshire, alongside the rest of the UK, faces significant future pressures such as population growth and climate change. The DWMP will help us mitigate the impacts of these pressures on our drainage and wastewater services, ensuring we maintain a robust and resilient drainage and wastewater system for our customers, communities, and environment into the future.

The DWMP will provide Yorkshire Water (YW) with the opportunity to:

- Develop a strategic best value and least cost plan encompassing the next 25 years and beyond to meet the requirements of our long-term ambitions; to reduce sewer flooding and protect and enhance the environment by considering the operation and impact of our storm overflows and wastewater treatment works.
- Facilitate greater collaboration and partnership working with stakeholders such as LLFAs and the EA to ensure targeted investment which benefits our environment and local communities more effectively.
- Understand customer and stakeholder expectations and requirements and how we will work to meet these expectations; particularly around priority areas associated with sewer flooding, sewage escapes, storm overflows and protecting the environment.
- Align with strategies and regulations set out by Government and the EA to achieve a common set of objectives and goals.

- Develop and implement future innovations through the use of technology and the adoption of Sustainable Drainage Systems (SuDS) also known as green/blue infrastructure, wherever possible. This is to provide best value and overall benefits for communities, customers, and the environment over the long term.
- Develop a plan which considers a wide range of options, balancing the needs of customers and communities today and for the future.
- Incorporate our asset health data into our plan to support solution identification for maximum benefit for our customers and the environment.

We collect and treat around 1 billion litres of wastewater, from homes and businesses, and rainwater, that goes into our 52,000km of sewers every day. To do this we operate 2000 wastewater pumping stations and 617 wastewater treatment works to safely collect and treat wastewater and rainwater before returning it safely back to the environment.

The DWMP will consider all aspects of our wastewater networks (foul, combined and surface water), our wastewater treatment works (WwTW), the interconnecting drainage systems from other Risk Management Authorities (RMAs), such as local authorities and the EA. It will consider how this impacts our environment, including discharges to rivers, streams, and other waterbodies.

Our DWMP will help us understand the potential scale of climate change and the effects that this may have across Yorkshire. Our DWMP considers the latest guidance, scientific understanding, and modelling techniques to identify what risks we may face in the future. By working now to develop effective partnership and cost-effective solutions, we will be able to minimise the disruption caused by flooding and protect our environmental water quality.

1.1 Requirements of the DWMP

In supporting the business planning process, the framework has been developed such that, through this DWMP, we will:

- Set out the company's assessment of long-term drainage and wastewater capacity and the drivers, risks and scenarios being planned for.
- Assess where (largely drainage) infrastructure managed by other stakeholders may impose additional risks to YW's drainage and wastewater services.
- Identify those options that offer best value to customers and the environment, ensuring robust, resilient, and sustainable drainage and wastewater services in the long-term.

The benefits of the framework are that our DWMP will:

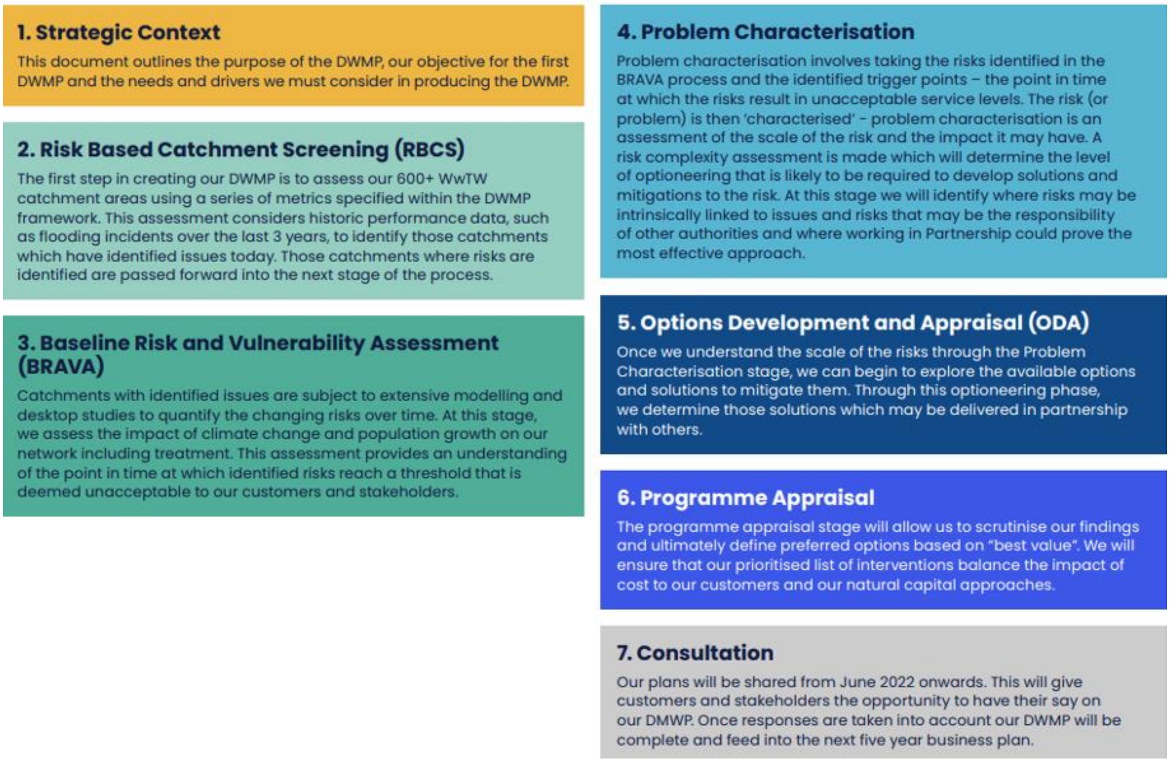
- Show how long-term plans support economic growth, resilient communities and how they protect and enhance the environment in a sustainable way.
- Provide a systematic understanding of service and wastewater system risks and vulnerability.
- Demonstrate a structured and auditable approach to identifying and developing options and presenting a robust best value investment plan.
- Facilitate the integration of partnership working and co-creation of solutions to understand the related works of others and deliver, where possible, integrated solutions. These will provide multiple benefits to achieve best value to the economy, society, and the environment over the long-term.
- Facilitate innovation (by identifying future challenges that will need new approaches to address them) and the development of an affordable, sustainable investment plan.

- Provide a clear, transparent, and consistent planning approach, with sufficient agility and adaptability to respond to long-term drivers for drainage and wastewater services.
- Promote informed debate about acceptability of different levels of risk.
- Provide greater confidence to customers, regulators and stakeholders in strategies identified, and resultant plan.
- Provide the basis for effective engagement with customers and stakeholders on levels of service, environmental performance, and resilience, now and for the future and on the choices and costs to customers in providing that service.

1.2 National DWMP approach

The Water UK DWMP framework[1] outlines the key steps that must be undertaken in the formation of the DWMP. These are documented in Figure 4 below.

Figure 4: DMWP Process Steps



1. Strategic Context

This document outlines the purpose of the DWMP, our objective for the first DWMP and the needs and drivers we must consider in producing the DWMP.

2. Risk Based Catchment Screening (RBCS)

The first step in creating our DWMP is to assess our 600+ WwTW catchment areas using a series of metrics specified within the DWMP framework. This assessment considers historic performance data, such as flooding incidents over the last 3 years, to identify those catchments which have identified issues today. Those catchments where risks are identified are passed forward into the next stage of the process.

3. Baseline Risk and Vulnerability Assessment (BRAVA)

Catchments with identified issues are subject to extensive modelling and desktop studies to quantify the changing risks over time. At this stage, we assess the impact of climate change and population growth on our network including treatment. This assessment provides an understanding of the point in time at which identified risks reach a threshold that is deemed unacceptable to our customers and stakeholders.

4. Problem Characterisation

Problem characterisation involves taking the risks identified in the BRAVA process and the identified trigger points – the point in time at which the risks result in unacceptable service levels. The risk (or problem) is then 'characterised' - problem characterisation is an assessment of the scale of the risk and the impact it may have. A risk complexity assessment is made which will determine the level of optioneering that is likely to be required to develop solutions and mitigations to the risk. At this stage we will identify where risks may be intrinsically linked to issues and risks that may be the responsibility of other authorities and where working in Partnership could prove the most effective approach.

5. Options Development and Appraisal (ODA)

Once we understand the scale of the risks through the Problem Characterisation stage, we can begin to explore the available options and solutions to mitigate them. Through this optioneering phase, we determine those solutions which may be delivered in partnership with others.

6. Programme Appraisal

The programme appraisal stage will allow us to scrutinise our findings and ultimately define preferred options based on "best value". We will ensure that our prioritised list of interventions balance the impact of cost to our customers and our natural capital approaches.

7. Consultation

Our plans will be shared from June 2022 onwards. This will give customers and stakeholders the opportunity to have their say on our DMWP. Once responses are taken into account our DWMP will be complete and feed into the next five year business plan.

1.3 Our approach to DWMP

Our DWMP will identify changes in level of risk to the core wastewater services we provide across a range of time horizons. By exploring different time horizons, we will identify and anticipate risks arising from climate change and population growth and the effects these may have on the levels of service we provide. Our baseline will be 2020 and our plan will cover 2025-2050 risks.

Our strategic context document is available to read on our website here:

https://www.yorkshirewater.com/drainage-and-wastewater-management-plans

This sets out the objectives for our first DWMP. It explains the drivers and benefits of a long-term plan and the performance measures we are assessing. It sets out how we intend to work with a wide

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[1] https://www.water.org.uk/policy-topics/managing-sewage-and-drainage/drainage-and-wastewater-management-plans/

range of stakeholders to ensure that we play our role in making Yorkshire a brilliant place to be – now and always.

The first cycle of the DWMP for YW is primarily focused on modelled hydraulic capacity of the wastewater system and changing future risk to: sewer flooding; storm overflow operation; and wastewater treatment works compliance, as a result of factors such as population growth and climate change. We have focused our first DWMP on these areas but in order to build a broad understanding, we have included data from our established business as usual processes for tackling blockages, collapses, campaigns to address sewer misuse and drawn on our innovation programme and pilots for wastewater. Inclusion of these components ensures that a holistic assessment is made of baseline performance and changes in future risk, as well as supporting identification of the best value interventions that may address multiple risks.

1.4 DWMP and WRMP similarities and differences

YW carries out other strategic planning activity, in particular the production of a Water Resources Management Plan (WRMP). This is a strategic holistic plan to maintain a secure supply of water to all of our customers over the next 25 years, whilst minimising impact on the environment. The framework for the development of DWMP's was based on that of the WRMPs however fundamental differences exist between the systems considered within these plans. The DWMP considers numerous, primarily gravity-based, sewer networks with localised risks, lending itself to a bottom-up build of solutions and scenarios. By contrast, the pressurised and interconnected grid system considered within the WRMP requires a different approach.

Similar to the DWMP, the WRMP incorporates future pressures on water supply and demand due to predicted changes to the climate. It also looks at future changes in population, housing, water use and metering trends in Yorkshire. The WRMP and DWMP follow the same time horizons and principles, to ensure resilient water and wastewater services now and in the future. Where appropriate, it is important that the two are considered together and complement each other when making business decisions.

Whilst efforts have been made to align the data and processes utilised within our DWMP with the dWRMP24 which is currently under review post consultation (for the regulatory period 2025-30), differing timescales and requirements have meant this has not always been possible. Where such differences exist, these are discussed within the relevant sections of this document.

1.5 Water Industry Act – Statutory duties

All water companies in England and Wales operate under a licence granted by the Secretary of State for the Environment, Food and Rural Affairs. The water sector in the UK must comply with several different legal requirements – these requirements are relevant to our DWMP, covering sewerage services, environmental standards, and flood protection and adaptation.

The Water Industry Act, 1991, sets out general duties and accountabilities of water companies. Of relevance to the DWMP is the duty to provide, extend and improve the public wastewater network to effectually drain connected areas – including foul drainage, water from roofs and associated areas and highways.

In the development of the DWMP, other legislation and policy has been considered. Key areas are listed below:

- Environment Act 2021 – specifically includes policy on storm overflows and provision for cycle 2 of the DWMP to become a statutory process once additional secondary legislation is in place.
- Storm Overflow Discharge Reduction Plan (SODRP) – published by Government in 2022. Sets targets to reduce the frequency of operation and the environmental harm caused by storm overflows between now and 2050.

- The Water Industry National Environment Programme (WINEP) – this process, overseen by the Environment Agency sets out a programme of actions that all water companies undertake to improve the environment.

2. PR24 and WINEP

The DWMP is a long-term strategic planning framework for the next 25 years and beyond. The DWMP will inform both YW's long-term delivery strategy and regulatory price review process including water industry business plan submissions. DWMP24 will inform YW's 2024 price review business plan (PR24) and the investment programme for the 2025 – 2030 period.

The price review process seeks to balance multiple long-term plans and priorities including other long term strategic planning frameworks such as the Water Industry National Environment Programme (WINEP). As such, the outputs of the DWMP will be reviewed in context with all other priorities affecting water companies including affordability to customers. Our DWMP long-term strategy aspirations will be reflected in the Long-Term Delivery Strategy (LTDS) tables that accompany the submission of the business plan in autumn 2023.

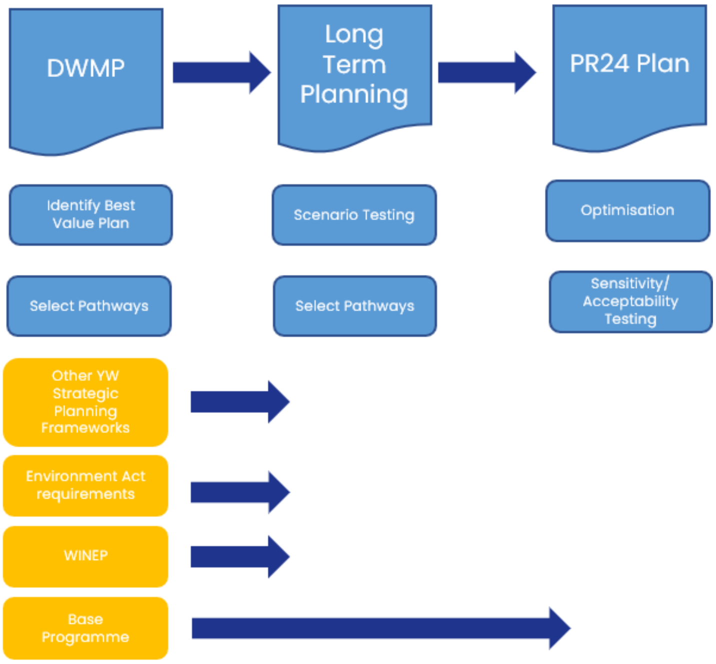
2.1 The price review process

The price review process is a five-year process of setting the price, investment, and service package that customers receive from water companies. This seeks to balance customer interests with the need to finance the delivery of water and sewerage services, including legal obligations, environmental and social duties. The price review process sets the billing or wholesale amount that water companies can charge their customers every 5 years.

We are currently working on the price review for 2024 (PR24) to set the wholesale price controls for the regulatory period 2025 to 2030. Our business plan for 2025 – 2030 (AMP8) will be published in autumn 2023 for assessment by the economic regulator, Ofwat. Final price limits will be set by Ofwat in December 2024.

As part of the price review process, we will produce a business plan that sets out how we will serve customers, communities, and the environment in the face of considerable challenge. To address climate change, changing societal expectations and affordability of bills, alongside many other pressing challenges, will require long-term planning and delivery strategies. The price review will therefore be significantly influenced by the direction established within various Strategic Planning Frameworks. See Figure 5 below.

Figure 5: Long-term planning schematic



2.2 Strategic Planning Frameworks

There are three main Strategic Planning Frameworks (SPFs) that inform the PR24 methodology, these are:

- Drainage and Wastewater Management Plans (DWMP)
- Water Resources Management Plans (WRMP)
- Water Industry National Environment Programme (WINEP)

The SPFs are standalone regulatory requirements. They will provide key inputs into water companies long-term delivery strategies and price review planning processes.

As the DWMP and WINEP both have a focus on the environment there are elements of interaction between these SPFs, particularly in respect of storm overflows and wastewater treatment works compliance. In comparison, there is less interaction between the DWMP and WRMP. although the amount of water that businesses and customers use, known as per capita consumption (PCC) has a direct association with the volume of wastewater generated.

2.3 Water Industry National Environment Programme (WINEP) and DWMP

The WINEP is a programme of work that water companies in England are required to undertake to meet their obligations with environmental legislation and UK government policy. It is co-developed by the EA and Natural England and the water industry. The work done on the draft and final DWMP24 has been utilised to help compile the data for the submission and within our final DWMP24 we have included relevant components of the wastewater WINEP as our short-term plan.

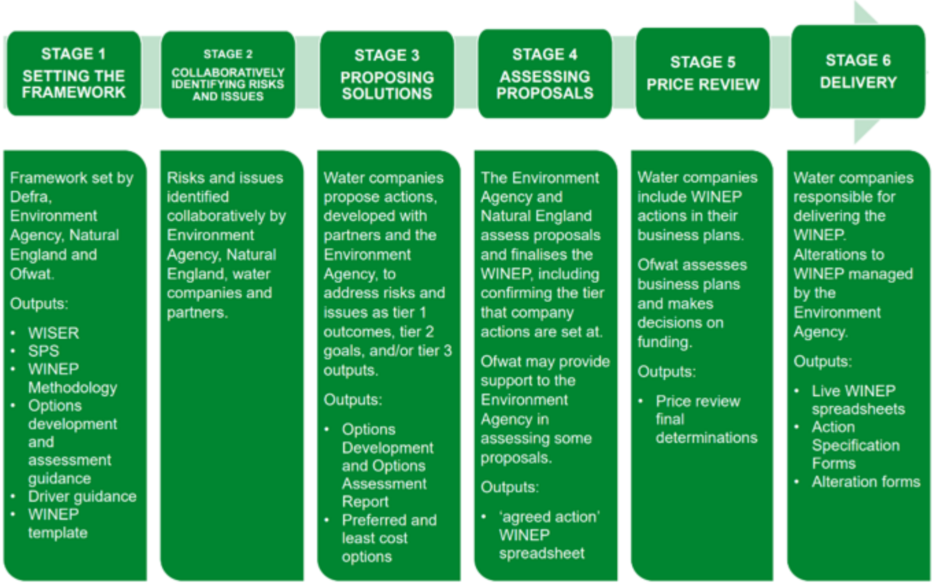
The WINEP is the most important and substantial programme of environmental investment in England and Wales. For the regulatory period 2020 to 2025 it consists of a national programme of £5.2 billion of asset improvements, investigations, monitoring and catchment interventions.

The Environment Agency (EA) published the draft water industry national environment programme methodology in July 2021.

https://www.gov.uk/government/consultations/review-of-the-water-industry-national-environment-programme-winep

This was followed by the release of the WINEP Options Assessment Guidance (Final version March 2022) and WINEP Options Development Guidance (Final version in July 2022). The driver guidance documents for individual areas of the program were published at regular intervals throughout 2022. The methodology sets out what the EA expected water companies to deliver. The Options Development Guidance set out a six-stage process showing how water companies should assess the risks and issues, propose solutions and how those solutions would be assessed by the EA. This is shown in Figure 6 below.

Figure 6: WINEP six-stage process



STAGE 1 SETTING THE FRAMEWORK

Framework set by Defra, Environment Agency, Natural England and Ofwat.

Outputs:

- WISER
- SPS
- WINEP Methodology
- Options development and assessment guidance
- Driver guidance
- WINEP template

STAGE 2 COLLABORATIVELY IDENTIFYING RISKS AND ISSUES

Risks and issues identified collaboratively by Environment Agency, Natural England, water companies and partners.

STAGE 3 PROPOSING SOLUTIONS

Water companies propose actions, developed with partners and the Environment Agency, to address risks and issues as tier 1 outcomes, tier 2 goals, and/or tier 3 outputs.

Outputs:

- Options Development and Options Assessment Report
- Preferred and least cost options

STAGE 4 ASSESSING PROPOSALS

The Environment Agency and Natural England assess proposals and finalises the WINEP, including confirming the tier that company actions are set at.

Ofwat may provide support to the Environment Agency in assessing some proposals.

Outputs:

- 'agreed action' WINEP spreadsheet

STAGE 5 PRICE REVIEW

Water companies include WINEP actions in their business plans.

Ofwat assesses business plans and makes decisions on funding.

Outputs:

- Price review final determinations

STAGE 6 DELIVERY

Water companies responsible for delivering the WINEP. Alterations to WINEP managed by the Environment Agency.

Outputs:

- Live WINEP spreadsheets
- Action Specification Forms
- Alteration forms

Source: Draft water industry national environment programme methodology, July 2021

Our PR24 WINEP submission was developed by a number of our subject matter experts and associated driver leads. We utilised peer review and third-party assurance to validate the submission. Water companies had to submit optioneering evidence for solutions to address environmental risks and issues identified with the EA by 30 November 2022 for most drivers and the remaining drivers by 23 January 2023. The submission consisted of Options Assessment Reports (OAR) and Options Development Reports (ODR) to explain how the final solution had been derived and we also submitted a spreadsheet of collated information.

Our wastewater WINEP submission for AMP8; 2025-2030, will focus on implementing the Storm Overflow Discharge Reduction Plan including no local ecological harm investigations and the installation of water quality monitors. For our WwTW's the focus is on improvements to inland bathing waters, phosphate, and nutrient removal linked to sanitary determinands, and improvements and investigations relating to chemicals. Our schemes will consider blue-green and traditional solutions to address the issues and seek to work in partnership to deliver outcomes where appropriate.

Our WINEP submission for storm overflows for AMP8 is covered in Section 3.4.

The Environment Act EnvAct_IMP1 driver requires us to reduce phosphorus levels from our continuous discharges by 80% by 2037 on a 2020 baseline. Our AMP7 WINEP programme, contains interventions that will reduce our discharges by circa 54%. The interventions proposed in our PR24 WINEP will remove approximately a further 9% and the remaining 17% will be planned in for PR29 AMP9 investment.

At the time of writing the DWMP the WINEP submission has not been fully agreed with the EA and is subject to change. The final DWMP contains the data from the November 2022 and January 2023 submissions with no alterations after this point. It is anticipated that the plan will be finalised by the

EA in June 2023. There are a small number of additional areas where there remains uncertainty and where, as a consequence, components of the DWMP could change.

- The definition of the no local adverse ecological harm standards and details of what no local adverse ecological harm investigations will need to include remain uncertain but we have included costs for investigations within the DWMP.
- Water Quality monitoring installation requirements are unclear. We have built our plan using the best available information at the time.
- Yorkshire has one confirmed inland bathing site and a number of proposed sites. These have been included within our AMP8 WINEP submission, with the delivery of the associated spill targets. These sites are subject to future designations and agreement with the EA with respect to the WINEP24 submission.

3. Storm overflows

3.1 What is a storm overflow?

Combined sewers carry foul water from homes and businesses as well as rainwater. Where rainwater cannot pass through impermeable surfaces such as paved areas, roofs, and highways, in many cases it drains to the combined sewer.

Usually, wastewater in sewers travels to one of our wastewater treatment works to be treated before it is safely returned to the environment. As rainwater can be unpredictable, we have permitted storm overflows on our sewer network to act as a relief valve, reducing the pressure on sewers during heavy rainfall events. Storm overflows stop the system from backing up and flooding homes and gardens by allowing heavily diluted wastewater to be discharged into watercourses.

Storm Overflows on the sewer network are also known as Combined Sewer Overflows (CSOs). Their operation is permitted by the EA and closely monitored by us and the EA. Many storm overflows have preliminary treatment such as screens or storm settlement before any discharge is made to the environment. YW have 2214 permitted storm overflows. The number of storm overflows fluctuates as sites are permitted or revoked and for the DWMP24 represents the position in November 2022.

98.1% of our Storm Overflows have Event Duration (EDM) installed. We plan to have 100% coverage by the end of 2023 where practicable. EDM records the number and duration of spills, which water companies report annually. In 2021, there were 70,062 spills from storm overflows in Yorkshire totalling 406,131 hours. In 2022, there were 54,273 spills from storm overflows in Yorkshire totalling 232,054 hours. This data can be accessed via the below link:

https://www.yorkshirewater.com/environment/storm-overflows-and-event-duration-monitoring/

YW is working to make this data available to everyone in near real time. Our near real time EDM reporting of storm overflow spills will be live by January 2024.

3.2 Investment in storm overflows in Asset Management Plan 7 (AMP7) 2020-2025

As part of the Water Industry National Environment Programme (WINEP) for AMP7, we are investigating the environmental impact of 158 frequent spilling overflows. By March 2023 we had completed 91 of these investigations, with a further 67 to be completed by March 2025. These investigations will help to support our storm overflow investment programme in AMP8 and beyond.

As part of our AMP7 commitments, we are investing £137 million by 2025 in storm overflow spill reduction improvements, investigation, and increased monitoring. We have also committed a further £180million of investment into driving reductions to our storm overflow spill frequency by the end of AMP7. This will focus on reducing spill frequency across a number of our storm overflow assets targeting a 20% reduction from the 2021 numbers. This programme of work is still in development and any investment in AMP7 will be reflected in future programmes of work for AMP8 and beyond but is not included within DWMP24 or WINEP related storm overflow submissions. Any improvements made in AMP7 that meet the requirements of the SODRP will be in addition to the number of interventions planned for AMP8. This may mean that for a small number of storm overflow assets, these will be completed in AMP7 and replaced in AMP8 with interventions brought forward from AMP9. This will be subject to agreement with the Environment Agency, with any changes reflected in cycle 2 of the DWMP.

Before the end of AMP7, we will also have increased the storm tank capacity at 50 of our larger wastewater treatment works. This will mean that we will be able to store an average of 29% more stormwater on these sites, instead of it being discharged to the environment in heavy rainfall.

In AMP7 we installed 58 solar-powered cameras on key storm overflow locations with a focus on the river Wharfe. This trial was part of our Dynamic Asset Maintenance transformation programme. These cameras allowed us to quickly assess the performance of our assets and mobilise our response more effectively and support the telemetry information we already receive from these assets. However, the decision has been made not to go ahead with scaling up this pilot to the wider business. Throughout the pilot, the cameras encountered a lot more wear and tear from flooding and vandalism than we anticipated. The attrition rate was higher than anticipated meaning this option is no longer viable. We still have the 17 cameras installed at 'active' sites which will be left in place and will continue to be used to enhance our operational response.

3.3 The Environment Act, Storm Overflow Discharge Reduction Plan & WINEP

The sewer system was constructed over the past century. Since then, increased rainfall, climate change, population growth and urban creep has put real pressure on sewer capacity. Society's expectations of the environment have also changed. A combination of these factors means that the future of combined sewer systems and the operation of associated storm overflows needs to be adapted to meet existing social expectations.

A Defra taskforce was established on storm overflows in August 2020 and the Environment Act 2021 contains new duties on government and water companies to "secure a progressive reduction in the adverse impact of discharges from storm overflows".

The government published a consultation on the Storm Overflow Discharge Reduction Plan[2] at the end of March 2022 and following the consultation period the government published its final Storm Overflow Discharge Reduction plan[3] on the 26 August 2022. The Environment Act means that the targets set out in the SODRP are legally binding and will require Water Companies to deliver the largest infrastructure programme in water company history.

The SODRP aggregates the requirements into three target areas:

1. Protecting the environment:

Headline target: Water companies will only be permitted to discharge from a storm overflow where they can demonstrate that there is no local adverse ecological impact. Sub-targets:

The headline target must be achieved for most (at least 75%) of storm overflows discharging in or close to high priority sites (as defined in Annex 1) by 2035. It must be achieved for all (100%) storm overflows discharging in or close to high priority sites by 2045. Water companies must achieve this target for all remaining storm overflows sites by 2050.

Annex 1 - Defining 'High Priority' sites: High priority sites include Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SAC), Urban Wastewater Treatment Regulations sensitive areas, chalk streams and waters currently failing our ecological standards due to storm overflows.

2. Protecting public health in designated bathing waters

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[2] https://consult.defra.gov.uk/water-industry/storm-overflows-discharge-reduction-plan/

[3] https://www.gov.uk/government/publications/storm-overflows-discharge-reduction-plan

Headline Target: Water companies must significantly reduce harmful pathogens from storm overflows discharging into and near designated bathing waters, by either: applying disinfection; or reducing the frequency of discharges to meet Environment Agency spill standards by 2035.

3. Ensuring storm overflows operate only in unusually heavy rainfall events

Headline Target: Storm overflows will not be permitted to discharge above an average of 10 rainfall events per year by 2050.

Screening Requirements for storm overflows water companies will be required to ensure all storm overflows have screening controls.

The report also contains the below requirements for water companies:

1. Water companies must comply with all their existing regulatory obligations and duties, including permits issued by the Environment Agency.
2. The Government expects water companies to have maps of their sewer networks and understand where properties with separate rainwater pipes are connected to their combined sewer network.
3. Water companies will clearly set out how they will meet their storm overflow targets in their Drainage and Wastewater Management Plans.
4. In developing the best solutions, water companies should base their decisions on robust evidence and explore ways in which they can maximise wider benefits where solutions can address multiple issues, delivering best value for people and the environment
5. We expect water companies to achieve year on year reductions in the amount of surface water that is connected to their combined sewer network.
6. We expect water companies to prioritise a natural capital approach, considering carbon reduction and biodiversity net gain, as well as catchment level and nature-based solutions in their planning.
7. We expect water companies to consider treatment of sewage discharges as an alternative solution where appropriate.

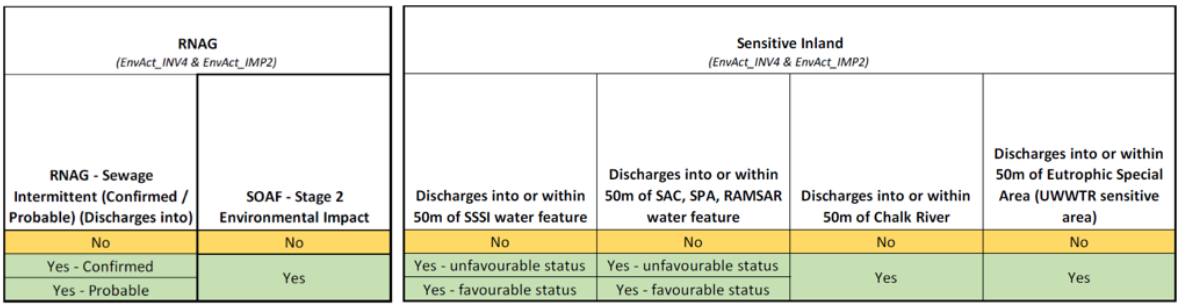
The details for each target area were published by the EA in the WINEP driver guidance in 2022 and is summarised below in Table 2. Additional clarity within the WINEP driver guidance states:

- 12/24 hour counting shall be applied for all spills – no discounting spills
- bathing waters discharge direct or less than 1km upstream in hydraulic continuity
- 6mm screen 1 in 5-year spill flow rate

We do not have any designated shellfish waters in the Yorkshire region, so these drivers have not been included in the summary.

A priority site is defined and agreed with the EA in line with the below guidance in Figure 7:

Figure 7: Priority site definition

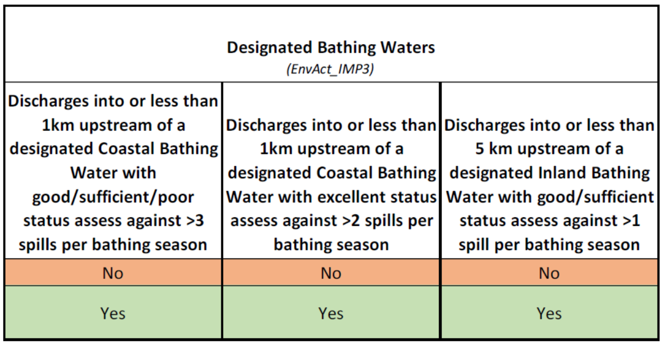


RNAG *(EnvAct_INV4 & EnvAct_IMP2)*		Sensitive Inland *(EnvAct_INV4 & EnvAct_IMP2)*			
RNAG - Sewage Intermittent (Confirmed / Probable) (Discharges into)	SOAF - Stage 2 Environmental Impact	Discharges into or within 50m of SSSI water feature	Discharges into or within 50m of SAC, SPA, RAMSAR water feature	Discharges into or within 50m of Chalk River	Discharges into or within 50m of Eutrophic Special Area (UWWTR sensitive area)
No	No	No	No	No	No
Yes - Confirmed	Yes	Yes - unfavourable status	Yes - unfavourable status	Yes	Yes
Yes - Probable		Yes - favourable status	Yes - favourable status		

Source: PR24 WINEP driver guidance – storm overflow reductions

The driver guidance sets out the definitions relating to inland and coastal designated bathing sites seen in Figure 8. We have one designated inland bathing site at Ilkley, and two proposed inland bathing sites where designations have been sought, see Section 3.5.

Figure 8: Bathing waters classification for storm overflows



Designated Bathing Waters *(EnvAct_IMP3)*		
Discharges into or less than 1km upstream of a designated Coastal Bathing Water with good/sufficient/poor status assess against >3 spills per bathing season	Discharges into or less than 1km upstream of a designated Coastal Bathing Water with excellent status assess against >2 spills per bathing season	Discharges into or less than 5 km upstream of a designated Inland Bathing Water with good/sufficient status assess against >1 spill per bathing season
No	No	No
Yes	Yes	Yes

Source: PR24 WINEP driver guidance – storm overflow reductions

Table 2: PR24 WINEP Driver Guidance Storm Overflow Reductions & Environment Act Continuous Water Quality Monitoring

Driver	Description	Obligation Date
EnvAct_INV4	Investigations to reduce storm overflow spills to protect the Environment so that they have no local adverse ecological impact	Investigations into storm overflows that will have an EnvAct_IMP2 scheme in PR24 or PR29. Investigations to inform PR24 EnvAct_IMP2 schemes should be completed by 30 April 2027. Other investigations should conclude by 30 April 2027.
EnvAct_IMP2	Improvements to reduce storm overflows spills to protect the Environment so that they have no local adverse ecological impact.	WaSCs (Water and Sewerage Companies) should include this driver for PR24 as early contribution to building their programme to achieve the Defra consulted target dates to achieve no local adverse ecological impact of: • 75%+ storm overflows discharging in or close to high priority sites by 2035. • 100% overflows discharging in or close to high priority sites by 2045. • all remaining storm overflow sites by 2050.

Table 2: PR24 WINEP Driver Guidance Storm Overflow Reductions & Environment Act Continuous Water Quality Monitoring

EnvAct_IMP3	Improvements to reduce storm overflows that spill to designated bathing waters to protect public health.	WaSCs should profile this driver over PR24 and PR29 and include this driver for PR24 at their own discretion as early contribution to building their programme to achieve the Defra consulted target date of 2035. Newly designated, bathing waters at poor status and storm overflows previously improved but not meeting current design objectives should be prioritised for PR24 at WaSC discretion.
EnvAct_IMP4	Improvements to reduce storm overflows spills so that they do not discharge above an average of 10 rainfall events per year by 2050.	WaSCs should include this driver for PR24 to achieve the target of at least: ● 38% of high priority storm overflows by 2030 and ● 14% of the total stock of their storm overflows by 2030
EnvAct_IMP5	Improvements to reduce storm overflow aesthetic impacts by installation of screens.	WaSCs should include this driver for PR24 where the storm overflow qualifies and has another improvement driver assigned for PR24.
EnvAct_INV1	Estuarine: Investigation/pilots to assess site suitability for continuous water quality monitoring of the receiving environment to assess any impact from storm overflows and wastewater treatment works discharge outlets. To include assessment of appropriate siting and monitoring parameters.	All Sites: 30 April 2027 Investigations/pilots at High Priority Sites to inform PR24 EnvAct_MON1 schemes should be delivered early in the PR24 timeframe as installation will be required by 31 March 2030 Investigations/pilots at non-high priority site must conclude by 30 April 2027 to inform PR29 planning
EnvAct_MON1	Estuarine: Installation of continuous water quality monitoring of the receiving environment to assess any impact from storm overflows and wastewater treatment works discharge outlets. To include ability to assess ecological harm.	High Priority Sites: 31 March 2030 Installation should be phased over the period 2025-2030 All other sites: 31 March 2035 Installation should be phased over the period 2030-2035
EnvAct_INV2	Inland complex: Investigation/pilots to assess site suitability for continuous water quality monitoring of the receiving environment to assess any impact from storm overflows and wastewater treatment works discharge outlets. To include assessment of appropriate siting and monitoring parameters.	All sites: 30 April 2027 Investigations at both high priority and non-high priority sites must conclude by 30 April 2027 to inform PR29 planning

Table 2: PR24 WINEP Driver Guidance Storm Overflow Reductions & Environment Act Continuous Water Quality Monitoring

EnvAct_MON2	Inland complex: Installation of continuous water quality monitoring of the receiving environment to assess any impact from storm overflows and wastewater treatment works discharge outlets. To include ability to assess ecological harm.	31 March 2035
EnvAct_INV3	Coastal: Investigation/pilots to assess site suitability for continuous water quality monitoring of the receiving environment to assess any impact from storm overflows and wastewater treatment works discharge outlets. To include assessment of appropriate siting and monitoring parameters.	All sites: 30 April 2027 Investigations at both high priority and non-high priority site must conclude by 30 April 2027 to inform PR29 planning
EnvAct_MON3	Coastal: Installation of continuous water quality monitoring of the receiving environment to assess any impact from storm overflows and wastewater treatment works discharge outlets. To include ability to assess ecological harm.	31 March 2035
EnvAct_MON4	Inland watercourses: Installation of continuous water quality monitoring of the receiving watercourse upstream and downstream of storm overflows and wastewater treatment works discharge outlets. To include ability to assess ecological harm.	High Priority Sites: 31 March 2030 Installation should be phased over the period 2025-2030 All other sites: 31 March 2035 Installation should be phased over the period 2030-2035
EnvAct_MON5	Develop and implement the ability to publish continuous water quality monitoring data in near-real time in a standardised format	31 March 2027

Source: PR24 WINEP driver guidance- Environment Act Continuous Water Quality Monitoring

There is currently no confirmed definition of the requirements of EnvAct_MON2, 3 & 4 and no clear process by which to establish no local adverse ecological harm impact or the investigations process required to define this. We have not published any costings in the final DWMP or associated data tables relating to the delivery of no local adverse ecological harm impact. This will be updated in cycle 2 for DWMP29 to be published in 2027. We have included within the final DWMP24 lump sum costs relating to EnvAct_Inv4 to inform EnvAct_Imp2 for AMP9 and beyond and also lump sum costs for EnvAct_Mon1-5 and associated investigations.

3.4 DWMP and storm overflows: Investment PR24 and beyond

A healthy and resilient natural environment is vital if we are to address the biodiversity crisis (Dasgupta review 2021[4]) and mitigate the impacts of climate change. It is widely acknowledged that giving people the opportunity to enjoy time outdoors in the natural environment has significant benefits for health and wellbeing.

We recognise that as a water company, we have a key part to play in helping to improve river water quality for people and wildlife. At YW we are working towards delivering 'A thriving Yorkshire. Right for customers. Right for the environment.' And we share the government's ambition for a significant reduction in the use of storm overflows. We recognise that achieving the step change in storm overflow performance that is required will not be easy. We are committed to playing our part but recognise that river health is not solely the responsibility of water companies, with other sectors such as agriculture and transport having a significant role to play.

DWMP24 has required significant hydraulic modelling undertaken within the 5-year DWMP cycle. 91% of our priority storm overflows are located within our promote catchments, discussed in Section 10.5. 85% of all our storm overflow assets are within our promote catchments. For draft, we costed improvements based only on those storm overflows within catchments triggering through to the BRAVA stage following RBCS. Based on the new SODRP and our consultation feedback, our approach has been to include costs and solutions for all storm overflow assets within the final DWMP24. Where we have a model, we have used this to provide a notional solution and cost, and where we do not have models that cover an overflow we have used an extrapolated cost. We cover this in more detail in Sections 10.7 and 11.

The SODRP sets out clear milestones to achieve improvements and meet targets for the priority overflows and the non-priority overflow asset base. These are detailed in Table 3 below. We have set out our plan to meet these requirements. Our WINEP submission for AMP8 covers 211 storm overflow assets for investment and is predominately made up of priority and inland and coastal bathing overflows. We are investing in assets impacting the inland bathing water at Ilkley and focusing investment on two proposed bathing water designations at Wetherby & Knaresborough. In our WINEP24 submission to the EA, we included interventions to meet the inland bathing water requirements for storm overflows at these locations. This will be reviewed in line with WINEP24 final agreements with the EA. remains subject to finalisation and confirmation by the EA.

Table 3:Storm overflow discharge reduction plan targets

AMP	AMP8	AMP9	AMP10	AMP11	AMP12
Year	2030	2035	2040	2045	2050
% of high priority site storm overflows improved	38%	75%	87%	100%	100%
% of bathing water sites improved		100%			
% of total storm overflows improved	14%	28%	52%	76%	100%

Source: https://www.gov.uk/government/publications/storm-overflows-discharge-reduction-plan

We have set out our long-term plan to meet these requirements. Our short-term plan, WINEP submission for AMP8, for the regulatory period 2025-2030 is detailed above. Our medium-term AMP9 investment plan for the regulatory period 2030-2035, focuses on any remaining coastal bathing assets and high priority sites and we will be looking to incorporate the outcomes of the no local ecological harm investigations into this plan in cycle 2. Our longer-term plan across AMPs10-12

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[4] https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

for the regulatory periods spanning 2035-2050 is to complete the priority sites and address all assets requiring intervention: That is to meet the requirements and installation of screens to ensure all assets have a compliant screen by 2050. This plan is also reflected in the Ofwat LTDS (Long Term Delivery Strategy) data tables that will accompany the PR24 business plan submission. We will work to enhance our SODRP in future AMPs and through future cycles of the DWMP as we build on learnings from delivering blue-green interventions and continue to grow and embed our partnerships, to allow optimal delivery of the plan. We have added a company ambition to our overflow delivery plan: We will aim to achieve 20% of our AMP8 overflows delivered with a blue-green infrastructure components to the solution. This increases in AMP9 and subsequent AMPs to 50% of solutions delivered with a blue-green infrastructure components to the solution each AMP. See Section 3.4.1 below, which describes how we are monitoring our surface water removal and some case studies on blue-green approaches.

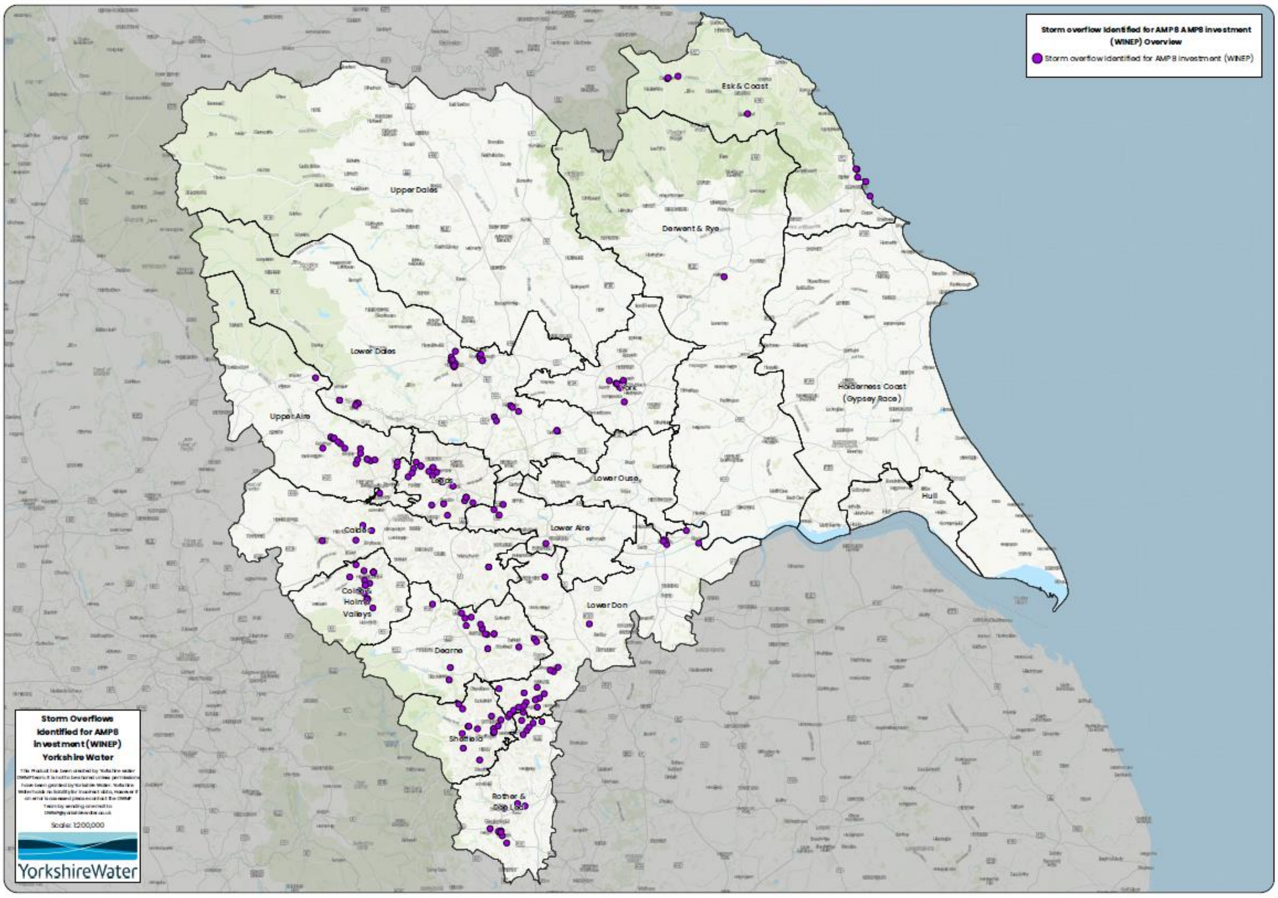
Two different delivery scenarios have been developed for implementing improvements to storm overflows in the DWMP24:

- **Reduce + Enhance:** Adopt blue-green solutions to manage and reduce the amount of rainfall entering our network to reduce our levels of risk (e.g., through the use of blue-green infrastructure and nature-based solutions or Sustainable Drainage Systems (SuDS) which look to manage flow in a cost-effective way whilst benefitting the environment and surrounding communities), then utilise traditional grey infrastructure solutions to meet the target if necessary.
- **Enhance:** Increase the capacity of our network through traditional 'grey' solutions, i.e., building bigger pipes, storage tanks and upgrading our existing assets.

See Section 4.4 and Section 10.7.3.4 for details on Level 4 storm overflows and approach to solution development.

Our submission for WINEP EnvAct drivers for AMP8 consists of an £800 million programme tackling 211 storm overflows across the region, as seen in Figure 9 below. These are predominately high priority sites as defined by the EA, alongside a number of proposed and actual inland and coastal bathing assets. Our AMP8 investigation for the EnvAct_INV4 driver will target 691 storm overflow assets: These are investigations to reduce storm overflow spills to protect the environment so that they have no local adverse ecological impact. These are predominantly on high priority sites, to allow for AMP9 and beyond scheme definition on number of spills per overflow to achieve the no local ecological harm targets. Costs submitted for EnvAct_INV4 investigations are forecast £73 million for AMP8. Costs for storm overflow monitor installations, EnvAct_Mon1-4 are forecast £391 million split over AMP8 and AMP9 for delivery. These costs remain subject to change, pending finalised methodologies and guidance for these components.

Figure 9: AMP8 WINEP storm overflow plan



3.4.1 Surface water management and blue-green solutions

In AMP7, YW set up a bespoke Surface Water Management performance commitment. The purpose of this was to incentivise and encourage implementation of a greater number of blue-green solutions by reporting the number of hectares of surface water run-off removed or reduced from the public sewer network due to blue-green infrastructure or surface water disconnections. Surface water management has multiple benefits, for our customers, the environment and for our own operations. As well as improvements to capacity-related service performance such as flooding and pollution, there are also social and human benefits: This includes adopting of natural capital interventions, such as improving amenity values, property prices, biodiversity, health, wellbeing and recreation, as well as financial capital benefits to us in terms of the avoided energy (and associated carbon) use. This performance commitment aims to make use of natural capital to increase social capital by creating better places to live, work and visit.

The performance commitment refers to three intervention types:

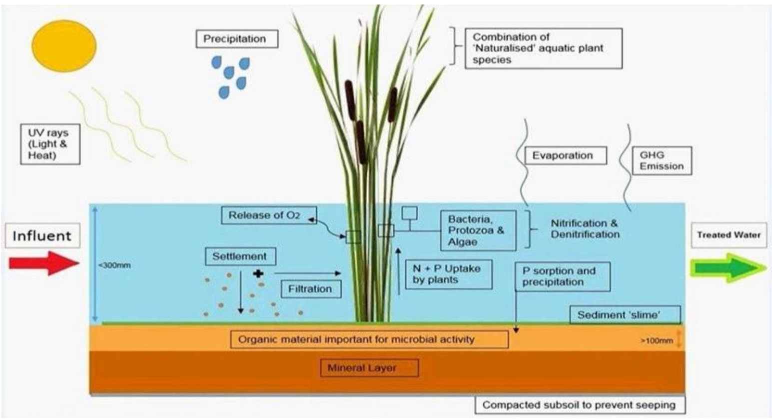
- blue-green infrastructure (natural capital) options to mimic the natural water cycle
- blue-green infrastructure to slow the flow of surface water into our network to maximise the capacity of our network during storms
- disconnection uses underground pipes (manufactured capital) to take surface water straight to receiving water courses.

Living with Water (LWW) in Hull and East Riding, is our flagship blue-green partnership, as described in Section 5.2.1 and in Appendix 1.2. The aim of the LWW blue-green plan for Hull is to remove surface water from the sewer network using blue-green solutions. This Performance Commitment will not exist in AMP8, but we will seek to report and track our blue-green interventions and ensure we are complying with our company ambition to deliver blue-green solutions.

Below are two examples of how we are utilising blue-green solutions to deliver outcomes relating to storm overflows and WwTW compliance issues and shows our commitment to deliver blue-green solutions, take on learnings and deliver more blue-green solutions like this over the coming AMPs.

We have undertaken a wetland full scale trial at our WwTW in Clifton, see Figure 11 below. Clifton is a small descriptive wastewater treatment site with a population equivalent of 180. The site was part of the PR19 water framework directive (WFD) driver to deliver a 4mg/l phosphorus target. This forms the first OTA (Operational Technical Agreement) to be developed with the EA and allows performance of the wetland to be monitored and managed until 2028. It's the first integrated constructed wetland (conceptual diagram as seen below in Figure 10) to be constructed and is seeing good levels of P removal. As a proof-of-concept solution, these positive results are promising for the future of similar solutions elsewhere in the region. The site has over 24,000 plants of 25 different species, which cover 3000m^2 of constructed wetland, made up of five ponds.

Figure 10: Integrated constructed wetland



Source: Via YW

Figure 11: Clifton wetland

Roundhay Park Lane CSO, in Leeds, has had a surface water separation and SuDS scheme constructed in AMP7. This was to deal with a river water quality issue identified from a UPM (Urban Pollution Management) study. Modelling revealed that the existing sewer had some capacity headroom. This was maximised as part of the scheme, with a new throttle installed to hold flows back and reduce spills from the CSO in smaller, more frequent events. Infiltration strip SuDS and highways water separation were also constructed, to ensure flood risk was not increased from the sewer system. Compensatory flood defences were constructed along the receiving watercourse to ensure that flood risk did not increase from the stream. The street with the planted SuDS, seen below in Figure 12 saw an increase in green permeable area and local people have an increased amenity from the planting schemes. Local wildlife also benefited from the creation of this new habitat.

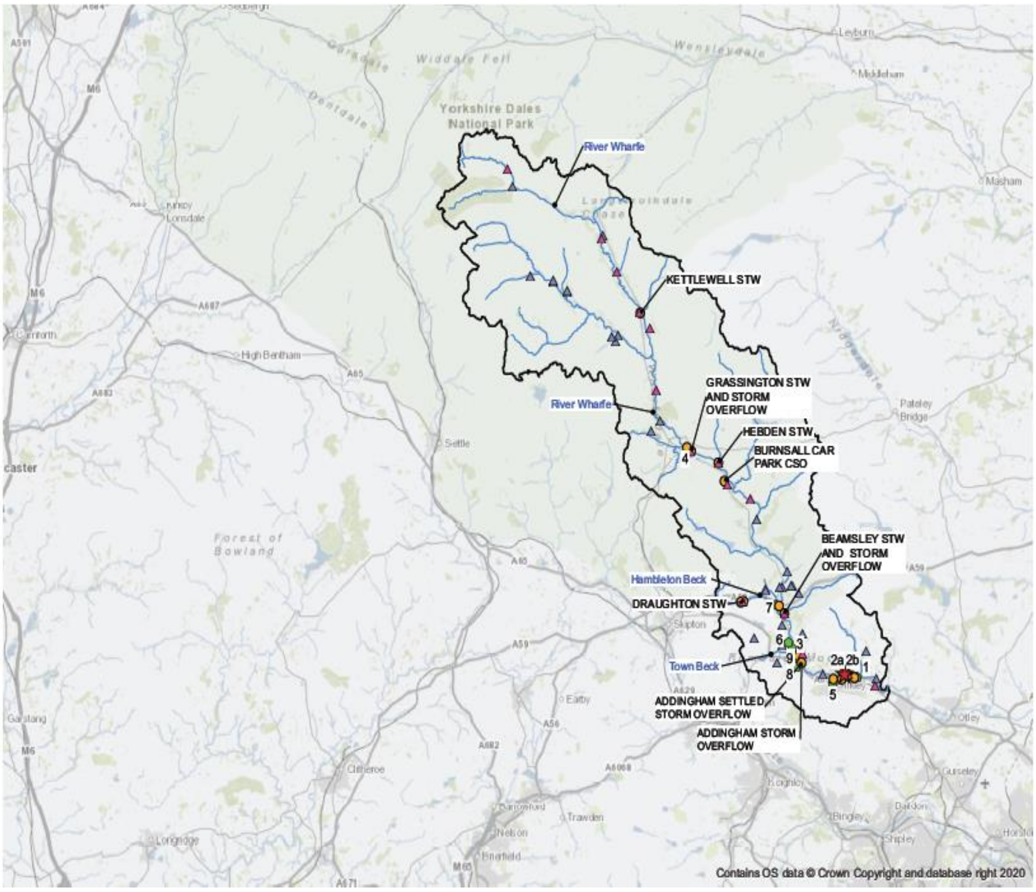
Figure 12: Rain gardens at Roundhay

3.5 Ilkley Inland Bathing Water

The river Wharfe in Ilkley became the UK's first riverine bathing water in December 2020. The river was designated, 'Wharfe at Cromwheel, Ilkley' with a sample point located upstream of Ilkley WwTW. The upstream catchment, starting in the Yorkshire Dales National Park is predominantly rural with several smaller settlements. There are 12 public WwTWs and 16 storm overflows within the upstream catchment. Images below show the bathing water location and assets, Figure 13, Figure 14 and Figure 15.

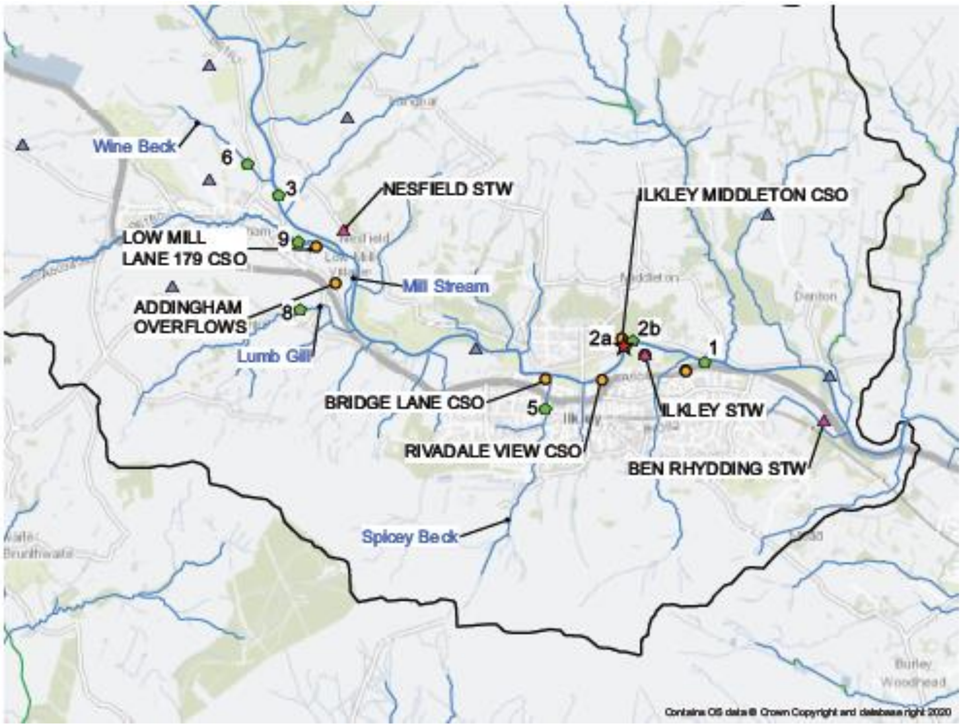
Figure 13: Ilkley inland bathing beach

Figure 14: YW assets on the river Wharfe



Source: Ilkley Bathing Water Public Report Stantec April 2022

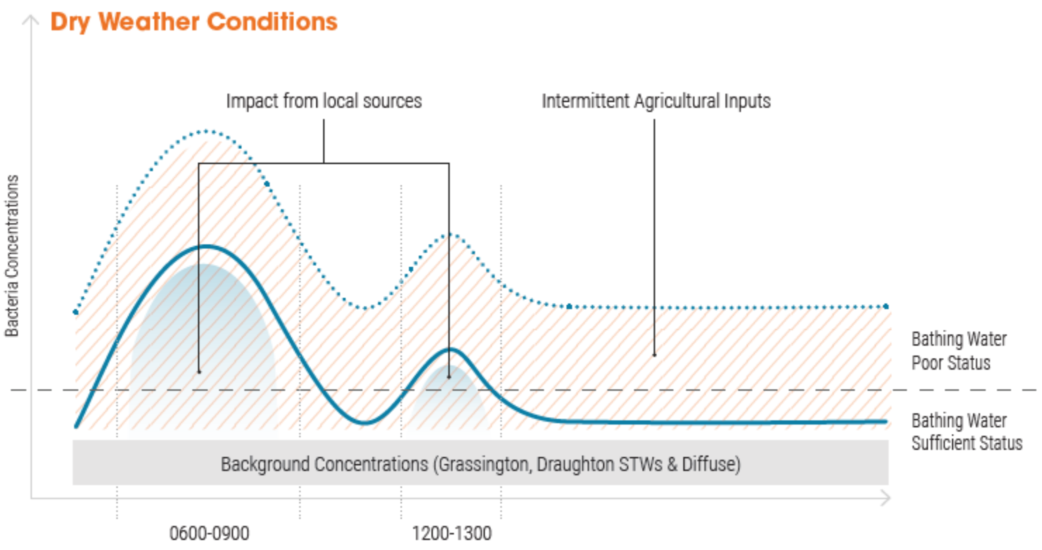
Figure 15: YW assets around Ilkley bathing beach



Source: Ilkley Bathing Water Public Report Stantec April 2022

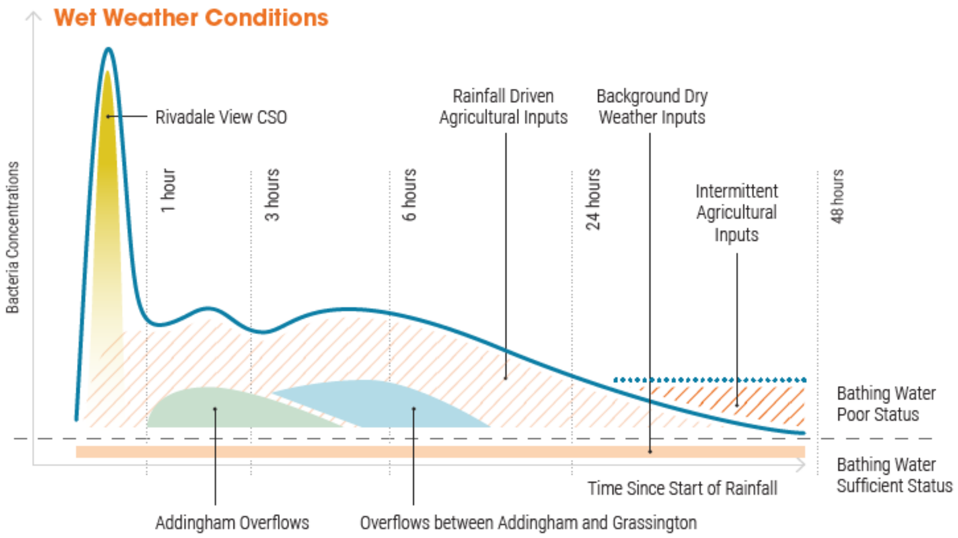
Following designation, in the 2021 bathing water season we began an interim digital modelling study to understand the impact from our assets on the bathing water quality. The model uses bacteria sample data, rainfall, river velocity data and continuous river water quality data to understand the baseline bathing water quality. The study found a level of background bacteria in the river Wharfe, which can in part be attributed to upstream wastewater treatment works as well as diffuse sources including agriculture. During wetter weather, an immediate peak in the bacteria was identified which could be attributed to storm overflows within the vicinity. This is followed by a further prolonged period of poorer bathing water quality as both upstream storm overflows and diffuse sources in the upper catchment travel down the catchment. This can be seen in Figure 16 and Figure 17 below.

Figure 16: Conceptual model of issues at Ilkley bathing waters in dry weather



Source – Stantec/YW report – Ilkley bathing water public report April 2022

Figure 17: conceptual model of issues at Ilkley bathing waters in wet weather



Source – Stantec/YW report – Ilkley bathing water public report April 2022

Since its designation, the 'Wharfe at Cromwheel, Ilkley' has been classified as 'Poor' following both the 2021 and 2022 bathing water season. We have commenced work in the catchment to invest up to £13 million including:

- Misconnection surveys within the immediate catchment to identify where foul drainage connections may have been connected to surface water assets which drain to the river.
- Upgrading the screen at Rivadale View storm overflow to reduce the impact of aesthetics on the bathing water Figure 18.
- Working in partnership with the Environment Agency and Yorkshire Dales Rivers Trust (YDRT) on the iWharfe project to increase engagement within the catchment, focussed on increasing catchment understanding and engaging with agriculture, carrying out walkovers to identify areas on the Wharfe for future management and engaging with farmers and landowners to help improve water quality.
- Significant infrastructure work to create a transfer sewer to reduce the number and volume of discharges from Rivadale View storm overflow using trenchless technologies to minimise disruption to the local community.
- Upstream disinfection at three WWTWs upstream of Ilkley on the river Wharfe.

Figure 18: Upgraded screens and panel at Rivadale View Storm Overflow

We have included within our WINEP and PR24 submissions investigations and improvements to continue to improve the water quality on the river Wharfe. Delivery of these interventions will be subject to finalisation of the WINEP24 programme with the EA.

3.5.1 Future inland bathing designations - Knaresborough & Wetherby/Boston Spa

As part of our WINEP submission we have included work to bring assets in and around a number of potential new inland bathing water designations up to SODRP targets. Whilst these do not have a formal designation, they have active campaigns to achieve a bathing water designation. Learning from Ilkley that has highlighted that from a stakeholder's perspective, the 5-year cycles in which the water industry operates are too slow. For this reason, we have included the requirements for active potential designations in our WINEP24 proposals. These remain subject to agreement with the EA. A suitable mechanism will be included in our PR24 business plan submission to protect customers from paying for activity that would not be required if future inland designations do not occur at these locations. Equally, we would look to Ofwat to agree a funding mechanism in AMP8, should any additional inland designations be made beyond these two identified locations, so that investment is not delayed until WINEP29.

We will monitor and work with other groups and organisations who are looking to promote inland bathing waters within the Yorkshire region to continue to promote funding and to prioritise these overflows in our overall plan.

4. Planning areas

4.1 Level 1: Yorkshire

Our Level 1 area represents our overarching plan for Yorkshire based on our wastewater boundary as shown in Figure 19. Level 1 is our high-level strategic output and outlines our approach to maintaining and improving a resilient wastewater system for Yorkshire. Our operational boundaries are different for DWMP and WRMP as they are based on different networks and billing areas. Additionally, we have some cross over with Northumbrian, United Utilities and Severn Trent where customers may receive a bill for wastewater services from one provider and a drinking water bill from another.

Figure 19: Level 1 Yorkshire Wastewater Boundary

Yorkshire is a beautiful and diverse region, comprising of small rural villages through to large urban and industrial areas. All with varying topographies and weather systems, from wet and windy along the Pennines in the west of the region to flat lowland coastal plains in the east. We have a mixture of house types with a tendency towards cellared properties. The type of drainage system within each area depends on the age and location of the sewer and the style of housing it was installed to drain resulting in a sewer network that is a mixture of foul water, surface water or combined systems.

Many of Yorkshire's towns and cities are built on rivers which have been historically straightened, diverted, or canalised to harness the power of water for use in the mills, or culverted to allow the expansion of the urban area or to conceal the polluted waterway. The river Sheaf for example, runs unseen beneath much of Sheffield. After significant investment and supporting legislation in recent years, our rivers are cleaner than they have ever been since the industrial revolution. This has enabled keystone species such as otters to return to our region and salmon to inhabit the rivers of our former industrial towns such as salmon now being present within the river Sheaf in Sheffield. And in response to increased national interest in safeguarding our rivers and coasts, the water industry will see its biggest environmental programme in AMP8. This will help to contribute towards a step change in river health, alongside any action by other key stakeholders in the environment.

In some places there are entire watercourses still connected into our wastewater network along with land drainage, industrial effluent and sewage flows from homes and businesses. Our network also varies in age, size, condition, and material. We have Roman sewers beneath York, Victorian redbrick tunnels serving Bradford, and modern plastic pipes serving new housing developments. The average age of our network is around 80 years old, and we spend £30-40 million every year to keep our 52,000km of sewers and over 2000 wastewater pumping stations working as they should.

Managing our sewer network is a complex task.

- The sewer network is not like the sealed, pressurised, pumped, drinking water distribution network which can be managed more easily.
- The Yorkshire sewer network (like much of the UK) is largely a gravity network with minimal pumping network.
- The sewer network is often misused and impacted by people flushing wipes, fats, oils, and greases down the drain which can cause blockages and restrictions in pipe capacity, increasing the risk of flooding.
- Rain easily enters the sewer network through drains from roofs, roads, and other impermeable surfaces. The network has historically been designed to cope with day-to-day rainfall events up to a 1 in 30-year event to protect properties from flooding (3.33% annual probability). The sewers are not designed for any more intense rainfall beyond this probability.

During periods of heavy rainfall, storm overflows on the network allow excess rainfall to discharge to watercourses to prevent the sewers from backing up and flooding homes and businesses. This approach to sewer network design has historically allowed us to balance the risks of flooding properties with discharging diluted storm flows to the environment. In addition, the mix of geology and soil types seen across Yorkshire means that there is little natural infiltration of surface water, so it has also historically drained to the sewer network.

However, a combination of increased rainfall linked to climate change, urban creep, population growth, and changing public expectations around the acceptability of storm overflows means that we need to design, operate, and manage our sewer network differently. This is so that it can continue to function effectively in the face of these challenges.

Our DWMP is a significant step forward in how we manage our network and meet these challenges. It attempts to model our existing mixture of housing stock, sewer type, and flows and predict how it will perform in the future given the impacts of additional housing development and a changing climate.

The county of Yorkshire is very diverse from an environmental perspective, and this is highlighted in Table 4 below. We have a vast array of critical areas that need environmental protection.

Table 4: Biodiversity in Yorkshire

RAMSAR sites (Wetlands)	3 intersect
Special Areas of Conservation (SAC)	20
Special Protection Areas (Birds) (SPA)	10
Sites of Special Scientific Interest (SSSI)	327
National Nature Reserves (NNR)	9 and 1 intersects
Marine Conservation Zone (MCZ)	2
Areas of Outstanding Natural Beauty (AONB)	3 and 1 under designation
National Character Areas (NCA)	21

4.1.1 Biodiversity

Biodiversity is the variety of life, be that plants, animals, fungi or micro-organisms, as well as the communities they form and the habitats in which they live. It is essential for people, providing vital services like clean water, carbon storage, underpinning our health and wellbeing and for the intrinsic value of species like salmon or kingfisher. Yorkshire Water relies on thriving, biodiverse catchments to allow us to provide our core services. As a business, we rely on functioning natural ecosystems to provide the services we deliver to our customers.

Ecosystems with high biodiversity can more efficiently recycle water, oxygen and carbon and contain a thriving community of species. Enhancing biodiversity, for example by creating farmland buffer strips along watercourses, can protect our raw water resources and boost resilience to flooding. For more information on biodiversity policy please see the below link to information on our website. **https://www.yorkshirewater.com/environment/biodiversity/**

During AMP7 we have worked closely with our conservation partners to identify how best we can play our part in reversing species decline in Yorkshire and restoring and protecting key habitats. Through consultation with our external Biodiversity Advisory Group (BAG), we identified that the most efficient use of our biodiversity funding would be to help provide long term core staff time to Rivers and Wildlife Trusts across the region, to allow them to collect evidence, plan strategies and write bids to bring in funding far in excess of our own contributions. Currently we are funding roles such as fisheries officers, biosecurity officers, invasive species Local Action Group convenors, agricultural officers, catchment partnership officers and a crayfish officer. This has, to date, unlocked around £5 million in external funding, as well as resulted in widespread citizen science surveys of our rivers, volunteer engagement, habitat creation, data sharing, joint strategic planning and data, all feeding into our PR24 submission. Our PR24 plan specifically includes increased levels of support to our catchment partnerships, as well as additional monitoring and resource support to help Local Authorities develop Local Nature Recovery Strategies, together with large scale wetland creation, species conservation, fish passage and river restoration programmes.

In AMP8 and beyond we have an incredible opportunity to benefit biodiversity in Yorkshire, with a combination of land management, nature-based solutions, a new OFWAT Common Industry Biodiversity Performance Commitment and a proposed £27 million WINEP conservation programme being our largest ever investment in biodiversity. Yorkshire Water has worked closely with our external BAG to co-create this programme.

As an example, one small element of our PR24 conservation submission includes a commitment to maintain the excellent native plant nursery at Nosterfield nature reserve run by the Lower Ure Conservation Trust. They have rescued wetland plants from across North Yorkshire that regionally have almost become extinct. And work with horticulturalists to identify effective propagation techniques, before growing these on and providing them and design advice to Non-Governmental Organisational (NGO) groups across the region. This also helps ensure our own NBS wetland can include regionally distinct and rare plants. Another element is to include actions such as our support to Yorkshire Wildlife Trust sites such as Wheldrake Ings SSSI on the Derwent, neighbouring our Elvington river abstraction. Here, we have already helped them purchase Nofence grazing collars to improve their management regime and also conduct appropriate habitat management to preserve the site. Both actions help develop a more sustainable outcome for biodiversity as well as having direct links to helping us mitigate the impact of our abstractions and improve water quality of our wetlands and rivers.

At a strategic level, when considering solution options, we have incorporated biodiversity within our decision making through our 6 capitals investment models, which provide positive natural capital values for the change in outcomes provided by nature-based solutions. Biodiversity Net Gain (BNG) will be calculated at project level within the subsequent design and delivery stages of our processes and becomes a material factor in our option design cost benefit assessments. Our plan has considered BNG within the SEA where it is noted that our two principal options provide the potential for BNG during reinstatement for any traditional grey infrastructure, and the potential for long-term positive effects on biodiversity within blue-green infrastructure. Fundamentally, it is already difficult to achieve 10% BNG on our projects due to the constraints of creating meaningful ecological outcomes on our typical treatment sites. As such we are already working on our rural estate and with Local Authority and NGO partners, to offset these impacts through the creation of biodiversity credits.

4.1.2 Groundwater

Groundwater plays an intrinsic role within the water cycle and contributes significantly to drinking water sources, streams, rivers and wetlands. All groundwater is legally protected under the Environmental Permitting Regulations 2016. Wastewater has the potential to impact on groundwater quality, particularly where groundwater is vulnerable to pollution. Within our Drainage and

Wastewater Management Plan we have included narrative relating to risks to groundwater to ensure we are making every effort to minimise polluting impacts on groundwater resources, habitats and the wider environment.

Scenarios particularly vulnerable to groundwater pollution and that are high priority in terms of groundwater protection for maintenance and improvements include:

- Protected zones
- Discharges/sewerage infrastructure near ephemeral streams
- Storm overflows to ground or dry ditches.
- Sewerage infrastructure below groundwater level (i.e. water table).

4.1.2.1 Protected zones

All groundwater abstracted for potable use is protected by groundwater Source Protection Zones (SPZ) defined by the Environment Agency. SPZ1 is closest to the abstraction point and is the zone of greatest risk from discharges to groundwater.

Where new developments are proposed within a SPZ1 for our groundwater sources we are consulted when planning permission is applied for. We provide comments to the local authority to protect groundwater and the source from the development and may engage with the Environment Agency to ensure developers properly mitigate the risk.

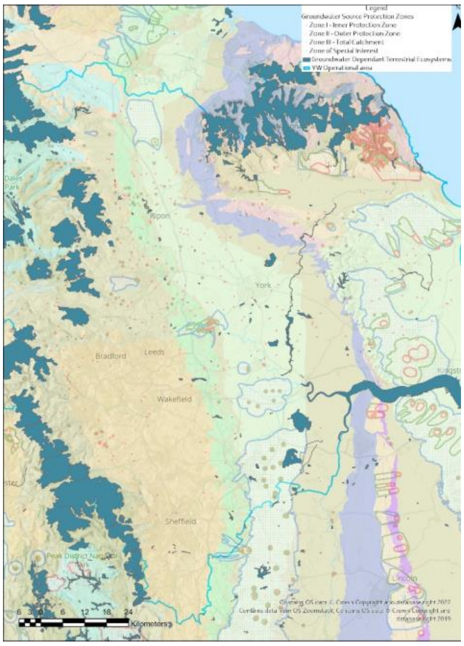
Where development is to proceed in an SPZ1 then we ask for all new sewerage systems on the developments are double lined to prevent leaks and prevent groundwater ingress into the sewer network. We promote the use of SuDS for surface water disposal and acknowledge this requires careful management to prevent pollution. A SuDS management train is critical for managing discharge quality with the use of swales, basins and shallow infiltration systems providing mechanisms for pollution attenuation. We do not recommend a discharge from a pipe direct to soakaway or using a deep soakaway that significantly shortens the path from surface to groundwater. These are not acceptable in areas where groundwater is used for potable supplies, especially for public water supplies.

Safeguard Zones (SgZ) are defined by the Environment Agency where a source is at particular risk from one or more pollutants. Investigations are carried out when a SgZ is defined and the contribution of the wastewater network to the risk is assessed. If the network is a significant factor then recommendations will be made to manage the risk.

Another potential area at risk from sewage discharges are groundwater dependant terrestrial ecosystem (GWDTE), and also Special Areas of Conservation (SAC) and Special Protection Area (SPA), and Sites of Special Scientific Interest (SSSI). Most GWDTEs are in areas of low population density and so the risk from sewerage is low. If impacts are detected, we would work with the relevant authorities to manage the risks. At this time, we have not been made aware of any SSSI, SACs or SPAs effected by sewage infrastructure.

These areas can be seen in the map below, Figure 20.

Figure 20 :Geology map of Yorkshire showing distribution of Source Protection Zones, and Groundwater Dependent Terrestrial Ecosystems that are SSSIs

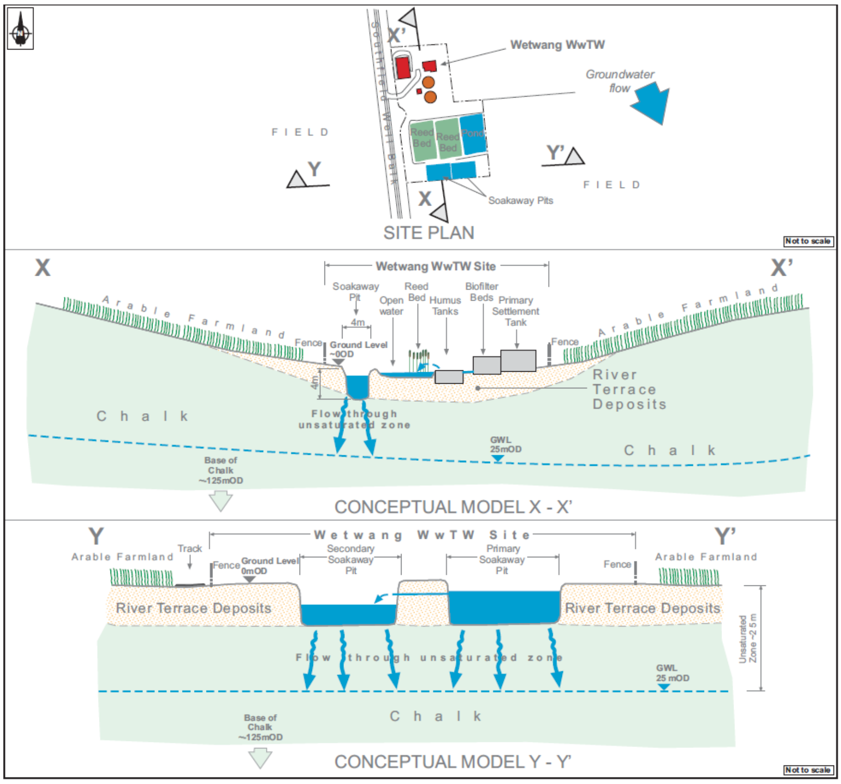


Source:-Via YW

4.1.2.2 Discharges/sewerage infrastructure near ephemeral streams

YW have a long-term programme of investigations into discharges in aquifers associated with ephemeral streams. Where the investigation shows there is an unacceptable risk, we work with the EA to amend the discharge permit to improve the situation or monitoring continues to ensure there is no detrimental impact from the discharge. We have made some minor changes to discharge permits but, in most cases, there is no detrimental impact. A diagram of the concept is shown below in Figure 21.

Figure 21: Conceptual model of WwTW with discharge to ground



Source: via YW

4.1.2.3 Storm overflows to ground or dry ditches.

Storm overflow discharges to ground or dry ditches, including those from wastewater pumping stations, are generally deemed low risk as the effluent is heavily diluted and there is an unsaturated zone above the groundwater where the effluent quality will improve due to biological and filtration activity in this zone.

4.1.2.4 Sewerage infrastructure below groundwater level (i.e. water table).

It is possible to identify areas at risk of groundwater infiltration to sewer. However, this is not a simple task as groundwater levels vary both seasonally and within relatively small areas. Increases in groundwater level due to reduction in groundwater abstraction also presents a risk of greater infiltration. Leakage from sewers to groundwater is a relatively small risk compared to ingress. The costs to seal all existing sewer systems does not match the level of risk to groundwater quality.

4.1.3 Nutrient neutrality

There is currently one designated 'nutrient advice area' within the Yorkshire Water region, the Hornsea Mere. We do not have any impact to Hornsea Mere. We will continue to work to the latest designations in respect of potential nutrient neutrality risks. The SEA consultation responses contains references to the Diffuse Water Pollution Plans, including the River Derwent, Hornsea Mere and Malham Tarn which have been particularly impacted by high Phosphate levels. We have considered the conclusions of the referenced reports and it is not apparent that YW owned assets are the cause, nor do they contribute to the issues identified at Malham or Hornsea. Work that was carried out has reduced the risk on the river Derwent as identified within the report. We will continue to support diffuse water pollution plans where actions are applicable to YW.

4.1.4 Net Zero

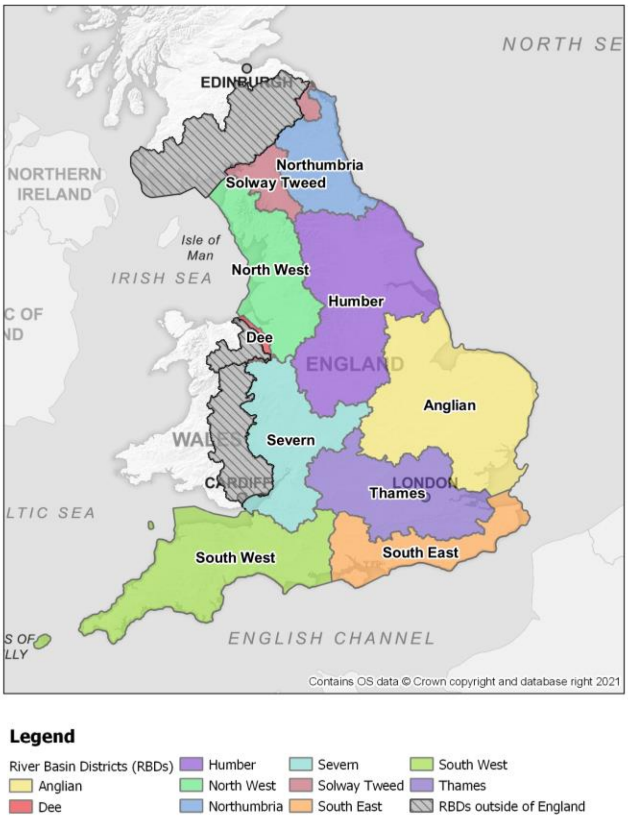
Yorkshire Water joined with other companies in the sector to set a target to achieve net zero carbon emissions for our operational (scope 1 and 2 emissions under the Greenhouse Gas Protocol) by 2030. We have been progressing this target via various pathways; procurement of renewable energy (electricity and gas), transition of our fleet vehicles to electric for light commercial vehicles and cars, and fuel switching to low carbon fuels for heavy goods vehicles and plant, increasing our energy efficiency and self-generation (solar, biogas, hydro and wind), and deploying innovative technologies to reduce our hard to abate process emissions. We have been making positive reductions despite continued growth in the population we serve, changes to our compliance requirements that increase our emissions from both potable and wastewater treatment works and increases to process emission factors driven by increased international understanding of the related science.

We are currently setting out our transition pathway aligned to the UK Government's 2050 net zero target, addressing all scopes of emissions – this continues work we have been doing in our capital development and procurement to drive down embedded (scope 3) emissions. Our capital programme is on track to deliver our 5-year target from 2020-2025 to reduce embedded emissions by 23%. As a large landholder across Yorkshire, we are also working to enhance the natural environment and find ways to sequester carbon. We have various woodland schemes completed and underway, and large-scale peatland restoration projects. We are also working with other stakeholders and partners in our catchment to find ways to help them lock in carbon in soil and grassland as part of our wider carbon contribution.

4.1.5 EA Humber River Basin District

Our Level 1 region is contained within the EA's Humber River Basin District (RBD). This can be seen below in Figure 22. The EA utilise these river basin districts to develop River Basin Management Plans (RBMP) which have a core aim of protecting and improving the quality of the water environment. In Figure 23 you can see the entire Humber basin river structure including the key rivers within our Level 1 area.

Figure 22: Humber RBD location



Source: Environment Agency[5]

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[5] https://consult.environment-agency.gov.uk/fcrm/draft-second-cycle-flood-risk-management-plans/

Figure 23: Key features of the Humber RBD

Source: Environment Agency[6]

4.2 Level 2: Strategic Planning Areas

We have divided Yorkshire into 17 Strategic Planning Areas (SPAs) which are generally aligned with the EA river basins alongside four urban areas (Hull, Leeds, Sheffield, and York). Each SPA consists of several individual catchments. These have been aggregated together so that stakeholders and customers can understand our plan at both local and regional levels. They can be seen below in Figure 24.

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[6] https://www.gov.uk/government/collections/draft-river-basin-management-plans-2021#humber-rbd

Figure 24: Level 2 SPAs

Table 5 highlights all our Level 2 areas and the type of area that they cover. It also presents the number of Level 3 catchments within each SPA and how many of these catchments were then subjected to the Baseline Risk and Vulnerability Assessment (BRAVA) process (described in Section 10.3).

Table 5: Level 2 SPA details

Level 2 SPA	Area description	Number of Level 3 catchments	Number of Level 3 BRAVA catchments
Calder	Urban	38	17
Colne & Holme Valleys	Rural, small towns and villages	8	4
Dearne	Urban areas, larger towns and some rural areas	50	27
Derwent & Rye	Rural, small towns and villages	68	27
Esk & Coast	Rural, coastal towns and bathing beaches	22	15
Holderness Coast (Gypsey Race)	Rural, coastal towns and bathing beaches	75	40
Hull	Urban	2	2
Leeds	Urban	1	1
Lower Aire	Urban areas, larger towns and some rural areas	12	11

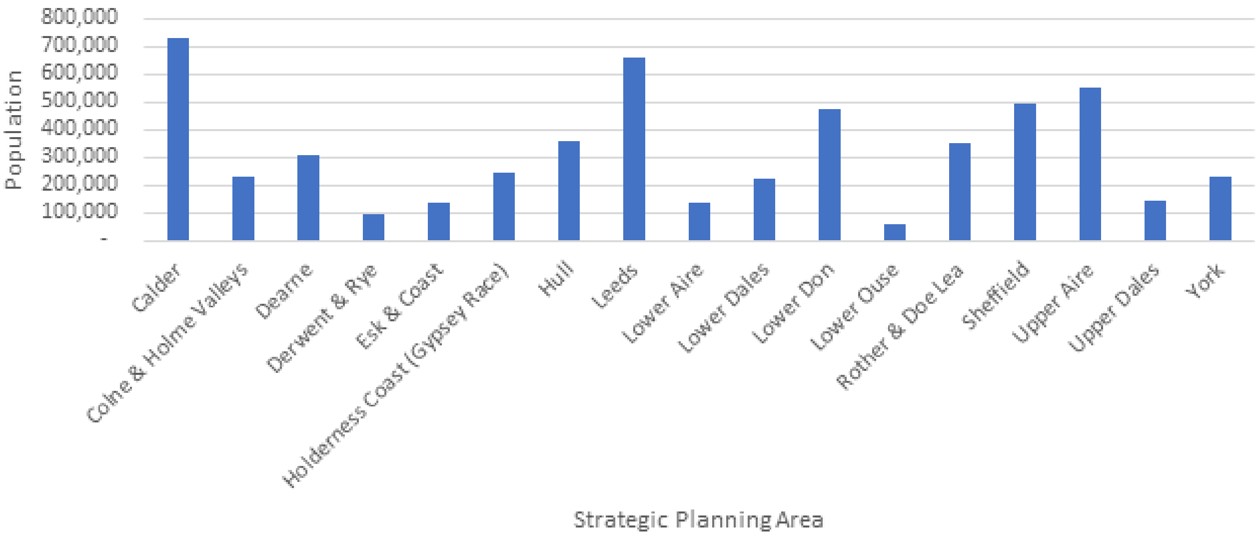
Table 5: Level 2 SPA details

Level 2 SPA	Area description	Number of Level 3 catchments	Number of Level 3 BRAVA catchments
Lower Dales	Rural, small towns and villages	53	32
Lower Don	Urban areas, larger towns, and some rural areas	34	28
Lower Ouse	Rural, small towns and villages	15	12
Rother & Doe Lea	Urban areas, larger towns, and some rural areas	23	13
Sheffield	Urban	9	2
Upper Aire	Rural, small towns and villages	28	17
Upper Dales	Rural, small towns and villages	159	77
York	Urban	20	10
Total		617	335

The SPAs represent a range of rural and urban catchments, discrete drainage areas, varying levels of hydraulic flood risk to properties, overflow risk and WwTW compliance risk. As seen below in Figure 25 the population varies between the Level 2 areas based on Level 3 BRAVA catchments and reflects the urban density of the Level 2 SPAs.

We have developed a series of storyboards for each Level 2 to provide a visual summary of the key catchment information and outputs of our DWMP processes. To see the storyboards and related information for each Level 2 please see Appendix C.

Figure 25: Population Equivalent by Level 2 SPA for BRAVA Catchments



4.3 Level 3: Catchments

We have 617 Tactical Planning Units (TPU) or wastewater treatment work catchments within our overall Level 1 area. These have been designated as our Level 3 catchments. These catchments include all the upstream foul, surface and combined sewer network, its wastewater pumping stations, storm overflows and a WwTW. The boundaries are defined as all the properties served by a WwTW. This allows stakeholders and customers to identify which Level 3 catchments are relevant to them and what our plans are for maintaining or improving those catchments to ensure a resilient local system.

In some situations, multiple Level 3 catchments drain to the same WwTW or WwTWs have shared processes, as summarised in Table 6. This is due to complexities in the connectivity between our networks and our WwTWs, or due to changes since the beginning of the development of the DWMP. These have been retained as individual Level 3 catchments for the DWMP. However, for some assessments, the WwTWs have been considered for both Level 3s catchments collectively.

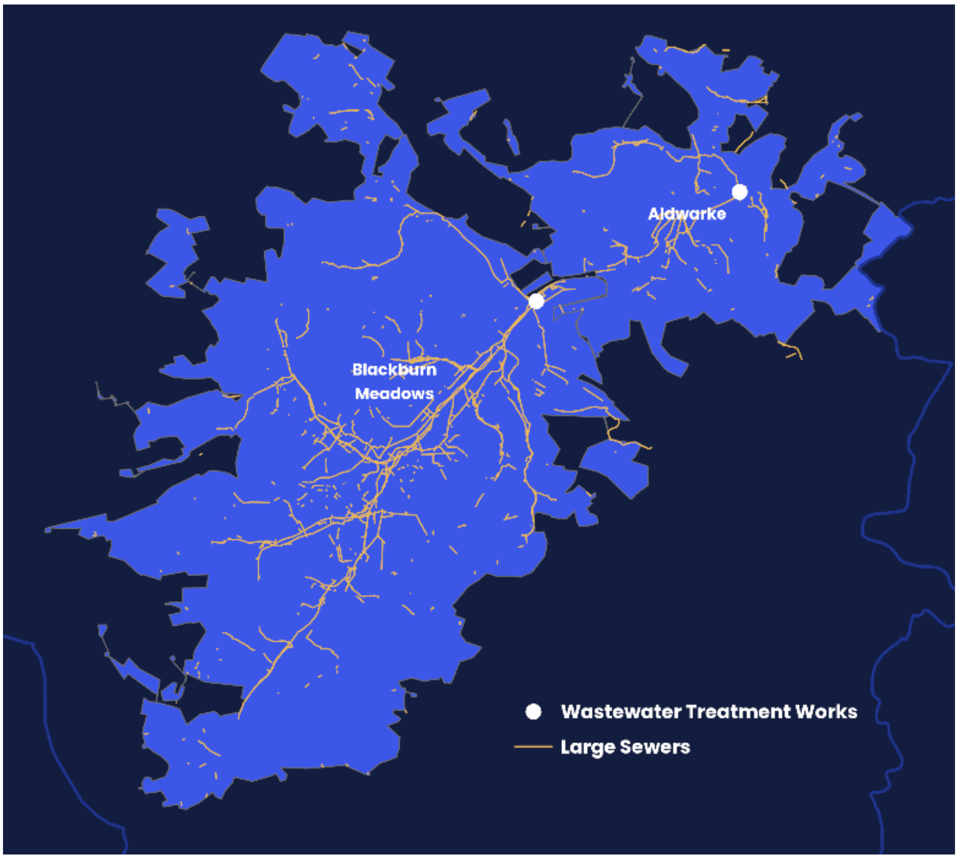
Table 6: Level 3 Catchments with Shared WwTWs:

Level 3 catchments	WwTW Name(s)	Reason
Huddersfield; Brighouse	Huddersfield Complex (DEIGHTON/WwTW; BRIGHOUSE/UPPER WwTW; BRIGHOUSE/LOWER WwTW; COLNE BRIDGE/WwTW; COOPER BRIDGE/WwTW)	Treatment processes spread across multiple sites with multiple final effluent discharges.
Northallerton; Romanby	ROMANBY/WwTW; NORTHALLERTON/WwTW	Final effluent from ROMANBY/WwTW discharges via NORTHALLERTON/WwTW.
Hillam; Sutton	SUTTON/WwTW	Terminal pumping station constructed to replace HILLAM/WwTW and divert flows to SUTTON/WwTW during AMP6.
Bagby; Thirsk	THIRSK/WwTW	Terminal pumping station constructed to replace BAGBY/WwTW and divert flows to THIRSK/WwTW during AMP6.

In addition to the Level 2 storyboards, we have also produced these for each of our Level 3 catchments. Please see Appendix D for individual catchment storyboards.

Figure 26 below illustrates two Level 3 catchments, Aldwarke and Blackburn Meadows which fall within the Sheffield Level 2 SPA.

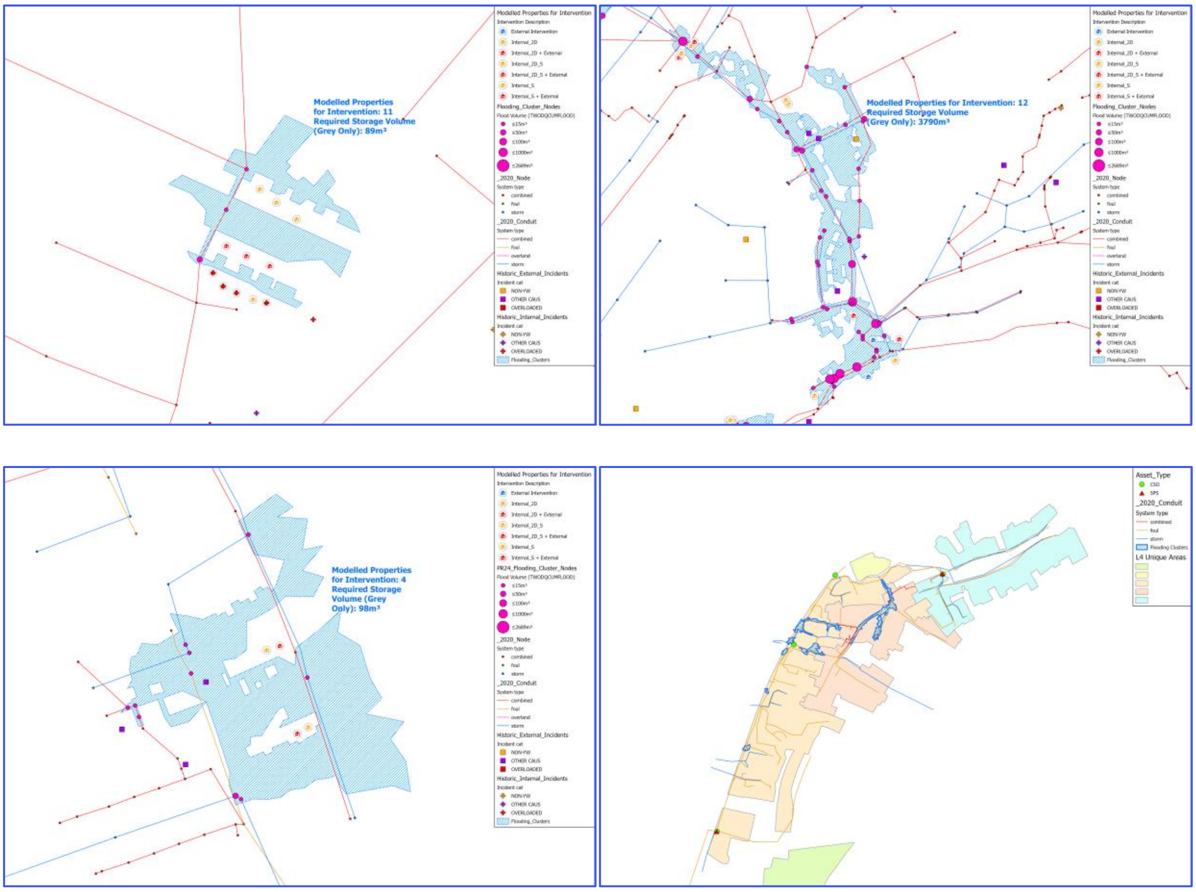
Figure 26: Two catchments within a Level 2 SPA



4.4 Level 4: Storm overflows and flood clusters

As part of our development of the DWMP24 from draft to final and linked to the SODRP and consultation feedback, we have developed Level 4s for each storm overflow and produced flood clusters, allowing us to focus on smaller drainage areas. The below images in Figure 27, show a range of flood clusters and how these link to other storm overflow and network assets. Sections 10.7.3.4 and 10.7.3.5.1 include more detail on how these Level 4s have been defined and used within the development of our DWMP.

Figure 27:Flood cluster examples



4.5 Climate change projections for our region

Our climate is already changing. We have seen a 1.1 degree rise in global temperature since the last century[7] and rainfall in the UK has become more intense[8], as warmer air can hold more moisture. Sea levels are rising along the Yorkshire coastline and storms are becoming more frequent and more severe. Further change is inevitable due to the carbon emissions already released into the atmosphere. The rate and severity of these changes is dependent on how much additional carbon is emitted.

The Met Office has produced different emissions scenarios to model how and when these climatic changes might occur. The high emission scenario assumes society carries on as it is now, with business as usual and continues to emit significant amounts of carbon. In this scenario, the planet warms by around 4 degrees by 2100, making vast swathes of the world too hot for human beings to survive. The low emissions scenario assumes that society takes significant action to reduce and eliminate carbon emissions, for example by switching to renewable energy, using electric vehicles, and stopping deforestation. This scenario assumes that we manage to keep global temperature rise

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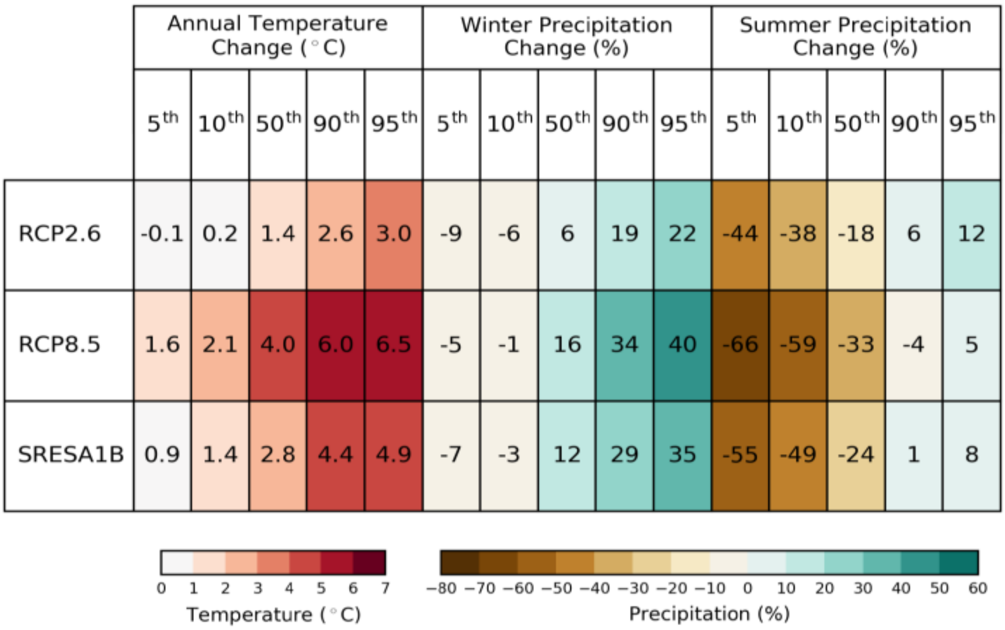
[7] **https://www.metoffice.gov.uk/research/climate/maps-and-data/about/state-of-climate**

[8] **https://www.sciencedirect.com/science/article/pii/S2212094721000372**

to less than 2 degrees, however even in this scenario there are still significant and severe changes to global weather patterns and debilitating impacts on the Yorkshire region. This will have implications for our sewer systems.

Figure 28 shows the predicted changes to rainfall and temperature under the low (Representative Concentration Pathway 2.6 (RCP2.6)) and high (Representative Concentration Pathway 8.5 (RCP8.5) emissions scenarios and also the Special Report on Emissions Scenario A1B (SRESA1B) for Yorkshire in the 2030s, 2050s and 2100.

Figure 28: Probabilistic Changes Over Region to End of Century



	Annual Temperature Change (°C)					Winter Precipitation Change (%)					Summer Precipitation Change (%)				
	5th	10th	50th	90th	95th	5th	10th	50th	90th	95th	5th	10th	50th	90th	95th
RCP2.6	-0.1	0.2	1.4	2.6	3.0	-9	-6	6	19	22	-44	-38	-18	6	12
RCP8.5	1.6	2.1	4.0	6.0	6.5	-5	-1	16	34	40	-66	-59	-33	-4	5
SRESA1B	0.9	1.4	2.8	4.4	4.9	-7	-3	12	29	35	-55	-49	-24	1	8

Source: Met Office[9]

Current emissions trajectories suggest it is unlikely that we will stay below a 1.5 degree rise in global temperatures by the end of the century. We have therefore carried out modelling assessments to understand how these changes in rainfall will impact on our ability to operate our sewer system safely and effectively.

4.6 Impacts of climate change on the Yorkshire region

In general, climate change will bring warmer, wetter winters and hotter, drier summers to our region. Rainfall will become more intense and more rain will fall in short, sharp bursts. There will be an increased risk of more frequent and heavier storms. Sea levels will rise. These changes will have various impacts on our sewer network and on the environment. For example, warmer, wetter winters will increase the risk of widespread flooding, such as that seen during the Boxing Day floods in 2015: It was declared a major incident for the north of England and saw the Prime Minister chair an emergency Cabinet Office Briefing Rooms (COBR) meeting.

These weather events can mean that our sewage network is overwhelmed, and our treatment works are inundated leading to dilute sewage being discharged untreated to rivers or the sea. High flows in rivers can also erode the protection around our sewer pipes, leaving them exposed to damage. High flows in rivers can also cause outfalls to be submerged or damaged and preventing them from freely discharging. Storms can lead to power cuts which can affect our ability to treat or pump

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[9] Met Office Hadley Centre (2018): UKCP18 Probabilistic Climate Projections.

sewage. Our sewer system can also be overwhelmed by the volume of rainfall and back up, causing flooding in customers' homes and gardens or in the street.

Hotter, drier summers may mean less flow in our sewers, causing more risk of blockages. Or sewage may become more concentrated and potentially septic as it is less diluted and sits in our sewers for longer. If rivers are low during dry spells in the summer, there is the potential for greater damage to the natural environment from storm overflows. Warmer rivers mean less oxygen dissolves in the water which can impact fish and other wildlife, as well as affecting the chemical quality of river water. Hotter summers could also dry out the clay soils we have in our region causing ground movement. This means that our sewer pipes are more susceptible to cracking or breaking, which could result in sewage escapes.

As a key focus for the DWMP is system capacity, we have included the impact of climate change on rainfall within our sewer network modelling. We have considered a number of the wider impacts discussed above within our wider BRAVA resilience assessment (Section 10.4) and have also carried out research to assess the impact of climate change on river water quality. We will look to take learning from this and ongoing industry wide research projects to further develop and improve the datasets we have for modelling climate impacts for our second cycle of DWMP development.

As climate change science is continually developing and incorporates a range of scenarios, we have undertaken sensitivity testing as part of our DWMP to understand the potential impact of different scenarios and datasets on our plan. This is discussed further in Section 12.2.1 of this report.

4.7 Role of other stakeholders in managing flood risk

There are a number of different organisations who are responsible for managing flooding, depending on whether the flooding is from rivers, the sea, rainfall, or the sewers. Water and sewerage companies have a statutory duty under the Water Industry Act, 1991 to “provide, improve and extend a system of public sewers so as to cleanse and maintain those sewers (and any lateral drain) to ensure that the area that they serve is effectually drained.”

We are a Risk Management Authority (RMA) under the Flood and Water Management Act (FWMA) 2010 and have a duty to co-operate with other RMAs such as the EA and Lead Local Flood Authorities in the management of all sources of flood risk. The FWMA is the main piece of legislation governing flood risk management in the UK and sets out who is responsible for different aspects of flooding risk. For example, the EA is responsible for flooding from main rivers and the sea, Local Authorities are responsible for flooding from smaller rivers and from rainfall, and in some places, there are also Internal Drainage Boards who manage land drainage. Water companies are responsible for flooding from their sewers, although there are exceptions such as when the sewer flooding is caused by rivers or the sea backing up into our system.

There are significant interdependencies between all these organisations as water does not respect jurisdictional boundaries. For example, we are very dependent on EA flood embankments and other defences which protect several of our assets. We also coordinate how we operate certain assets with the EA to manage flood risk, such as our pumps in York and Hull which are critical in managing water levels linked to the rivers and sewers in those areas.

The FWMA is implemented though the national Flood and Coastal Erosion Risk Management (FCERM) Strategy which was published in 2020. The vision for the strategy is “A nation ready for, and resilient to, flooding and coastal change – today, tomorrow and to the year 2100”. The three main themes of the strategy are:

- climate resilient places
- resilient infrastructure and growth, and
- a nation of people ready to respond.

The strategy sets out the expectations about how all the different organisations should work together and how different plans such as DWMPs should align with the strategy. Our DWMP helps contribute to the national FCERM strategy by setting out:

- How we will help create climate resilient places by maintaining and enhancing our sewer network to manage current and future flood risk, protecting customers and the environment from sewer escapes.
- How we will manage flood risk through a mixture of solutions including nature based blue-green solutions such as SuDS, potentially contributing to environmental net gain.
- How we will work in partnership where possible to manage surface water flooding.
- How we will maintain and improve our sewer network, so it continues to function effectively and supports economic growth, new development and creates jobs.
- How we will support and educate communities so they don't abuse our sewers and can play their role in managing current and future flood risk.

We are also engaged with the Humber 2100 strategy team which is still in the early stages of development. We will assess how these proposals may interact with our assets and our plans as more detailed information becomes available. More information can be found in this link:

https://consult.environment-agency.gov.uk/humber/strategyreview/user_uploads/humber-2100--storymap-content-for-website.pdf

5. Partnership working

Partnerships are formed by interested parties who come together to deliver outcomes that have benefits for all parties. Working in partnership with others means that we can deliver more for our customers and the environment. We've continued to develop and deliver partnership projects to reduce flood risk and improve river health, whilst delivering community and environmental benefits in Yorkshire. Partnerships take many forms, from Strategic Partnerships; Project Partnerships and partnerships to operate and maintain assets, this is discussed further in Section 11.5.

As a Risk Management Authority (RMA) in Yorkshire, our role is to manage flood risk, manage the risk of flooding to water supply and sewerage facilities, and flood risks from the failure of our infrastructure. We must ensure that we have the appropriate level of resilience to flooding, to be able to maintain essential services during civil emergencies (including those defined by the Security & Emergencies Direction[10]) and manage the impact and reduce the risk of flooding and pollution to the environment.

We are part of a large region with 14 Lead Local Flood Authorities (LLFA). The region has several areas of complex shared risk, such as York and Hull which are particularly prone to flooding. Our duties alongside other RMA's include collaboration and engagement with all 14 of our LLFAs, Internal Drainage Boards (IDBs), local, regional and national Environment Agency and private landowners on matters relating to flooding. This forms a crucial part of partnership working and the co-design, co-delivery and funding of schemes to reduce flood risk across the region.

5.1 The importance of partnership working

Partnership working is key to helping manage drainage and wastewater, now and in the future. It needs to form the cornerstone of what we do, to help us achieve the desired outcomes for our customers, and the environment. Our vision is that through partnerships of varying sizes, alongside other organisations and communities we will:

- co-invest in time, commitment and funding

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[10] **https://www.gov.uk/government/publications/water-company-security-and-emergency-measures-ministerial-direction**

- co-create solutions
- identify co-funding from sources within and external to the water sector, and
- consider who is best placed to deliver solutions and transfer funding as required through mature working.

Traditionally, many drainage and wastewater problems have been solved through hard engineering, water company focused approaches. We believe that we can instead resolve many of these problems, either fully or in part, through partnership solutions and working with communities. It is particularly important when looking at surface water management, due to the fragmented nature of responsibilities across a number of Risk Management Authorities (RMAs). This is further discussed in the government report Surface water and drainage: review of responsibilities[11].

The government plans to implement Schedule 3 of the Flood and Water Management Act 2010 in 2024. This will extend powers to a newly create Sustainable Drainage System Approving Body (SAB) who will approve and adopt sustainable drainage systems (SuDS) as part of new developments. The right to connect to the sewer for drainage from private new development sites under the current Section 106[12] of the Water Industry Act 1991 will be conditional upon a SAB approved sustainable drainage design for the new development, with water authorities becoming a statutory consultee in the planning process.

We welcome Schedule 3 as a framework which supports and aligns with our own ongoing investment in assets to address climate change, urbanisation and a growing population. SuDS slow, store and infiltrate rainwater that would otherwise enter the sewer network unrestricted. Implementing Schedule 3 will unlock opportunities to build resilience into our communities and when supported by new national standards, will not only relieve pressure on our drainage infrastructure, but also deliver high quality blue–green infrastructure. This includes benefiting biodiversity and water quality and creating amenity value for our Yorkshire communities.

We recognise that effective partnerships take time and effort to forge, create, and build trust. Good practice in developing them can be followed, but flexibility and creating common values is critical. Those which are successful are invested in fully by each partner (including money, time, and effort) and recognise the value of the contributing and connected stakeholders.

One partnership will always be unique to another: Different values, objectives, characteristics, previous experience, and the organisations involved create uniqueness, even if the common cause has similarities. Flexible approaches to joint working will provide positive outcomes. Our experiences show that many continuous funding streams, including timescales and investment horizons are mis-aligned across the partnership and require greater effort to enable co-funding to align. In some circumstances, it has not been possible to align co-funding within an acceptable timescale. The opportunities for policy and regulatory change to better support this method of delivery in the future are described in our position statement, 'Making Partnerships Work' published in September 2021[13]

We believe that our partnerships create value when we form them in the right way: Where all parties come together at the start, with the ability for others to join along the journey. Partners, stakeholders, and communities alike need to have their voice heard and their input valued.

5.2 Partnerships at YW

We will be seeking to continue to strengthen our existing partnerships and identify opportunities to develop new strategic partnerships in the future. As one of our strategic aims within the DWMP is to remove surface water from the network, the cross organisational nature of this challenge spanning RMAs, means we are likely to need to work in strategic partnership across the region, to develop a blue-green plan for Yorkshire. We will also be looking to mature our processes and ways of working

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[11] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911812/surface-water-drainage-review.pdf

[12] https://www.legislation.gov.uk/ukpga/1991/56/section/106

[13] https://www.yorkshirewater.com/media/dlobrmno/position-paper-making-partnerships-work.pdf

to deliver project level partnerships, which will be an important part of delivering our storm overflow programme.

We currently have a performance commitment measure in AMP7 - Working with Others (WWO) which has delivered in partnership, a number of different schemes, as detailed below in Appendix A, Section 1.1. We also have three strategic wastewater partnership schemes running within Yorkshire which are detailed as case studies in Appendix A, Section 1.2- 1.4. These are Living with Water, Bathing Water and Connected by Water. These case studies seek to demonstrate what can be achieved when working together and how this can support the DWMP aspirations to expand partnership working.

We have a long-standing commitment to partnership working and have delivered multiple schemes in partnership with our LLFAs and the EA over the last ten years, including collaborative working with Scarborough Borough Council on the new sea wall in Runswick Bay, contributing to property level flood protection to complement Leeds Flood Alleviation Scheme 1(FAS), and multi-agency schemes in Malton, York, Doncaster and elsewhere to protect against flooding. We have built on this learning and are now developing and delivering strategic level partnerships across whole sub regions such as Living with Water and our emerging Connected by Water partnerships.

We have also reviewed and refreshed our internal processes and established a new Surface Water Management Group. This group meets quarterly and seeks to identify and bring together any opportunities for collaborative projects. It prioritises these linked to available funding, scale of benefits delivered and ensures the successful development and delivery of partnership opportunities.

At YW we have a well-established flood risk and engagement team who work alongside the Yorkshire Lead Local Flood Authorities (LLFA) and the Environment Agency to better understand and manage flood risk in the region. The team are responsible for representing the company at a number of forums including the Regional Flood and Coastal Committee (RFCC) and the local Flood Risk Partnership meetings as well as at authority specific forums and local council meetings. These meetings can be proactive and reactive but should ultimately lead to better understanding between Risk Management Authorities (RMAs) and the opportunity to manage shared risks in partnership.

This partnership approach has delivered surface water removal from a combined sewer in the Sheffield area; disconnection of a watercourse that was discharging to a sewer system in Otley; installation of a small storage tank for 3 properties in York and re-routing of surface water in the village of Roos, in the East Riding. The team also manage the process for sharing hydraulic models and other data which can be used for strategic planning of larger flood alleviation schemes.

5.2.1 Living With Water

In 2023, the Living with Water (LWW) partnership commenced work on its first collaboratively designed and delivered scheme as part of the blue-green plan for Hull. The installation of permeable paving on a densely populated inner-city street will capture rainwater falling on the property roofs, front yards, pavement and road; storing and slowing the flow of water into the local combined sewer. The project will increase flood resilience to over 80 properties and has been designed to manage the impacts of climate change. This has been coupled with a Hull City Housing project[14] to update the frontage of the properties, which provides a further opportunity to manage surface water from downpipes and remove them from the traditional drainage system. The two schemes will deliver major regeneration to the area, as well as flood resilience benefits. This can be seen below in images in Figure 29 depicting work onsite at Rosmead Street and an artist's impressions of the street after construction.

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[14] https://www.yorkshirewater.com/news-media/news-articles/2022/living-with-water-and-hull-city-council-to-transform-rosmead-street/

Figure 29: Rosmead Street

Design work is progressing quickly for four other projects in the AMP7 programme, with all schemes expected to start on site in 2023. The programme will install a range of SuDS assets across the city in partnership with the local authorities to improve management of surface water from roads and roofs. The assets to be installed range from swales and ponds to geo-cellular storage. All of the projects are supported by in-depth customer consultation and co-creation with numerous community events and engagement.

Local schools have also taken up Living with Water lessons to raise awareness of flood risk among students and provide an opportunity for them to share their ideas for SuDS designs with our delivery partners. Living with Water has recently developed a digital platform to allow students and communities to retrofit SuDS on their street, supporting them to learn more about SuDS, their appearance and their associated costs and benefits. The team have also added to the Living with Water education offering by creating a Scout and Girlguiding badge which raises awareness of flood resilience through fun resources. Below is a link to these resources.

Living with Water Badge Resources | Living With Water.

The images below, Figure 30, depict the online resource, a group of scouts interacting with the LWW badge and resources and an example of our presence at an engagement event. A detailed case study on LWW is available in Appendix 1.2 of this document.

Figure 30: Living With Water engagement

5.2.2 DIG (Doncaster, Immingham and Grimsby)

We continue to develop strategic partnerships where there is opportunity to work collaboratively to deliver greater benefit to customers and the environment. One new partnership currently being formed and scoped is Doncaster, Immingham and Grimsby – known as DIG. As part of the Flood and Coastal Resilience Innovation Fund, Yorkshire Water is working with Doncaster Council to create SuDS in two areas of Doncaster. This is to reduce flooding, increase flood resilience and improve the local environment over 5 years from 2022-27. We have finished the first phase of investigations and are now working to find construction partners capable of making our early designs a reality. This partnership involves, YW, Anglian Water and a number of council areas.

With extensive monitoring in place on our sewer networks, we are engaging with local residents and schools to understand our design constraints and improve public understanding of rainwater management and our ambitions. This included extensive questionnaire surveys of the local area and visits for schools to our learning labs. By the end of the project, we are hoping to have significantly reduced flooding impacts in the area and greatly improved the understanding of our customers around the work we do at Yorkshire Water, including customer engagement.

5.2.3 Growing Resilience project

We also have well established partnerships in the Calderdale area. Between 2019 and 2021, and in partnership with the National Trust, we delivered the Growing Resilience project. This was a £2.6 million project which delivered 151 hectares of woodland creation with 112,000 trees planted, 862 Natural Flood Management interventions, 86 hectares of restored heathland and 103 hectares of restored peatland across YW and National Trust land. This work links to our aspirations to slow the flows of surface water reaching our sewers by containing it in upland areas using trees and 'leaky dams' [15].

The YW land was at Gorpley Reservoir in the Upper Calder Valley and some pictures of the tree planting can be seen below Figure 31.

Figure 31: Tree planting at Gorpley Reservoir

5.2.4 Landscapes for Water and Catchment Partnerships (CaBA)

Building on this partnership success and catchment working, we are now working with National Trust on a larger project, Landscapes for Water. This is aiming to deliver multiple aspects of habitat restoration, woodland creation, natural flood management and upland restoration across some 5,500 hectares of YW/National Trust land in the South Pennines. The woodland creation is being funded largely through the White Rose Forest, as part of the Northern Forest programme, and we are currently in the process of finalising a bid to West Yorkshire Combined Authority (WYCA) to fund the Natural Flood Management (NFM) components. The programme is running in parallel with, and complementary to, other ongoing activities such as YW's investment in upland restoration. Our upland restoration programme across the region, whilst focussed primarily on improving raw water quality (for drinking water), also provides other benefits. This includes improved retention of water in blanket bogs, helping to slow the flow, reduce sediment in runoff, providing more diverse habitats and biodiversity, protecting sequestered carbon and over time, to sequester more carbon. In the future, there will be potential to explore options that would result in direct alignment of the DWMP and the Water Resource Management Plan.

We are actively involved in numerous catchment-based initiatives that incorporate nature-based solutions. These are often co-designed and delivered with members of the Catchment Partnerships (CaBA) and meet the aims of wider communities. Examples of this include biodiversity enhancement programmes, SuDS, invasive species control, and whole river connectivity / fish pass initiatives. We are increasingly delivering our responsibilities through working in partnership and focussing on the wider needs of communities and the environment, rather than only addressing our own assets and compliance. This partnership approach has many advantages including leveraging funding, so delivers greater value to our customers than if we acted alone. This approach to partnership working across catchments ensures that we unlock the full potential of our on-going water quality investment and ensures we deliver optimal outcomes for our customers and the environment.

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[15] https://www.yorkshirewater.com/news-media/news-articles/2019/national-trust-natural-flood-management-january-2019/

We have worked closely in AMP7 with a number of CaBA partnerships and voluntary groups to help facilitate the extent of and quality of citizen science monitoring. The outcomes from these programmes have not only included improved knowledge of our own impacts, leading to future investment, but also more engaged customers and partners, helping us work jointly on solutions to restore nature. One example is working with the Esk and Coastal Streams Catchment Partnership to set up a multi-agency monitoring approach to the river Esk, particularly focused on preservation of endangered freshwater species. A combination of YW, EA and citizen science; public participation in research and monitoring has taken place to build an evidence base. This is linked to our WINEP24 submission, under the 25-year environment plan driver for water quality upgrades in AMP8. YW has been able to support the training of volunteer monitoring groups as well as setting up data share mechanisms and allowing the North York Moors National Park to commission their own independent monitoring to validate results.

We recognise we have a responsibility to help ensure that catchment management plans and Local Nature Recovery Strategies (LNRS) are produced in a way that will lead to meaningful outcomes for biodiversity and we can ensure we can align with the plans. We have provided 5 years staff time funding to Catchment Partnership officers at various CaBA host rivers trusts. This is to allow the time to co-create their catchment management plans and ensure they are as effective as they can be.

We are currently establishing a strategic partnership between ourselves and the Rivers Trusts within Yorkshire (see below). The purpose of the group is to build an informal, collaborative forum within which the parties can support each other and identify opportunities to work together. The aim of this Partnership is to enhance and protect the resilience and sustainability of river catchments within the Yorkshire region. During its initial, development phase, the partnership will focus on a series of recognised operational issues linked to assets/nodes, with a view to identifying additional operational and strategic areas of focus for intervention in due course.

YorkshireWater · The Rivers Trust · CALDER RIVERS TRUST · Aire Rivers Trust · DON CATCHMENT RIVERS TRUST · Yorkshire Dales Rivers Trust · EAST YORKSHIRE RIVERS TRUST · YORKSHIRE ESK RIVERS TRUST

5.2.5 Maintenance Partnerships - Dronfield

One further partnership to highlight is linked to the operation and maintenance of the Gosforth Valley detention basin which stores surface water and offers treatment capability via its wetland function. The basin is maintained in partnership in a landlord and tenant arrangement with YW and Lea Brook Valley (LBV) charity. As seen below, Figure 32, and described in further detail in Appendix A Section 1.5.

Figure 32: Gosforth Valley detention basin

LBV CIO
LEA BROOK VALLEY

6. Customer and stakeholder engagement

Our approach to customer and stakeholder engagement on the DWMP has been wide ranging. We've commissioned market research to understand the views of customers and have held direct engagement with a number of stakeholders including local authorities and the Environment Agency. All our engagement has been underpinned by a commitment to being open and transparent with the data that supports the development of our plan, through our innovative online data hub.

Through our engagement on the DWMP, we've shared the evidence we have of emerging pressures and challenges facing the wastewater systems and environment across Yorkshire. We've invited stakeholders to review our data, contribute their own evidence, and share details of emerging plans, which may impact our work (for example, aspirations for significant new development with plans to connect into the sewer network).

As well as ensuring that our plan is based on the most robust and up to date evidence, our engagement has also been focused on identifying areas where there are opportunities for partnership working which can deliver wider benefits for our communities.

The sections below provide more detail on how we've involved customers and stakeholders in the development of our plan and how their engagement has shaped our approach.

6.1 Taking an open and transparent approach to data

One of the key principles underpinning all our engagement on the DWMP has been the need to be open and transparent with our data. Our innovative online hub has been a key part of our approach and has provided an interface for customers and stakeholders to access interactive maps and data reflecting the core issues highlighted in the DWMP. The Hub can be accessed through the following link:

https://drainage-and-wastewater-management-plan-yorkshirewater.hub.arcgis.com/

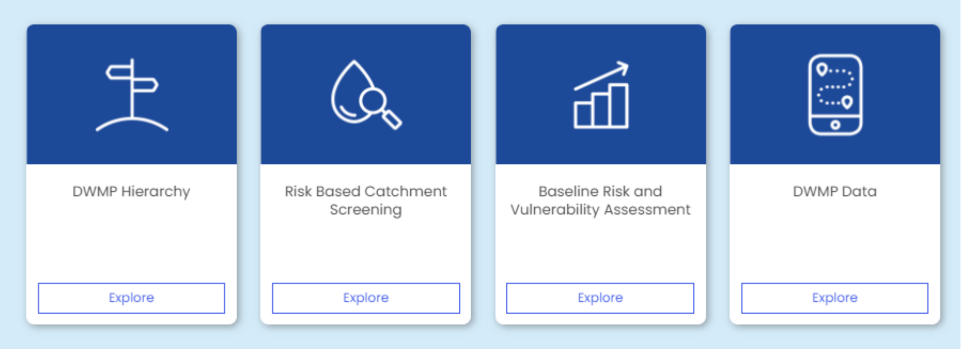
We have designed the Hub to be flexible, allowing it to evolve over time and enabling us to ensure suitability for individual stakeholder groups. Stakeholders have their own space within the Hub within which they can see the area relevant to them. This allows engagement on a more bespoke level as the information provided is relevant to the individual stakeholder. They are also able to share their own data with YW in a secure environment.

Feedback has been overwhelmingly positive, with over 100 individual users representing approximately 30 organisations, now having an account. We are able to share risk information and DWMP outputs at a scale not possible before. A key finding is that individuals do not need to be Geographical Information Systems (GIS) experts or even experts in flood risk management to utilise the hub data. The interactive and intuitive elements of our Hub and the series of dashboards, apps and maps we have produced, allow our stakeholders to interact with and understand our data in a way never successfully attempted before.

The use of the Hub allows all these elements to be linked together in a manageable and coherent way. It also gives us and the stakeholders the opportunity to shape and enhance our DWMP Hub for future cycles (i.e., beyond the next regulatory period 2025 to 2030).

The Hub has over 183 maps and 95 operational dashboards across the 17 different strategic planning units. The Hub is structured as below in Figure 33:

Figure 33: Hub Structure



6.1.1 DWMP hierarchy

Figure 34 shows our Level 3 wastewater treatment works (WwTWs) catchments and our Level 2 Strategic Planning areas. This section can be accessed by all users and provides high level information such as the catchment name and population served by our wastewater treatment works and their catchment boundaries. This can be seen as represented in Figure 34, Figure 35 and Figure 36 below.

Figure 34: Visual representation of Level 1, 2 and 3 information from YW Hub

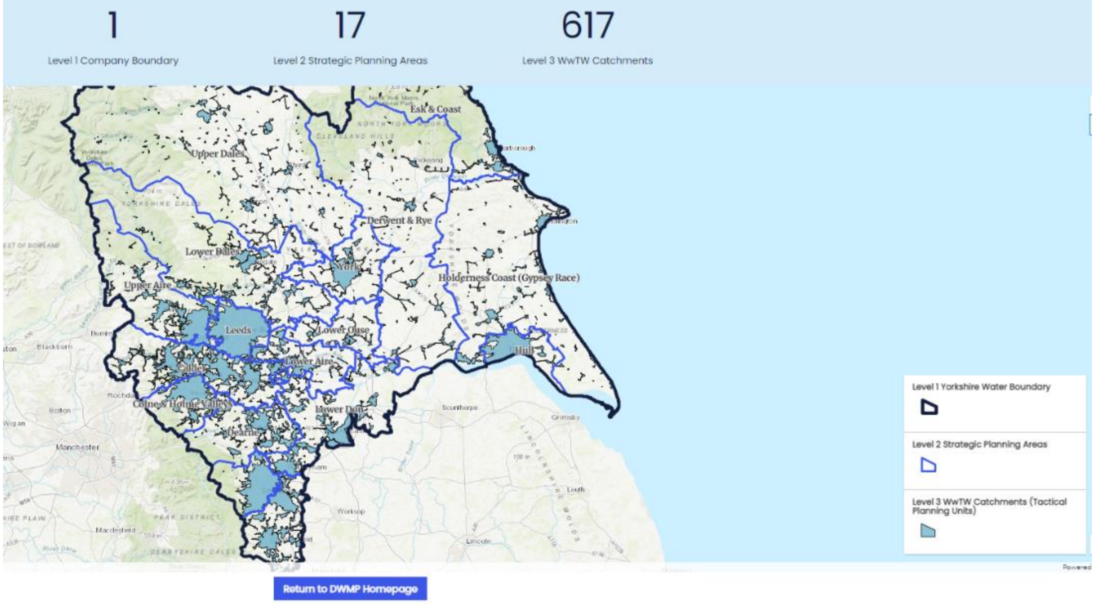


Figure 35: Example of visual representation of Level 2 and 3 catchment detail from YW Hub

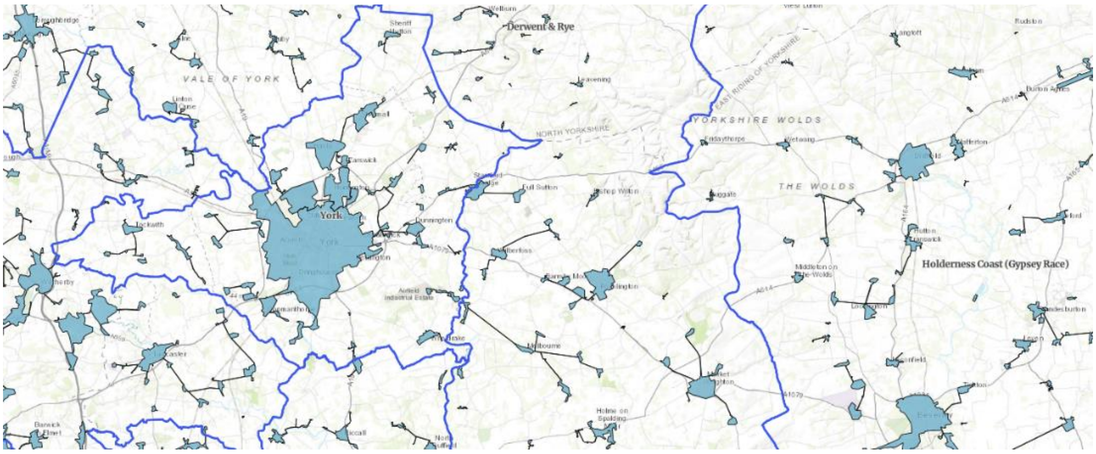
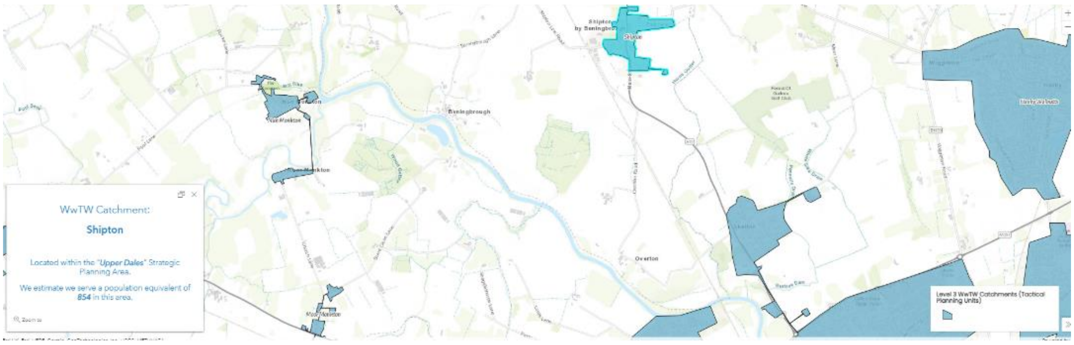


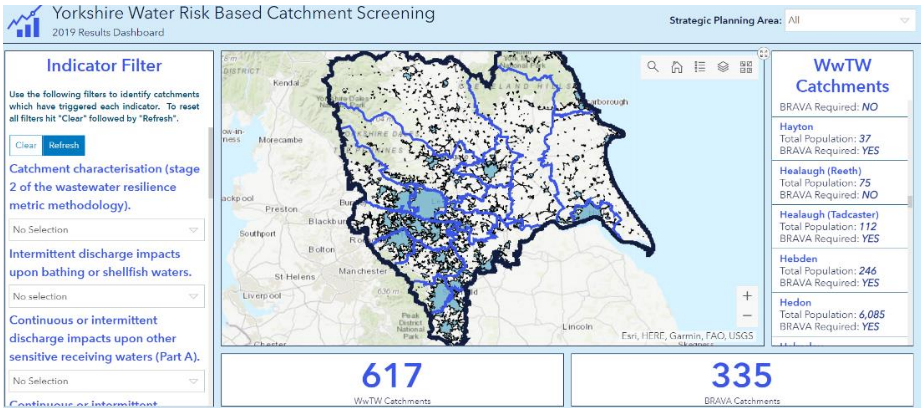
Figure 36: Example of visual representation of Level 3 catchments from YW Hub



6.1.2 Risk Based Catchment Screening (RBCS)

A dashboard, shown in Figure 37 below, uses a map and interactive filters and indicators to allow all users to view and understand which of our catchments triggered under the RBCS process. It mirrors the publicly available results which were originally published via an excel spreadsheet.

Figure 37: The RBCS Dashboard: YW Hub



Yorkshire Water Risk Based Catchment Screening

2019 Results Dashboard

Strategic Planning Area: All

Indicator Filter

Use the following filters to identify catchments which have triggered each indicator. To reset all filters hit "Clear" followed by "Refresh".

Catchment characterisation (stage 2 of the wastewater resilience metric methodology).

No Selection

Intermittent discharge impacts upon bathing or shellfish waters.

No selection

Continuous or intermittent discharge impacts upon other sensitive receiving waters (Part A).

No Selection

WwTW Catchments

BRAVA Required: *NO*

Hayton
Total Population: *37*
BRAVA Required: *YES*

Healaugh (Reeth)
Total Population: *75*
BRAVA Required: *NO*

Healaugh (Tadcaster)
Total Population: *112*
BRAVA Required: *YES*

Hebden
Total Population: *246*
BRAVA Required: *YES*

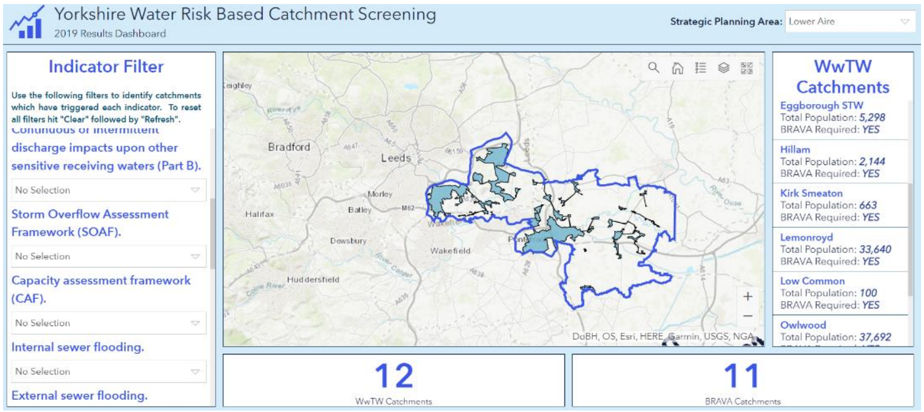
Hedon
Total Population: *6,085*
BRAVA Required: *YES*

617
WwTW Catchments

335
BRAVA Catchments

An example of the Lower Aire Level 2 Strategic Planning Unit (SPU) with Baseline Risk and Vulnerability Assessment (BRAVA) catchment information is shown in Figure 38 below:

Figure 38: Lower Aire Level 2 SPA



Strategic Planning Area: Lower Aire

Indicator Filter

Use the following filters to identify catchments which have triggered each indicator. To reset all filters hit "Clear" followed by "Refresh".

Continuous or intermittent discharge impacts upon other sensitive receiving waters (Part B).: No Selection

Storm Overflow Assessment Framework (SOAF).: No Selection

Capacity assessment framework (CAF).: No Selection

Internal sewer flooding.: No Selection

External sewer flooding.

WwTW Catchments

Eggborough STW
Total Population: 5,298
BRAVA Required: YES

Hillam
Total Population: 2,144
BRAVA Required: YES

Kirk Smeaton
Total Population: 663
BRAVA Required: YES

Lemonroyd
Total Population: 33,640
BRAVA Required: YES

Low Common
Total Population: 100
BRAVA Required: YES

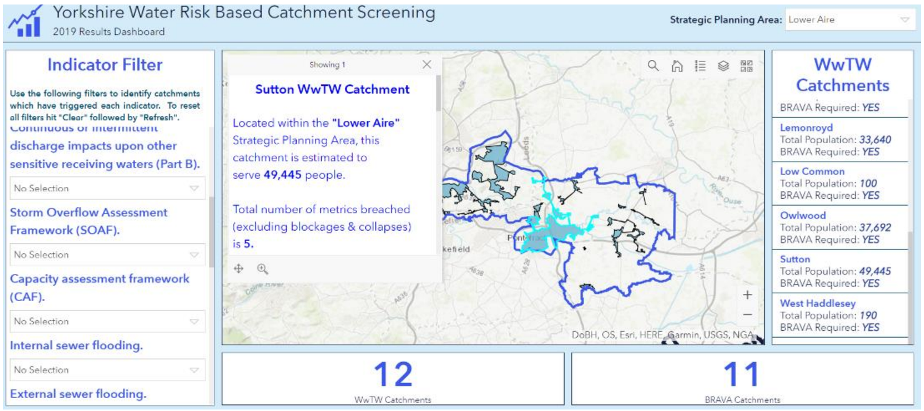
Owlwood
Total Population: 37,692

12 WwTW Catchments

11 BRAVA Catchments

The details behind the RBCS data for each catchment assessment can also be seen. This is by clicking on the catchment on the map in the hub as shown below in Figure 39. This highlights the number of metrics exceeded and if BRAVA was to be applied. Further details of the RBCS and BRAVA processes are provided in Section 10.1 and 10.3 respectively.

Figure 39: RBCS Metrics Information for Sutton Level 3 Catchment



Strategic Planning Area: Lower Aire

Indicator Filter

Use the following filters to identify catchments which have triggered each indicator. To reset all filters hit "Clear" followed by "Refresh".

Continuous or intermittent discharge impacts upon other sensitive receiving waters (Part B).: No Selection

Storm Overflow Assessment Framework (SOAF).: No Selection

Capacity assessment framework (CAF).: No Selection

Internal sewer flooding.: No Selection

External sewer flooding.

Sutton WwTW Catchment

Located within the "Lower Aire" Strategic Planning Area, this catchment is estimated to serve 49,445 people.

Total number of metrics breached (excluding blockages & collapses) is 5.

WwTW Catchments

BRAVA Required: YES

Lemonroyd
Total Population: 33,640
BRAVA Required: YES

Low Common
Total Population: 100
BRAVA Required: YES

Owlwood
Total Population: 37,692
BRAVA Required: YES

Sutton
Total Population: 49,445
BRAVA Required: YES

West Haddlesey
Total Population: 190
BRAVA Required: YES

12 WwTW Catchments

11 BRAVA Catchments

6.1.3 Baseline Risk and Vulnerability Assessment (BRAVA) and Problem Characterisation

This dashboard details which of our catchments fall into our different Problem Characterisation categories. This was determined as part of our extensive computer modelling work assessing predicted risk up to 2050 undertaken within our BRAVA analysis. Further details of the BRAVA and Problem Characterisation processes are provided in Section 10.3 and 10.5 respectively. The definitions are shown below in Figure 40 and examples of how this looks on the Hub are shown in Figure 41, Figure 42, Figure 43 and Figure 44.

Figure 40: Problem Characterisation Definitions

Promote

Develop strategic catchment based solution options to address predicted risks and look for potential opportunities for partnership working

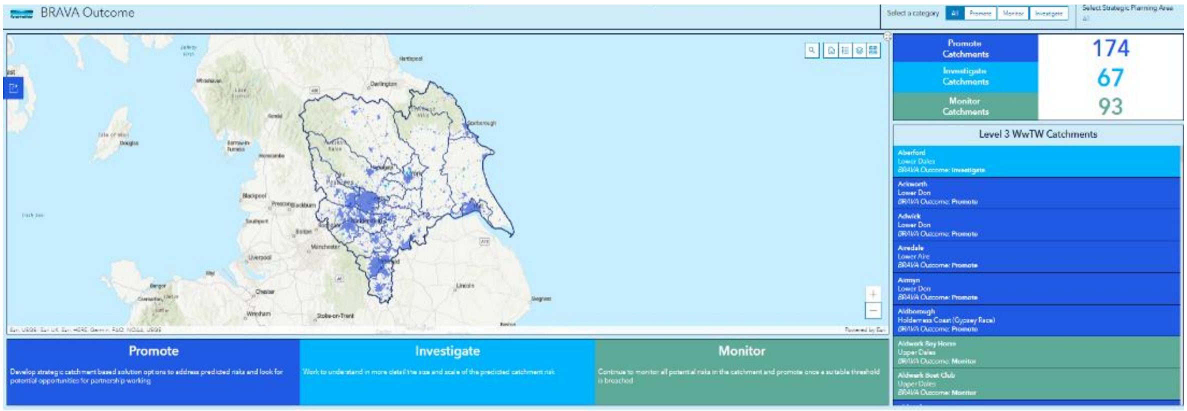
Investigate

Work to understand in more detail the size and scale of the predicted catchment risk

Monitor

Continue to monitor all potential risks in the catchment and promote once a suitable threshold is breached

Figure 41: Region Split of Problem Characterisation Catchments from YW Hub



BRAVA Outcome

Select a category: All | Promote | Monitor | Investigate

Select Strategic Planning Area: All

Promote Catchments	174
Investigate Catchments	67
Monitor Catchments	93

Level 3 WwTW Catchments

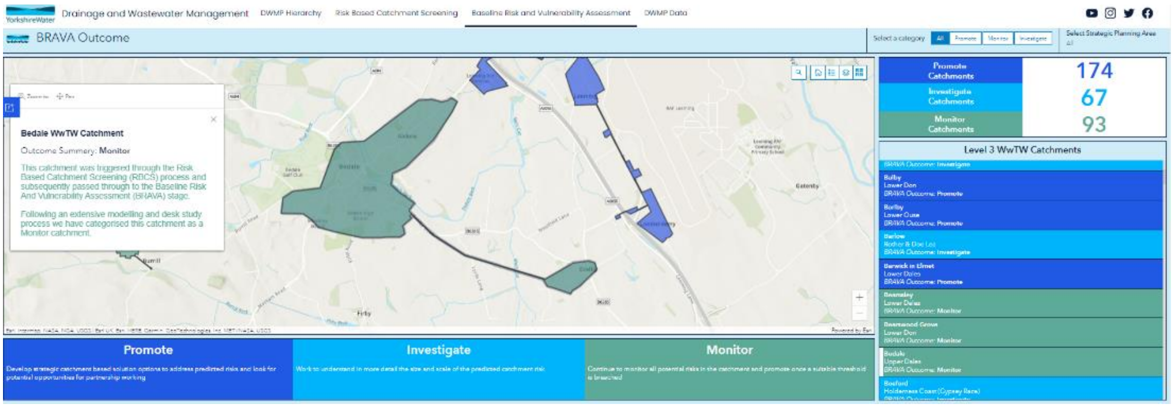
- Aberford
Lower Dales
BRAVA Outcome: Investigate
- Ackworth
Lower Don
BRAVA Outcome: Promote
- Adwick
Lower Don
BRAVA Outcome: Promote
- Airedale
Lower Aire
BRAVA Outcome: Promote
- Airmyn
Lower Don
BRAVA Outcome: Promote
- Aldborough
Holderness Coast (Gypsey Race)
BRAVA Outcome: Promote
- Aldwark Bay Horse
Upper Dales
BRAVA Outcome: Monitor
- Aldwark Boat Club
Upper Dales
BRAVA Outcome: Monitor

Promote: Develop strategic catchment based solution options to address predicted risks and look for potential opportunities for partnership working

Investigate: Work to understand in more detail the size and scale of the predicted catchment risk

Monitor: Continue to monitor all potential risks in the catchment and promote once a suitable threshold is breached

Figure 42: An Example of the Information Available for a 'Monitor' Catchment – Bedale



BRAVA Outcome

Select a category: All | Promote | Monitor | Investigate

Select Strategic Planning Area: All

Bedale WwTW Catchment

Outcome Summary: **Monitor**

This catchment was triggered through the Risk Based Catchment Screening (RBCS) process and subsequently passed through to the Baseline Risk And Vulnerability Assessment (BRAVA) stage.

Following an extensive modelling and desk study process we have categorised this catchment as a Monitor catchment.

Promote Catchments	174
Investigate Catchments	67
Monitor Catchments	93

Level 3 WwTW Catchments

- BRAVA Outcome: Investigate
- Balby
Lower Don
BRAVA Outcome: Promote
- Barlby
Lower Ouse
BRAVA Outcome: Promote
- Barlow
Rother & Doe Lea
BRAVA Outcome: Investigate
- Barwick in Elmet
Lower Dales
BRAVA Outcome: Promote
- Beamsley
Lower Dales
BRAVA Outcome: Monitor
- [illegible]
Lower Don
BRAVA Outcome: Monitor
- Bedale
Upper Dales
BRAVA Outcome: Monitor
- Beeford
Holderness Coast (Gypsey Race)

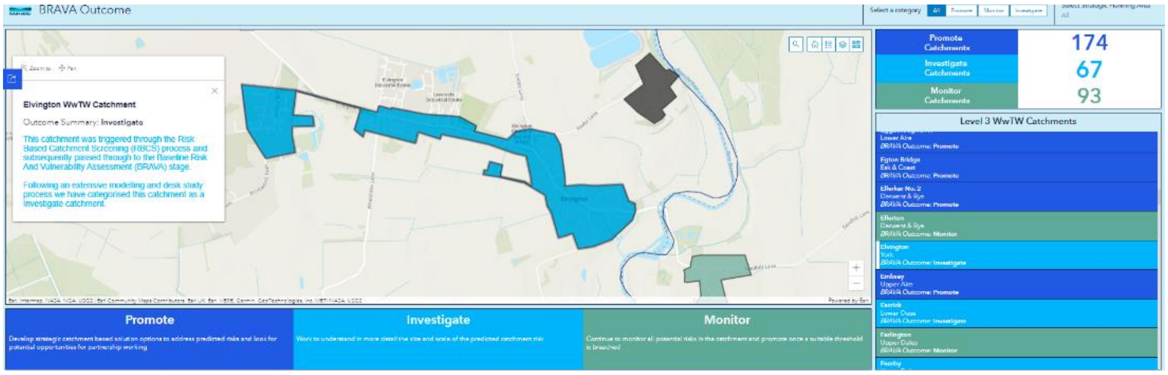
Promote: Develop strategic catchment based solution options to address predicted risks and look for potential opportunities for partnership working

Investigate: Work to understand in more detail the size and scale of the predicted catchment risk

Monitor: Continue to monitor all potential risks in the catchment and promote once a suitable threshold is breached

Bedale is assigned Monitor due to the evaluated risk level being low.

Figure 43: An Example of the Information Available for an 'Investigate' Catchment – Elvington



Elvington WwTW Catchment

Outcome Summary: **Investigate**

This catchment was triggered through the Risk Based Catchment Screening (RBCS) process and subsequently passed through to the Baseline Risk And Vulnerability Assessment (BRAVA) stage.

Following an extensive modelling and desk study process we have categorised this catchment as a investigate catchment.

Promote Catchments	174
Investigate Catchments	67
Monitor Catchments	93

Level 3 WwTW Catchments

Lower Aire
BRAVA Outcome: Promote

Egton Bridge
Esk & Coast
BRAVA Outcome: Promote

Ellerker No. 2
Derwent & Rye
BRAVA Outcome: Promote

Ellerton
Derwent & Rye
BRAVA Outcome: Monitor

Elvington
York
BRAVA Outcome: Investigate

Embsay
Upper Aire
BRAVA Outcome: Promote

Exwick
Lower Ouse
BRAVA Outcome: Investigate

Farlington
Upper Dales
BRAVA Outcome: Monitor

Feorby

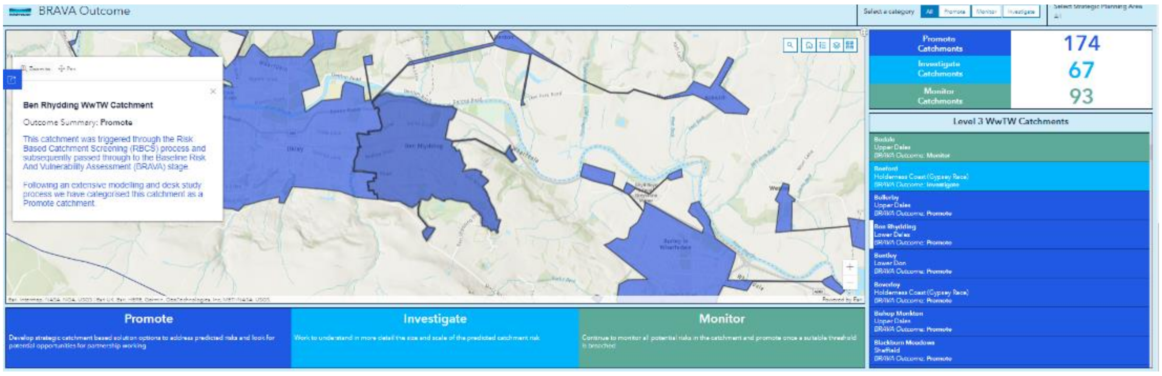
Promote: Develop strategic catchment based solution options to address predicted risks and look for potential opportunities for partnership working

Investigate: Work to understand in more detail the size and scale of the predicted catchment risk

Monitor: Continue to monitor all potential risks in the catchment and promote once a suitable threshold is breached

Elvington is assigned Investigate due to the confidence assessment of the data used within the BRAVA assessment.

Figure 44: An Example of the Information Available for a 'Promote' Catchment – Ben Rhydding



Ben Rhydding WwTW Catchment

Outcome Summary: **Promote**

This catchment was triggered through the Risk Based Catchment Screening (RBCS) process and subsequently passed through to the Baseline Risk And Vulnerability Assessment (BRAVA) stage.

Following an extensive modelling and desk study process we have categorised this catchment as a Promote catchment.

Promote Catchments	174
Investigate Catchments	67
Monitor Catchments	93

Level 3 WwTW Catchments

Bedale
Upper Dales
BRAVA Outcome: Monitor

Beeford
Holderness Coast (Gypsey Race)
BRAVA Outcome: Investigate

Bellerby
Upper Dales
BRAVA Outcome: Promote

Ben Rhydding
Lower Dales
BRAVA Outcome: Promote

Bentley
Lower Don
BRAVA Outcome: Promote

Beverley
Holderness Coast (Gypsey Race)
BRAVA Outcome: Promote

Bishop Monkton
Upper Dales
BRAVA Outcome: Promote

Blackburn Meadows
Sheffield
BRAVA Outcome: Promote

Promote: Develop strategic catchment based solution options to address predicted risks and look for potential opportunities for partnership working

Investigate: Work to understand in more detail the size and scale of the predicted catchment risk

Monitor: Continue to monitor all potential risks in the catchment and promote once a suitable threshold is breached

Ben Rhydding is assigned Promote due to the evaluated risk level being high.

6.1.4 DWMP data

A series of datasets and dashboards containing flooding, capacity and environmental impact information are available to our key local stakeholders for each of our Level 2 areas. If you are a key local stakeholder and require access, please email: **dwmp@yorkshirewater.co.uk** or click on the hub links to sign up.

6.2 Engagement with Local Authorities

To inform the development of our long-term strategies, and our five-year business plan, we have been working to establish a co-creation process with the Yorkshire Leaders Board. The Yorkshire Leaders Board is made up of the Leaders and Chief Executives of each of the 16 local authorities in Yorkshire, plus the two regional Mayors. In 2021 we agreed a process of structured engagement with the Leaders Board, through a series of regional roundtable events with representatives from the local authorities nominated by the Yorkshire Leaders Board. These events are broadly structured in three phases:

- **Phase one** involves us talking to local authorities about their local challenges, and their priorities across a wide range of issues. This helps us to understand the challenges the region is facing and the needs of local authorities.
- **Phase two** takes these discussions further and applies them in the context of our emerging long-term strategies to play water's role in making Yorkshire a brilliant place to be – now and always. These discussions allow us to explain the frameworks we operate within for long term strategic planning (DWMPs, WRMPs, etc) and will allow us to co-

create our long-term visions and strategies in partnership with local authorities to ensure they reflect the needs of the region.

- **Phase three** will take the long-term joint strategies we've created and apply them to the five-year business plan, resulting in a co-created business plan for 2025 – 2030.

Throughout this process we will be reporting back to the Yorkshire Leaders Board on the work of the regional roundtables. At each stage we aim to demonstrate how the feedback we are receiving is being built into our plans and is making a material difference to our approach.

Our engagement on the DWMP has been a key part of this overall approach. We held a regional roundtable in December 2021 which focused on understanding the challenges faced by local authorities and their priorities. This gave us valuable feedback and helped us understand differences within the region on key issues such as economic development and housing growth strategies. We then built on this with a further roundtable in February 2022, where we discussed the DWMP framework in the context of how it could support their priorities identified in the first roundtable. This second roundtable helped us to begin to gather more detail around where we should be pitching our level of ambition, as well as identifying opportunities for collaboration though the DWMP.

In May 2022, we held a further roundtable to update local authorities on progress with the DWMP and to brief them on the implications of the new storm overflow targets.

Internally, the outcomes of the regional roundtables and other stakeholder engagement are captured and fed into our PR24 governance processes. This ensures that stakeholder feedback is provided directly to practitioners who are developing our plans, through to our PR24 Steering Group. This is made up of senior managers and Directors, then through to the YW Leadership Team and ultimately the Board.

The YW region is also served by councils not included in the Yorkshire Leaders Board, so separate engagement has been required to ensure all local authorities have had chance to view and input into the plan. The level 2 Strategic Planning Area that covers Rother & Doe Lea has the following councils: Bolsover & NE Derbyshire District Councils, Derbyshire County Council, Chesterfield Borough Council. Opportunities for engagement and liaison with us and on our plan, have therefore been offered, as well as access to the DWMP Hub.

We held a face-to-face engagement workshop in January 2023 and invited every LLFA, the EA, Rivers Trust and National Park representatives to engage with us on our plans, ask questions and identify potential interactions. We provided an overview of the DWMP process, our modelling, the different scenarios we have used and had maps showing our plans for stakeholders to review and comment on. We will use this information to further refine our plans. Our partnerships team and flood risk and engagement team will be following up any opportunities identified and will continue to work closely with each stakeholder. This is to identify and progress any opportunities linked to delivery of our SODRP and flood clusters in a blue-green solution and to develop our approach to co-development for cycle 2 of the DWMP.

6.3 EA engagement

The YW DWMP team have developed a strong working relationship with the local EA by facilitating regular meetings and update sessions. This allows us to work together developing close alignment between the EA's Flood Risk Management Plan (FRMP) and our DWMP. We have focused this alignment in the following areas:

- Environment Planning for Water Quality
    - High-level approach to River Basin Management Plans (RBMPs).
- FCERM (Flood and Coastal Erosion Risk Management)
    - Progress on FRMPs – Measures taken forward, thoughts on future projects, development of the Flood Plan Explorer Website.
- Strategic Flood Risk

    - National strategic direction for FRMPs and facilitating alignment of future cycles with the DMWP.
- Stakeholder engagement
    - Stakeholder thoughts and feelings towards the DWMP, specifically where FRMP measures referenced the DWMP
    - Identification of “significant” risk and issues hotspots and the most appropriate approach to displaying these in our Hub to maximise the opportunities to identify partnership approaches.
    - Future development of the Hub; additions, changes, general feedback.

Initially, we hosted a series of workshops with local stakeholders, including the EA in late 2019. These were designed as introductory sessions to understand how DWMPs can align with local and strategic goals going forward.

This developed in early 2020 to meetings with local EA and local authorities to discuss how the FRMPs were to be developed for the Humber region and how measures created for the FRMPs can link together with the DWMP. It allowed us to ensure that collaborative approaches and thinking were considered and embraced when it came to longer term strategic thinking.

Taking on board the feedback we had from our regulators and stakeholders the way in which we manage stakeholder engagement going forward needs to be reviewed and take on board suggested options to revamp how we engage. This will look to include Level 2 SPA workshops and utilise a more ‘engage, deliberate and decide’ approach in cycle 2. We will also continue to build on the work and relationships we have forged highlighted in Section 5 and Appendix A.

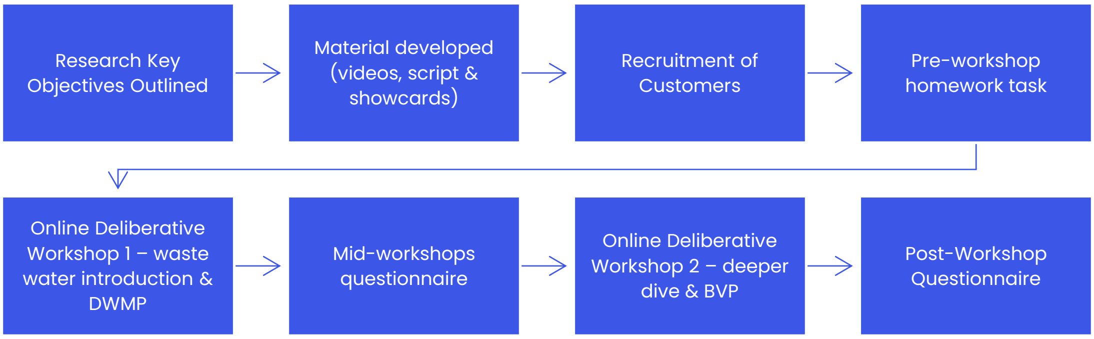
6.4 Customer research

We commissioned Turquoise to undertake a series of customer market research workshops designed to cover a variety of demographics over 10 workshops in February / March 2022. This covered over 80 customers with a mixture of householder (HH) and non-householder (NHH) customers.

A deliberative, qualitative approach was employed to investigate household and non-household customer views upon what the core focus and priorities should be for YW’s DWMP.

The overall aim of the research was to assess customers’ views of what a 'best value’ DWMP plan would look like, including the drivers of investment and how this should be prioritised to ensure resilient drainage and wastewater services in the YW region into the future. Figure 45 below shows how the project was built.

Figure 45: Customer market research plan



The specific principal research objectives that needed to be explored were:

Wastewater Services:

- Awareness and perceptions of YW's services.
- Exploration of customers knowledge and awareness of the wastewater network and systems.
- Exploration of customer perceptions around wastewater services and network responsibilities.
- Knowledge and experience of wastewater issues such as sewer flooding; odour; blockages etc.

Drainage and Wastewater Issues:

- Customer knowledge, awareness and understanding of internal and external sewer flooding.
- Why do customers think sewer flooding occurs?
- What factors are important in deciding which sewer flooding issues should take priority?
- What are customers' expectations and requirements in terms of levels of service?
- Customer knowledge, awareness and understanding of treated effluent from a wastewater treatment works and storm overflows into watercourses.
- Have customers heard of treated effluent or storm overflows?
- What do they understand and feel about treated effluent returning to the watercourses and use of storm overflows?
- How acceptable are these aspects of the wastewater service?

YW DWMP Measures and Metrics

- To understand customer priorities.
- What issues should YW prioritise?
- Flooding vs Overflows vs Environment vs Treatment.
- Customers to rank in order of priority what is most important to them.
- Sewer Flooding: Internal or External property flooding.
- Customer views on current YW measures and performance.

Future Challenges and Planning

- Exploration of customer awareness of the future challenges for YW's wastewater network
- Climate change (rainfall that is more intense and longer in duration)
- Population growth
- What do customers believe YW should be focussing on given the future challenges ahead?
- Exploration and perceptions of the solution options; nature-based e.g., sustainable drainage systems (SuDS) vs traditional solutions e.g. storage tanks
- Should YW be focussing on maintaining current performance or improving and tackling future challenges?
- Best Value Plan (BVP)
- Exploration of customers BVP for the DWMP

The 10 workshops were conducted across a mixture of demographics within the YW region. Respondents were recruited from differing areas within the region; urban, rural and coastal. In addition, customers who had been impacted by wastewater system failures were also approached to take part in the research.

6.4.1 Workshops participants

The Workshops were constructed based on the following criteria:

- Demographics

- Age
- State Pensioner
- Citizens 18-20 years, Citizens 21-30 years current non bill payers
- Marital status
- Gender
- Income (including low income)
- Household and business customers and citizens

Additional workshops engaged water dependent business customers e.g., food manufacturing, with a mix of urban and rural business locations. Business customers were recruited from across several sectors such as agriculture, retail, service, and the hospitality industry. This engagement was in line with MOSL (Market Operator Services Limited) for the non-household retail market in England.

6.4.2 Core findings of the research

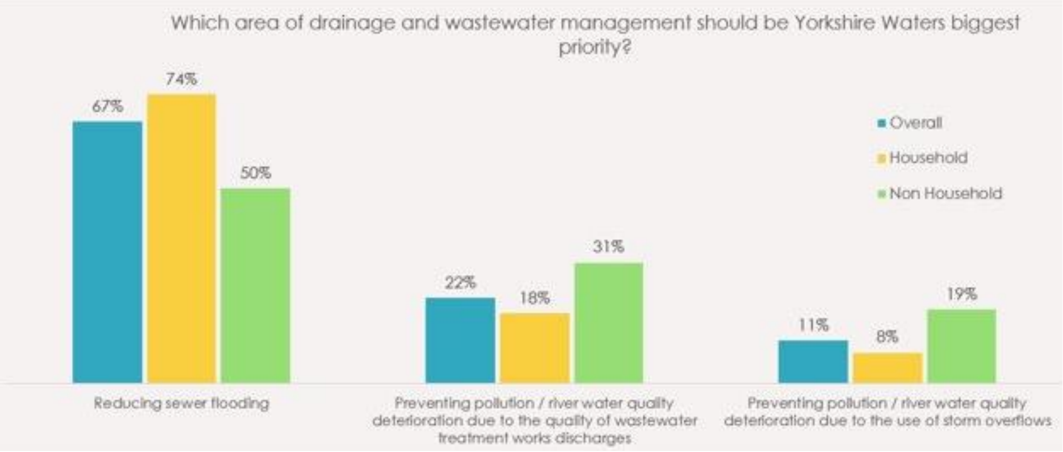
Consistent with other research that has been conducted within the water industry, generally, customers took water for granted. They rarely gave any thought to the water that came out of their taps or the wastewater that leaves their properties. When asked to think about the wastewater leaving their homes, kitchen sinks, toilets, showers, and baths were far more front of mind than surface water runoff including rainwater from roofs. Most customers were aware of who was responsible for the pipes and drains on their property but had not considered the impact of climate change on wastewater services.

There was a general lack of awareness of YW activities and water company activities. In regard to wastewater, this was even less so and customers identified a need for education, particularly on topics like responsibilities for different drainage systems, tackling blockages and how the sewer network interacts and functions.

Customers wanted us to hit our current targets as a priority. They recognised that more investment was needed given increasing populations and climate change to ensure that improvements and regular maintenance were undertaken. Equally, the consensus was that YW needed to improve because it was felt that the current wastewater system is not fit for purpose.

Customers were often shocked and appalled by storm overflows. Specifically, the function that they play in relieving the sewer system to prevent flooding and potentially leading to untreated sewage discharging into rivers and seas. Once the issues were explained to customers, how the system operates and why, they then felt that storm overflows were a necessary ‘Plan B’ or a backup contingency plan to prevent sewage entering their home. In terms of priorities, internal sewer flooding was seen as more of a priority than storm overflow spills, as seen below in Figure 46 and Table 7:

Figure 46: Summary of workshop outputs: Risk prioritisation



Source: Turquoise on behalf of Yorkshire Water

Table 7: Summary of Workshop Outputs: Risk Prioritisation

Measure	Ranking
Minimising risk of internal flooding of properties due to incapacity of sewers during heavy rainfall	1.
Minimising risk of external flooding of areas of land due to incapacity of sewers during heavy rainfall	2.
Improving resilience of the wastewater and drainage system to extreme events	3.
Improving the condition of the sewers e.g., by predicting blockages and / or collapses along the network	4.
Monitoring and improving wastewater flow and quality compliance to ensure treated water discharged to river / sea meet allowed standards	5.
Monitoring and improving storm overflows on how they are operating and the effect this may have on the river water / sea water they are entering	6.

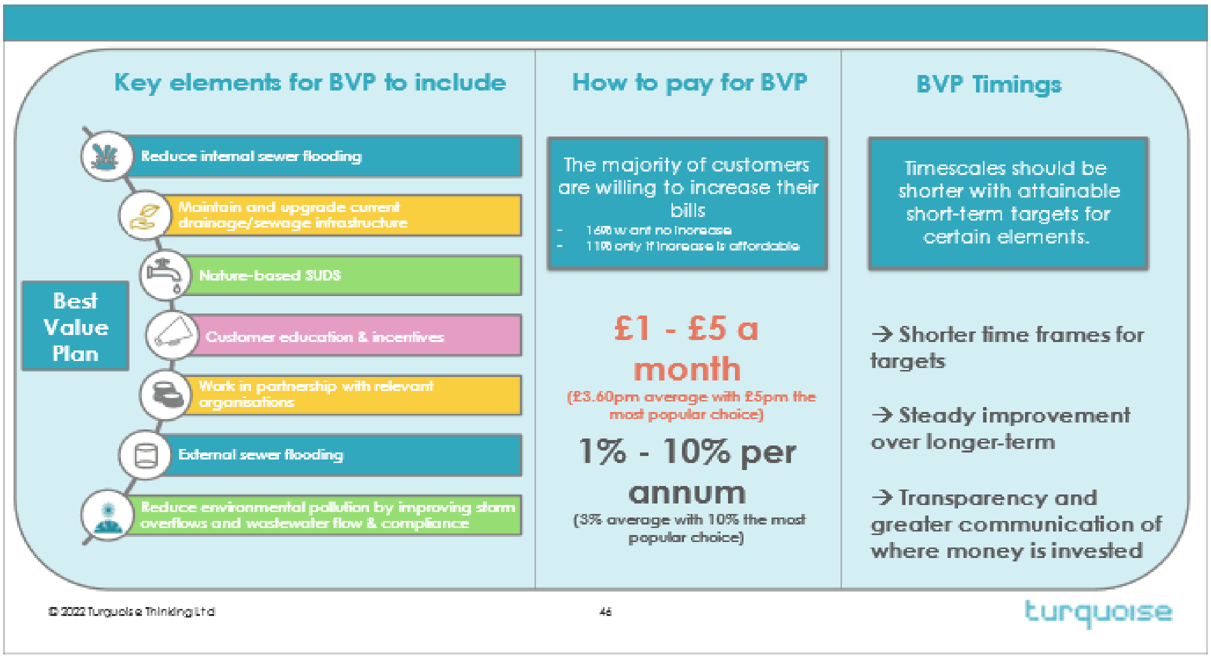
Source: Turquoise on behalf of Yorkshire Water

Customers were prepared to pay a small increase to fund wastewater improvements and with that increased money, customers wanted us to exceed statutory measures in the medium to long term. It was felt that a combination of nature-based and traditional carbon intensive solutions needed to be utilised to solve the problems in the medium to long-term. This insight comes from a standalone piece of research conducted specifically for the dDWMP and does not relate to any work done for bill impacts for final DWMP, or work done for the wider PR24 process.

Customers were asked as a final exercise to create a BVP based on everything they had heard and learnt across the workshops. The key outcomes are listed below and shown in Figure 47.

- Reducing internal sewer flooding
- Maintaining and upgrading the current wastewater system infrastructure
- Starting to use SuDS where appropriate
- Customer education
- Working in partnership with key organisations such as the EA and (building) developers
- Reducing external sewer flooding
- Reducing environmental pollution by improving/reducing storm overflow outcomes and wastewater flow and compliance

Figure 47: Summary of workshop outputs: BVP outcomes



Key elements for BVP to include

Best Value Plan

- Reduce internal sewer flooding
- Maintain and upgrade current drainage/sewage infrastructure
- Nature-based SUDS
- Customer education & incentives
- Work in partnership with relevant organisations
- External sewer flooding
- Reduce environmental pollution by improving storm overflows and wastewater flow & compliance

How to pay for BVP

The majority of customers are willing to increase their bills
- 16% want no increase
- 11% only if increase is affordable

£1 - £5 a month

(£3.60pm average with £5pm the most popular choice)

1% - 10% per annum

(3% average with 10% the most popular choice)

BVP Timings

Timescales should be shorter with attainable short-term targets for certain elements.

→ Shorter time frames for targets

→ Steady improvement over longer-term

→ Transparency and greater communication of where money is invested

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turquoise

Source: Turquoise on behalf of Yorkshire Water

Customers' priorities for the short-term were around us hitting targets and maintaining the network:

- Meet the targets; particularly internal and external sewer flooding, especially in high-risk areas and demonstrate improvements.
- Reduce the amount of pollution incidents to rivers from storm overflows.
- Maintain the sewage network, for example, removing blockages.
- Reduce clean (drinking) water network leaks per year – leaks have a knock-on impact on wastewater in the system as they enter the sewers and limit their capacity.
- Reduce blockages and educate customers about preventing blockages.
- Start to change customers, both household and business, mindsets, and behaviour towards taking personal responsibility for surface run off potentially by installing water butts or rain gardens.
- Encourage customers to install water meters – again, reduced clean water usage would mean less pressure on the wastewater system.
- Work with other agencies like councils and EA.

Customers' priorities for the medium-term were around making improvements and adapting to future challenges:

- Improve the sewage network using a combination of nature-based solutions (SuDS) and tried and tested /carbon intensive methods i.e., building bigger tanks and sewers.
- Work with developers to use new ways to deal with excess run off.
- Use Government legislation with developers so they use SuDS.
- Continuing to change customers' mindsets, both household and business, and behaviour towards taking personal responsibility for surface run off.
- Reduce the amount of river pollution incidents linked to storm overflows and/or sewage escapes.

For the longer-term customers wanted YW to look towards exceeding targets and continuing to adapt to future challenges:

- Improve the sewerage network using a combination of nature-based solutions (SuDS) and tried and tested/carbon intensive methods such as building bigger tanks and sewers.
- Utilise excess water by storing it for future use.
- Have more stringent standards for treated sewage effluent.
- Have fewer or no river pollution incidents so river quality is improved.
- Exceed the standards.
- Continue to change customers, both household and business, mindsets, and behaviour towards taking personal responsibility for surface run off

6.5 Other stakeholder engagement

6.5.1 Yorkshire Forum for Water Customers

The DWMP team have had regular meetings with the Yorkshire Forum for Water Customers to discuss the DWMP and share and shape progress. The Yorkshire Forum for Water Customers was brought together by YW under the guidance of the Independent Chair to support the company to manage its business in the best interests of its customers.

In preparation for the next price review for the regulatory period 2025 to 2030, the forum will challenge YW on behalf of its Board to ensure the business plan fairly reflects customers views gained from quality customer engagement and that it is delivering on its performance commitments. The Yorkshire Forum for Water Customers are responsible for:

- reviewing progress against our existing performance commitments
- providing on-going challenge to Yorkshire Water on the quality of customer engagement for the 2025-2030 business plan, helping to identify any gaps that need to be addressed., and
- providing independent assurance to the Board of Yorkshire Water on the quality and use of customer research in Yorkshire Water's 2025-2030 business plan

The Yorkshire Forum for Water Customers membership is made up of a number of customer and stakeholder representative bodies. The Forum is currently independently chaired by Andrea Cook OBE. Members currently represent Consumer Council for Water (CCW), Natural England (NE), National Farmers Union (NFU), organisations concerned with vulnerability and affordability, EA, and other community leaders.

7. Asset Health and Performance Commitments linked to DWMP

Whilst our DWMP has focused mainly on the hydraulic nature of our sewer network, overflows and wastewater treatment works flow and compliance, we also undertake work across our assets classed as 'business as usual' and generally funded from base maintenance. These activities are those which we carried out every day to ensure that our assets are operated and maintained to deliver the required service to our customers and protect the environment. Our sewer network is a mixture of foul, surface and combined sewers and storm overflows which require regular proactive maintenance and reactive responses. We have telemetry alarm systems and predictor tools that inform us of issues and may also receive customer contacts that alert us to issues. The majority of our reactive customer contacts and subsequent incidents relate to asset health metrics; blockages and collapses of sewers, with around 5% of incidents caused by confirmed hydraulic overloading of the wastewater system. The impact of these incidents can be internal or external flooding or properties or pollution incidents. We have regulatory performance commitments which track our performance in respect of these impacts. AMP8 will see the introduction of a new performance commitment which will track the average spill frequency of our storm overflow assets. In order to minimise spills, prior to any scheme investment to address hydraulic requirements, we aim to keep our overflows clear of blockages and monitor their performance.

We have an internal fleet of jetting resources, CCTV and vactor capability to undertake our proactive and reactive work on the sewer network and associated storm overflows. This includes a repair and maintenance contract for civils repairs. Our teams undertake proactive maintenance visits to all our storm overflows and identified hotspot sewers. We define our hotspot areas based on the last 5 years flood and pollution data to focus on highest risk properties and assets. We undertake desilting activities to ensure our sewers have sufficient capacity particularly in storm conditions and undertake sweep jetting of our sewers in known blockage hotspot areas. We are also looking to undertake a new communications education campaign focusing in on areas with the highest history of blockages caused by fats and wipes and flushing unsuitable materials.

We are currently installing sewer gully loggers in areas of high-risk internal sewer flooding. With over 22,000 already installed and plans to deliver up to 40,000 in total, within the next year, these loggers provide a telemetry system early warning. Systems logic then generates alarms and an operational response in order that the team attend site can resolve any blockage that is forming before it creates a potential impact, such as an internal property flooding or pollution. Details surrounding our innovation programme and pilots can be found in Section 8.

Alongside identifying and resolving issues relating to sewer flooding, we also carry out proactive and reactive work to reduce or resolve pollution incidents. Our Pollution Incident Reduction Plan (PIRP) 2022-2025 can be found on the below link.

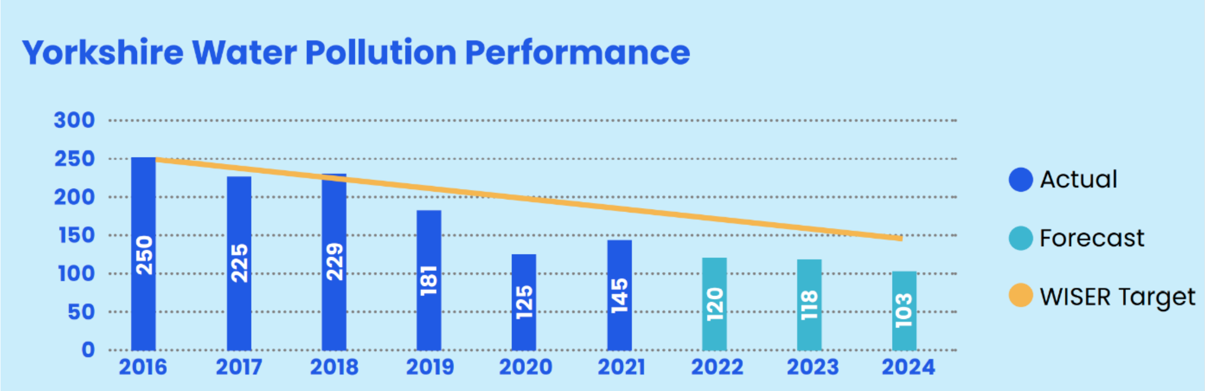
https://www.yorkshirewater.com/environment/pollution/

Our pollution incident reduction plan explains how we will reduce pollution incidents across our asset base. Our plan is aspirational and will be dynamic as it evolves to meet the scale of the challenge and develop and deploy the most cost-effective solutions.

One of the main causes of pollution is blockages in the sewer network. In Yorkshire we have 52,000Km of sewer network and respond to around 38,000 network escapes a year which are typically caused when the wrong things are flushed down the toilet or drained in the sink. 70% of all blockages are caused by wet wipes which is why we've called for a ban on plastics in all single-use sanitary items, as well as an end to 'fine to flush' labelling and the introduction of mandatory 'do not flush' warnings on all packaging.

We recognise the need to eliminate pollution incidents, particularly the most serious incidents. The Environment Agency expects all water companies to prevent serious pollution incidents and requires us to have effective pollution reduction plans to minimise the less serious 'category 3' incidents. Using 2016 performance as a baseline, the Environment Agency expects a 40% reduction in total pollution by 2025. For us this represents having no more than 150 pollutions per year by 2025, however, we're committed to going further and plan to outperform this target so that we have no more than 103 incidents per year by 2025. This can be seen below in Figure 48.

Figure 48: YW pollution performance



Source: YW Pollution Incident Reduction Plan (PIRP) 2022-2025

There are five enabling themes within our PIRP relating to storm overflows, sewers, SPS's and WwTWs:

1. Process improvement and governance

2. Training, competence and culture
3. Data and Technology
4. Maintenance and investment
5. Risk and assurance

On the sewer network this includes over 1,000 network monitors at high-risk manholes close to watercourses. This allows us to spot when blockages are forming, so that we can respond and remove them before they cause a pollution incident. We also deploy an intelligent sewer maintenance approach using data-based approach to network maintenance using asset condition, incident history, proximity to water course, job history and weather data to inform our proactive maintenance plans. Alongside this we have a dedicated sewer overflow maintenance team and over 3,500 monitor points to detect issues relating to storm overflows that enable us to react quickly to reduce pollution risk. We are currently reviewing our maintenance schedules to ensure they are fit for the future.

In respect of our Sewage Pumping Stations (SPSs), we have three main strategies for minimising pollution incidents from these assets; wet well cleaning, intelligent pump reversal and electrical signature analysis. Even with wet well cleaning, pump blockages often occur on sewage pumping systems due to the inappropriate disposal of wet wipes, sanitary products, and kitchen waste such as fats, oils and grease. We're installing equipment to provide automatic recognition of a blockage which will then mean the pump flow can be reversed, thus relieving the blockage prior to any potential pollution and enables us to have more time to deploy a colleague to site to fully resolve the cause. We have installed electrical signature analysis to monitor motor performance of rotating equipment including pumps. This technology analyses the electrical current to determine if there is a problem developing prior to failure. Upon detection we're able to dispatch an engineer prior to it failing and potentially causing a pollution incident.

Rising Mains associated with our SPSs also present a pollution risk when they fail. We've installed pressure monitors on 60 of our highest risk rising mains which will provide us with live performance information. Using pre-set triggers, the system highlights where an asset is drifting outside of its expected operating envelope, which can be an indication of failure or a developing problem. This will enable us to respond quickly to any developing issues and resolve them before they cause a pollution incident.

At our WwTW assets, we are continually monitoring alarms and have installed a system of intelligent alarms to enable us to respond to flow related issues and reduce pollution risk. We are also installing technology to be able to restart pumps following a power failure to reduce pollution risk.

WwTW compliance is driven by an operational and maintenance plan for each site and regular operational visits. We run a trigger system based on operational samples and instrumentation alerts and investigate variance from normal site performance. A number of daily performance reports are shared with the teams to allow close monitoring of all aspects of our treatment processes and final effluent quality compliance. We undertake investigations with our technical team including site visits, additional sampling, and desktop studies. Action plans are implemented once a root cause of any performance variation has been determined. All information is recorded centrally and are reviewed to ensure we are achieving the optimal performance from our WwTW sites.

In order to maintain our assets effectively and deliver service to customers and protect the environment, as measured by our performance commitments (PC), we utilise base expenditure. Base expenditure includes routine year on year costs which companies incur in the normal running of their business in order to provide a base level of good service to customers and the environment. It also includes maintaining the long-term capability of assets, expenditure to comply with current legal obligations and to improve efficiency. Ofwat stated in their final PR24 methodology that they expect '*companies to deliver a transformation in performance to ensure they can meet the long-term requirements of customers and the environment. To deliver this transformation we expect companies to challenge themselves to deliver stretching levels of performance from their base expenditure allowance'*.

As part of our DWMP, we have set out in the associated DWMP data tables a view of our long-term performance forecasts for pollution and flooding performance commitments as well as improvements to asset health, as measured by the sewer collapse performance commitment. Performance against pollution and flooding PCs is predominantly driven by sewer blockage and collapse components of performance, which make up over 95% of our internal sewer flooding incidents. The delivery of the DWMP whilst focusing on hydraulic risk and requirements of the sewer network, will also support the delivery of the PCs and service to our customers in the longer term.

In respect of WwTW compliance, it is forecasted that base expenditure will achieve the 100% target for the Wastewater Treatment Works compliance PC. It will be important that through the delivery of interventions to address flood risk and storm overflow reduction in the network consideration is given to the impact on WwTW. The impacts of these interventions identified in the DWMP will be considered as we deliver each solution so as not to compromise our final effluent quality or compliance at WwTWs.

Beyond AMP8, we have assumed steady improvements in these PC measures which we believe are stretching in the context of what we believe the funding allowance will be but also deliverable. We would anticipate the unit rate of reduction would increase as we move closer to zero on all measures but equally innovation, new ideas, techniques and technology should lead to further improvements.

Delivery of improvements to these PC measures is vital for our customer and environmental aspirations and may support some delivery of the DWMP.

Our data science team collate and interpret our data to enable us to focus on hotspot areas for problem resolution and we utilise a modelling system to review our blockage and collapse data to provide insight into where to focus activity. We have used this data to focus on the top 5% of sewers within our region, ranked by risk of predicted sewer collapse or blockage, as seen in Figure 49 and Figure 50, below. Thematic mapping/hot spotting has been undertaken on a Level 2 rather than regional Level 1 basis to improve visibility of the results.

Figure 49: YW collapse hot spots

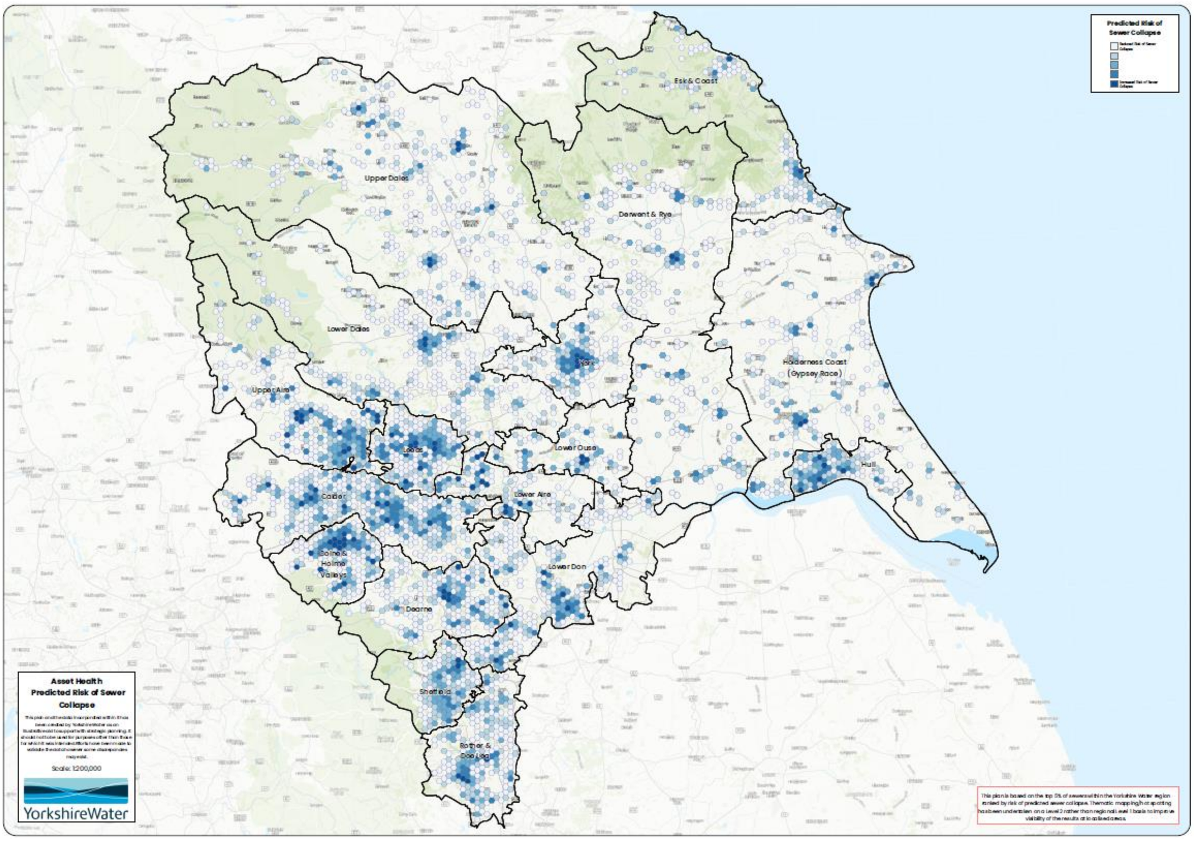
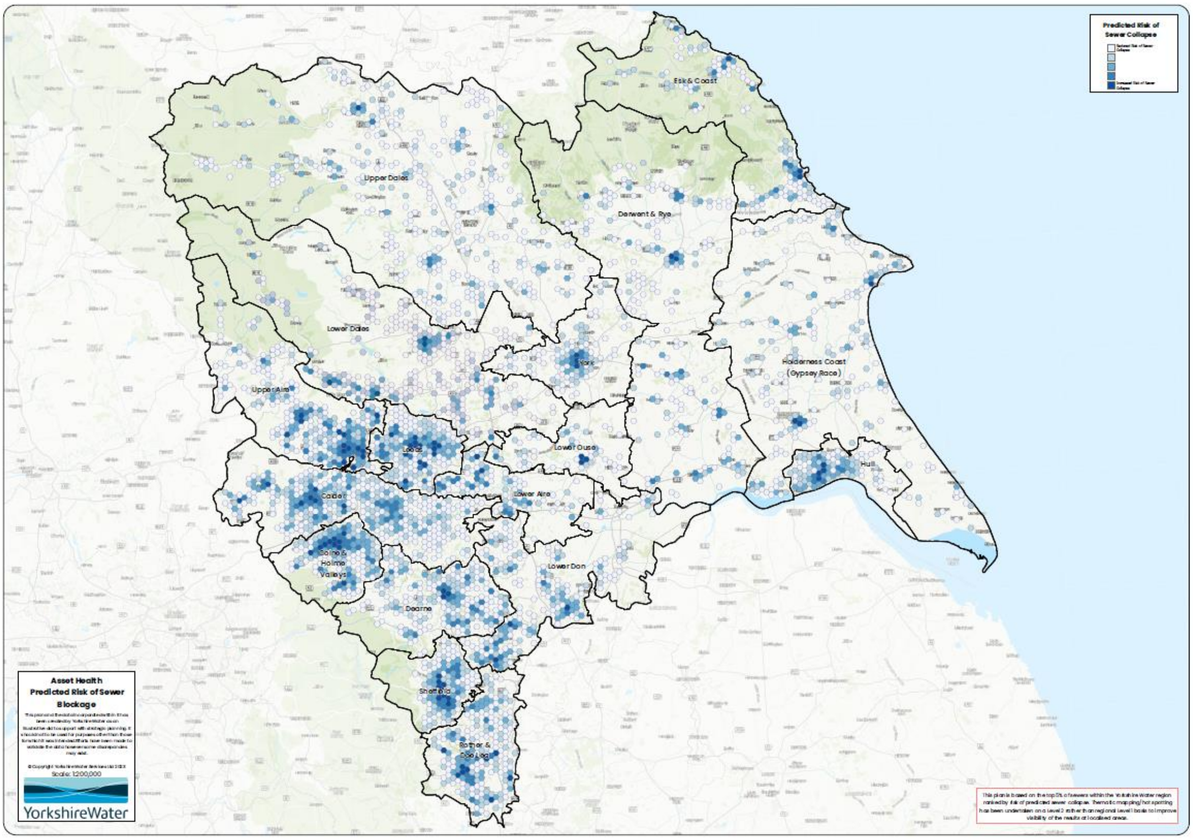


Figure 50: YW blockage hot spots



As can be seen here the areas where we have greatest risk are predominately in our denser urban areas and align with the areas of highest predicted flood risk and the prevalence of storm overflow assets. This presents the opportunity to consider risks holistically and identify best value solutions. Where any scheme or solution is promoted into our project lifecycle, see Section 11.5, we will assess all associated issues and ensure that all opportunities are assessed to reduce or resolve all identified risks in an efficient way, whether they be an asset health risk, a modelled hydraulic risk, or a reported performance risk.

8. Innovation and DWMP

Innovation is integral to the progression of the DWMP through its current and future cycles, ensuring we are finding the best ways to resolve existing and emerging risks. Innovation is key to ensuring we achieve our business plan efficiently. This includes achieving our PC level targets, continuing to deliver efficiently and looking at new technologies and alternative ways to resolve our risks. Our innovation approach includes the use of pilots and trials which we can then be expanded and embed one a detailed review of costs and benefits has been completed. This is also intrinsically linked to our work detailed in Section 7.

8.1 AMP7 Wastewater Network Innovation Projects

Our innovation team are currently undertaking smart wastewater networks pilots in two geographical areas within the region, the town of Ilkley and Holbeck, in south Leeds. There is a designated inland bathing water on the river Wharfe at Ilkley and therefore storm overflow operation and pollution related incidents are a key focus in this catchment. Holbeck has a very high incidence of internal and external sewer flooding.

The purpose of the project is to establish a Smart Wastewater Network, with objectives to:

- demonstrate the ability of 'smart' to enable a systemic approach to Wastewater
- demonstrate the ability of 'smart' technologies to enable 'smart' business processes, and ‘smart’ decision making
- support the developing 'Smart City' concept.

The pilot projects will also address critical strategic and operational business challenges.

In Ilkley 20 cutting-edge water quality monitors are being trialled on the river Wharfe alongside installation of 150 innovative flow and level monitors in the sewer network. Additionally, a trial of Smart and “leaky” water butts will assess the potential to work with the local community to manage and mitigate impact on the wastewater network. The results of the monitor trials on the river Wharfe will inform how YW delivers its duties in respect of the Environment Act. The outcome of the water butt trial will assess the potential for a wider rollout.

In Holbeck we have mapped all the sewer gullies and soil stacks on the Holbeck sewer network utilising new technology. 3,000 assets were surveyed in Holbeck and of these, 2,000 were previously unmapped. This data has been uploaded and incorporated into our corporate mapping system. The technology used has produced high-quality 3D images of our network assets. The project team has also employed data analytics software, utilising machine learning, local rainfall forecasts and e-learning algorithms, alongside our existing telemetry to understand the usual activity and behaviour on the network. From this, the software can detect early sewer blockage formations, help optimise network performance and avoid pollution incidents occurring.

The use of the new asset mapping tools will now be utilised on the wider YW wastewater network. Lessons learnt from this project around integration and data quality requirements are already being taken forward for use on the AMP7 Storm Overflow spill reduction project. The product will be used to predict and prevent pollution incidents on the network, reducing impacts on customers and the environment.

8.2 AMP8 Wastewater Innovation Projects

Our innovation focus for AMP8 for wastewater networks will look to include:

- Full catchment end-to-end asset rationalisation, network control and process optimisation
- System separation
- Network mapping and asset health
- Energy from sewers

8.2.1 Full catchment end-to-end asset rationalisation, network control and process optimisation

This project will be looking to build on the Smart Networks project in AMP7 and 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 storm overflows 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. The extra control in the network will also benefit the downstream wastewater treatment process, delivering a more consistent product and volume for treatment enabling us to reduce energy costs and greenhouse gas emissions.

8.2.2 System Separation

This project will focus on the need to find innovative ways to separate foul water from mixing with surface water in our combined sewers, enabling us to reduce the frequency of spills from storm overflows and reduce property flood risk. This will include opportunities 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 or removing lead supply pipes in the same trench.

8.2.3 Network mapping and asset health

A key enabling activity for both catchment control and system separation is network mapping. With the transfer of private sewer network, to water company ownership in 2011 it was estimated we took on an additional 26,000km of sewer network. This transferred network has a greater share of internal and external flooding incidents associated with it than the remainder of our network. Better understanding our network, both its location and condition, will help us to understand root causes of problems. Building on ideas explored in AMP7 will help us to create the tools, systems and processes required to rapidly map, survey and condition grade our network at an affordable price.

8.2.4 Energy from sewers

Recognising Yorkshire Water's commitment to target net zero, we need to explore how sewers and sewage 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.

8.3 AMP7 Wastewater Treatment Innovation Projects

Alongside evaluating and promoting low carbon, natural, passive wetland-type wastewater treatment processes, which include our Integrated Constructed Wetland solution at Clifton WwTW, "ARMPhos" use at Thornton-le-Beans WwTw and reedbeds at High Royd WwTW, we have been working on development of a Phosphorus Technology Matrix (P-Tech Matrix).

We have deployed a feasibility study of "Oxymem" (Membrane Aerated Biofilm Reactor - MABR) as part of a WINEP scheme at Dewsbury WwTW. This followed a desktop evaluation of the Oxymem

(MABR) solution which Is a "cassette-based" treatment solution which potentially adds treatment capacity to an existing Activated Sludge Plant (ASP) and removes the need for additional infrastructure.

We have supported various projects to explore alternatives to chemical dosing for phosphorus removal, including electrocoagulation and the use of rare earth elements such as Lanthanum. We trialled a prototype return liquor treatment process to recover nitrogen and phosphorous for use as a sustainable fertiliser. This was achieved by reducing the nutrient load In the return liquor, by breaking the nutrient cycle in the treatment process, which liberated process capacity and reduced the need for additional treatment capacity driven by WINEP phosphorous compliance.

Another innovation project is to increase understanding of greenhouse gas process emissions from our wastewater and sludge treatment processes. The programme has trialled a range of measurement and modelling approaches and evaluated emission reduction processes. Work Is ongoing with process emissions across a range of projects we are contributing to:

- Contributing to the Water Industry Process Emissions Community of Practice
- Cranfield PhD to measure and model GHG emissions from treatment wetlands linked to Clifton WwTW
- Contributing to Jacobs and Northumbrian Water's trickling filter emissions project
- Working with Royal Haskoning to measure and model post-digestion GHG process emissions
- Trial of Eliquo Elovac bench-top biogas extraction tests and methane concentration analysis
- Trial of Suez's AirAdvance 360 emissions measurement solution
- Trial of Jacobs' Unisense liquid phase monitoring
- Desktop evaluation of Suez's ActiLayer ASP emissions reduction process

8.4 AMP8 Wastewater treatment key areas of innovation focus

8.4.1 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 (Perfluoroalkyl and Polyfluoroalkyl Substances), pharmaceuticals and AMR (antimicrobial resistance), and other contaminants such as microplastics from wastewater. Greater understanding of candidate technologies is required to inform a response to the need to manage these substances in the future. The preferred approach would be to control these substances at source, but it is likely water companies will need to play a part in reducing these chemicals in the environment. We will need to assess the process efficiency and consequences (i.e. chemical destruction or accumulation in sludge), carbon impact and cost to be able to respond to the need.

8.4.2 Net zero (carbon and process emissions)

A large part of achieving net zero goals will be curtailing process emissions. Building on work started in AMP7, further work Is required to measure wastewater process and fugitive emissions. This is particularly nitrous oxide and methane and will involve characterising all treatment and sludge processes to develop tailored mitigation strategies. We want to be able to demonstrate successful mitigations and enable accurate reporting of greenhouse gas emissions through the carbon accounting workbook. Auto-monitoring and plant control will be required to optimise and balance final effluent compliance, sludge quality, process emissions, carbon, energy and chemical use.

8.4.3 Ammonia recovery

Ammonia production to support agriculture consumes 3% of global energy, with its destruction to protect water health consuming another 2%. We will look to explore ways in which ammonia can be made more sustainable. This may include piloting domestic and/or 'commercial scale' urine separation and source reuse and technologies to recover ammonia from sludge liquors. We will also need to be able to investigate carbon and energy balance of various alternative approaches and explore market viability of each.

8.4.4 Small WwTW

We will investigate opportunities for process and technology improvements to deliver operationally efficient and compliant small, rural wastewater treatment works to complement our wider larger wastewater treatment works compliance.

9. Draft to Final DWMP24

9.1 Consultation dDWMP24

Our consultation was launched on the 1 July 2022 on our dDWMP24 and ran for 12 weeks until 23 September 2022. We posed a number of questions to help us understand what our customers, stakeholders and regulators wanted in terms of direction of our plan, how we had built up the plan and also thinking about the scenarios we had proposed, and the costs of plan presented. Below is a selection of the questions asked.

- Thinking about our Drainage and Wastewater Management Plan 24 overall, how supportive or unsupportive are you of our draft plan? And explain why
- Please rank our four scenarios in order of preference with a score of 1 being the most preferred scenario to 4 being the least. And explain why
- The scenarios are with costs to deliver each scenario using our Best Value Plan (BVP) & least Cost plan optimisation. Can you rank them in order and state why you have chosen each scenario based on BVP or least cost plan
- To what extent do you/your organisation believe that Yorkshire Water should be prioritising partnership working to deliver Drainage and Wastewater Management Plan solutions?
- Finally, do you have any further comments about our Draft Drainage and Wastewater Management Plan or anything we should consider for the next iteration of the plan?

The outcomes of this survey were analysed and are discussed below.

9.2 Consultation Feedback dDWMP24

In response to this consultation, we received responses on our dDWMP24 and Strategic Environmental Assessment (SEA). Responses were received from our regulators Ofwat and the Environment Agency and a number of other stakeholders: Including the Consumer Council for Water (CCW), Natural England and Historic England, a number of Rivers Trusts, five local councils, a catchment-based partnership, a National Park and eleven customers. Ofwat and the Environment Agency provided full written responses to our dDWMP24, with recommendations for improvements in their response. This was also followed up by a multi-agency feedback session facilitated by Defra, which CCW also attended.

There are several key themes included in the responses received. These are:
- Importance of partnership working.
- Support for a Best Value Plan (BVP) approach.
- Requirement to demonstrate compliance with all aspects of the Storm Overflows Discharge Reduction Plan (SODRP[16]).
- Provide increased clarity on the short, medium, and long-term elements of our plan.
- Support for reducing the levels of flood risk at properties.

Figure 51, Figure 52 and Figure 53 show some of the outcomes from our consultation survey.

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[16] https://www.gov.uk/government/publications/storm-overflows-discharge-reduction-plan

Figure 51: Consultation Responses Summary

88% of stakeholders preferred the BVP approach to the DWMP scenarios

The environment & nature-based solutions are key reoccurring feedback points

100% of stakeholders agreed that partnership working is important for YW to deliver DWMP solutions

Figure 52: Preferred Scenario Feedback

Scenario
2

Annual average of no more than **10 spills** per storm overflow, plus **no environmental harm** from storm overflows and **reduced** levels of property flood risk from hydraulic sewer flooding and ensure our WwTWs have sufficient capacity to allow us to remain compliant with our current environmental permits.

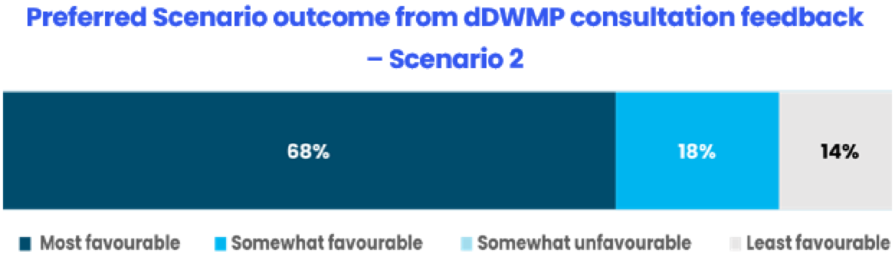

Figure 53: Support for Scenario 2 Best Value Plan (BVP) or Least Cost Plan

66% of responses selected Scenario 2 for Best Value or Least Cost Plan

"We MUST aim for the highest possible environmental outputs and if that means reduced profits, so be it. It's a moral duty to ensure that our consumption of the earths resources do not detrimentally impact on other species that share this planet."

"The focus must be on climate change, reducing flood risk, and being future proof and resilient to our changing climate."

"Reducing environmental harm is still our preferred scenario, however If delivery costs were a limiting factor, then reducing costs may need to be considered.."

The least cost plan doesn't provide the additional multi- benefit outcomes which will be key to community buy in of complex retro fit schemes.

In general, 'best value', solutions should be sought given the impact of any works on customers' bills.

In addition to the individual response to our draft DWMP consultation received from Ofwat, a letter to all water companies was issued on 11 October 2022 providing Ofwat's industry overview of draft Drainage and Wastewater Management Plans[17]. A high-level summary of the comments and feedback themes within this industry overview are summarised below:

9.2.1 Ofwat Industry DWMP Comments

- Company plans on storm overflows are lacking. All or part of the UK government's storm overflow targets have not been included in the DWMPs for English water companies.
- There is insufficient evidence to support the investment needs and inadequate development of costs and benefits of solutions, particularly for schemes with multiple benefits.
- There is a lack of ambition in prioritising improvements from base expenditure, and prioritising nature-based solutions or surface water separation options.
- There is a lack of focus and maturity in partnership solutions

We have taken the comments from the industry overview into consideration in the development of our final DWMP. These are broadly aligned with the individual feedback points we received from Ofwat, outlined below, and we have provided responses to these within our Statement of Response. We have not provided further individual responses to the comments within the industry overview.

9.2.2 Ofwat YW DWMP Bespoke Feedback Themes

- Overall Plan Quality – planning objectives and risk assessment
- Decision Making and Option Appraisal
- Storm overflow reduction plan
- Costs, funding and affordability considerations
- Stakeholder engagement
- Assurance and Governance

This feedback requires us to include all aspects of the storm overflow discharge reduction plan within our DWMP for all storm overflow assets. It also asks us to provide more granular detail on costing and bill impacts of our final plan alongside a fully assured plan.

Within their response to our consultation, the Environment Agency (EA) provided a covering letter, executive summary and supporting document. We have responded to the detailed comments included within the supporting document as this provided the greatest level of detail. The EA feedback themes were broadly consistent with Ofwat's feedback. There were a few differences within the EA feedback, and this included feedback on groundwater, climate change and enhancing our stakeholder engagement. The EA wanted us to ensure we were including all aspects of impacts to groundwater in our plan, that we considered carbon impacts in our solutions and that we work with the EA closer in cycle 2 to embed a more joined up stakeholder engagement plan.

9.3 Statement of Response

We produced and published our statement of response to our consultation feedback at the end of January 2023. Here is a link to the document.

https://www.yorkshirewater.com/media/q3eakdvx/yw-statement-of-response-january-2023.pdf

It outlines feedback to points raised by our regulators, stakeholders and customers. We have answered the query, signposted inclusion in our final draft or will look to incorporate the feedback in cycle 2.

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[17] https://www.ofwat.gov.uk/publication/letter-to-water-companies-ofwats-industry-overview-of-draft-drainage-and-wastewater-management-plans-2022/

9.4 Changes Draft to Final

Based on the feedback we received we have changed our approach to our DWMP between draft and final predominately to incorporate all the storm overflow assets and to develop flood clusters, linking them to storm overflows where applicable.

We have incorporated sensitivity testing within our plan to allow for more alternative climate change rates and also population growth predictions. We have included potential bill impacts for our plan, but this is stand alone and not linked to any bill increases for AMP8 and beyond. This will be subject to our final determination for PR24 from Ofwat.

We have included all relevant wastewater aspects of the WINEP24 within our plan costs and reviewed our approach to short-, medium- and long-term planning. We have included asset health metric and performance commitment information within our final plans to increase the robustness of the plan in the long-term.

We have reworked the Options Development and Appraisal sections to reflect our new approach to solution build up, costing and benefits appraisal.

The focus on the plan has evolved between draft and final, with the significant scale of the SODRP influencing the scale and pace of interventions within the plan. As part of the process, we have carried out a modelled hydraulic flood risk assessment which considers the scale of the risk in 2050. The increase in risk, predominantly from climate change and urbanisation means that we forecast that by 2050, c73,000 properties in Yorkshire are modelled as being at risk from flooding from hydraulic causes. We have sought to maintain the link between blue green infrastructure solutions to reduce storm overflows spills and the beneficial impact this will have on flood risk. This has been included in the DWMP data tables. Interventions to reduce the 2050 modelled hydraulic flood risk have been phased into the long-term plan. These risks and interventions have been identified using a high-level approach based on the volume of 'flood water' that would require storage in the network, or attenuation through blue-green infrastructure solutions. These high-level solutions will require further validation and development as part of cycle 2 of the DWMP.

Although the DWMP plan is primarily driven by the SODRP, as described the link has been maintained to flood risk reduction and to performance and risks associated with our WwTW and asset health metrics which have been built into the plan. This will facilitate selection of the most effective and efficient solutions to address risks in the short and long term.

10. Process steps and methodology

10.1 Risk Based Catchment Screening (RBCS)

Risk Based Catchment Screening (RBCS) is one of the first processes completed during the development of the DWMP. All the Level 3 catchments within the YW region have been subjected to a high-level risk-based assessment against a series of indicators to establish potential levels of risk, both now and in the future. Those catchments identified as carrying higher levels of risk proceed to the more detailed Baseline Risk and Vulnerability Assessment (BRAVA). The RBCS process allows effort during the subsequent phases of developing the DWMP to be focussed on the catchments requiring more immediate intervention. We have only completed the RBCS screening process once and have not repeated the process as referred to within the guidance. This would have provided limited changes to the catchments prioritised for BRAVA.

10.1.1 Approach

The 617 Level 3 WwTW catchments within our region were assessed against a range of indicators also referred to as screening criteria. This was generally undertaken using information available from existing YW reporting systems or from other relevant stakeholders or Risk Management Authorities (RMAs). The assessment was completed in October 2019. In order to standardise the assessment, Water UK identified 17 standard indicators to be used by each water company to undertake this high-level assessment.

The 17 standard indicators can be viewed within the DWMP Framework Document – '*Appendix B Risk-based Catchment Screening*' (September 2019)[18]:

Table B-1, within the Framework Appendices for RBCS, illustrates and describes how to assess each indicator and lists the trigger criteria used to advance the catchment to the subsequent BRAVA investigations.

The 17 standard indicators were identified as either 'first tier' or 'second tier' to help differentiate between the priority of each indicator when considering whether further assessment is required. Generally, all criteria were classed as 'first tier' except for the following which were classed as 'second tier':

- Catchment characterisation (stage 2 of the wastewater resilience metric methodology).
- Continuous or intermittent discharges impact upon sensitive receiving waters (part B).

The following process, as detailed within the RBCS appendix of the DWMP framework, was followed when summating the total number of breaches of screening criteria across both indicator tiers:

- If **two or more** indicators are breached (excluding sewer collapses and blockages – see third bullet) then a BRAVA is required to identify whether and to what extent changes in future inputs impact on planning objectives.
- If **one** indicator is breached (again, excluding sewer collapses and blockages – see next bullet) then a BRAVA is required, if the indicator causing the single breach is included within the first tier.
- If **only** the sewer collapses and/or blockages indicators are breached then this is to be treated as if no indicators are breached, i.e., there is no requirement to undertake the DWMP BRAVA and problem characterisation steps.
- If **no** conditions are met this implies that there is no current evidence to suggest that the Level 3 catchment is likely to be vulnerable to changes in future inputs and therefore a detailed baseline risk and vulnerability assessment is not required.

10.1.2 Methodologies

We have developed a series of methodologies that are broadly in line with the processes detailed within the RBCS appendix of the DWMP framework and are summarised below. We have assessed and reported the number of catchments triggering on each indicator. This then allows the above tiered approach to be applied to determine the number of catchments progressing to BRAVA.

Several of the methodologies utilise data from a preceding three-year period, this varies between calendar years and financial years dependent on the individual assessment. When referring to calendar years, this covers the period from 1 January 2016 to 31 December 2018 with individual years running from 1 January to 31 December. When referring to financial years, this covers the period from 1 April 2016 to 31 March 2019 with individual years running from 1 April to 31 March.

10.1.2.1 Catchment characterisation (Tier 2)

This is in-line with the Water UK DWMP framework documentation '*Stage 2 of the wastewater resilience metric methodology'* and part of the common PR19 performance commitment.

The categorisation was based on several criteria such as how steep the catchment was, was there a reliance on pumping, did the catchment have more than 75% combined system, any previous hydraulic flooding incidents and how rapid the response to rainfall was. This assessment was initially undertaken on our Drainage Area Zones (DAZs) rather than at an individual Level 3. YW

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[18] **https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-B.pdf**

corporate systems utilise DAZs which are spatial areas, defined to represent either a single WwTW catchment, a collection of WwTW catchments or a broadly hydraulically independent area of network within a WwTW catchment. Each DAZ was classified with a score from 1 to 5 (low to high) based on the above criteria, with those scoring a 4 or 5 triggering against this indicator. Where a DAZ intersects more than one Level 3 catchment, all catchments intersecting that DAZ were given the same characteristic score. Where a Level 3 catchment intersected more than one DAZ, an assessment was made as to whether the catchment should trigger or not based on whether any of the individual DAZ characteristic scores suggested triggering should occur and the proportion of overlap between the DAZs and the Level 3.

Following the above methodology, the RBCS assessment triggered 616 catchments on this indicator. The Micklefield catchment was identified as the only catchment which did not trigger.

10.1.2.2 Intermittent discharge impacts upon bathing or shellfish waters

This assessment was undertaken using the YW Event Duration Monitoring (EDM) database to identify those overflows discharging to bathing waters, and these compared against the EA bathing water quality classification. Any catchment containing an overflow discharging to a bathing water that did not achieve good classification in 2019 triggered on this indicator. There are no designated shellfish waters within the YW region.

Following the above methodology, the RBCS assessment triggered two catchments on this indicator. The Bridlington & Scarborough catchments were the only catchments where bathing water was not classed as meeting Good in 2019.

10.1.2.3 Continuous or intermittent discharge impacts upon other sensitive receiving waters – Part A

This assessment was undertaken using Natural England's Designated Sites dataset and reviewing where YW are the responsible party for remedies associated with freshwater pollution, with a financial year for completion post the DWMP baseline year of 2020. Where a catchment contains an asset associated with the remedy, this would result in the catchment triggering.

Following the above methodology, the RBCS assessment triggered no catchments on this indicator.

10.1.2.4 Continuous or intermittent discharge impacts upon other sensitive receiving waters – Part B (Tier 2)

This assessment was undertaken using Natural England's Designated Sites dataset and reviewing where YW are the responsible party for threats associated with water pollution, with a financial year for action post the DWMP baseline year of 2020. Where a catchment contains an asset associated with the threat, this would result in the catchment triggering. Upon review of this data all asset associated with a threat had either been investigated and resolved or proven not to be an issue.

Following the above methodology, the RBCS assessment triggered no catchments on this indicator.

It is noted that the required actions for some threats due for completion before the baseline year of 2020 were investigations which may identify the need for future investment. Whilst this hasn't resulted in the Level 3 catchment triggering on this indicator a review has confirmed all Level 3 catchments associated with such an investigation have proceeded to BRAVA based on other metrics.

10.1.2.5 Storm Overflow Assessment Framework (SOAF)

This assessment was undertaken based on those YW storm overflow assets identified as requiring a SOAF investigation. These investigations are included in the WINEP element of our PR19 programme based on a previous assessment of spill frequency. Any Level 3 catchments which included a storm overflow requiring a SOAF investigation triggered against this indicator. Some manual analysis was required to check appropriate matching of storm overflows to Level 3 catchments as a result of YW systems utilising DAZs.

Following the above methodology, 74 catchments triggered on this indicator.

10.1.2.6 Capacity Assessment Framework (CAF)

This assessment was undertaken utilising results from our existing hydraulic model stock to establish the return period at which surcharge is first predicted in pipes. Scores were assigned to individual pipes based on the return period and then scores aggregated to Level 3 catchments in line with the methodology detailed in the Capacity Assessment Framework[19]. Any catchments scoring a 4 or 5 have triggered against this indicator. No assessment has been undertaken for catchments without a model due to a lack of available data.

Following the above methodology, the RBCS assessment triggered 90 catchments via this indicator out of a possible 226 that had available data.

10.1.2.7 Internal Sewer Flooding (ISF)

The internal sewer flooding assessment was undertaken using a dataset containing the locations of all internal sewer flooding incidents occurring during the last three financial years. Incident data is based on YW Performance Commitment reporting methodologies for AMP6.

The incident data was mapped to individual Level 3 catchments and the following approaches taken based on the catchment Population Equivalent (PE):

- **Catchment with PE < 2,000** – Each catchment was assessed and any which contained an internal sewer flooding incident during the entire three-year period triggered.
- **Catchments with PE > 2,000** – The number of properties connected to the sewer network was identified for each catchment and the catchment triggered if the following criteria detailed in the RBCS Appendix of the DWMP methodology were met:
    - Annual flooding incidents (number per 10,000 connected properties) in any of the preceding 3 years is greater than the baseline value for upper quartile performance (annual flooding incident rate of >1.68 per 10,000 connections) and,
    - The number of incidents is >1 in total over the last three years, excluding any incidents where permanent measures have been put in place to address the root cause of the sewer flood risk (e.g., permanent solutions for hydraulic overload or sewer defect rehabilitation).

Following the above methodologies, five catchments with population equivalent less than 2,000 triggered on this indicator, whilst 120 catchments with population equivalent greater than 2,000 triggered. Therefore, a total of 125 catchments triggered on this indicator.

The flooding incident dataset used for this assessment included non-reportable incidents. As the upper quartile target is representative of reportable incidents only, the approach taken is conservative. It should also be noted that incidents attributed to collapses were discounted from the assessment on the assumption that the issue would have been rectified. Sensitivity testing has been undertaken to establish the impact on the RBCS assessment if undertaken using reportable incidents only and including those incidents attributed to collapses, the results of which are summarised below:

- A total of 98 catchments would trigger on this indicator including collapses and excluding non-reportable incidents.
- 28 catchments which have triggered in our RBCS assessment would not trigger if using the differing incident data. All of these catchments would proceed to BRAVA regardless of this due to triggering on other RBCS indicators.

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[19] **water.org.uk/wp-content/uploads/2018/12/Capacity-Assessment-Framework-Project-Report-Final.pdf.**

- 1 catchment did not trigger in our RBCS assessment but would trigger using the differing incident data. This catchment proceeded to BRAVA due to triggering other RBCS indicators.

10.1.2.8 External Sewer Flooding (ESF)

The external sewer flooding assessment was undertaken using a dataset containing the locations of all external sewer flooding incidents occurring during the previous three financial years. Incident data is based on YW Performance Commitment reporting methodologies for AMP6.

The incident data was mapped to individual Level 3 catchments and the following approaches taken based on the catchment PE:

- **Catchment with PE < 2,000** – Each catchment was assessed and any which contained more than 10 external sewer flooding incidents during the entire three-year period triggered.
- **Catchments with PE > 2,000** – The number of properties connected to the sewer network was identified for each catchment and the catchment triggered if the following criteria detailed in the RBCS Appendix of the DWMP methodology were met:
    - Annual flooding incidents (number per 10,000 connected properties) in any of the preceding three years is greater than the baseline value for upper quartile performance (annual flooding incident rate of >17.07 per 10,000 connections) and,
    - The number of incidents is >10 in total over the last three years, excluding any incidents where permanent measures have been put in place to address the root cause of the sewer flood risk (e.g. permanent solutions for hydraulic overload or sewer defect rehabilitation).

Following the above methodologies, 11 catchments with population equivalent less than 2,000 triggered on this indicator, whilst 152 catchments with population equivalent greater than 2,000 triggered. Therefore, a total of 163 catchments triggered on this indicator.

The flooding incident dataset used for this assessment included non-reportable incidents. As the upper quartile target is representative of reportable incidents only, the approach taken is conservative. It should also be noted that incidents attributed to collapses were discounted from the assessment on the assumption that the issue would have been rectified. Sensitivity testing has been undertaken to establish the impact on the RBCS assessment if undertaken using reportable incidents only and including those incidents attributed to collapses, the results of which are summarised below:

- A total of 132 catchments would trigger on this indicator including collapses and excluding non-reportable incidents.
- 31 catchments which have triggered in our RBCS assessment would not trigger if using the differing incident data. 29 of these catchments would proceed to BRAVA regardless of this due to triggering on other RBCS indicators.

10.1.2.9 Pollution incidents (Category 1, 2 and 3)

The pollution incidents assessment was undertaken using a dataset containing all category 1, 2 and 3 pollution incidents occurring during the previous three financial years.

The incident data was mapped to individual Level 3 catchments with a catchment triggering if any of the following criteria were met:

- For any of the previous three years data, a category 1 or 2 incident has occurred; or,
- For the previous 3 years data the performance for the catchment is classed as ‘Amber’ or ‘Red’ (for 2017, this being greater than 25 incidents per 10,000 km of sewer); or,

- Where at least one category 3 wastewater incident has been recorded in the last 3 years and measures have not been put in place to address pollution risk.

Following the above methodology, the RBCS assessment triggered 140 catchments on this indicator.

10.1.2.10 WwTW quality compliance

Data was obtained from the YW Wastewater Asset Planning Team detailing the WwTWs which had failed to achieve quality compliance, in line with the Environmental Performance Assessment (EPA) criteria, in the previous three calendar years. A failing WwTW during any of the three years resulted in the Level 3 triggering.

Following the above methodology, the RBCS assessment triggered 21 catchments on this indicator.

10.1.2.11 WwTW Dry Weather Flow (DWF) compliance

For all treatment works where appropriate flow measurement is undertaken, measured Q90[20] flow data was obtained from the YW Wastewater Planning Asset Team for the preceding five calendar years, 2014-2018. For any WwTW where the measured Q90 exceeded the DWF permit limit for two consecutive years, this resulted in the Level 3 triggering.

Following the above methodology, the RBCS assessment triggered nine catchments on this indicator.

10.1.2.12 Storm overflows

We have collated available data and evidence to identify any potential risk of overflows breaching their environmental permits, in line with the methodology detailed within the RBCS appendix of the DWMP framework.

Following this methodology, the RBCS assessment triggered 34 catchments on this indicator.

10.1.2.13 Risks from interdependencies between other Risk Management Authority (RMA) systems

We have taken two approaches to this indicator, identifying where we already know other RMAs have concerns through previous stakeholder engagement and assessing the potential level of risk within the catchments based on the Environment Agency's Flood Zone 3 Flood Map which provides an indication of areas with a 1 in 100 (1%) or greater chance of flooding each year from rivers; or with a 1 in 200 (0.5%) or greater chance of flooding each year from the sea.

A spatial assessment was undertaken to establish if 30% or more of the area within each Level 3 catchment falls within Flood Zone 3, if this was the case, the catchment triggered on this indicator. It was considered that if 30% of the catchment is at risk of regular flooding, an improved level of understanding of our drainage risks within this catchment would be beneficial.

Following the above methodology, the RBCS assessment triggered 46 catchments on this indicator, including the Goole, Bentley and Hull catchments; these have a known history of major flood events.

Testing was undertaken to establish the impact that selecting a threshold different to that of 30% had on the number of catchments proceeding to BRAVA. Reducing the threshold by 10% would result in 9 fewer Level 3 catchments proceeding to BRAVA, increasing the threshold by 10% would result in a further 10 Level 3 catchments requiring a BRAVA. The total population associated with these catchments is in the region of 1650 in both cases, this is not considered to be significant in terms of the overall population progressing to BRAVA. When reviewing this screening indicator in future cycles of DWMP development, consideration will be given to utilising additional data and information, particularly that arising through enhanced partnership working.

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[20] Q90 is a measure of total daily volume arriving at the treatment works. Total daily volumes are in excess of this value for 90% of the year.

10.1.2.14 Planned residential new development

We utilised our existing population projection dataset, provided by our consultant Edge Analytics in 2016, and containing population projections mapped to census enumeration districts. This included the projected data for the 2020 baseline as well as 2030 (10 year) and 2045 (25 year). This data was then assessed in conjunction with the thresholds detailed in *Figure B-1* and *Table B-3* of the Water UK DWMP Framework Documentation *'Appendix B Risk-Based Catchment Screening'*[21].

A catchment triggered if the 10-year and 25-year projected populations exceeded the thresholds detailed within the framework. We have elected not to trigger catchments which would trigger based on exceedance of the 25-year projection threshold alone. This approach was taken due to the level of uncertainty associated with longer term projections. Sensitivity testing confirmed that a further 26 catchments with a population of approximately 15,000 would have progressed to BRAVA if we had assessed against the 25-year threshold. We will continue to monitor these catchments and the approach taken to this metric during subsequent cycles of DWMP development.

Following the above methodology, the RBCS assessment triggered 187 catchments on this indicator.

10.1.2.15 Water Industry National Environment Programme (WINEP)

The WINEP at the time of screening was reviewed to identify catchments within which an existing WINEP WwTW investigation was planned, or there was an existing WINEP scheme that would not be completed before the DWMP investment year of 2025. This allowed us to work efficiently by not duplicating effort on existing WINEP schemes.

Following the above methodology, the RBCS assessment triggered 104 catchments on this indicator.

10.1.2.16 Sewer collapses

The sewer collapses assessment was undertaken using a dataset containing the locations of all sewer collapse incidents occurring during the previous three financial years.

The incident data was mapped to individual Level 3 catchments and the following approaches taken based on the catchment PE:

- **Catchment with PE < 2,000 –** Assessment was undertaken and a trigger occurred when 2 or more collapse incidents were identified within the Level 3 in any of the previous years.
- **Catchment with PE > 2,000 –** Further GIS analysis was undertaken to establish the total length of sewerage within each of the Level 3 WwTW catchments and normalisation undertaken using this. The average YW collapse rate for 2018/19 was calculated, and trigger occurred if the Level 3 catchment collapse rate was greater than the YW average.

Following the above methodologies, 100 catchments with population equivalent less than 2,000 triggered on this indicator whilst 82 catchments with population equivalent greater than 2,000 triggered. Therefore, a total of 182 catchments triggered on this indicator.

10.1.2.17 Sewer blockages

The sewer blockages assessment was undertaken using a dataset containing the locations of all sewer blockage incidents occurring during the previous three financial years.

- **Catchment with PE < 2,000 –** Assessment was undertaken, and a trigger occurred when 2 or more blockage incidents were identified within the Level 3 in any of the previous years.
- **Catchments with PE > 2,000 –** Further GIS analysis was undertaken to establish the total length of sewerage within each of the Level 3 WwTW catchments normalisation

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[21] https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-B.pdf

undertaken using this. The average YW blockage rate for 2018/19 was calculated, and trigger occurred if the Level 3 catchment blockage rate was greater than the YW average.

Following the above methodologies, 237 catchments with population equivalent less than 2,000 triggered on this indicator whilst 151 catchments with population equivalent greater than 2,000 triggered. Therefore, a total of 388 catchments triggered via this indicator.

10.1.3 RBCS screening results

The number of Level 3 catchments that triggered against each of the indicators is summarised in Table 8. We have used the results of each indicator and applied the tiered approach as described in Section 10.1.1 to determine the catchments that required the next stage in the DWMP process which was BRAVA. This resulted in 335 Level 3 catchments progressing through to BRAVA. The remaining 282 Level 3 catchments have been assigned a runway of “Observe” for the purposes of the DWMP. These will be subject to review during future cycles of DWMP development.

Table 8: RBCS Triggers per Catchment

Trigger	No of Catchments that Triggered
Catchment Characterisation (Tier 2)	616
Bathing or Shellfish Waters	2
Discharge to sensitive waters (part A)	0
Discharge to sensitive waters (part B) (Tier 2)	0
SOAF	74
CAF	90
Internal Sewer Flooding	125
External Sewer Flooding	163
Pollution Incidents	140
WwTW Q compliance	21
WwTW DWF compliance	9
Storm Overflows	34
Other RMA systems	46
Planned Residential Development	187
WINEP	104
Sewer Collapses	182
Sewer Blockages	388

The individual RBCS results for each of the 617 Level 3 catchments is provided within the catchment summaries provided in Appendix D. These are also collated and summarised for each Level 2 within Appendix C.

10.2 Planning objectives

The DWMP framework outlines the need for risks to be measured against a series of planning objectives. Where possible, our planning objectives align with our standard performance commitments but focusing on hydraulic capacity for the first cycle of the DWMP. We have shared these with our stakeholders via the Yorkshire Leaders Board for comment. By measuring both our current and future performance against these, as part of BRAVA, we can identify where interventions and investment may be required.

10.2.1 National planning objectives

We worked collaboratively with the other water companies and Water UK to establish six national planning objectives against which outputs were produced by all Water Companies and provided to key stakeholders for review in December 2020 for information.

The six national planning objectives are summarised below:

PO-01:	Risk of sewer flooding in a 1 in 50-year storm
PO-02:	Storm overflow performance
PO-03:	Risk of wastewater treatment works quality compliance failure
PO-04:	Internal sewer flooding risk
PO-05:	Pollution risk
PO-06:	Sewer collapses risk

Further detail on the approach taken to establish these planning objectives and the methodologies for assessing against them during BRAVA is provided in the technical note, BRAVA planning objectives for the first cycle of DWMPs[22], produced by Water UK. A summary of the national planning objectives is provided in Table 9 below.

Table 9: National planning objectives summary

Ref	Planning objective	Description
PO-01	Risk of sewer flooding in a storm	Percentage of population at risk of sewer flooding in a 1-in-50-year return period storm for the Baseline (2020) and the long-term (2050) timeframes.
PO-02	Storm overflow performance	The performance of both network overflows (Storm Overflows) and WwTW storm tank overflows for the Baseline (2020) and the long-term (2050) timeframes.
PO-03	WwTW compliance	Performance of wastewater assets to treat and dispose of sewage in line with the discharge permit conditions imposed on sewage treatment works for both the Baseline (2020) and the long-term (2050) timeframes. Measure includes the performance of water treatment assets for the water supply service in line with the discharge permit conditions imposed on water treatment works. The discharge permit compliance metric is reported as the number of failing sites and not the number of failing discharges.
PO-04	Internal sewer flooding	The number of internal flooding incidents per year (hydraulic overload and other causes) only for the Baseline (2020) timeframe. This includes sewer flooding due to severe weather events normalised into incidents per 10,000 connected properties.
PO-05	Pollution incidents	Category 1 – 3 pollution incidents normalised into incidents per 10,000km of wastewater network and only for the Baseline (2020) timeframe.
PO-06	Sewer collapses	Number of sewer collapses normalised into incidents per 1,000km of wastewater network and only for the Baseline (2020) timeframe. Include bursts to rising mains, even where failures are accidental rather than due to weakness in pipe condition.

We discuss our approach to assessing our levels of risk against these national planning objectives in Section 10.3.2.

10.2.2 Our bespoke planning themes

We have built upon the national planning objectives, and in some instances, expanded our asset performance assessments beyond the stated requirements, in order to understand our risk position against three key themes that reflect our strategic drive and ambition, shown below in Table 10.

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[22] https://www.water.org.uk/wp-content/uploads/2020/07/BRAVA-planning-objectives-for-the-first-cycle-of-DWMPs.pdf

Through the refinement of the national planning objectives, we have introduced an increased level of granularity to improve our understanding of our asset performance and associated risk position to inform the development of our plan.

Table 10: Strategic ambition and bespoke planning objectives

We take care of your wastewater and protect you and the environment from sewer flooding	PO-07: Managing risk of internal property sewer flooding from hydraulic causes (1 in 30 year) PO-08: Managing risk of external flooding within the property curtilage from hydraulic causes (1 in 30 year)
We protect and improve the water environment	PO-09: Managing Storm Overflow Performance PO-10: Wastewater Treatment Works (WwTW) Flow Compliance PO-11: Wastewater Treatment Works (WwTW) Quality Compliance
A resilient future network*	PO-12: Managing risk of internal property sewer flooding from hydraulic causes PO-13: Managing risk of external flooding within the property curtilage from hydraulic causes

*this represents the Risk of 1:50 storm outlined in our Strategic Context document.

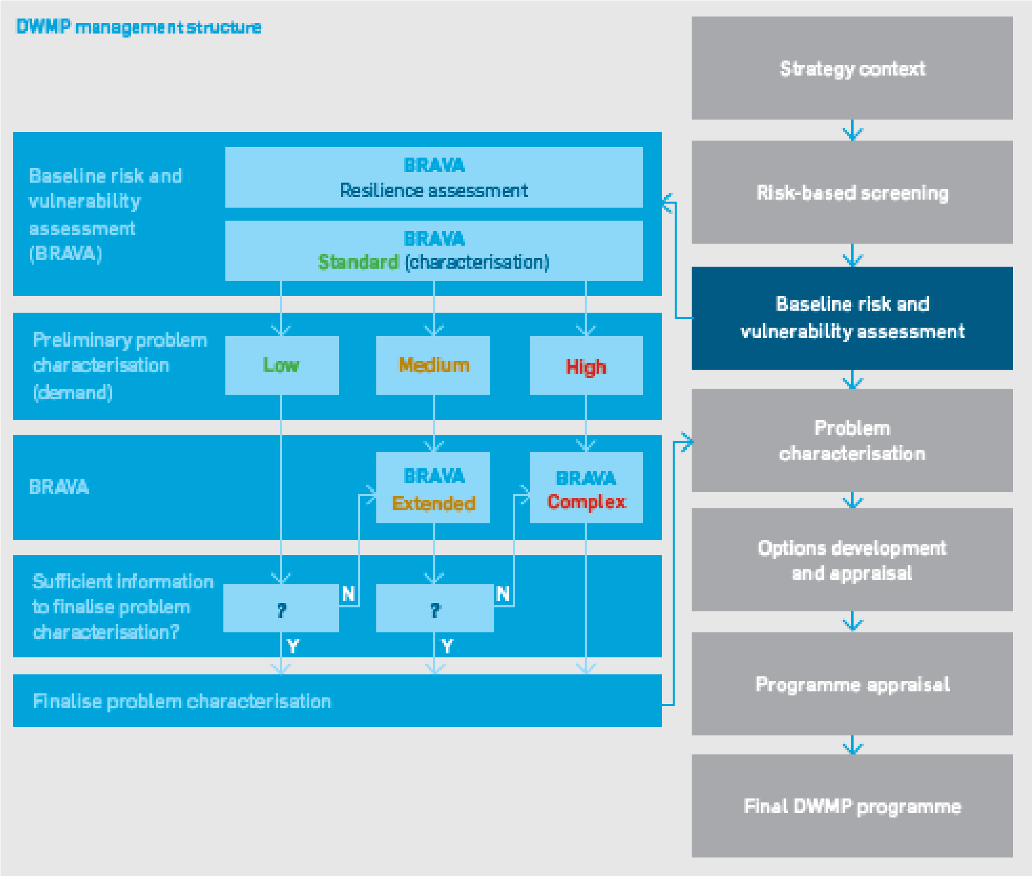
Further detail on the assessment of the bespoke Planning Objectives is provided in Section 10.3.3.

10.3 BRAVA

The 335 Level 3 catchments that progressed through the RBCS stage were then advanced to the BRAVA stage where they are assessed in greater detail against the Planning Objectives, both National and Bespoke, described in Section 10.2.

The Water UK framework outlines the process shown in Figure 54 for undertaking BRAVA.

Figure 54: Schematic of the DWMP BRAVA process



Source: Water UK[23]

The BRAVA stage of the DWMP is aiming to assess the risk and vulnerability of a catchment both for the present day and for future epochs. Within our BRAVA assessment we have considered a present-day baseline at 2020 with interim and medium-term future scenarios at 2030 and 2050 with a long-term epoch set at year 2080.

10.3.1 Hydraulic modelling

To complete the BRAVA stage, we have utilised extensive hydraulic modelling data. We have invested in creating and maintaining several hydraulic models to cover our region and support with our business planning processes. These models are built to varying standards and specifications having been developed over the last two decades in response to a variety of different drivers in these catchments. We have model coverage for approximately 77% of the current population of Yorkshire. Historic model development has progressively focussed on our highest risk areas, and we continue to develop our modelling stock in relation to need.

Our hydraulic models contain a representation of a drainage catchment, including:

- The location, size and gradient of our sewers and manholes.
- The location and key parameters of other assets such as storm overflows, pumping stations and outfalls.
- An assessment of the nature of contributing flows from population, trade, infiltration, and rainfall response.
- Catchment characteristics such as slope and soil type

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[23] https://www.water.org.uk/wp-content/uploads/2021/10/DWMP_Framework_Report_Main_Report_September_2021.pdf

These can be used as tools to understand system hydraulics and performance and to scenario test future situations. Some models are built for a specific purpose, such as to understand the performance of a specific asset, others are built as general catchment models, in YW these are developed to support our Drainage Area Plans (DAPs) which are developed for specific Drainage Area Zones (DAZs).

10.3.1.1 Drainage Area Zone to Level 3 Catchment

A DAZ can contain multiple small towns, villages and suburbs all served by their own wastewater treatment works, alternatively several DAZs can join and flow to a single wastewater treatment works, usually by gravity.

Our wastewater operations are structured around DAZs, this is how we operate as a business and collect and report data and how we plan our resources. The DWMP is structured around Level 3 catchments, which is a representation of all flows draining to a single wastewater treatment works. For the purposes of the DWMP it has been necessary to transition from DAZs to Level 3 catchments for assessment and reporting purposes. In some situations, a single DAZ model may have contained multiple Level 3 catchments, conversely, for several of our Level 3 catchments, particularly our larger urban conurbations, multiple DAZ models needed to be amalgamated to create the Level 3 model. Consequently, within a given Level 3 the model age and quality can vary across the Level 3 catchment. Further to this, for a minority of Level 3 catchments, part of the wastewater network was not covered by an existing model meaning a complete Level 3 catchment model was unavailable.

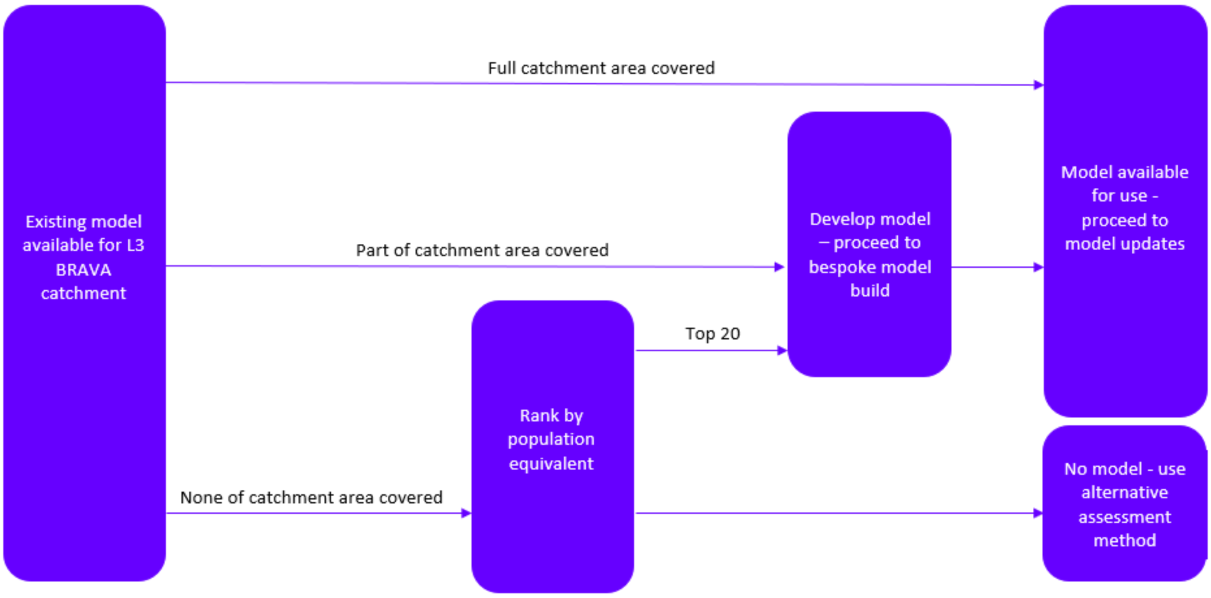
10.3.1.2 Model availability

Of the 335 BRAVA catchments, models were available for all or part of the catchment in 213 instances. These were constructed for a variety of purposes ranging from Urban Pollution Management (UPM) Manual, Water Framework Directive (WFD) assessments to use in DAPs. With dates ranging from 1999 to 2020. Models are a snapshot in time and are only verified for the specific purpose identified at that time. Therefore, the models available in the modelling library may have been verified, but not necessarily for the purpose required for DWMPs, nor at the location required, and may not contain all the changes that have occurred in the catchment since it was verified.

For those Level 3 catchments with missing sections of network and the larger of the Level 3 catchments where no model was available, a bespoke model build process was produced to create a model that would be suitable for the DWMP BRAVA assessment; this is discussed further in Section 10.3.1.3. However, for 102 Level 3 catchments, this meant that no model was available, and an alternative assessment method would be required to complete BRAVA.

The model availability and ultimate BRAVA assessment method is summarised in Figure 55, below:

Figure 55: Model availability for use in DWMP



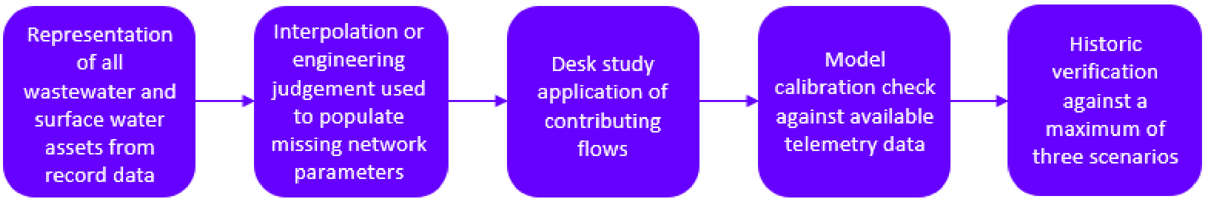
10.3.1.3 Bespoke DWMP model build

Of the 335 Level 3 BRAVA catchments, 122 had no model or only partial model coverage. Most of the Level 3 catchments with no model representation were small in relation to the population they served. Of the original 122 Level 3 catchments with no model, 86 had a population equivalent (PE) of less than 2,000 with 36 having a PE of equal or above 2,000.

Ideally all BRAVA catchments would have been covered by a current hydraulic model. Given the time available this was not feasible and as such those catchments covering the largest PE were prioritised for model representation. This resulted in models for the largest 20 Level 3 catchments, in terms of PE, having a new model built and calibrated for the purposes of our DWMP assessment.

Due to time constraints a bespoke model build, and calibration process was developed for use in our DWMP. This makes use of our comprehensive in-house modelling specification but expedites some processes. Given the strategic nature of the DWMP this was considered to provide a suitable tool for use in the BRAVA assessment. The bespoke model build process is summarised in Figure 56, below. It is acknowledged this process is high level, however it provides some increased confidence compared to a simple model build merely using the sewer function designation for area allocation. We will work on improving this tool for cycle 2 alongside any new model builds or upgrades.

Figure 56: Overview of Bespoke Model Build Process



The 20 models built following the bespoke methodology were then uplifted for the short-, medium- and long-term planning horizons using the same methodology as the uplifts for existing hydraulic models.

10.3.1.4 Model updates

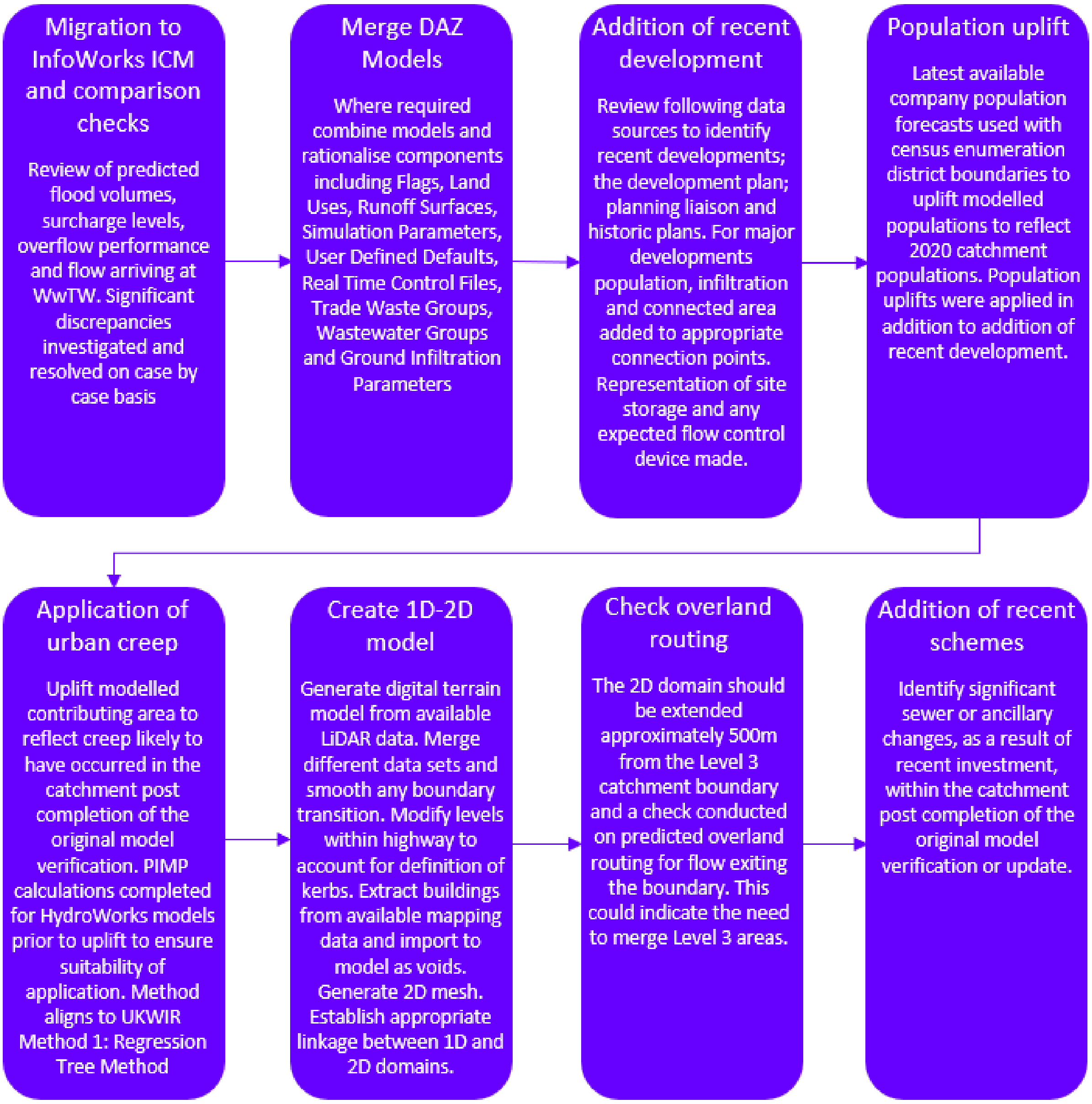
As noted above, the available models have previously been built to investigate specific needs or for drainage area planning and therefore follow the modelling procedures of that time.

A bespoke model update methodology was produced. This set out the process to update models to a current and future epoch. This was designed to be a targeted update focusing on significant catchment alterations and was achievable across all required catchments in the timeframe.

10.3.1.5 Creation of the baseline model

The process used to create the baseline 2020 model is summarised in Figure 57 below:

Figure 57: Overview of process to create the baseline model



Migration to InfoWorks ICM and comparison checks

Review of predicted flood volumes, surcharge levels, overflow performance and flow arriving at WwTW. Significant discrepancies investigated and resolved on case by case basis

Merge DAZ Models

Where required combine models and rationalise components including Flags, Land Uses, Runoff Surfaces, Simulation Parameters, User Defined Defaults, Real Time Control Files, Trade Waste Groups, Wastewater Groups and Ground Infiltration Parameters

Addition of recent development

Review following data sources to identify recent developments; the development plan; planning liaison and historic plans. For major developments population, infiltration and connected area added to appropriate connection points. Representation of site storage and any expected flow control device made.

Population uplift

Latest available company population forecasts used with census enumeration district boundaries to uplift modelled populations to reflect 2020 catchment populations. Population uplifts were applied in addition to addition of recent development.

Application of urban creep

Uplift modelled contributing area to reflect creep likely to have occurred in the catchment post completion of the original model verification. PIMP calculations completed for HydroWorks models prior to uplift to ensure suitability of application. Method aligns to UKWIR Method 1: Regression Tree Method

Create 1D-2D model

Generate digital terrain model from available LiDAR data. Merge different data sets and smooth any boundary transition. Modify levels within highway to account for definition of kerbs. Extract buildings from available mapping data and import to model as voids. Generate 2D mesh. Establish appropriate linkage between 1D and 2D domains.

Check overland routing

The 2D domain should be extended approximately 500m from the Level 3 catchment boundary and a check conducted on predicted overland routing for flow exiting the boundary. This could indicate the need to merge Level 3 areas.

Addition of recent schemes

Identify significant sewer or ancillary changes, as a result of recent investment, within the catchment post completion of the original model verification or update.

10.3.1.6 Creation of the future models

The baseline model was subject to further model adjustment for population, urban creep, and wastewater consumption rate to generate the future epoch models.

10.3.1.6.1 Population growth

The latest available population predictions provided by our external supplier were used along with census enumeration district boundaries and our corporate address point data to determine Level 3 future catchment populations. The population predictions include predictions up to a 2045 epoch. The 2045 population has been utilised within the 2050 and the 2080 epoch models.

Where the baseline modelled population was less than the predicted 2030 and 2045 projected populations, then the model population was globally uplifted to align to these predictions.

Whilst the latest population projection available at the time of the assessments was utilised, ahead of PR24 and WRMP24 we have worked with our external supplier to develop a series of new population growth forecasts for a range of scenarios, utilising updated data. Given the timescales required to undertake BRAVA and the subsequent phases of DWMP development, particularly where hydraulic modelling was required, we were unable to fully utilise this updated dataset within our DWMP assessments. Sensitivity testing relating to this is discussed further in Section 12.2.3.

In addition to uplifting population, we have also represented major planned developments in line with the process utilised for updating the baseline models. Where information relating to the timing of developments was available this has been utilised when establishing the model epoch for inclusion. For residential developments without planned dwelling counts, these have been included in the 2050 and 2080 epoch models only, with an assumed dwelling density rate.

10.3.1.6.2 Urban creep

Urban creep is the term assigned to the conversion of permeable spaces to impermeable over time, this is assessed and applied to the model at a property level and might represent the creation of a driveway, an extension, or a new patio. These individual, small and incremental increases in impermeable area can have a significant impact on the wastewater system during rainfall when the cumulative impact of all the changes are evaluated within a catchment.

The age of some properties means it is unlikely further creep can occur as there is no remaining permeable space to be converted.

Our company Modelling Specification was followed to represent creep within the future epoch models. The methodology aligns with the UKWIR Method 1 – Regression Tree method.

10.3.1.6.3 Wastewater consumption reduction

The future per capita consumption (PCC) rates were aligned to values within our WRMP19[24], which was the latest available data at the time of undertaking the modelling work. Overall, this suggests that average consumption would reduce in the future. The available data is shown in Figure 58 below, the weighted average has been utilised. The 2044/2045 consumption rate has been utilised within the 2050 and the 2080 epoch models.

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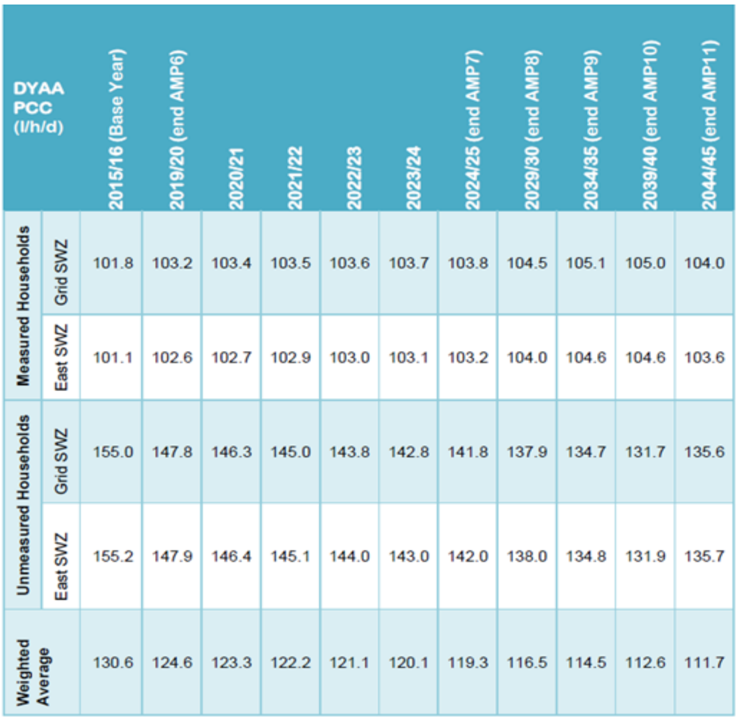
[24] **https://www.yorkshirewater.com/media/aeohjl3o/water-resources-management-plan-2019.pdf**

Figure 58: Summary of YW Dry Year Annual Average PCC Forecasts by AMP period



DYAA PCC (l/h/d)		2015/16 (Base Year)	2019/20 (end AMP6)	2020/21	2021/22	2022/23	2023/24	2024/25 (end AMP7)	2029/30 (end AMP8)	2034/35 (end AMP9)	2039/40 (end AMP10)	2044/45 (end AMP11)
Measured Households	Grid SWZ	101.8	103.2	103.4	103.5	103.6	103.7	103.8	104.5	105.1	105.0	104.0
	East SWZ	101.1	102.6	102.7	102.9	103.0	103.1	103.2	104.0	104.6	104.6	103.6
Unmeasured Households	Grid SWZ	155.0	147.8	146.3	145.0	143.8	142.8	141.8	137.9	134.7	131.7	135.6
	East SWZ	155.2	147.9	146.4	145.1	144.0	143.0	142.0	138.0	134.8	131.9	135.7
Weighted Average		130.6	124.6	123.3	122.2	121.1	120.1	119.3	116.5	114.5	112.6	111.7

An alternative approach to PCC has been undertaken for the WwTW assessments, as discussed in the relevant BRAVA and ODA sections of this report.

10.3.1.7 Modelled rainfall

The developed hydraulic models have been simulated with design and time varying rainfall.

10.3.1.7.1 Design rainfall

Discrete Design Rainfall events were generated using Flood Estimation Handbook (FEH13) Depth Duration Frequency (DDF) descriptors. To determine the correct descriptors for each Level 3 catchment the catchment centroid coordinates were used. The process created rainfall events including 1 in 1, 2, 5, 10, 30, 50 and 100 year events at durations of 60, 240 and 480mins. These durations have been selected in line with the Risk of Sewer Flooding in a Storm methodology[25]. Only winter design events were created, representing the worst case in terms of rainfall depth with no seasonal adjustment factor applied.

Multi-profile 'RED' Rainfall events were created allowing initial conditions for different soil class types and/or different runoff volume models to be set in the rainfall files. The FEH13 catchment descriptors were based on 100% of the catchment area and located at the catchment centroid coordinates. However, in circumstances where rainfall characteristics varied significantly over a Level 3 catchment an averaged data set was produced.

It should be noted that no evaporation or seasonal correction factor was applied. Return periods of 1 and 2 years were generated using Peaks Over Threshold (POT) and return periods of 5 years or greater are generated using Annual Maximum (AM).

10.3.1.7.2 Design rainfall: Climate change uplift

We have been working on assessing the impact of Climate Change on our drainage models since 2012 and were one of the first water companies in England to commission research into how best to do this. In 2012 we commissioned HR Wallingford to assess how climate change would affect both

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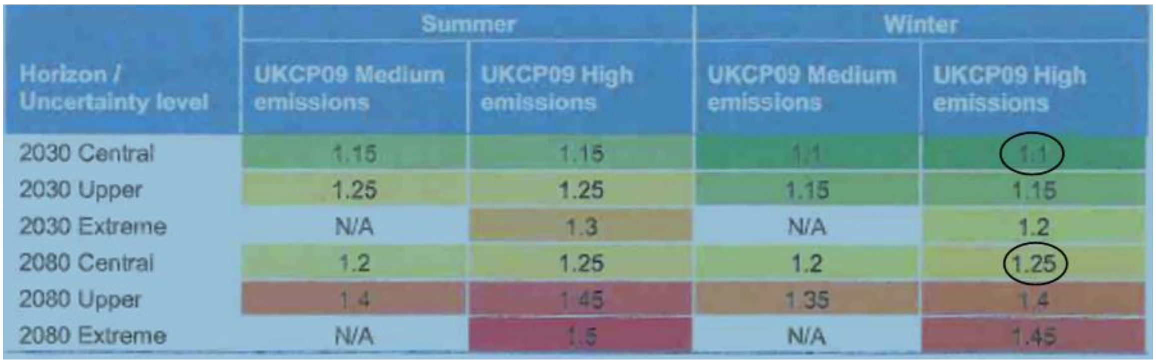
[25] https://www.ofwat.gov.uk/wp-content/uploads/2019/04/Reporting-guidance-Risk-of-sewer-flooding-in-a-storm_final_290319.pdf

annual and seasonal rainfall across the Yorkshire region under medium and high emissions scenarios for the 2030 and 2080 epochs. The headline findings were that winters will be wetter with greater depths of rainfall and summer will be drier on average but with an increasing number of heavy rainfall events. The size of the changes depend on how much more carbon is emitted since the high emissions scenario has larger changes.

This work was based on a set of climate projections called UKCP09 and resulted in a set of recommended uplifts to design storms to use in our DAPs. The high emissions P50 2030 and high emissions P50 2080 uplift values have been selected and applied to the rainfall uplifts, this is equivalent to high emissions central 2030 and high emissions central 2080 in the revised HR Wallingford document, as shown in Figure 59 below.

Figure 59: Recommended climate change uplift factors for 2030 and 2080, summer and winter design events



Horizon / Uncertainty level	Summer		Winter	
	UKCP09 Medium emissions	UKCP09 High emissions	UKCP09 Medium emissions	UKCP09 High emissions
2030 Central	1.15	1.15	1.1	1.1
2030 Upper	1.25	1.25	1.15	1.15
2030 Extreme	N/A	1.3	N/A	1.2
2080 Central	1.2	1.25	1.2	1.25
2080 Upper	1.4	1.45	1.35	1.4
2080 Extreme	N/A	1.5	N/A	1.45

Source: HR Wallingford on behalf of Yorkshire Water

There has been substantial industry-wide collaborative activity to create the datasets required for use in modelling FUTURE-DRAINAGE. For example, in 2018 the Met Office published the latest set of UK Climate Projections (UKCP18). This was followed by the release in 2019 of a very detailed dataset of sub-daily rainfall at very small scales (2.2km) such as that used in drainage models. This dataset was not available for us to use in this first round of DWMPs, however following a NERC funded project called FUTURE-DRAINAGE, and an UKWIR project which is updating industry tools to apply this data, we will be able to fully make use of this revised data for our second round of DWMPs. Sensitivity testing to understand the potential impact of this new data has been undertaken, as detailed in Section 12.2.1. We are an active member of the research and modelling community of practice to make sure we are always using the most up to date science and understanding.

The design uplift value for 2050 was interpolated at 16%.

This approach differs from that utilised for WRMP24 however the timing requirements for available data were not consistent. It is also noted that the key impacts of climate change considered in the two frameworks differs, with the DWMP primarily focussing on rainfall depth and intensity during individual events which is not necessarily a key consideration of the WRMP.

10.3.1.7.3 Design rainfall: Antecedent conditions

The output FEH13 rainfall files were populated with the relevant UCWI/API30 uplift values for the baseline, 2030, 2050 and 2080 epochs, the following values have been applied as shown below in Table 11.

Table 11: FEH13 Design Rainfall NAPI and UCWI Values for YW DWMPs

	NAPI Soil 1 (mm)	NAPI Soil 2 (mm)	NAPI Soil 3 (mm)	API Soil 4 (mm)	NAPI Soil 5 (mm)	UCWI
Baseline Initial Conditions	0.1	1.5	4.1	17.0	54.0	141
2030 Initial Conditions	0.1	1.7	4.6	19.0	29.0	143
2050 Initial Conditions	0.1	2.0	5.2	20.9	64.8	144
2080 Initial Conditions	0.2	2.3	5.9	23.0	71.0	145

10.3.1.7.4 Time series rainfall

For Time Series Rainfall events (TSRs) we used an existing baseline stochastic time series generated by HR Wallingford in 2012. The HR Wallingford Report titled “Using UKCP09 in Sewer Network Modelling” and dated April 2013 contains eight timeseries profiles across our region. These series were perturbed for climate change using the UKWIR ‘RED-UP’ tool to 2030, 2050 and 2080 epochs. Appropriate evaporation rates for summer and winter were also applied. Each Level 3 catchment used the stochastic series it is geographically located in, and the time series rainfall was pro-rated (up or down) based on the ratio of the Level 3 Seasonal Annual Average Rainfall (SAAR) (from FEH13) compared to the stochastic time series SAAR.

As the current version at the time the modelling work was completed, version 2 of the RED-UP tool was used for this assessment. An updated version, RED-UP v3 has since been released. The potential impact of this new version is discussed further in Section 12.2.1.

10.3.2 National BRAVA assessment methodologies

To undertake the first steps of the BRAVA process, we established a series of methodologies to address the National Planning Objectives, these built on information and guidance published by Water UK.

10.3.2.1 PO-01: Risk of sewer flooding in a 1 in 50 event

As noted in Section 10.3.1.5, where possible, a 1D-2D linked model has been created. Post processing analysis of the hydraulic simulations reviewed the predicted flow routes against the building footprints to establish if the property is considered to be at risk. It should be noted that model confidence will vary between models for the reasons given earlier. The baseline 2020 and 2050 models have been utilised for the assessment.

For 102 BRAVA catchments, no model was available and a high level, 2D only, model has been generated. Within these models the below ground network is not explicitly represented. Reported flooding and the presence of storm overflows within the catchment have been used to assess the below ground network capacity. An assumed drainage rate is then subtracted from the applied rainfall as shown in Table 12.

Rainfall is applied to the surface terrain and post processing analysis reviewed the predicted flow routes against the building footprints to establish if the property is considered to be at risk.

For the 2050 assessment the applied rainfall has been uplifted based on climate change projections. No adjustment of the drainage removal rate has been made.

Table 12: Sewer network capacity

Assessed Sewer Potential	Assumed Drainage Rate	Description
High Potential	20 mm/hr	No storm overflow, no reported flooding
Medium Potential	12 mm/hr	1 or more storm overflows, no reported flooding

Table 12: Sewer network capacity

Assessed Sewer Potential	Assumed Drainage Rate	Description
Low Potential	6 mm/hr	Contains reported flooding

For both 1D-2D linked models and 2D only models, a property is considered to be at risk of internal flooding if the maximum depth adjacent to a building exceeds the defined threshold in at least one of the simulated M50 rainfall events. The guidance provided by Water UK did not specify the thresholds to be used. The following thresholds have been used:

- If the property has a mapped cellar – 0.001m
- Where there is no cellar – 0.100m

A score of not significant (0), moderately significant (1) or very significant (2) is then assigned to each Level 3 catchment based on the percentage of residential properties at risk of flooding. The following thresholds have been applied and are shown in Table 13:

Table 13: BRAVA scores and threshold criteria for internal sewer flooding 1 in 50

BRAVA Score	Threshold
0	0% of residential properties predicted to flood internally
1	<5% of residential properties predicted to flood internally
2	5% or more of residential properties predicted to flood internally

The assessment has been repeated at Level 1 and Level 2 using the same thresholds defined above. Where Level 3 catchments did not require a BRAVA, these have been excluded from the Level 1 and Level 2 assessments.

10.3.2.2 PO-02: Storm overflow performance

In the majority of instances, a 1D hydraulic model has been used. The models have been simulated for a continuous 10-year period and the annual average spill performance has been calculated using the EA 12/24 hour block method. It should be noted that model confidence will vary between models and that in a few instances the full 10-year series has not been completed therefore the assessment is based on a smaller data set. The baseline 2020 and 2050 models have been utilised for the assessment.

For each asset a risk score was calculated for each epoch based on the model predicted annual average spill frequency as set out below in Table 14, it should be noted these are defined within the national guidance.

Table 14: BRAVA storm overflow risk scores and threshold criteria

Risk Level (Score)	Average Annual Spill Frequency	Bathing Water Average Spill Frequency
Not significant (0 points)	<20	<3
Moderately significant (1 point)	21-40	4-10
Very significant (2 points)	>40	>10

The worst case between annual average spill frequency and average bathing season spill frequency has been used for each asset where this is applicable.

For 102 BRAVA catchments, no model was available. In these instances, the national guidance advises that Event Duration Monitoring (EDM) data be utilised. Where:

1. EDM report data provides an average spill frequency, this reported spill frequency was utilised. It should be noted that this may be based on a single year of data with the most recent available complete year being 2019.
2. EDM Category is given as EDM2 (D) (i.e. the overflow does not require EDM monitoring based on watercourse amenity or spill count) or is undefined, then a classification of Not Significant was applied.

Where EDM data was unavailable the EDM significance class and observed pollution incidents (January 2017 – December 2019) were used to provide an indication of risk, where it was possible to attribute a pollution incident to a storm overflow. This is shown in Table 15 below.

Table 15: Storm overflow risk score matrix where no available model

Risk Level (Score)	EDM Significance Class	Associated Historic Pollution
Not significant (0 points)	EDM2 (B) or EDM2 (A)	None
Moderately significant (1 point)	EDM2 (B) or EDM2 (A)	Single occurrence category 3 – category 5
	EDM2 (C)	None or single occurrence category 3 – category 5
Very significant (2 points)	EDM2 (C) or EDM2 (B) or EDM2 (A)	Multiple occurrence category 3 – category 5 or any category 1 or category 2 incident

The baseline method outlined above provided a non-numeric risk score, it was therefore assumed the calculated spill frequency falls at the mid-point of the band, for instance 'Not Significant' would have a calculated spill frequency of 10. This allowed the calculated spill frequency to be uplifted by 16% for the 2050 assessment. This uplift was based on the climate change uplift applied to design rainfall for this epoch.

A weighted point score was calculated to aggregate the individual asset scores into a Level 3 score, the formula for which is outlined below, again this is defined within the national guidance:

$$L3\ Weighted\ Point\ Score = \frac{(sum\ of\ individual\ asset\ scores\ within\ L3 * 100)}{(total\ nr\ of\ CSOs\ within\ L3 * 2)}$$

The thresholds below have then been used to translate the weighted point score into a classification of: not significant (0), moderately significant (1) or very significant (2) for each Level 3. The guidance provided by Water UK did not specify the thresholds to be used. The thresholds set out in Table 16 have been applied.

Table 16: BRAVA scores and threshold criteria for storm overflow performance

BRAVA Score	Threshold
0	<15%
1	15-30%
2	>30%
Not Applicable	Catchment doesn't proceed to BRAVA or catchment does not contain a storm overflow

The Level 1 and 2 scores are calculated by normalising the Level 3 BRAVA scores using the catchment population equivalent. Where Level 3 catchments have not been subject to a BRAVA these have been excluded from the aggregation.

10.3.2.3 PO-03: Risk of wastewater treatment works quality compliance failure

As suitable model data is not readily available for all of the WwTW assets, Operator Self-Monitoring (OSM) sample data for the three sanitary parameters (Biological Oxygen Demand (BOD), Ammonia (Amm) and Total Suspended Solids (TSS)) for the last 3 calendar years (2017-2019) has been used.

Where WwTWs have no numeric permit conditions (descriptive permits), an assessment has not been undertaken and the associated catchments have been flagged as “Not Applicable”.

Annual ratios have been calculated for each WwTW based on the annual average of the sample results for each of the three parameters and 50% of the appropriate permit compliance limit.

$$Annual\ Ratio_{(BOD/Amm/TSS)} = \left(\frac{Annual\ Sample\ Ave_{(BOD/Amm/TSS)}}{\left(Permit\ Limit_{(BOD/Amm/TSS)} \times 0.5\right)} \right)$$

The annual ratios for each parameter have then been averaged over the three-year period, and the maximum three-year average across the three parameters taken as the worst-case:

$$\begin{array}{c} Worst \\ Case \\ Ratio \end{array} = MAX\left(3\ Yr\ Ave.\ Ratio_{(BOD)},\ 3\ Yr\ Ave.\ Ratio_{(Amm)},\ 3\ Yr\ Ave.\ Ratio_{(TSS)}\right)$$

The assessment has been undertaken against 50% of the permit compliance limit to allow for 50% serviceability and provide meaningful results. Annual averages have been assessed as the focus is on failure due to treatment capacity issues rather than intermittent issues. As the assessment is based on historic data, no amendments to the scores have been made to allow for recently completed or upcoming schemes.

These ratios have been used to assign bandings to each Level 3 catchment, with the risk of failure either considered to be not significant (0), significant (1) or very significant (2).

The guidance provided by Water UK did not specify the thresholds to be used. The thresholds in Table 17 have been applied.

Table 17: BRAVA scores and threshold criteria for WWTW quality compliance

BRAVA Score	Threshold
0	Worst Case Ratio < 0.85
1	Worst Case Ratio ≥ 0.85 and <1
2	Worst Case Ratio ≥ 1
Not Applicable	Catchment doesn’t proceed to BRAVA or WwTW has descriptive permit / isn’t appropriate for assessment.

In order to assess long-term risk (2050), the worst-case ratio has been factored based on the projected change in domestic population between 2020 and 2050. It should be noted that the approach to representing population projections utilised for WwTW compliance assessments differs from that used in the network hydraulic modelling. Individual developments (identifiable from local plans and databases held by our developer services team) have not been included in the assessment of domestic population growth for the purposes of the WwTW assessment, instead utilising catchment level projections only. Whilst the conservative approach of including individual developments in addition to the population uplifts was considered appropriate and necessary for the network modelling to allow for spatial distribution and representation of localised contributions from the developments within the catchment, this was not considered appropriate for the WwTW assessment for which foul flows have the most significant impact and catchments are considered in their entirety. The same catchment level projection dataset has been used for both the network and the treatment assessments.

Additionally, no reduction in the future per capita consumption (PCC) values have been made for the WwTW assessments. Our WRMP19 forecasts a reduction in future PCC and whilst this has been built into the model assessments on the networks a more conservative approach was taken in relation to the treatment works assessments. This was primarily due to the coarse approach taken for the WwTW population uplifts. It is assumed that there is no change to permitting requirements or the assets. These projected ratios have been used to assign 2050 bandings to the Level 3 catchments in line with the thresholds used for the baseline assessment, listed above.

The Level 3 scores have been aggregated based on Population Equivalent in order to determine a score for Level 1 and for each Level 2 area. Where catchments have not been assessed these have been excluded from the aggregation.

10.3.2.4 PO-04: Internal Sewer Flooding (ISF) risk

As suitable model data is not readily available across all our Level 3 Catchments, the last three years of annual performance data has been used. This covers the financial years 2017, 2018 and 2019.

The method involves calculating the total number of incidents within each Level 3 Catchment for each of the three years then taking the average value. This value was then normalised into incidents per 10,000 connected properties to give a rate which is comparable with the internal sewer flooding performance commitment.

To determine whether the catchment risk was deemed as not significant (0), significant (1) or very significant (2) we have used the performance commitment levels for AMP6 as thresholds.

The following thresholds have been applied shown in Table 18:

Table 18: BRAVA scores and threshold criteria for internal sewer flooding

BRAVA Score	Threshold
0	Normalised incident rate < 1.34 (PC Level for 2024/25)
1	Normalised incident rate ≥ 1.34 and < 1.68 (PC Level for 2020/21)
2	Normalised incident rate ≥ 1.68

The assessment has been repeated at Level 1 and Level 2 using the same thresholds given above. Where Level 3 catchments did not require a BRAVA, these catchments and the properties within them have been excluded from the Level 1 and Level 2 assessments.

10.3.2.5 PO-05: Pollution risk

As suitable model data is not readily available across all our Level 3 Catchments, the last three years of annual performance data has been used. This covers the calendar years 2017, 2018 and 2019. The method involves calculating the total number of incidents within each Level 3 Catchment for each of the three years then taking the average value. This value was then normalised into incidents per 10,000km of sewer to give a rate which is comparable to the pollution incidents performance commitment.

To determine whether the catchment risk was deemed as not significant (0), significant (1) or very significant (2) we have used the performance commitment levels for AMP6 as thresholds.

The following thresholds have been applied shown in Table 19:

Table 19: BRAVA scores and threshold criteria pollution

BRAVA Score	Threshold
0	Normalised incident rate < 19.5 (PC Level for 2024/25)
1	Normalised incident rate ≥ 19.5 and < 24.51 (PC Level for 2020/21)
2	Normalised incident rate ≥ 24.51

The assessment has been repeated at Level 1 and Level 2 using the same thresholds given above. Where Level 3 catchments did not require a BRAVA, these catchments and the sewer lengths within them have been excluded from the Level 1 and Level 2 assessments.

10.3.2.6 PO-06: Sewer collapse risk

As suitable model data was not available across all our Level 3 Catchments, the last three years of annual performance data has been used. This covers the financial years 2017, 2018 and 2019.

The method involves calculating the total number of incidents within each Level 3 Catchment for each of the three years then taking the average value. This value was then normalised into incidents per 1,000 km of sewer to give a rate, comparable to the sewer collapses performance commitment.

To determine whether a catchment was deemed as not significant (0), significant (1) or very significant (2) we have used the performance commitment levels for AMP6 as thresholds.

The following thresholds have been applied as shown in Table 20:

Table 20: BRAVA scores and threshold criteria sewer collapse risk

BRAVA Score	Threshold
0	Normalised incident rate <15.39 (PC Level for 2024/25)
1	Normalised incident rate ≥15.39 and <18.26 (PC Level for 2020/21)
2	Normalised incident rate ≥18.26

The assessment has been repeated at Level 1 and Level 2 using the same thresholds given above. Where Level 3 catchments did not require a BRAVA, these catchments and the sewer lengths within them have been excluded from the Level 1 and Level 2 assessments.

10.3.2.7 Summary of National BRAVA planning objectives outputs

The initial national output from BRAVA was based upon these six standard Planning Objectives. These results can be viewed in Appendix C. The results are also summarised for each Level 2 within Table 21.

Table 21: Summary of Common BRAVA Level 2 Outputs

Level 2 Catchment	PO-01 Risk of sewer flooding in a Storm		PO-02 Storm Overflow Performance		PO-03 WwTW Compliance		PO-04 Internal Sewer Flooding	PO-05 Pollution Incidents	PO-06 Sewer Collapses
	2020	2050	2020	2050	2020	2050	2020	2020	2020
Calder	1	2	2	2	1	1	2	1	0
Colne & Holme Valleys	2	2	2	2	0	0	2	2	
Dearne	1	1	1	2	1	1	2	2	2
Derwent & Rye	1	1	1	1	0	1	1	2	0
Esk & Coast	1	1	1	1	0	0	2	2	0
Holderness Coast (Gypsey Race)	1	1	1	1	0	0	2	2	0
Hull	2	2	0	0	0	0	1	0	0
Leeds	1	1	2	2	0	1	2	0	0
Lower Aire	1	1	2	2	1	1	2	2	0
Lower Dales	1	2	2	2	1	1	2	2	0
Lower Don	1	1	1	1	0	0	2	2	0
Lower Ouse	1	1	1	1	0	0	2	0	0
Rother & Doe Lea	1	1	2	2	0	0	2	2	0
Sheffield	2	2	2	2	0	0	2	1	0
Upper Aire	2	2	2	2	2	2	2	2	0
Upper Dales	1	1	1	1	1	1	2	2	1
York	1	1	1	1	0	0	2	2	0

10.3.3 Bespoke planning objectives

We chose to develop and assess our Level 3 catchments against a bespoke set of planning objectives, these have some commonality with the national planning objectives, but some modifications have been made to the assessments and a 0-5 scoring system has been used to provide greater granularity in the results. The same hydraulic models and simulation results have been used in the national and bespoke planning objectives in the majority of instances.

For the bespoke planning objectives and subsequent sections of DWMP development we have utilised an updated population equivalent dataset for screening purposes. This updated dataset incorporates an amendment to the method used for the inclusion of trade flow and overnight visitors but no change to the domestic population data. As some of the RBCS assessment methodologies are influenced by the population equivalent, we have undertaken sensitivity testing using the updated population equivalent dataset which confirmed that this would have had no material impact on the screening process, with the same catchments proceeding to BRAVA. We have also undertaken sensitivity testing on the Level 2 and Level 1 National BRAVA Outputs which utilise population equivalent for aggregation of Level 3 scores. No changes were noted, with the exception of one Level 2 catchment (Derwent and Rye) for which the 2020 BRAVA score would change from 0 to 1. This has been accepted on the basis that we have built upon the processes and scoring of the National BRAVA assessments for the purposes of our bespoke assessments and have utilised the outputs of our bespoke assessments rather than the national outputs for the subsequent phases of the DMWP process.

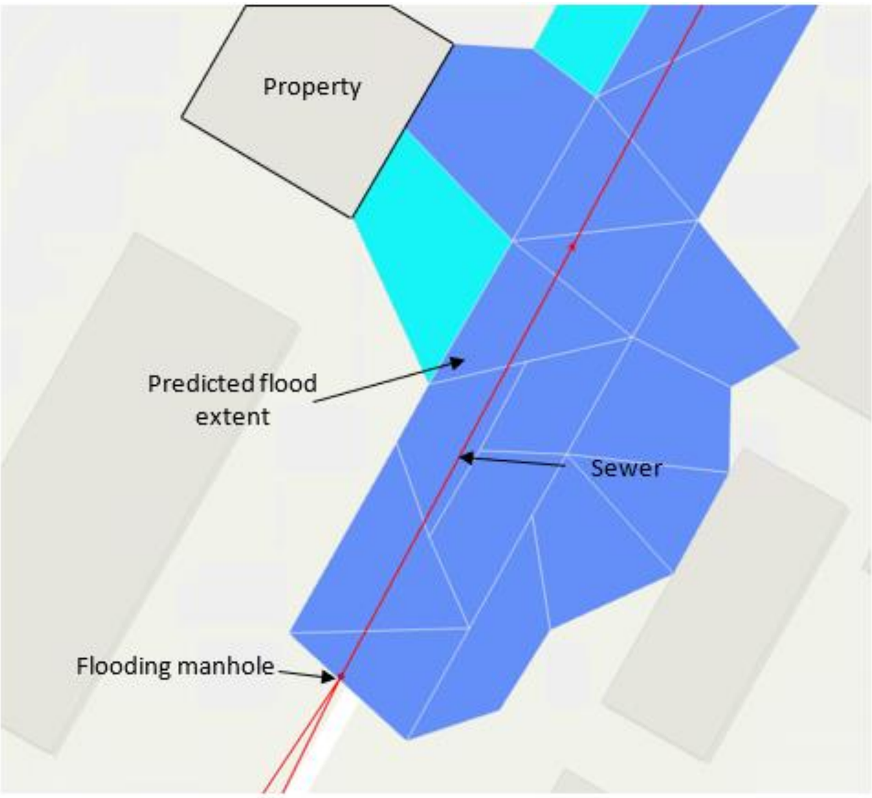
10.3.3.1 PO-07: Managing internal flooding risk

The same hydraulic models were utilised for this bespoke planning objective and the assessment for PO-01.

Within the analysis carried out a property can be predicted to flood internally from two mechanisms. A property can be affected by both mechanisms simultaneously. Both residential and commercial property address points have been included within this assessment, with property boundaries taken from available topographic mapping data.

As noted in Section 10.3.1.5, the 1D-2D models contain a representation of the below ground network, including the expected inputs to the system and the in-system hydraulics. If flooding occurs at a modelled manhole, flow can route over a representation of the surface terrain. If the maximum predicted depth of flood water adjacent to the building equals or exceeds the defined threshold, the property is considered to be affected by internal flooding. It is possible for flood water to escape from combined, foul and surface water sewers. See Figure 60 below:

Figure 60: Example 2D Predicted Flood Routing



In addition to the flood risk from overland flow assessed for the national planning objective, a consideration of risk arising from sewer surcharge has also been made for catchments with a 1D-2D linked model.

An automated routine has joined all property address points from billing data to the nearest modelled foul or combined sewer. The assumed flood depth at the property is calculated as the difference between the interpolated maximum top water level in the sewer at the connection point and the property ground level taken from LiDAR. Table 22 below provides further information on thresholds and filters to be applied. The filters remove properties from the analysis where the automated routine has made unlikely connections. For instance, the sewer invert level at the connection point must be less than the property level for the property to connect via gravity to that sewer.

The surcharge assessment has not been considered for the storm system due to greater uncertainty regarding the likelihood of properties having connection points to the surface water sewer. Future cycles may utilise this analysis on the storm system in areas where there is a separate system installed.

It should be noted that this assessment is an automated process and high-level assumptions and simplifications have been made when considering connectivity of properties to the sewer network. This assessment has only been completed for those catchments with a 1D-2D sewer network model.

The definition of internal flood risk is summarised in Table 22 below, one of the thresholds needs to be breached for the property to be considered as at risk of flooding. The assessment has been carried out for each return period and epoch.

Table 22: Thresholds and filters internal flooding

Flood Risk	Threshold for Flooding	Filters
Internal Flood Risk Surcharge*	≥ 0.1m depth at property	All statements must be true for a surcharge risk to be reported: • The sewer invert level at the connection point must be less than the property level • The predicted TWL must be greater than or equal to the soffit level + 300mm at the connection point • The distance to the nearest conduit connection point must be less than or equal to 30m • The surcharge risk should be greater than or equal to property level + 100mm
Internal Flood Risk 2D	≥ 0.1m depth on the 2D mesh adjacent to the property	

*Where available model is 2D only, this metric has not been assessed

For each property, an annualised score was calculated based on the simulated return periods during which internal flood risk was predicted. The maximum possible annualised score for any given property is 1.833. For example, if a property is predicted to flood in a 1 in 5-year event, it is also predicted to flood during the subsequent lesser return period events or 1 in 10- and 1 in 30-year. Therefore, based on Table 23 below, the final annualised score for the property would be 0.333.

Table 23: Annualised score for internal flooding up to M30

Return Period	Annualised Score
1	1
2	0.5
5	0.2
10	0.1
30	0.033

The individual property scores were summed across each Level 3 catchment to determine an annualised internal flood risk score for each epoch, both as an absolute and as a percentage of the maximum potential property risk within the catchment (where 100% would indicate all properties are predicted to flood internally in a 1 in 1-year event). The percentage score was included to highlight smaller catchments where a significant proportion of the catchment is considered to be at risk, the risk in these catchments would not be as clear when utilising the absolute score only, particularly when compared to larger catchments.

The annualised scores were converted to performance bands for each Level 3 catchment using the parameters in Table 24 below.

Table 24: Catchment performance band for internal flooding

Band	Absolute	Percentage
0	0	0

Table 24: Catchment performance band for internal flooding

1	<25	<0.25%
2	25≥ AND <50	0.25%≥ AND <0.5%
3	50≥ AND<75	0.5%≥ AND <0.75%
4	75≥ AND <100	0.75%≥ AND < 1%
5	≥ 100	≥ 1%

The overall performance band was calculated as the average of the absolute and percentage 1-5 band. For example, if the band for the absolute score is 1 and the percentage is 2, the final score would be 1.5.

10.3.3.2 PO-08: Managing external flooding risk

The same hydraulic models were utilised for this bespoke planning objective and the assessment for PO-01.

The methodology for assessing external flood risk is similar to the 2D aspect of PO-07 detailed above.

External flooding is assessed using predicted flooding on the 2D mesh only. The threshold for flooding in this instance is a flood depth of ≥ 0.01m within the property curtilage. Both residential and commercial property address points have been included within this assessment, with property boundaries taken from available topographic mapping data.

As with the internal flood risk assessment, an annualised score was calculated for each property based on the simulated return periods during which external flood risk was predicted. The maximum possible annualised score for any given property is 1.833.

The individual property scores were summed across each Level 3 catchment to determine an annualised external flood risk score for each epoch, again both as an absolute and as a percentage of the maximum potential property risk within the catchment (where 100% would indicate all properties are predicted to flood externally in a 1 in 1 year event).

The annualised scores were converted to performance bands for each Level 3 catchment using the parameters in Table 25 below:

Table 25: Catchment Performance Band for External Flooding

Band	Absolute	Percentage
0	0	0
1	<25	<0.25%
2	25≥ AND <50	0.25%≥ AND <0.5%
3	50≥ AND<75	0.5%≥ AND <0.75%
4	75≥ AND <100	0.75%≥ AND < 1%
5	≥ 100	≥ 1%

The overall performance band was calculated as the average of the absolute and percentage 1-5 band.

10.3.3.3 PO-09: Managing storm overflow performance

The same hydraulic models were utilised for this bespoke planning objective and the assessment for PO-02. Where the full 10-year suite was not available in a small number of catchments for PO-02, the assessment of this bespoke objective utilises the full 10-year time series rainfall for all catchments with a 1D hydraulic model.

As per the PO-02, a risk score has been calculated based on spill frequency for each storm overflow, and the assessment repeated for each epoch. To increase the granularity of the assessment, the range of scores allocated to each storm overflow was increased, up to a maximum of 20. The assessment was carried out based on the average annual spill frequency and where relevant the average bathing season spill frequency, with the worst case of these taken as the final score for the asset. The scoring used remained consistent across the epochs. The scoring used remained consistent across the epochs and is detailed below in Table 26.and Table 27.

Table 26: Storm Overflow Scoring Based on Average Annual Spill Frequency

Average Annual Spill Frequency	Score
0	0
≤10	1
≤20	2
≤40	4
≤100	8
≤200	15
≤365	20

Table 27: Storm Overflow Scoring Based on Average Bathing Spill Frequency

Average Bathing Spill Frequency	Score
0	0
≤3	1
≤5	2
≤10	4
≤25	8
≤50	15
≤365	20

As per the national approach, a weighted point score has been calculated to aggregate the individual asset scores into a Level 3 score, this uses the formula below:

$$L3\ Weighted\ Point\ Score = \frac{(sum\ of\ individual\ asset\ scores\ within\ L3*100)}{(total\ nr\ of\ storm\ overflows\ within\ L3*20)}$$

This weighted point score has then been converted to a performance band for each Level 3 catchment using the parameters in Table 28 below:

Table 28: Catchment Performance Bands for Storm Overflow Spill Frequency (modelled)

Band	Threshold
0	0
1	≤5%
2	≤10%
3	≤20%
4	≤40%
5	≤100%

For the 102 Level 3 BRAVA catchments with no hydraulic model available a simplistic approach has been taken within the bespoke planning objective assessment. If the catchment contains a storm overflow the catchment has been given a score of 5 to indicate it is high risk, primarily as the future performance is unable to be assessed in a comparative way to the other BRAVA catchments. Where a Level 3 catchment does not contain a storm overflow a score of 0 has been assigned. Table 29 summarises the scoring approach taken for catchments with no hydraulic model.

The approach for PO-02 made use of EDM data in the first instance however a limited number of overflows within the 102 BRAVA catchments with no existing hydraulic model had available EDM data, limiting the benefit. During future cycles of DWMP development we will look to increase both model coverage and the utilisation of EDM data, with further work also undertaken to evaluate and understand potential differences between the EDM data and predicted overflow performance from the hydraulic models.

Table 29: Catchment Performance Bands for Storm Overflow Spill Frequency (Un-modelled):

Band	Threshold
0	Level 3 catchment does not contain storm overflow
5	Level 3 catchment contains storm overflow

10.3.3.4 PO-10: Managing treatment works flow compliance risk

The national BRAVA planning objectives focussed on the compliance of our WwTWs with the water quality elements of their environmental permits. In addition to this, we have established an additional bespoke planning objective and assessment to understand and quantify the level of risk associated with ensuring our WwTWs are compliant with dry weather flow limits within their permits. The population and PCC values utilised for the national PO-03 were used within the assessment of this bespoke metric.

In order to assess the risk of failure to comply with the dry weather flow limits at our WwTW assets we have utilised measured Q90 flow data for the preceding three calendar years (2017 – 2019). Where no flow monitoring data was available, predominantly those sites with descriptive permits, an assessment has not been undertaken and the associated catchment flagged as “Not Applicable”.

The three-year average Q90 has been calculated and a ratio between this and the consented DWF limit was determined using the following calculation:

$$DWF\ Ratio = \left(\frac{Average\ Q90_{(2017-2019)}}{(DWF\ Permit\ Limit)} \right)$$

Predicted Q90 values for 2030, 2050 and 2080 were determined through factoring of the 2020 average Q90 value based on the projected increase in domestic population. Ratios against the DWF consent were subsequently determined for each epoch using the same approach as above.

In addition to utilising the DWF ratios to understand potential headroom and the level of risk, an assessment of whether there have been any individual years (2017-2019) for which the measured Q90 has exceeded the DWF consent has been undertaken.

For each Level 3 catchment a performance band has been assigned based on the thresholds defined in Table 30.

Table 30: Catchment performance bands for WwTW flow compliance

Band	Ratio (3 year average or predicted Q90 v DWF consent)	Annual Q90 v DWF Consent Exceedance Count
Not Applicable	Descriptive permit / No available data	
1	<0.9	0
2	≥ 0.9 AND <1.0	0
3	≥ 1 AND <1.1	<2
4	≥ 1.1 AND <1.2	<3
5	≥ 1.2	≥ 3

The band assigned is the maximum of the score from the two assessments (i.e. a WwTW with a single annual exceedance and a ratio of 0.95 is assigned a score of 3). As the count of exceedances is based on a count of binary data (i.e., the consent was or was not exceeded), we have elected not to project a change to this value for future epochs. Where the 2020 band was assigned based on the exceedance count, this band was carried forward for the future epochs, and only increased if the future ratio was such that the next threshold was exceeded.

10.3.3.5 PO-11: Managing treatment works quality compliance risk

Whilst an assessment of compliance with environmental permit quality limits at WwTWs was undertaken for PO-03 we have elected to build upon the approach taken for that assessment. The population and PCC values utilised for the national PO-03 were used within the assessment of this bespoke metric.

Assessing against 50% of the permit compliance limit, as undertaken for the BRAVA National Reporting, was subsequently considered to be overly conservative as this assessment suggested an unrepresentative number of WwTW requiring intervention. Sensitivity testing confirmed assessing against 100% of the permit compliance limit resulted in very few WwTWs being identified as at risk.

The same OSM sample and consent data used for the national planning objective has been reused for this assessment and the same time period assessed. Where WwTWs have no numeric permit conditions (descriptive permits) or no available data, they have been excluded from the initial part of this assessment.

Annual ratios were calculated for each WwTW based on the annual average of the sample results for each of the three parameters and 75% of the appropriate permit compliance limit using the following equation:

$$Annual\ Ratio_{(BOD/Amm/TSS)} = \left(\frac{Annual\ Sample\ Ave_{(BOD/Amm/TSS)}}{(Permit\ Limit_{(BOD/Amm/TSS)} \times 0.75)} \right)$$

The annual ratios for each parameter were averaged over the three-year period, and the maximum three-year average across the three parameters taken as the worst-case:

$$\begin{matrix} Worst \\ Case \\ Ratio \end{matrix} = MAX\left(3\,Yr\ Ave.\ Ratio_{(BOD)}, 3\,Yr\ Ave.\ Ratio_{(Amm)}, 3\,Yr\ Ave.\ Ratio_{(TSS)}\right)$$

This bespoke assessment was based against 75% of the permit compliance limit, as 75% exceedances are regularly monitored by the compliance team to identify and intervene on any potential issues at a WwTW prior to failure. The selection of 75% is considered to provide an improved balance between level of risk and potential investment need when compared to the 50% threshold.

To assess future risk, the worst-case ratio was factored based on the projected change in domestic population between 2020 and 2030, 2050 and 2080 respectively. This utilised the same population data as the dry weather flow assessment, as discussed in Section 10.3.3.4.

Given the intermittent nature of water quality failures linked to permits, in addition to assessing the average sample values, counts of both the number of individual samples which have exceeded 75% of the consent limit and the number of years with a notifiable water quality failure were incorporated into the assessment. The same three-year period for which OSM samples were assessed (2017-2019) has been reviewed.

In order to assess the count of samples exceeding 75% of the consent, each determinand was assessed individually. The maximum value across the three determinands was used as the final value. For example, if a site had four samples that exceeded 75% of the BOD consent, and three samples that exceeded 75% of the ammonia consent, the value used in the final assessment would be four.

The notifiable water quality failure counts utilise data provided by the YW Wastewater Quality Performance Manager. This data included all quality failures (i.e., failures due to other determinands (such as phosphorus, UV issues etc) and highlighted any works with non-sanitary issues. This would also highlight any descriptive works which had failed to comply with their permit.

As the assessment was based on historic data, no amendments to the scores were made to allow for recently completed or upcoming schemes. It assumed that there was no change to permitting requirements or the assets at this stage. Consideration of recent and/or committed future schemes was made during the ODA stage.

As with the flow assessment, for each Level 3 catchment a single 1-5 performance band was defined for each catchment. Thresholds were set for these bands and are defined as shown in Table 31

Table 31: Catchment Performance Bands for Quality Compliance

Band	Average Sample / 75% Consent Ratio	Count of 75% exceedances	Count of failing years (2017-2019)
Not Applicable	Descriptive permit / No available data		
1	<0.9	<3	<1
2	≥ 0.9 AND <1.0	≥ 3 AND <6	≥ 1
3	≥ 1 AND <1.1	≥ 6 AND <9	≥ 1
4	≥ 1.1 AND <1.2	≥ 9 AND <12	≥ 2
5	≥ 1.2	≥ 12	≥ 3

The final band assigned to the Level 3 catchment is the maximum of the score from the three assessments. As the count of 75% exceedances and count of failing years are based on counts of binary data (i.e., exceedance/failure did or did not occur) we have elected not to project a change to these values for future epochs. Where the 2020 band was assigned based on the 75% exceedance count or the count of failing years, this band was carried forward for the future epochs, and only increased if the future ratio was such that the next threshold was exceeded.

10.3.3.6 PO-12: Managing internal flooding risk and resilience

This assessment utilised the same hydraulic methodology and approach as PO-08 Managing internal flood risk.

Whereas PO-08 focused on assessing the level of risk associated with rainfall events with return periods ranging from 1 in 1 to 1 in 30 years, this bespoke planning objective focused on 1 in 50 and 1 in 100-year events. The same definition of flooding has been used.

Table 32 below shows the annualised score for the different return periods assessed as part of this planning objective.

Table 32: Annualised score for internal flooding M50 – M100

Return Period (Year/M)	Annualised Score
50	0.02
100	0.01

For each property, an annualised score was calculated based on the simulated return periods during which internal flood risk was predicted. The maximum possible score for any given property is 0.03.

The individual property scores were summed across each Level 3 catchment to determine an annualised internal flood risk score for each epoch, both as an absolute and as a percentage of the maximum potential property risk within the catchment (where 100% would assume all properties flood in a 1 in 50-year event).

The annualised scores were converted to performance bands for each Level 3 catchment using the parameters in Table 33 below:

Table 33: Catchment performance band for internal flooding resilience

Band	Absolute	Percentage
0	0	0
1	<2.5	<2.5%
2	2.5≥ AND <5.0	2.5%≥ AND <5.0%
3	5.0≥ AND<7.5	5.0%≥ AND <7.5%
4	7.5≥ AND <10.0	7.5%≥ AND < 10.0%
5	≥ 10.0	>10.0%

The overall performance band was calculated as the average of the absolute and percentage 1-5 band.

10.3.3.7 PO-13: Managing external flooding risk and resilience

This assessment utilised the same hydraulic methodology and approach as PO-09 Managing external flood risk.

Whereas PO-09 focused on assessing the level of risk associated with rainfall events with return periods ranging from 1 in 1 to 1 in 30 years, this bespoke planning objective focused on 1 in 50 and 1 in 100-year events. The same definition of flooding has been used.

As with the internal flood risk assessment, an annualised score was calculated for each property based on the simulated return periods during which external flood risk was predicted. The maximum possible annualised score for any given property is 0.03.

The individual property scores were summed across each Level 3 catchment to determine an annualised external flood risk score for each epoch, again both as an absolute and as a percentage of the maximum potential property risk within the catchment (where 100% would indicate all properties are predicted to flood externally in a 1 in 50- year event).

The annualised scores were converted to performance bands for each Level 3 catchment using the parameters in Table 34:

Table 34: Catchment performance band for external flooding resilience

Band	Absolute	Percentage
0	0	0
1	<2.5	<2.5%
2	2.5≥ AND <5.0	2.5%≥ AND <5.0%
3	5.0≥ AND<7.5	5.0%≥ AND <7.5%
4	7.5≥ AND <10.0	7.5%≥ AND < 10.0%
5	≥ 10.0	>10.0%

The overall performance band was calculated as the average of the absolute and percentage 1-5 band.

10.3.3.8 Summary of bespoke BRAVA planning objectives outputs

The results of BRAVA stage using the bespoke planning objectives are summarised in Table 35 - Table 41 below:

Table 35: Frequency of catchments within each performance band for PO-07

	0	1 / 1.5	2 / 2.5	3 / 3.5	4 / 4.5	5	Total
2020	38	126	45	57	34	35	335
2030	34	100	48	63	37	53	335
2050	32	84	46	73	31	69	335
2080	30	66	49	78	19	93	335

Table 36: Frequency of catchments within each performance band for PO-08

	0	1 / 1.5	2 / 2.5	3 / 3.5	4 / 4.5	5	Total
2020	27	81	38	90	41	58	335
2030	20	58	44	87	55	71	335
2050	17	47	32	93	53	93	335
2080	15	34	24	92	50	120	335

Table 37: Frequency of catchments within each performance band for PO-09

	0	1	2	3	4	5	Total
2020	58	18	24	48	86	101	335
2030	58	15	20	50	86	106	335
2050	57	13	17	55	87	106	335
2080	57	11	15	50	96	106	335

Table 38: Frequency of catchments within each performance band for PO-10

	Not Applicable	1	2	3	4	5	Total
2020	70	241	4	13	6	1	335
2030	70	221	24	11	6	3	335
2050	70	196	28	28	7	6	335
2080	70	157	37	27	25	19	335

Table 39: Frequency of catchments within each performance band for PO-11

	Not Applicable	1	2	3	4	5	Total
2020	81	184	46	10	11	3	335
2030	81	184	46	10	11	3	335
2050	81	184	46	10	11	3	335
2080	81	182	45	11	12	4	335

Table 40: Frequency of catchments within each performance band for PO-12

	0	1 / 1.5	2 / 2.5	3 / 3.5	4 / 4.5	5	Total
2020	29	82	64	85	57	18	335
2030	27	66	61	91	55	35	335
2050	25	58	62	94	47	49	335
2080	23	43	66	95	40	68	335

Table 41: Frequency of catchments within each performance band for PO-13

	0	1 / 1.5	2 / 2.5	3 / 3.5	4 / 4.5	5	Total
2020	14	58	54	100	63	46	335
2030	13	42	58	90	80	52	335
2050	12	32	51	101	76	63	335
2080	12	24	41	103	73	82	335

10.3.4 Comparison between national and bespoke planning objectives

As discussed in Section 10.3.3 of this report, we have developed the bespoke planning objectives to build upon the national planning objectives and increase granularity in the results. Whilst some of the national and bespoke planning objectives are comparable, a number of key differences do exist, as summarised in Table 42.

It was not considered necessary to develop additional bespoke comparative planning objectives for:

- PO-05: Pollution risk
- PO-06 Sewer collapses risk

Similarly, the three bespoke planning objectives below do not have comparable national planning objectives, as these represent risks not considered in the national assessments.

- PO-08: Managing risk of external flooding within the property curtilage from hydraulic causes (1 in 30 year)
- PO-10: Wastewater Treatment Works (WwTW) Flow Compliance
- PO-13: Managing risk of external flooding within the property curtilage from hydraulic causes

Table 42: Summary of key differences/similarities between national and bespoke planning objectives

National Planning Objective	Key Differences	Bespoke Planning Objective	Key Differences
PO-01: **Risk of sewer flooding in a 1 in 50-year storm**	• 1 in 50 event only • 2D mechanism assessment only • Residential address points only considered • Flood threshold varied for consideration of cellars • Rapid model builds using 2D terrain model only where no 1D/2D linked DWMP model available • 0/1/2 score	**PO-12:** **Managing risk of internal property sewer flooding from hydraulic causes**	• Annualised score from M50 and M100 events • Considered 2D and S mechanisms • All residential and commercial address points considered • No variation in flood threshold for cellared properties as surcharge risk considered • Rapid model builds using 2D terrain model only where no 1D/2D linked DWMP model available • 0-5 score
PO-02: **Storm overflow performance**	• Full 10-year dataset not available for all catchments • Where no hydraulic model utilised EDM and pollution data to obtain surrogate • Storm overflows given score of 0/1/2 • Weighted to obtain Level 3 score 0/1/2	**PO-09:** **Managing Storm Overflow Performance**	• Full 10-year dataset available for all catchments with a 1D model • Where no hydraulic model and catchment contains a storm overflow, applied score of 5, high risk as risk unknown • Storm overflows given score from 1-20 to increase granularity • Weighted to obtain Level 3 score 0-5
PO-03: **Risk of wastewater treatment works quality compliance failure**	• Assessment against 50% of permit limits • 0/1/2 score	**PO-11:** **Wastewater Treatment Works (WwTW) Quality Compliance**	• Assessment against 75% of permit limits • Includes single sample exceedance count • Includes assessment of notifiable failing years • 1-5 score

Table 42: Summary of key differences/similarities between national and bespoke planning objectives

National Planning Objective	Key Differences	Bespoke Planning Objective	Key Differences
PO-04: **Internal sewer flooding risk**	• 2020 assessment only based on observed data • Includes non-hydraulic risk • 0/1/2 score	**PO-07:** **Managing risk of internal property sewer flooding from hydraulic causes (1 in 30 year)**	• Modelled 1D-2D predictions used for 2020, 2030, 2050 and 2080 • Considered 2D and S mechanisms, hydraulic risk only • All residential and commercial address points considered • No variation in flood threshold for cellared properties as surcharge risk considered • Rapid model builds using 2D terrain model only where no 1D/2D linked DWMP model available • 0-5 score
PO-05: **Pollution risk**	N/A	**No comparable bespoke planning objective**	N/A
PO-06: **Sewer collapses risk**	N/A	**No comparable bespoke planning objective**	N/A
No comparable national planning objective	N/A	**PO-08:** **Managing risk of external flooding within the property curtilage from hydraulic causes (1 in 30 year)**	N/A
No comparable national planning objective	N/A	**PO-10: Wastewater Treatment Works (WwTW) Flow Compliance**	N/A
No comparable national planning objective	N/A	**PO-13: Managing risk of external flooding within the property curtilage from hydraulic causes**	N/A

10.3.5 Planning objective themes

Given the volume of data and the commonality in some of the bespoke planning objectives (i.e., internal and external flooding) some planning objectives were combined into four key planning themes.

- Flood Risk
- Storm Overflow Performance
- WwTW Compliance
- Resilience

The alignment between the bespoke planning objectives and the key planning themes is summarised in Table 43. Where multiple bespoke planning objectives fall under the same theme, they have been grouped and the scores combined to produce an overall 1 to 5 banding for each theme. Each of these themes were assessed for the four epochs: Baseline (2020), short-term (2030) and long-term (2050 and 2080). The aggregation of planning objectives is a similar approach to that outlined within the Problem Characterisation section of the DWMP Framework.

Table 43: Mapping of bespoke planning objectives to planning themes

Planning Theme	Bespoke Planning Objectives	Combination of Performance Bands
Flood Risk	PO-07: Managing risk of internal property sewer flooding from hydraulic causes (1 in 30 year) PO-08: Managing risk of external flooding within the property curtilage from hydraulic causes (1 in 30 year)	75% PO-07 + 25% PO-08
Storm Overflow Performance	PO-09: Managing Storm Overflow Performance	100% PO-09
WwTW Compliance	PO-10: Wastewater Treatment Works (WwTW) Flow Compliance PO-11: Wastewater Treatment Works (WwTW) Quality Compliance	Maximum of P0-10 and PO-11
Resilience	PO-12: Managing risk of internal property sewer flooding from hydraulic causes PO-13: Managing risk of external flooding within the property curtilage from hydraulic causes	75% PO-12 + 25% PO-13

10.3.6 BRAVA outputs

The results of the planning themes are summarised in Table 44 - 47 below:

Table 44: Frequency of catchments under each performance band for flooding

	2020	2030	2050	2080
0	19	17	15	14
≤1	83	64	58	46
≤2	93	87	75	70
≤3	56	66	77	77
≤4	38	38	22	29
≤5	46	63	88	99

Table 45: Frequency of catchments under each performance band for storm overflows

	2020	2030	2050	2080
0	58	58	57	57
1	18	15	13	11
2	24	20	17	15
3	48	50	55	50
4	86	86	87	96
5	101	106	106	106

Table 46: Frequency of catchments under each performance band for WwTW compliance

	2020	2030	2050	2080
Not Applicable	70	70	70	70
1	179	164	146	119
2	46	61	58	55
3	19	17	34	32
4	17	17	18	36
5	4	6	9	23

Table 47: Frequency of catchments under each performance band for resilience

	2020	2030	2050	2080
0	12	11	9	8
≤1	31	24	21	19
≤2	101	92	87	70
≤3	99	106	104	117
≤4	48	41	34	29
≤5	44	61	80	92

The approach undertaken for each of the 335 Level 3 catchments that triggered as requiring BRAVA through RBCS was consistent and is representative of the "Standard" BRAVA referred to within the DWMP framework. Best available data at the time of undertaking the assessments was utilised to complete the BRAVA assessment. Within the time available, further iterations and refinement of the BRAVA process utilising alternative datasets, referred to as "Extended" and "Complex" BRAVA within the framework, could not be undertaken and therefore have not been completed for this Cycle of the DWMP. However, it is expected that, once a core pathway has been selected (post consultation) high-level sensitivity testing will be undertaken on the plan value.

The 282 Level 3 catchments that did not trigger as requiring a BRAVA through RBCS have been classified as Observe. The various assessments for the national and bespoke planning objectives detailed in this report have not been undertaken. These catchments have however been included within the wider resilience assessment discussed in Section 10.4.

10.3.7 Understanding exceedance within our DWMP

The outputs of our BRAVA assessment allow us to:

- Identify risk across all BRAVA catchments.
- Evaluate the magnitude of risk within each BRAVA catchment using a comparable scoring system.
- Evaluate how the risk is predicted to change in the future.

We have not set defined exceedances as outlined within the DWMP Framework. It is our view that a defined exceedance sets out a position below which risk is considered acceptable and this may not always be the case. Risk cannot always be characterised as acceptable (i.e., below the exceedance) and unacceptable (i.e., above the exceedance). Risk is subjective and the magnitude of any residual risk position will vary dependent on investment. Through our consultation we hope to establish our customer and stakeholder views on balancing risk with investment need.

High level screening of the primary drivers behind the catchment risks are discussed further within the Problem Characterisation section of this report.

10.4 Wider resilience

In addition to the detailed baseline risk and vulnerability assessments (BRAVA) discussed in Section 10.3 of this report, we have also undertaken a wider assessment of critical resilience issues in line with the DWMP framework. This assessment has focused on four main areas of risk or potential need:

- Fluvial and/or coastal flooding of WwTW and critical pumping stations
- Power outages
- Outages to remote communications (telemetry systems)
- Response recovery plans

This assessment has been undertaken at the BRAVA stage for all Level 3 wastewater treatment works catchments, regardless of the outcome of RBCS. We have undertaken this assessment based on the data available at the time of completion. We have a growing asset base and are continually taking steps to improve our resilience through installing measures on existing and new assets where appropriate. We continue to review our preparedness and use learning from previous events to develop the plans we have in place to deal with outside events. We will continue to monitor our levels of risk and resilience through subsequent cycles of DWMP development.

10.4.1 Flooding

The Yorkshire region has and will continue to experience flooding from all sources including rivers, rainfall, and the sea. YW assets are, by necessity, often located next to rivers or the sea for storm overflows and returning treated effluent safely back to the environment, and as such are exposed to potentially higher levels of risk. Inundation of key wastewater assets, namely wastewater treatment works and pumping stations, can significantly impact asset performance. This can result in environmental harm or additional wastewater flooding, either from the asset directly or the upstream network.

Outside of the development of the DWMP, we have developed a Flood Resilience Dashboard which can be used to evaluate the level of flood risk and potential impact of flooding across our waste and clean asset base. This dashboard builds upon previous business flood risk assessments and datasets and is available for use for a wide range of purposes including risk assessing solutions during development, understanding our insurance exposure, and informing our operational response.

The assessment of flood risk summarised within the dashboard has been undertaken using the EA's long-term risk of flooding maps for Flood Zones 2 and 3 and also the Risk of Flooding from Surface Water (RoFSW). It should be noted that these third-party datasets do not include the impacts of climate change. A region wide dataset that does include the impacts of climate change is not currently available. The newly published roadmap[26] for the national Flood and Coastal Erosion Risk Management Strategy states that the EA will publish a new national assessment of flood risk for use by all risk management authorities before 2025. However, it is not clear if this will include the impacts of climate change or not.

The flood risk assessment considered all above ground wastewater assets against the EA maps. Each asset was assigned a flood score based on the level of flood risk and the criticality of the asset. The approach taken differed between our larger sites with multiple assets associated with them (WwTWs) and our smaller assets (e.g., wastewater pumping stations). For larger sites, a detailed assessment was undertaken based on the proportion of assets on the site (buildings, structures, and roads) impacted by each flood zone. For smaller assets, the assessment was based on a single point location for the asset.

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[26] **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1080740/FCERM-Strategy-Roadmap-to-2026-FINAL.pdf**

Different weightings were applied to the different flood zones to reflect a differing likelihood of occurrence ranging from 3.3 for 1 in 30 RoFSW to 0.1 for 1 in 1000 RoFSW.

The criticality score used was based on the existing site criticality assigned within our asset inventory. This is based on a number of factors dependent on the asset type, including the population served and impact of failure, with the sites serving the greatest population and highest potential impact having the highest criticality and a score of 5. The weighted flood scores were calculated for each asset.

This exercise allowed creation of a prioritised list of assets at risk. These are currently being reviewed as part of our business plan development to identify if any additional resilience measures are required and will be reflected in cycle 2 of the DWMP where work is required or has occurred to improve resilience.

For the purposes of our DWMP, we have translated the weighted scores calculated within the existing dashboard, ranging from 0 to 39, to align with the 0 to 25 scoring used for the other wider resilience assessments discussed in the subsequent sections. The scores have been translated as detailed in Table 48:

Table 48:Weighted flood score conversion to DWMP flood risk score

Weighted Flood Score	DWMP Flood Risk Score
0	0
0-1	5
1-5	10
5-10	15
10-15	20
>15	25

An adjustment has also been made to reduce the scores using the multipliers listed in Table 49 and Table 50 where existing flood resilience measures have previously been installed and where mitigation plans, or Vulnerable Asset Plans (VAPs), used to maintain service in adverse conditions, are in place. We have used a variety of measures to protect some of our critical and vulnerable infrastructure by raising control panels and kiosks on plinths, increasing the height of instrumentation and actuated valves above flood levels and sealing cable ducts and installing watertight access covers where equipment cannot be relocated.

Table 49: Existing resilience measures in place score

No	1
Yes	0.5

Table 50: Mitigation plan or VAP score

No	1
Yes	0.8

10.4.2 Power

A significant number of our wastewater assets, notably wastewater treatment works and pumping stations rely on power to remain operational. Power is generally supplied across our region by Northern Powergrid. In the event of power outages, we are reliant on backup systems to continue operability of the asset and to minimise impact of disruption, these include:

- process storage on site
- dual power supplies from separate electricity grid supply points
- fixed standby generators
- Uninterruptable Power Supply (UPS – a battery system designed to prevent critical loads losing power)
- mobile generator connection point
- remote monitoring and control of the asset

The majority of our most critical wastewater assets have backup generators and/or uninterruptible power sources on site and are prioritised for reconnection by Northern Powergrid where necessary. We also have a contract with a generator provider who can supply emergency backup generators and maintenance. We have positively responded to significant events, such as the outages experienced during Storm Arwen in November 2021 and take learning from such events into future resilience planning.

Our engineering specification requires a risk assessment to be carried out for each powered asset to establish its ability to continue operating through power outages and any mitigation requirements. This risk assessment includes an assessment of the probability of supply failure at that individual asset. We have compiled data on historic power outages at key clean water assets and mapped this to postcode zones to create a spatial dataset detailing the probability of supply failure. For our DWMP, we have multiplied the probability of power failure within a postcode zone, the criticality of the asset and whether a mitigation plan is in place to establish a risk score for all powered WwTWs and pumping stations, using the bandings listed in Table 51, Table 52 and Table 53 below.

Table 51: Probability of Power Failure Score

High	5
	4
	3
	2
Low	1

Table 52: Asset Criticality Score

A – Very High	5
B – High	4
C – Medium	3
D – Low	2
A – Very High	5

Table 53: Mitigation Plan Score

No Existing Mitigation Plan	1
Existing Mitigation Plan	0.8

10.4.3 Remote communications

We use Supervisory Control and Data Acquisition (SCADA), our Regional Telemetry System (RTS) and mobile data telemetry assets to provide visibility of our assets. This enables us to remotely operate our asset base from our central Service Delivery Centre (SDC) and respond to any alarm generated by the telemetry systems. SCADA allows remote control and intervention of critical assets and is generally installed at our larger WwTW sites. Whilst the availability and use of remote communications systems brings a significant number of benefits, we are also exposed to risk in the event of communication outages, particularly in catchments with a high number of critical assets. There is also a higher level of risk associated with any assets without installed remote communications.

A risk score has been calculated for each asset based on the presence of remote communications at that site and the criticality of the asset using the scores detailed in Table 54, Table 55, Table 56 and Table 57 the formula detailed below:

Table 54: SCADA Score

Yes	3
No	0

Table 55: RTS Score

Yes	2
No	0

Table 56: No Telemetry Present Score

Yes	5
No	0

Table 57: Asset Criticality Score

A – Very High	5
B – High	4
C – Medium	3
D – Low	2
E – Very Low	1

$$Asset\ Remote\ Communication\ Risk\ Score = (SCADA + RTS + No\ Telemetry) * Asset\ Criticality$$

10.4.4 Overall resilience scoring

For all WwTWs and wastewater pumping stations within the region we have determined an overall “Asset Resilience Risk Score” as follows:

$$\begin{aligned} Asset\ Resilience\ Risk\ Score = {} & Asset\ Flood\ Risk\ Score + Asset\ Power\ Risk\ Score + \\ & Asset\ Remote\ Communications\ Risk\ Score \end{aligned}$$

The individual asset resilience risk scores have been summed for each Level 3 catchment to establish a risk score, with each Level 3 then classified as either Low, Medium, or High risk for consideration during future work within the catchment. The results of this assessment are provided in the Level 3 storyboards provided in Appendix D.

10.4.5 Our response to incidents

Our approach to flood resilience follows the Cabinet Office’s guidance[27] and follows the below four-box model for infrastructure resilience. This recognises that it is not cost effective or practical to install permanent flood defences at every asset, and that in some cases it is better to allow the site

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[27] https://www.gov.uk/government/publications/keeping-the-country-running-natural-hazards-and-infrastructure

to flood but enable it to be recovered quickly afterwards, for example by ensuring critical electrical equipment is above flood levels. See Figure 61 below:

Figure 61: YW Infrastructure resilience four box model[28]

Over time, we have taken steps to improve the resilience of our existing assets where possible including raising electrical panels or installing assets on raised plinths. All new assets or significant upgrades to existing assets must ensure that flood risk is mitigated to a 1 in 200 level of protection through design, wherever practical, to ensure ongoing asset reliability and resilience. Following flood events, we also aim to reinstate or repair the asset, so it has more resilience than previously (e.g., install replacement equipment at a higher level or replace dry well pumps with submersible pumps).

Extra capacity in some storm tanks beyond their permit can provide an additional level of resilience during high flows and we also have the ability to tanker away wastewater from strategic points to reduce impacts. This operational response and recovery are an important tool to manage and resolve events.

We are classified as a ‘Category 2’ responder under the Civil Contingencies Act and therefore have duties under the Flood and Water Management Act to respond effectively and efficiently to events. We have strong operational response and recovery capabilities and have successfully managed multiple largescale flood events in recent years. We operate bronze, silver, and gold escalation to reflect the severity of the incident and response required as part of our standard incident response.

At a site level, we have Vulnerable Asset Plans which are operational contingency plans, used by our operational teams to enable them to follow the correct procedure in the event of an incident or in preparation for an event which may impact assets. This can be related to a forecast of expected high winds, high rainfall or tidal surges which could impact our assets, customers, or the environment. The plans also set a trigger level for intervention and implementation of the plans.

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[28] Taken from Keeping the Country Running: Natural Hazards and Infrastructure, Cabinet Office. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/61342/natural-hazards-infrastructure.pdf

The YW SDC has established incident management plans and escalation routes for dealing with any issues which may be impacting or have the potential to impact our assets, the public or the environment. In addition, we have strategically located stocks of demountable flood barriers, mobile pumps and an emergency response vehicle to deploy where required. We support, co-operate and co-ordinate activities with other RMAs, including the EA and the emergency services during incidents. This ensures that risks of harm to staff, public, assets and the environment are minimised and services are restored as quickly as is practicable. There is also provision to provide support for clean-up operations as quickly as possible after an incident.

10.4.6 Coastal erosion

We have around 90km of coastline, half of which is made up of very soft glacial till soils and is rapidly eroding. Many homes and villages have been lost to the sea along the Holderness coast and climate change is accelerating the speed of erosion. As sea levels rise more frequent storms erode the shoreline further.

To examine our risk from coastal erosion the National Coastal Erosion Risk Mapping (NCERM) produced by the EA has been used. This identifies which assets are at risk now, in the 2030s, 2050s and 2080's. The result of this mapping has allowed us to relocate further inland some of our at-risk assets. In 2016, we moved Flamborough Head wastewater pumping station inland and have recently completed relocating our WwTW at Withernsea further inland to reduce the risk of coastal erosion impacting these assets. We have a small number of assets still at risk along our coastline and will seek to include these assets for additional resilience alongside those at risk from river, sea or surface water flooding where appropriate as part of our ongoing business planning. Due to the discrete nature of this risk, we have excluded it from the overall resilience scoring described in earlier sections.

10.5 Problem characterisation

In determining the next steps for each BRAVA catchment, a runway has been assigned within the Problem Characterisation stage. This considers both the calculated risk level and an assessment of confidence in the results of the BRAVA that was undertaken.

The calculated risk level is based around the 1-5 performance band of the key planning themes:

- Flood Risk
- Storm Overflow Performance
- WwTW Compliance

These are described in Section 10.3.5.

The resilience planning theme has not been included in this step as it was considered that during optioneering, the types of interventions that would be developed to mitigate flood risk in larger storms would be different in nature to those used in more frequent events. The resilience performance bands should be viewed alongside the wider BRAVA Resilience assessment (detailed in Section 10.4.4) for each catchment as noted on the Level 3 catchment storyboards in Appendix D. The resilience planning theme is not intended to identify required investment but to flag levels of risk within the catchment for future consideration.

10.5.1 Confidence assessment

To each of the themes, a confidence level was established for each Level 3 catchment, as outlined in Table 58.

Table 58: Confidence scores for flood risk, storm overflow performance and WwTW compliance

Confidence Score	Level	Flood Risk	Storm Overflow Performance	WwTW Compliance
5	Low Confidence	Based on 1/3 LiDAR resolution and 2/3 model confidence	Based entirely on model confidence	Data confidence level fixed at 3, consistent datasets used across all catchments
4				
3	↕			
2				
1	High Confidence			

Each model was assessed to determine a model confidence score. This was based primarily on model age, pro-rated by area where a model is a combination of models of different ages. Models with high levels of confidence from existing verified model stock were given the highest confidence score. Low confidence scores were assumed for any new DWMP models built as part of the rapid build process as defined in Section 10.3.1.3 or those built before 2009. Any 2D only models, developed for the assessment of PO-01 were considered low confidence and scored appropriately.

10.5.2 Assessing the problem characterisation metrics

The planning theme band and the assigned confidence was then used to determine how each Level 3 catchment should progress through the next stages of the development of the DWMP. Each of the Level 3 BRAVA catchments were classified as; Monitor, Investigate or Promote.

- **Monitor** – Small catchment or lower risk. Future monitoring required.
- **Investigate** – Higher risk but with reduced confidence. Uncertainty in data should be reduced through investigation to confirm outcomes of risk assessment and if optioneering is required.
- **Promote** – Higher risk and sufficient confidence. Catchment should proceed through to option development and appraisal stage (ODA). Catchment level interventions to be developed and costed.

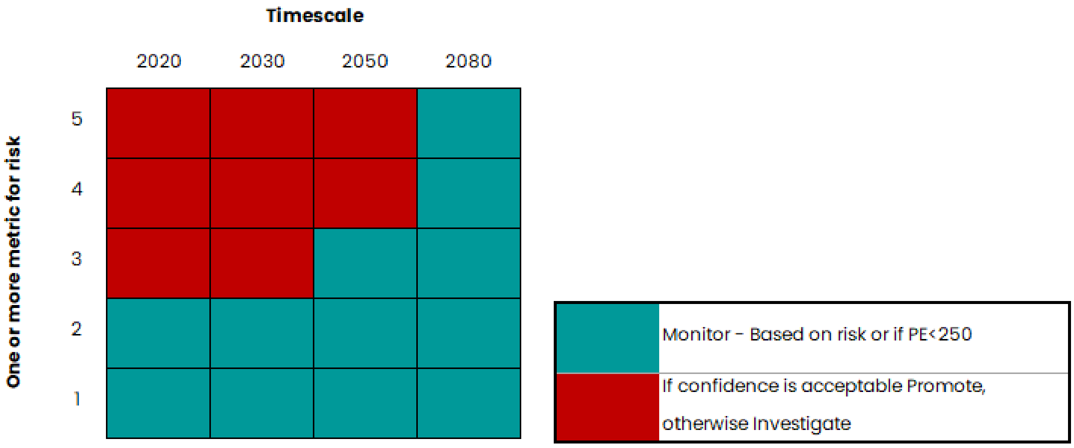
Where monitor and investigate are assigned this should not be interpreted as there being no risks present within the catchment. Risks may be present and therefore mitigation may be required. The same is true of catchments that did not trigger within RBCS. For instance, there could be a storm overflow within a non-BRAVA catchment which may not comply with the requirements of the final Storm Overflow Discharge Reduction plan and therefore intervention would be required for the asset.

It should be noted that the assessment was carried out separately for the network-based themes (flood risk and storm overflow performance), and the WwTW compliance theme. This was done as the solutions are likely to differ substantially in approach and complexity and the timescales within which they need to be implemented.

It is important to note with regards to the network, we have taken a catchment-based approach. If one planning theme was triggered and Promote assigned, then we considered both planning themes within the options development stage for the network. This allowed us to take a holistic catchment-based approach and drive to achieve efficiency in our long-term plan by reducing all identified risk within the catchment, rather than focusing on the triggered risks only.

The logic matrix used is shown in Figure 62 below:

Figure 62: YW problem characterisation matrix



Timescale

One or more metric for risk	2020	2030	2050	2080
5	🟥	🟥	🟥	🟩
4	🟥	🟥	🟥	🟩
3	🟥	🟥	🟩	🟩
2	🟩	🟩	🟩	🟩
1	🟩	🟩	🟩	🟩

🟩	Monitor - Based on risk or if PE<250
🟥	If confidence is acceptable Promote, otherwise Investigate

As shown in the logic matrix, differing trigger thresholds were used for the different time epochs. It was considered that for a catchment to trigger an intervention in the longer-term 2050 epoch, a greater level of risk was required. This is due to the level of uncertainty increasing as we progress further into the future, influenced by uncertainty in climate change projections and the materiality of predicted growth amongst other factors. It should also be noted that the predictions for the 2080 epoch, particularly with regards to climate change, are considered too uncertain at this stage to trigger investment. However, the analysis undertaken provides a useful insight as to how risks may increase beyond 2050.

10.5.2.1 Flood risk and storm overflow performance

All Level 3 catchments were initially assessed based on their Population Equivalent (PE). For 2020 to 2050, if the PE of the catchment is less than or equal to 250 the catchment has been assigned to Monitor. Such catchments account for approximately 0.1% of the PE within the BRAVA catchments. The assumption being that any risk realised in these small catchments is likely to be addressed during the AMP period and will not require the level of strategic planning developed for the DWMP. The 250PE threshold was selected to align to the threshold for WwTWs requiring a numeric environmental permit. In addition, any catchment where both the network metrics have a risk score below the threshold for that epoch, were also assigned as Monitor.

If the population threshold and risk threshold were exceeded for either flood risk or storm overflow performance, then an additional check was carried out on the assigned confidence. If the confidence was acceptable (score of 3 or less), then the catchment was assigned to Promote. Where the confidence is low, an outcome of Investigate was assigned.

In a small number of instances, some catchments are predicted to increase in population and cross the assigned 250 PE threshold by 2050. These have been assigned to Investigate rather than Monitor as the WwTW may require a future change of permit conditions. This is likely to trigger an investment need within the future. If this need does arise, the catchment will be reviewed as a whole, and any wider network investment evaluated. Costs have not been included for these catchments at this stage as the need is still too uncertain.

Table 59 below shows the breakdown of network assignments between Monitor, Investigate and Promote and the reason for the assignment based on the above matrix.

Table 59: Problem characterisation runway assignment: Networks

Runway	Nr of Level 3 catchments	Reason
Monitor	68	Small catchment size
	31	Low risk
Investigate	69	Low confidence
	7	Crosses descriptive threshold
Promote	160	Higher risk and sufficient confidence

10.5.2.2 WwTW performance

Due to the assessment of a single metric, a simpler approach was used for the WwTWs runway assignment. The 2050PE threshold described above remains valid for this metric and approach.

Data confidence for WwTW compliance (flow and quality) has given a fixed confidence level of 3 and promotion is then primarily dependent on the level of risk seen. A WwTW with high risk levels is assigned Promote; emerging or low risk will be progressed to Monitor.

Table 60: Problem characterisation runway assignment: Treatment

Runway	Nr of Level 3 Catchments
Monitor	288
Investigate	7
Promote	40

10.5.3 Overall runway

The most significant of the network and treatment runway assignments in terms of level of intervention required (i.e., Promote greater than Investigate, which is in turn greater than Monitor), has been used to assign an overall outcome for each Level 3 catchment.

The overall outcome is summarised in the Table 61 below:

Table 61: Problem characterisation runway assignment: Overall

Runway	Nr of Level 3 Catchments
Monitor	96
Investigate	65
Promote	174

Suitable hydraulic models were not available for 10 of the Promote catchments. These have been assigned Promote based on the treatment planning theme, the network has been assigned either Monitor or Investigate. No development of network solutions has been undertaken for these catchments, in line with other catchments that have triggered Monitor or Investigate, however the treatment element has been taken forward for consideration during the ODA stage.

The approach outlined above is considered comparable to the Strategic Need element of Problem Characterisation outlined within the DWMP framework. The framework provides a standard question set which assesses the scale of concern relating to near term or future risk arising from either the flow or load entering the drainage network or the capacity of the drainage network. The framework notes, the question set should be applied to each planning objective or aggregation of planning objectives, to provide a score of Not Significant, Moderately Significant or Very Significant dependent upon the predicted impact on the provided levels of service. The Problem Characterisation matrix in Figure 62, has been applied to an aggregation of planning objectives for network performance and a separate aggregation for WwTW performance and appraises the near term and future predicted levels of service in terms of Monitor (Not Significant) or Promote (Moderately or Very Significant). Within the Problem Characterisation process applied within our DWMP, where the data is considered to be of low confidence an outcome of Investigate has been assigned.

The Complexity Factors assessment detailed within the Problem Characterisation section of the framework has not been carried out. This process is aimed at exploring the nature of the risks and vulnerabilities that exist within the DWMP. The question set provided within the framework focuses on appraising the level of concern associated with current or future uncertainties. As common data sets have been used and, as far as possible, the same approach has been taken to the development and assessment of data, the complexity factors assessment is likely to be similar for all catchments. It is expected that, once a core pathway has been selected (post consultation) high-level sensitivity testing will be undertaken on the plan value.

The framework Problem Characterisation stage provides a Low, Medium, or High classification which corresponds to increasing complexity of the optioneering and decision-making approaches to be applied within the subsequent stages of the DWMP. For this cycle of our DWMP we have focused on developing a strategic plan for the higher risk catchments only. A single consistent approach to optioneering has been undertaken at a catchment level within all Promote catchments The focus on these catchments is predominantly dictated by time and data availability and we anticipate expanding our assessment for future cycles to cover a wider proportion of our region.

10.5.4 Preliminary screening

The Promote catchments have gone through some preliminary screening in order to identify probable causes or drivers behind the predicted system performance evaluated during the BRAVA stage.

The preliminary screening is aimed at identifying flow contributions that could be addressed to reduce the risk within the catchment

A total of five metrics have been considered:

- Inflow and Infiltration
- Trade
- Growth
- Connected area
- Direct connections

10.5.4.1 Inflow and infiltration

An initial assessment of catchment infiltration was undertaken for each Level 3 catchment using the average measured Q80 volume for the period 2017-2019 for the catchment WwTW and the theoretical DWF formula:

$$DWF(Q80) = PG + I + E$$

Where:

DWF(Q80) = total dry weather flow (m^3/d)

P = catchment population

G = per capita domestic flow ($m^3/head/day$)

I = infiltration (m^3/day)

E = Trade effluent flow (m^3/day)

For catchments where the estimated catchment infiltration accounted for more than 25% of DWF(Q80), and the 2050 PE was greater than 2500, a further model assessment was undertaken to increase confidence. For a number of reasons such as varying consumption between catchments, fluctuating trade flows and holiday populations the assessment using Q80 and the catchment characteristics can provide spurious results.

The model test evaluated the proportion of daily volume arriving at the WwTW that could be considered as either inflow or infiltration. A duplicate model was produced with all infiltration (base and storm induced) removed from the model. This model and the original model were simulated for two four-day periods, one representative of dry conditions and one of storm. For this analysis a M5-480 winter storm was selected. The difference in predicted daily volume arriving at the WwTW between the original model and the model with inflow and infiltration removed was reviewed and a high, medium, or low potential assigned based on the thresholds listed below:

- High ≥ 50%
- Medium ≥ 35% and <50%
- Low <35%

10.5.4.2 Trade

The consented trade flow was expressed as a percentage of the Q80 value. High, medium, or low potential was assigned based on the thresholds below:

- High ≥ 10%
- Medium ≥ 5% and <10%
- Low <5%

10.5.4.3 Growth

The modelled population was reviewed for 2020 and 2050 and the population increase between these two epochs used as a measure of growth. High, medium, or low potential was assigned based on the thresholds below:

- High ≥ 15%
- Medium ≥ 10% and <15%
- Low <10%

A total of 10 catchments were unable to be assessed for this metric as no model was available.

10.5.4.4 Connected area

An evaluation of the proportion of impermeable area connecting to the foul or combined system within the Level 3 catchment has been made.

The total modelled area connecting to the foul or combined system has been calculated and the proportion considered to be impermeable area has been evaluated. This was assessed based on the 2020 epoch model.

High, medium, or low potential was assigned based on the thresholds below:

- High ≥ 15%
- Medium ≥ 5% and <15%
- Low <5%

A total of 10 catchments were unable to be assessed for this metric due to no model being available.

10.5.4.5 Direct connections

An evaluation of the number of surface water connections to the foul or combined network within the sewer record data has been undertaken to give an indication of potential direct connections.

High, medium, or low potential was assigned based on the thresholds below:

- High ≥ 25
- Medium ≥ 5 and <25
- Low <5%

10.5.4.6 Summary of preliminary screening

A summary of the number of Promote catchments classified as high, medium, or low potential for each metric is given below in Table 62:

Table 62: Preliminary screening classification summary

Potential	Inflow and Infiltration	Trade	Growth	Connected Area	Direct Connections
High	30	6	122	36	17
Medium	46	10	13	88	42
Low	98	158	29	40	115
Not Assessed			10	10	

This table shows that growth is high in a significant number of catchments. However, it should be noted that potential for reduction of one of the above metrics does not necessarily translate to a reduction of risk. For instance, growth is likely to have a contribution to dry weather flow contributions and may impact upon the treatment works flow compliance. A reduction in dry weather flow contributions is something that should be targeted as this would result in long term sustainable benefits such as reduced treatment costs. However, the dry weather flow is likely to be a small proportion of the storm flow where the network is combined. Therefore, a reduction in growth may have a minimal impact upon predicted storm overflow operation and flood risk. This would present an opportunity to work collaboratively and seek local betterment.

Predicted storm overflow operation and flooding performance are considered to be most heavily influenced by connected area to the sewer network. Inflow and infiltration and direct connections could also be influencing factors.

10.6 DWMP Scenarios

The preceding stages of the DWMP have evaluated current and future risk within the catchments that triggered BRAVA against the national and bespoke planning objectives.

For dDWMP, the highest risk catchments were identified and proceeded through preliminary screening, to understand potential drivers within each catchment, before progressing to Option Development and Appraisal (ODA), this approach for dDWMP is summarised in Section 10.7.3.1 below.

Options were developed for four different scenarios, each with a different target level of service to be provided in 2050. The four different service positions incurred different investment requirements and yielded different benefits; this was explored through our consultation (see Section 9.1). The feedback indicated a clear preference for DWMP Scenario 2. As such the approach to ODA for our final DWMP has been amended to focus on DWMP Scenario 2 only.

We have refined the DWMP Scenario 2 definition slightly from draft, to bring a greater level of alignment between the aims of this scenario and the requirements of the SODRP, this includes providing interim targets. The revised DWMP scenario definition is presented below in Table 63.

Table 63: DWMP Scenario 2 summary

Element	Details	Timing
Deliver the requirements of the Storm Overflow Discharge Reduction Plan	Annual average of no more than 10 spills per storm overflow	
	Annual bathing season average of no more than 2 spills per storm overflow discharging to coastal bathing waters, to support achieving excellent bathing water classification	75% high priority sites achieved by 2035
	Annual bathing season average of no more than 1 spill per storm overflow discharging to inland bathing waters	100% bathing water sites achieved by 2035
	Installation of continuous water quality monitoring to assess any impact from storm overflows and wastewater treatment works discharge outlets	Monitoring installed by 2035
	Provision of screening at all storm overflows	Screens by 2050
	Ensure no local ecological harm from storm overflows	
Reduce Modelled Hydraulic Flood Risk	Reduce model predicted risk of internal and external hydraulic sewer flooding of properties up to a 1 in 30 return period, compared to the 2050 position	By 2050
Maintain WwTW Compliance	Ensure all of our wastewater treatment works remain compliant with current environmental permits and any future changes to permits	100% in AMP8

We have maintained the BRAVA approach and Problem Characterisation assessment of each of the 617 catchments from draft; including the assignment of 'promote', 'investigate', 'monitor'. The approach to ODA has changed for final. The primary change is a move away from a catchment-based approach with solution strategies evaluated for the whole Level 3, to ODA now being undertaken at a Level 4. This is necessary to:

- Allow ODA to be undertaken for all storm overflow assets as required by the SODRP, rather than just those within promote Level 3's.
- Allow the interim delivery targets stipulated within the SODRP to be met.
- Allow flood risk mitigation to be considered for all BRAVA Level 3's.
- Provide our customers and stakeholders with greater clarity of the short-, medium- and long-term elements of our plan as requested within our consultation.

Our approach to short-, medium- and long-term prioritisation of storm overflows, flood clusters and inclusion of the WwTW WINEP and growth drivers is documented in the following ODA sections (Section 10.7).

10.6.1 Storm overflows

The developed plan will align to the delivery of targets and timescales set out within the SODRP. Where a storm overflow has been identified as requiring an intervention, in line with current SODRP guidance, then a scheme has been developed to resolve the risk.

In two instances (both bathing water locations) the 2030 model predicted spill frequency exceeds the target spill frequency but the 2050 model predicted spill frequency is within target. This is attributed to differences in the generated climate change perturbed rainfall series and grouping of spill events. Schemes have been developed for these overflow locations within our costed plan.

It should be noted that no solutions have currently been developed to mitigate the no local adverse ecological harm impact from our storm overflows. This is due to the fact that site specific investigations are required in order to identify the scale of works required at each site to achieve a no local adverse ecological harm solution and the scope requirements for these investigations is still to be finalised and published. We have progressed one high priority storm overflow asset which has a detailed UPM solution to deliver no local adverse ecological harm at this location as it met the requirements of the EnvAct_INV4 driver.

We have included notional AMP8 WINEP investigation costs within the DWMP. On completion of the investigations, we will be able to undertake high level scoping and optioneering to identify the possible solutions to mitigate no local adverse ecological harm from any storm overflows where the investigations identify a requirement. It is anticipated these would be included within cycle 2 of the DWMP.

A total of 474 sites have been identified to be investigated and planned to be completed before April 2027, this covers 75% of the identified high priority overflow sites. A further 217 investigations will be completed post April 2027, but within AMP8, and these cover the remaining high priority storm overflow sites and completes the remaining overflows within our large urban conurbations.

This approach may result in a need to re-invest a small number of AMP8 sites within future AMPs should the outcome of the subsequent investigations show that less than 10 spills per annum on average are required to meet the no local adverse ecological harm requirements.

A classification of no local adverse ecological harm from our storm overflow assets does not necessarily mean good river water quality status will be achieved. The contribution of other risk sources is not considered, unless a full UPM study is undertaken where other impacts from other sources maybe identified. River water quality can be dependent on many other, potentially unknown, point and diffuse sources of pollution.

10.6.2 Flood risk

For assessing flood risk a trigger for intervention has been set at a property level. In Section 10.3.3.1, we discussed the two different flooding mechanisms that have been assessed; 2D overland risk and 1D surcharge. We have set different intervention triggers for these mechanisms. The following would trigger for investment:

- Any property predicted to flood internally from the overland mechanism up to and including 1 in 30-year event resulting from hydraulic incapacity.
- Any property predicted to flood internally from the surcharge mechanism up to and including 1 in 2-year event resulting from hydraulic incapacity.
- Any property predicted to flood externally up to and including a 1 in 2-year event resulting from hydraulic incapacity.

Where a property exceeds one of the above criteria then a scheme would be triggered; it is assumed that a 1 in 30-year standard of protection is offered by the solution.

The reduced trigger level for surcharge is due to greater uncertainty associated with this metric. The assessment is founded on a number of coarse assumptions regarding connection point, which is likely to be over predicting risk level. Therefore, a more cautious approach to option development has been taken at this stage. However, the surcharge metric can be considered a surrogate for limited capacity within the network in lower return period events. We will continue to improve our understanding of the property connection points to the main sewer and therefore help to reduce uncertainty around the evaluation of risk from this mechanism.

10.6.3 WwTW

The target for wastewater treatment works was consistent across the four scenarios presented in our dDWMP and remains the same in our final scenario, maintain 100% compliance with our environmental permits.

There are two triggers which dictate whether WwTW investment is required:

- Investment required as a result of WINEP driver.

- Investment required to ensure compliance with environmental permit where risk of non-compliance is identified due to growth.

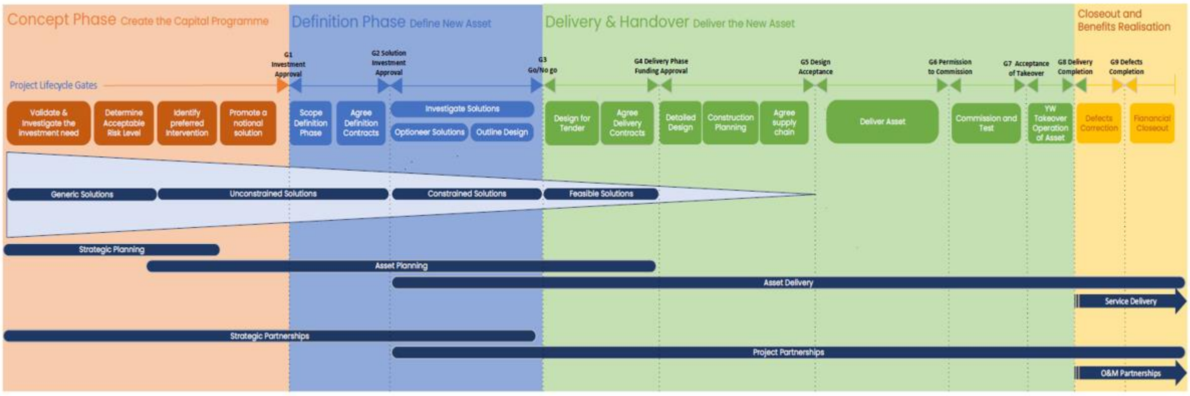
Additional detail on the approach taken to identify the investment requirements is detailed in Section 10.7.4.

10.7 Options development and appraisal

The main aim of the Option Development and Appraisal (ODA) process is to provide a framework that will enable us to develop robust and best value interventions to address the levels of risk associated with our planning themes, where these arise in the planning period.

It is important to note that the ODA undertaken for the DWMP provides only the first step in our Yorkshire Project Lifecycle (refer to Section 11.5). The DWMP comes under 'Strategic Planning' within the concept phase shown in Figure 63 below.

Figure 63: Project Lifecycle and solution interactions



A common risk management hierarchy is utilised throughout all stages of the Project Lifecycle; this is the basis of the DWMP Risk Management Hierarchy shown in Figure 64 below. The hierarchical process allows us to assess the appropriate level and nature of intervention we need to deploy.

Figure 64: Risk management hierarchy

DWMP Risk Management Hierarchy		
1	**Monitor**	Monitor performance.
2	**Investigate**	Gather additional data and/or information to improve understanding of risk and support development of cost beneficial interventions, if required.
3	**Optimise (operate and invigorate)**	Operate and maintain systems to maximise existing capacity and minimise risk.
		Domestic and business customer education.
4	**Reduce or remove**	The management and control of rainfall induced flows to reduce the quantity of flow within the wastewater system. Where appropriate schemes should be developed (and funded) in Partnership with stakeholders to develop mutually beneficial solutions.
		Generic customer side management options to manage the use of water in customer properties (domestic and trade).
		Measures to reduce the contaminant load within the wastewater system.
		Measures to reduce the receptor risk (where other options have been demonstrated to be non cost beneficial).
5	**Enhance (fabricate)**	Construct new assets using efficient construction approaches to manage flows and loads within the conveyance system or at wastewater treatment works to minimise impacts on customers and the environment.

The DWMP ODA stage has been delivered at scale and as such it has not been possible to understand the unique drivers of each identified risk. Consequently, the output from the DWMP is to define high-level strategic option strategies such as 'Monitor', 'Reduce' or 'Enhance'. Approximations of the solution build-up have been made within the DWMP, to support costing development. However, these should not be considered as the final delivery option detail.

During our definition phase of the project lifecycle, further site-specific assessment of the identified risk will be undertaken with greater analysis of local model confidence. If necessary further information would be collected such as flow data, utility locations, land ownership and ground conditions. Evaluation of this data could significantly alter a schemes feasibility and cost benefit assessment therefore the risk management hierarchy would be revisited to establish if the option selected within the DWMP is still valid considering more granular data. Consequently, it is possible that within the lifecycle of a project a proposed solution can change, and it is also possible that with the addition of further information a monitor solution is established.

A list of generic options has been created which has been aligned to each of the stages within our risk management hierarchy.

10.7.1 Generic options

A comprehensive standard list of generic options was compiled by the National DWMP Implementation Group and used as a starting point for option development. We have reviewed this list to determine which of the generic options are retained as currently acceptable for consideration within the context of our DWMP for future delivery plans and to note how they align to our risk management hierarchy shown above in Figure 64. Some of the options are applicable regionally only and where appropriate, this has been noted within the comments.

It should be noted that for some of the considered solutions which have been "retained" as considered acceptable, it has not been possible to reliably evaluate the potential costs or benefits, this has been noted within the sections below. As such for the purposes of our strategic planning and DWMP we have focused on a reduced list of options in order to achieve a comparative, high-level cost and benefit assessment for different options.

10.7.1.1 Monitor

In addition to reviewing performance there are a number of generic options to be taken forward and considered, these are set out in Table 64, below. No assessment of the cost or benefit associated with these options has been made within the overall developed plan. This is primarily due to uncertainty around tangible benefit quantification.

Table 64: Generic option screening: monitor

Generic Option	Description	Comment
Influence policy	Influence policy internally and at higher levels, provide evidence to support reasoning	Retain (Level 1)
Build stakeholder relationships	Internal and external	Retain
Domestic and business customer education	Improve understanding of the water cycle and wastewater systems	Retain (Level 1)

10.7.1.2 Investigate

In some instances, further information is needed to improve our understanding of risk and to support the development of cost beneficial interventions.

Within our dDWMP some Level 3s were classified as investigate based on low model confidence. For Final, a Level 4 model confidence assessment has not been undertaken due to restrictions on availability of time. Options were developed using the available modelling data as the best available information. Where no model was available extrapolations were utilised.

Level 4 model confidence assessments will be considered as part of the project lifecycle within the definition phase. Future DWMP cycles will seek to improve the local model confidence assessment and incorporate it as part of the strategic planning stage. Costs have not been included in this cycle of the DWMP and we will look to incorporate in future cycles.

10.7.1.3 Optimise

In some instances, the most sustainable solution is to ensure that what is currently in place is working as effectively and efficiently as it can.

A key element of being able to maximise the potential of our system is its serviceability condition. This includes pipes being free of obstructions which reduce their capacity, such as roots or fats, oil and grease blockages, screens being clean and flap valves and pumps being in good condition.

Additionally, we recognise that technology is changing, and this presents opportunities for us to manage and operate our network differently in the future to improve efficiency. Table 65 summarises the generic options falling within the optimise category.

Table 65: Generic option screening: optimise

Generic Option	Description	Comment
Maintenance & rehabilitation (where approach is different to Business as Usual (BAU))	Enhanced operational maintenance allows the system to be maintained proactively, maximising the use and longevity of existing assets. Intelligent asset maintenance to maintain service and improve asset health via pro-active and targeted operation and maintenance programmes.	Reject for DWMP. Valid base funded business solution
Intelligent asset / system operation	Controlling flow movement or treatment process in reaction to the current situation. Allows the system to be operated proactively, maximising the use of existing assets to improve efficiency. These options cover a range of different approaches e.g., modifying the start-stop levels at strategic pumping stations, creation of new network control points which allow for flow to be temporarily held back in the catchment, active asset control linked to weather radar.	Pilot
Domestic and business customer education	A roll out of an education programme to improve understanding of the importance of reduced flows and misuse of the system, and the impact this has on the environment and sewerage system.	Retain (Level 1)
WwTW rationalisation / centralisation	Close smaller treatment works and transfer flows to a larger one to maximise existing capacity and minimise risk.	Retain
Future technology	Await or develop new technologies that could improve the efficiency of existing assets.	Retain (Level 1) – Pilot prior to adoption

There is still much to understand about the advantages and disadvantages of adopting emerging and future technologies. As such we will seek to pilot and trial new concepts before rolling out as tried and tested solutions. We currently have a number of smart network trials in progress. The findings from these trials will help us to understand the circumstances in which a given technology can be utilised most effectively and provide evidence on the expected efficiencies. Further information on Innovation is available in Section 8.

The level of uncertainty at present, regarding where best to deploy these emerging technologies and what level of performance enhancement they would result in, has meant for this cycle of our DWMP, these options are not considered within the developed costed plan. As site-by-site risk evaluation is undertaken it is expected that optimise solutions could be applied in some locations, particularly within the short term whilst partnerships are developed, and blue-green schemes are given time to mature.

We have already run a number of education campaigns (e.g., to raise awareness of sewer network abuse) across the Yorkshire regions and in targeted areas. This is a solution we will continue and develop; however, no assessment of the cost or benefit has been made within the overall developed plan. This is primarily due to uncertainty around tangible benefit quantification.

10.7.1.4 Reduce

The reduce options have been subdivided into generic options which target different components of flow. These have been evaluated and grouped as:

- wastewater and trade effluent
- rainfall induced flow, and
- contaminant load.

Where the above options do not present a suitable cost benefit then options to reduce the receptor risk may need to be considered.

10.7.1.4.1 Wastewater and Trade Effluent

Reduction in wastewater flows considers where the adopted company policy encourages reduction in water consumption through education, financial reward and simple retrofit options. These measures, shown in Table 66 below, are designed to further reduce the quantity of wastewater (domestic or trade) within the sewerage system.

It should be noted that a future reduction in average per capita consumption has already been built into our future epoch hydraulic model predictions.

Table 66: Generic option screening: reduce wastewater and trade effluent

Generic Option	Description	Comment
Water efficient appliances	Supplying customers with household appliances which are designed to reduce water consumption. Reduced consumption can also benefit the wastewater system by reducing the dry weather flow to be conveyed through the sewer network and through the WwTWs.	Retain (Level 1)
Water efficient measures	Water efficiency measures can be installed within buildings with the purpose of reducing water consumption. Reduced consumption can also benefit the wastewater system by reducing the dry weather flow to be conveyed through the sewer network and through the WwTWs.	Retain (Level 1)
Customer incentives	Financially rewarding customers who sign up to a range of programs which are designed to help customers make smart choices in managing and/or utilising water and wastewater services. This for example could include use of metering/smart metering along with different tariff designs.	Retain (Level 1)
Greywater treatment and reuse (domestic)	Install systems to treat and re-use household water (excluding toilets) for flushing toilets and gardening use. Either at property level or larger scale to reduce both flow and load to the system.	Reject – further work needed to understand customer acceptability

Table 66: Generic option screening: reduce wastewater and trade effluent

Generic Option	Description	Comment
Blackwater treatment and reuse	Install systems, at property level or larger scale, to treat and re-use household water. Options vary from pre-treatment before the wastewater is conveyed through to a WwTW, to complete treatment of blackwater.	Reject – further work needed to understand customer acceptability
Effluent re-use	Recycle wastewater treatment works flow within the catchment.	Reject – further work needed to understand customer acceptability
Greywater treatment and reuse (commercial / industry) or package treatment	Install systems to treat and re-use commercial water, considered treatment levels vary from treatment for potable use to pre-treatment for discharge into the combined or foul sewer network.	Retain for new trade effluent discharge consent applications and where revisions are required.

The preliminary screening undertaken as part of the dDWMP highlights that a significant proportion of the promote catchments are likely to have a high potential for a reduction in wastewater due to future planned growth. However, whilst a reduction in dry weather flow sources may provide long term sustainable benefits in terms of reduced treatment costs, the dry weather flow is anticipated to be a small proportion of the storm flows therefore the potential to mitigate storm overflow operation and flooding may be limited. These measures are expected to be limited to new build situations and further work would be needed to understand customer acceptability of some options.

Additionally, some of the measures are difficult to assess on a catchment scale as the potential uptake is unknown and therefore benefit quantification may be considered subjective. As such these measures have been discounted for consideration within the strategic plan development, although a number remain in consideration for future delivery plans. We have however undertaken high level screening as part of treatment optioneering to highlight catchments where this broader option may be beneficial.

10.7.1.4.2 Rainfall induced flow

Measures to reduce the quantity of rainfall induced flow within the system are shown below in Table 67 below.

Table 67: Generic option screening: reduce rainfall induced flow

Sub Option	Description	Comment
Reduction or removal of inflows and / or infiltration	Reduction or removal or inflows and infiltration through measures such as disconnection and re-routing of watercourse flows or surface water systems connecting directly to foul/combined systems, source control measures, pipe lining.	Retain
Surface water system disconnection / flow separation	Separate surface water from combined systems by constructing new surface water networks or for example disconnection of down pipes to soakaways.	Retain
Strategic blue-green corridors	Combine the management of blue and green spaces in urban environments with a focus on placemaking.	Retain

Table 67: Generic option screening: reduce rainfall induced flow

Surface water source control measures	Managing surface water and maximising its potential for re-use. Opportunities for large-scale source control installation such as retrofitting in highways and around buildings, as well as aligning with ongoing programmes like local authority highway upgrades or major opportunity area developments (green roof, permeable paving). Rainwater harvesting or active management of surface water such as smart water butts	Retain

A reduction in inflow and infiltration will present a sustainable solution. However, source identification is not always possible, and removal can be challenging or present a poor cost benefit.

For this first cycle of our DWMP we have proposed further investigation for those Promote catchments where the preliminary screening suggested inflow and infiltration was high. This screening information will be shared as part of the project lifecycle for further consideration within the solution development and in future cycles.

10.7.1.4.3 Contaminant load

Measures to reduce the contaminant load entering the network are shown below in Table 68.

Table 68: Generic option screening: reduce contaminant load entering the network

Sub Option	Description	Comment
Tanker to works	Tanker high containment load flows from point source to treatment works to reduce load passing through network.	Reject – unacceptable as a permanent solution due to carbon impacts and impact on local residents
Direct line to works	High containment load flows piped from point source directly to treatment works to reduce load passing through network.	Retain for new connections or revisions
Pre-treatment within the network	Chemical dosing prior to flow reaching the treatment works to relieve the load transferred to the WwTW or to remove contaminants.	Retain for new connections or revisions
Catchment management initiatives	Treat either diffuse or point source non-domestic elements of wastewater before they enter the sewer system.	Retain
Treatment decentralisation	Remove flows from a treatment works and create localised treatment works	Retain

The preliminary screening undertaken highlights limited opportunity for the above options. Due to the bespoke nature of the solutions required in each instance, they have been discounted from assessment in the development of our strategic plan with the exception of treatment decentralisation which has been considered at a high level during optioneering for treatment risks. They remain in consideration for future delivery plans.

10.7.1.4.4 Receptor risk

Measures to reduce the risk to the receptor are shown below in Table 69.

Table 69: Generic option screening: reduce receptor risk

Sub Option	Description	Comment
Surface water pathway measures and design for exceedance	The need to provide safe conveyance (as opposed to storage) for floodwater during an extreme rainfall event (when the capacity of the sewer network is exceeded). Could, significantly mitigate the risk of considerable damage to public and private property and even loss of life that could result from an extreme rainfall event Understanding where flow will go when a system is overloaded. Accept the flood and mitigate where that flow would go. e.g., a water plaza concept	Retain
Mitigation	Surface water receptor measures. Keep floodwater away from buildings and strategic infrastructure in event of a storm. This would include property level resilience measures (floodgates, non-return valves, pumps etc.)	Retain
Storm management	Treatment of storm discharges	Retain and review
Modify consents / permits	Review permit with regulators and meet new permit conditions	Retain
Integrated catchment solutions	Treating and control the other contributors to the environment. This includes working with EA and other stakeholders on nutrient balancing and other integrated catchment solutions.	Retain
River catchment / flexible permitting	Work with regulators to balance loading within the RBD.	Retain

The above options should be considered as a last resort and therefore only considered where other solutions have been demonstrated not to be cost beneficial. Due to the bespoke nature of the solution required in each instance, these solutions have been discounted from assessment in the development of our strategic plan with the exception of river catchment/flexible permitting which has been considered at a high level during optioneering for treatment risks. They remain in consideration for future delivery plans.

10.7.1.5 Enhance

Measures where we can look to add to our assets to improve performance and reduce risk can be seen below in Table 70.

Table 70: Generic option screening: enhance

Generic Option	Description	Comment
Network modification	Changes to the sewer network to improve performance via modification of existing assets or creation of new ones. This may include sewer replacement to increase capacity or creation of additional storage volume to reduce storm impact.	Retain
Wastewater transfers	The movement of flow to another part of the network, Level 3 catchment, or company. This may include WwTW rationalisation.	Retain
Treatment modification	Invest in new assets to provide additional capacity within site footprint or by expansion.	Retain

10.7.2 Consideration of existing schemes

As a business we are continuously investing in order to provide the appropriate level of service and reduce our levels of risk. Some of the risks that have been identified within our wastewater catchments during the BRAVA phase of the DWMP have already been identified within the business and have been allocated either recent (late AMP6) or planned investment (AMP7) in order to address them, either directly or as a secondary benefit of another scheme.

Recent and planned investment in storm overflows in AMP7 is focused on reducing the average number of spills from overflows across the asset base. As the SODRP targets were only published in August 2022 it is acknowledged that any investment made will have reduced spills but not to the new SODRP targets. Consequently, for storm overflows with AMP7 investment the DWMP options may be considered conservative, however the overall need for investment is still required. Recent scheme outputs and improvements will be taken into consideration as options progress through the project Lifecycle.

Wastewater treatment works compliance risk has been assessed at an asset level and therefore recent and planned investment has been considered prior to progressing to option development. A review of schemes delivered during AMP6 or planned for delivery during AMP7 has been undertaken for all catchments which progressed from Problem Characterisation as 'Promote' for WwTW compliance. This review included internal consultation to confirm the materiality of the identified risks and checks against recent asset performance where appropriate. Where an existing scheme is anticipated to reduce the identified risk, an option has not been developed within the DWMP. At the time of the review the exact scope of AMP7 schemes had not been defined and therefore it has been necessary to make some assumptions with regards to their outcomes and resultant levels of risk, immediately after the completion of the scheme and post the scheme design horizon. We will continue to monitor our performance and future risk levels at these sites following the completion of the schemes, with future investment requirements identified during subsequent cycles of DWMP development.

10.7.3 Networks ODA

A number of the generic options detailed within Section 10.7.1 of this report have either been rejected for this cycle of the DWMP or discounted from the cost benefit assessment undertaken for this cycle. Specifically, regarding the network, the following options remain in consideration for further assessment as part of the option development stage:

- Reduce rainfall induced flow
    - Surface water system disconnection / flow separation
    - Strategic blue / green corridors
    - Surface water source control measures
- Network modification

We have considered two main potential approaches in order to achieve the scenario targets. These are outlined below:

- **Reduce + Enhance:** Adopt blue-green solutions to manage and reduce the amount of rainfall entering our network to reduce our levels of risk (e.g. through the use of blue-green infrastructure and nature-based solutions or Sustainable Drainage Systems (SuDS) which look to manage flow in a cost-effective way whilst benefitting the environment and surrounding communities), then utilise traditional grey solutions to meet the scenario target if necessary. This option approach considers a reduction in rainfall induced flow and network modification.
- **Enhance:** Increase the capacity of our network through traditional 'grey' solutions, i.e., building bigger pipes, storage tanks and upgrading our existing assets. This option approach considers network modification only.

It should be noted that for our DWMP we have utilised our company Decision Making Framework (DMF) tool that we utilise for business decision making, planning and the development of our Price Reviews. This is in order to ensure consistency in approach between these two processes. The DMF monetises benefits based on changes in service measure performance.

10.7.3.1 Overview of draft approach

For our dDWMP a Level 3 approach was taken, and options were developed for both Reduce and Enhance approaches for 'Promote' catchments only.

Four scenarios with differing targets were evaluated. For each option approach, each service measure has been evaluated as the change in expected performance when compared to a baseline 2050 position. Programme Appraisal was undertaken for each scenario independently. During this stage the DMF made the following selections:

- Solution approach to utilise within each Promote catchment (Reduce or Enhance).
- How many years to phase the estimated catchment investment over (based on the developed options).
- When to commence the estimated catchment investment between 2020 – 2050

Table 71 below, provides a summary of the options that were assessed for each of the network planning themes and the linked service measures that were evaluated in the DMF.

Table 71: Network solution overview

Planning Themes	Enhance	Linked Service Measures	Reduce + Enhance	Linked Service Measures
Managing Flood Risk	Evaluate number of properties for intervention	Internal flooding of a habitable area External flooding within the property boundary inhibiting access	Assumed 50% impermeable area disconnection Evaluate revised number of properties for intervention	Internal flooding of a habitable area External flooding within the property boundary inhibiting access Area of Green Space Surface water separated from combined Surface water intercepted/harvested
Managing Storm Overflow Performance	Based upon the approach used within the National SOEP report[29]	Water quality change due to storm overflow Non-swimmable to swimmable Reduction in volume weighted spill frequency	Assumed 50% impermeable area disconnection Based upon the approach used within the National SOEP report	Water quality change due to storm overflow Non-swimmable to swimmable Reduction in volume weighted spill frequency Area of Green Space Surface water separated from combined Surface water intercepted/harvested

We also undertook a series of economic assessments to establish which of the four scenarios provides the best value for our customers and the environment now and in the future.

As a reduction in connected impermeable area has the potential to benefit both flood risk and storm overflow operation, catchments were considered holistically i.e., a single evaluation of cost and benefit for each option approach (Reduce and Enhance) for each catchment.

Costing was undertaken using a standard unit cost approach for impermeable area reduction, storage tank sizing and property flood risk mitigation

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[29] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1030980/storm-overflows-evidence-project.pdf

10.7.3.2 Key changes in approach for final

Timescales between draft and final were tight and precluded significant re-modelling work. However, the optioneering approach was refined using the modelling results available from draft. Re-optioneering work for storm overflows was prioritised to support the WINEP submission.

Consultation feedback, discussed in Section 9.2, and the requirement to accommodate the SODRP targets led to the following key changes in approach to ODA for the network:

- Focus on Scenario 2 only
- Full regional coverage for storm overflows
- Coverage of all BRAVA Level 3s for flood risk mitigation assessment
- Utilisation of company and bespoke cost models rather than unit cost approach
- Optioneering undertaken at Level 4 (see Section 4.4)

The approach taken to the option development is at a higher level of granularity than set out within the DWMP Framework. The outputs provide a high-level overview of the investment level required to deliver the differing targets within the scenario. Additionally, they provide a high-level comparative assessment of the potential cost and benefit differences between the two proposed solution approaches, when other constraints are not considered.

Sections 10.7.3.4 and 10.7.3.5 below cover the approach used to build up our final DWMP plan.

10.7.3.3 Impermeable area reduction

The network planning themes for managing flood risk and managing storm overflow performance are driven by network capacity. Reducing the volume of rainwater entering the sewer is considered to improve capacity and therefore contribute to meeting the scenario targets.

As outlined in Section 6.4.2, our customers and stakeholders have expressed a preference to use SuDS and nature-based solutions to address the challenges we face, and this aligns with our ambition. It is widely accepted that these options provide wider social and environmental benefits than traditional grey solutions, although they will not always be appropriate for specific locations and may not provide the best value.

We developed a 2050 epoch model for each network model containing a Promote catchment (noting that a network model can contain more than one Level 3) that aimed to represent an ambitious reduction in the connected contributing impermeable area of 50%. This was undertaken through a coarse factoring down of modelled contributing area contained within the sub-catchments. Checks on the remaining sub-catchment contributing area were undertaken within models using the Wallingford Runoff Volume model to ensure a PIMP (Percentage Impermeability) of 20% or more remained. Where this condition was not satisfied, a reduced proportion of the connected contributing area was removed. Therefore, in some instances the applied impermeable area reduction may be less than 50%.

Area that connects to both the foul combined and the storm system has been reduced. The storm system was included, as in some instances there is predicted flood risk from this system; although it should be noted that the model confidence can vary by area of the model and system type. Additionally, flow separated from the foul combined system will need to be discharged to an alternative location, therefore separation on the storm system provides some opportunity to create capacity for the separated foul/combined flows. No reduction to area, included in the models, to represent urban creep has been made. Urban creep within future epoch models is a prediction of impermeable area creation that may occur in the future. We hope that some of our Level 1 solution measures (domestic and business customer education and influencing policy, for instance) will reduce the risk associated with urban creep in the future. At the time of the optioneering work, uncertainty regarding the potential magnitude of possible future change, resulted in us taking a conservative approach that we would not reduce creep rates.

The developed Impermeable Area Reduction model was simulated, and the model results have been processed utilising the methodologies outlined within the BRAVA section of this report, section 10.3, to evaluate the residual flood risk and assess any predicted storm overflow operation.

The BRAVA assessment was based on a 10-year data period, due to time constraints the option development stage has been based on a single year only. For ease of comparison the selected single year used for option assessment, is contained within the already simulated 10-year period. The year closest to the Seasonal Annual Average Rainfall (SAAR) from within the 10-year typical time series rainfall period has been selected. This has been simulated to evaluate the impact the reduction in impermeable area has on storm overflow operation.

Comparison of the residual flood risk and storm overflow operation to the targets for our scenario provides an assessment of any further 'grey' network enhancement that might be required. The process for this is described in Sections 10.7.3.4 and 10.7.3.5 below.

10.7.3.4 Storm overflows

Every storm overflow contained within a hydraulic model has been reviewed against the 2050 target spill performance to establish if there is an investment need. Where possible, two generic option approaches have been considered:

1. Reduce + Enhance: Impermeable area reduction and offline tank solution
2. Enhance: An offline tank solution

Requirements for storm overflows were established and defined based on the PR24 WINEP guidance released in July 2022 and are discussed in full in Section 3.3.

All overflows have been considered independently.

10.7.3.4.1 Offline tank solutions: Method

This approach is common to both generic options.

Hydraulic modelling completed for the dDWMP predicted yearly spill counts and volumes for each overflow in 2050. Solutions were developed to limit spill frequencies to either:

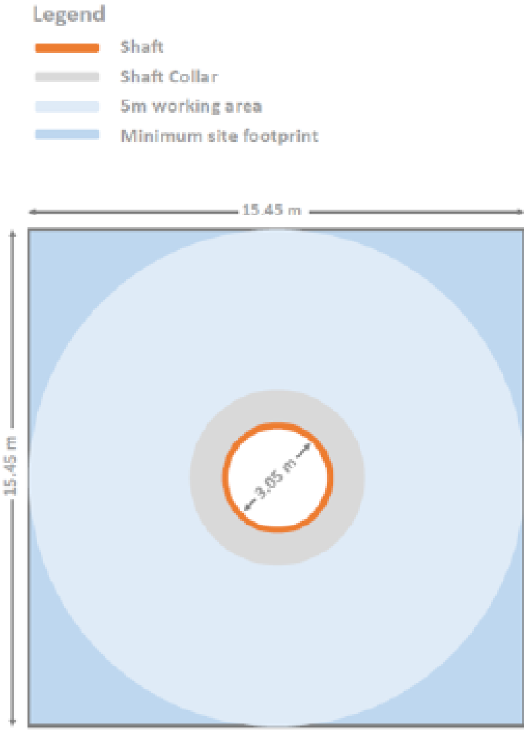
- an average of 10 spills per annum,
- an average two spills per bathing season for coastal bathing water assets, or
- an average one spill per bathing season for inland bathing water assets.

The tank storage volumes were approximated based on the spill volume of the target+1 spill when spills are ranked by volume.

For the Enhance option, the storage volume was calculated based upon the baseline model predictions. For the Reduce + Enhance option, the calculation was conducted on a model with 50% of the connected impermeable area removed (refer to Section 10.7.3.3) from the model. It should be noted that impermeable area removal testing was modelled at a Level 3, this may not directly correspond to benefit at a Level 4.

Storage volumes were translated to one of four standardised tank diameters, ranging from 3.05m to a maximum of 25m diameter. An allowance for a site working area (proportional to shaft diameters) during construction was allowed for and is shown in Figure 65 below.

Figure 65: Example land parcel requirement for 3.05m dia. shaft



An automated GIS routine was run to compile a regional dataset of land parcels. These were discounted if there was intersection with any of the following sensitive site designations listed below:

- World heritage sites
- Ramsar sites
- Proposed/candidate Ramsar sites
- Special Protection Area (SPA)
- Possible/candidate Special Protection Area (cSPA)
- Special Area of Conservation (SAC)
- Possible/candidate Special Area of Conservation (cSAC)

Flags were placed on land parcels intersecting the following designations:

- Scheduled monument
- Listed building
- Registered battlefield
- Registered parks and gardens
- Archaeological important areas
- Locally listed heritage assets
- Conservation area (Built)
- Heritage coasts
- Sites of Special Scientific Interest (SSSI) and associated Impact Risk Zones
- Local and National Nature Reserves
- Ancient woodland
- Areas of Outstanding Natural Beauty (AONB)
- National Park
- Marine Conservation Zones
- Local Wildlife Sites (LWS)
- Site of Importance for Nature Conservation (SINC)
- Local Geological Site (LGS)
- Nature Improvement areas
- Priority Habitat Areas

Site designations were only included where information was available in nationally available datasets (as published in September 2022) and within a GIS format.

Suitable land parcels were identified for each storm overflow solution. Land parcels had to:

- Have an area greater than the required plan area (constraints on circularity were included)
- Be within 1.6km search radius of the storm overflow (from centre point of the land parcel)

Where more than one suitable land parcel was identified a 'preferred' land parcel was assigned based on proximity to the storm overflow.

This was a high-level assessment and some identified land parcels may not be suitable once construction constraints are considered.

Each overflow was assessed independently and there is a risk that the same land parcel is selected for multiple storm overflow solutions. It was identified that 86 land parcels were shared between two or more overflows compared to 876 which were independent. This remains a risk and will be flagged during scheme development and where necessary combined solutions will be considered.

A further automated GIS routine was used to approximate a preferred pipe route from the storm overflow location to the centre point of the preferred land parcel. Pipe routes were excluded from intersecting certain key site designations (as per tank parcel routine) and from passing through buildings, structures and property curtilage identified within MasterMap. The shortest permissible path was selected as the preferred option. This is shown in Figure 66 below.

Figure 66: Example land parcel selection and pipe route

It has been assumed that the pipe from the storm overflow to the storage tank will be a gravity pipe and at the same diameter as the existing overflow spill pipe. Tank emptying is assumed to be a pumped rising main, with pump and rising main size related to the proposed tank diameter. A comparison of the storage volume to the tank emptying rate was conducted, where this was found to be prohibitive, the option was rejected as unfeasible. This reduces the viable options available to address the need and a reduce and enhance solution was proposed. We will review this process for cycle 2 to ensure we have a range of viable options.

10.7.3.4.2 Offline tank solutions: Costing

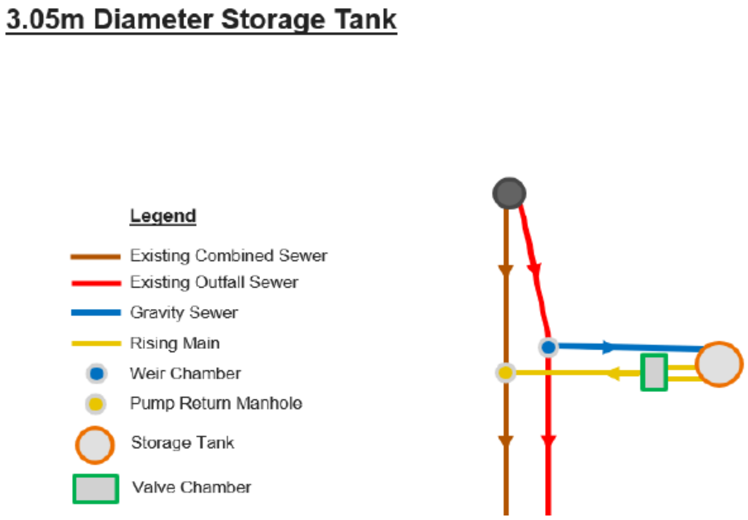
High-level outline designs were created for the tank solutions to support the cost build up. An allowance for standard items such as; manholes, pumps, hydro ejectors, odour control units, MCC, power supply, screen and screen chamber were made. This is shown below in Figure 67.

Screens have been sized based on the incoming pipe diameter only. This may mean screens, and associated screening chambers, are over or under sized when local hydraulic conditions are factored in.

Where pipe routes cross key constraints such as watercourses, railway lines and major roads, these have been flagged within the generated schematic design. No adjustment is made within the cost build up at this stage, further assessment will be undertaken in any subsequent design stage.

An additional depth of excavation was provided for to make allowance for the plug, cover slab and depth loss due to head losses or depth loss due to the weir height.

Figure 67: Example storage tank schematic



Key metrics such as pipe size, length, pump return rate, tank size, screen size have been utilised to develop a high-level Bill of Quantities (BoQ) for each solution. The generated BoQ was supplied to our in-house costing team to allow company cost models to be applied. This provided total CAPEX, OPEX, embodied carbon and operational carbon values for each storm overflow scheme.

The following standard assumptions were made within the cost build up:

- Gravity mains to be constructed from concrete at a depth of 2-4m within a Type 3/4 road (as defined in the New Roads and Street Works Act 1991).
- Rising mains to be constructed from plastic material within a Type 3/4 road.
- Hydro ejectors assume to be all duty except 1 standby
- Run time of return pumps and hydro ejectors assumed to be 4%
- M&E maintenance calculated as annual fraction of the capital value of the asset.

10.7.3.4.3 Connected area disconnection: Method

This approach is applicable to the Reduce + Enhance generic option only.

Where possible unique Level 4s were defined for each storm overflow. These were defined by iteratively tracing upstream of each storm overflow within the available hydraulic models and identifying those sub-catchments connecting to the storm overflow (independent of any other overflow). Starting at the furthermost downstream point and working upstream, unique areas draining to each storm overflow were defined and removed from the next iteration. Iterations were completed until a unique area was defined or it was determined not possible to assign. This process is shown schematically in Figure 68 through to Figure 70 below.

Figure 68: Schematic of tracing to define connected area upstream of each storm overflow

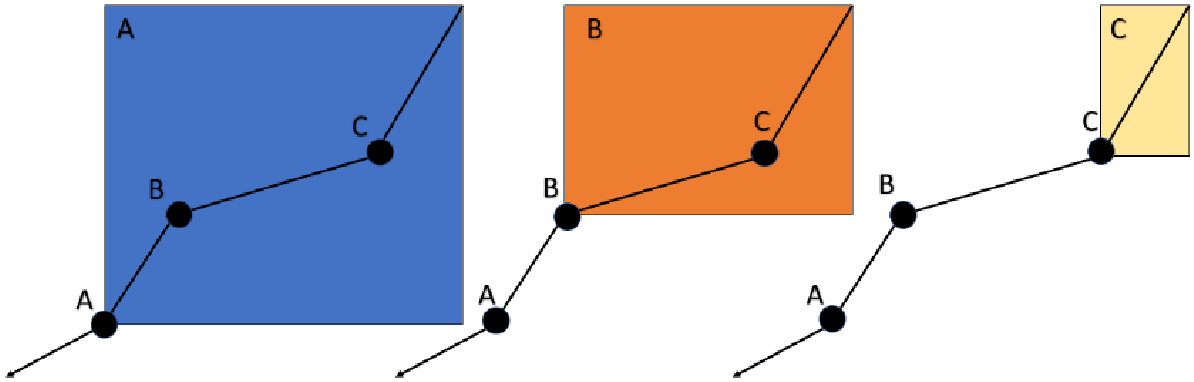


Figure 69: Schematic of defined connected areas upstream of each storm overflow overlaid

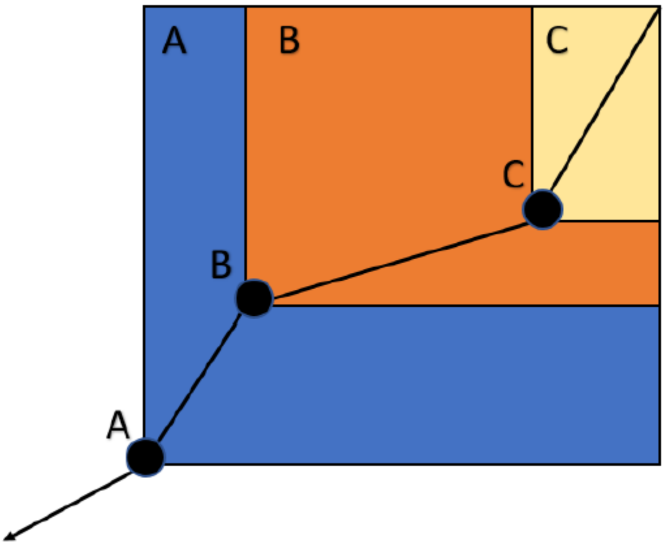
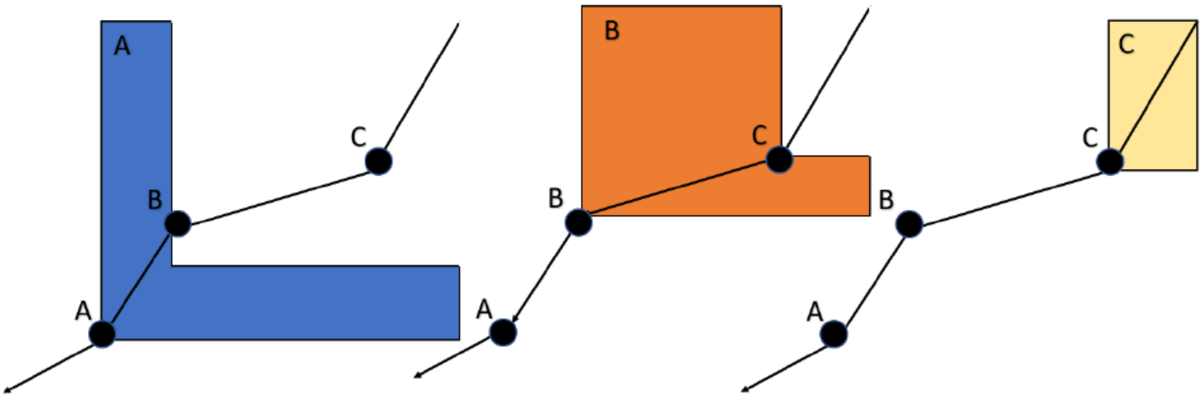


Figure 70: Schematic of unique defined connected area upstream of each storm overflow



No hydraulic assessment of the network connectivity has been undertaken. Consequently, hydraulic break points may exist between storm overflows, and the effect of these has not been considered.

Once all the sub-catchments connected to a storm overflow had been identified the difference in connected impermeable area between the baseline model and the impermeable area reduction model for each sub-catchment can be summed. This provides the total impermeable area for removal per storm overflow.

The Impermeable Area reduction in the model, reduced area connected to both the foul/combined system and the storm system. Reduction in area connected to the storm network is not expected to significantly influence the operation of the storm overflow. However, it may bring wider benefits within the Level 4. Consequently, all modelled sub-catchments that were not assigned to a storm overflow were geospatially queried and where possible linked to storm overflow to complete the definition of a Level 4. This is shown below in Figure 71 and Figure 72.

Figure 71: Schematic of tracing to define connected area upstream of each storm overflow and interaction with independent storm network

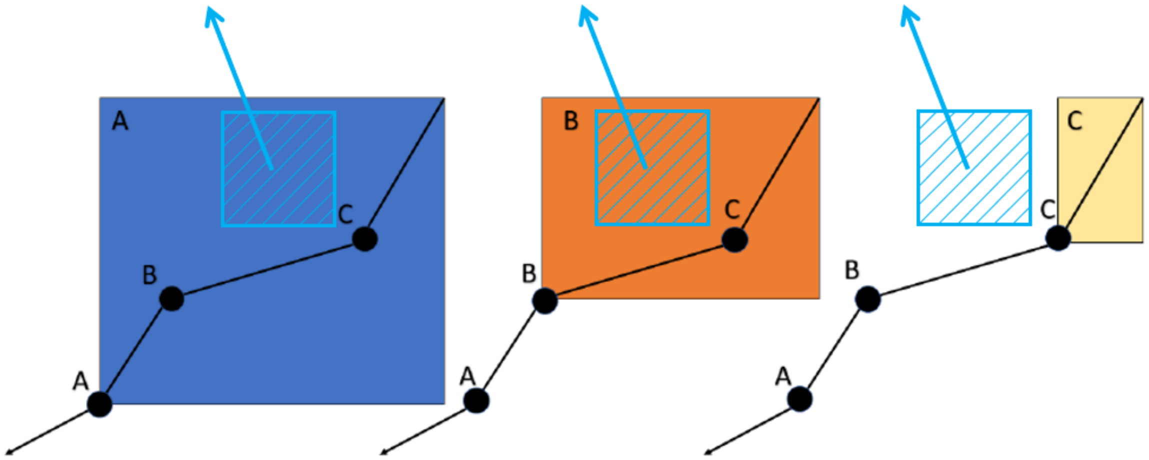
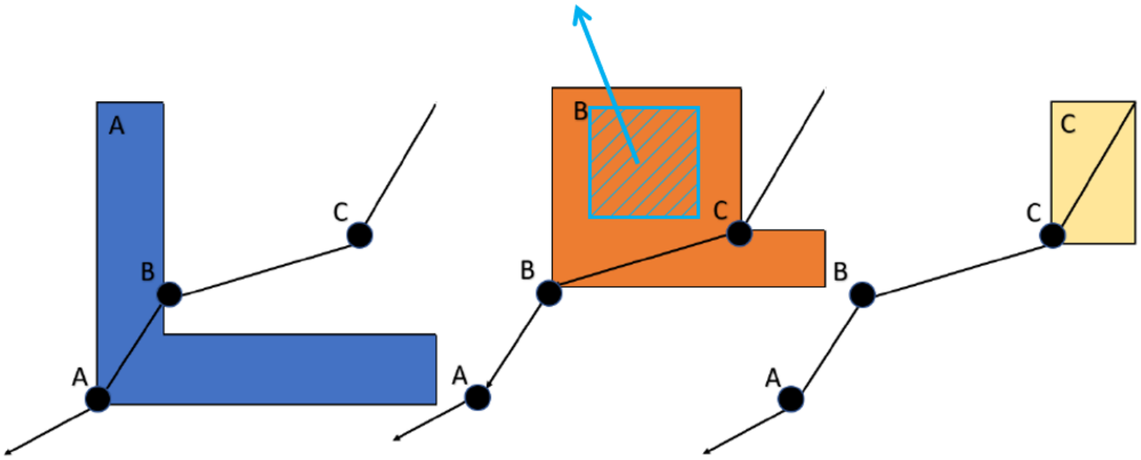


Figure 72: Schematic of Level 4 including independent storm network



Whilst these areas may overlap geospatially, the impermeable area will have been assigned to either the foul/combined or the storm system within the hydraulic model and therefore area is not double counted between system types.

Overflows at WwTWs were discounted from this approach. These were excluded, as the Level 4 area concept, i.e. the area between the last storm overflow(s) and the WwTW, was deemed unlikely to result in sufficient area reduction to significantly impact on the spill frequency from the WwTW overflows. In reality a wider catchment solution would be required, which would incorporate multiple Level 4 areas. In some instances, it was not possible to define a unique upstream area. For these locations a Reduce + Enhance solution has not been generated.

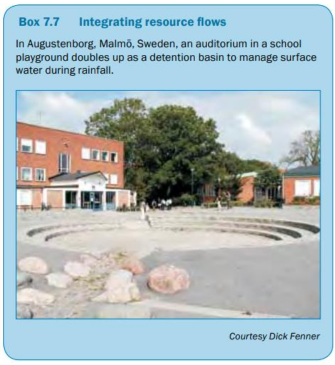
A limitation of this approach is that the area reduction was applied at a Level 3. Where overflows are in series the required storage volume in the impermeable area reduction model may not correspond to the area removed solely from the Level 4. Consequently, instances may exist where the additional grey storage volume is currently underestimated.

10.7.3.4.4 Connected area disconnection: Costing

Standard designs were created for the SuDS intervention types listed in Figure 73 below to provide a notional £/m^2 or £/m^3 of intervention:

Figure 73: SuDS intervention types

Intervention: Pocket basin
Description: Small detention basin on roadside

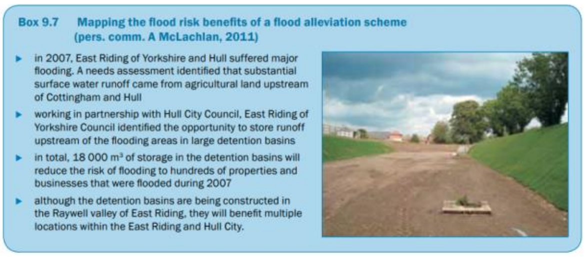


Box 7.7 Integrating resource flows

In Augustenborg, Malmö, Sweden, an auditorium in a school playground doubles up as a detention basin to manage surface water during rainfall.

Courtesy Dick Fenner

Intervention: Detention basin grassland
Description: Detention basin in green space



Box 9.7 Mapping the flood risk benefits of a flood alleviation scheme (pers. comm. A McLachlan, 2011)

- in 2007, East Riding of Yorkshire and Hull suffered major flooding. A needs assessment identified that substantial surface water runoff came from agricultural land upstream of Cottingham and Hull
- working in partnership with Hull City Council, East Riding of Yorkshire Council identified the opportunity to store runoff upstream of the flooding areas in large detention basins
- in total, 18 000 m^3 of storage in the detention basins will reduce the risk of flooding to hundreds of properties and businesses that were flooded during 2007
- although the detention basins are being constructed in the Raywell valley of East Riding, they will benefit multiple locations within the East Riding and Hull City.

Intervention: Bio-retention (verge)
Description: Small depression in roadside verge

Figure 1 A newly installed retrofit rain garden (courtesy Darren Bos)

Intervention: Bio-retention (road)
Description: Small depression in road

Box 2.7 A future opportunity to remove flows and improve water quality in the US

- in Portland, Oregon, several streets have been through a transformation
- this has not only substantially reduced the amount of water going into the existing and purified any inputs, but also improved the urban space and calmed traffic
- the bioretention areas were retrofitted in 2003
- this was achieved by getting the residents involved in the design process. This included how much parking space to remove and what types of planting they prefer
- the residents have a shared responsibility to maintain the bioretention areas
- an information board (seen on the right of the image) provides local residents with useful and interesting facts about the bioretention areas.

Intervention: Commercial waterbutt
Description: Tank to attenuate roof runoff on commercial property

Box 13.1 Retrofit rain garden, Islington

- a retrofit rain garden in Islington is being monitored to understand its performance. Middlesex University are monitoring water volumes, water quality and soil moisture content
- a bespoke rainwater tank and service chamber were designed and built to incorporate the monitoring equipment (see figure). The water butt near the rain garden contains the monitoring equipment
- all equipment will be removed after 12 months once the monitoring is complete.

Intervention: Geocellular storage
Description: Below ground crate storage

Courtesy Jacobs Engineering, Ruth Newton, Tilt Dam, Wayne Rushmere, Floodgate and Graham Fairhurst

Intervention: Permeable paving
Description: Engineered surface allowing infiltration to below ground attenuation or infiltration to ground

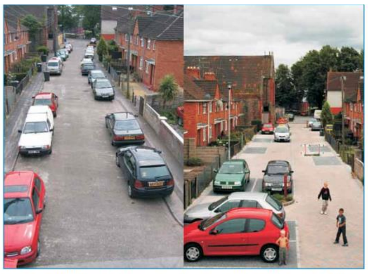


Figure 1 Bristol Dings Home Zone showing pre and post regeneration with permeable paving (courtesy Sustans)

Source: CIRIA document, Retrofitting to manage surface water (C713), published 2012

Indicative solutions were generated characterising varying housing densities and available green space. In each solution a blend of the SuDS features above was assumed with the proportional split of each SuDS feature varying in each solution. An overview of this is given in Figure 74.

A high-level BoQ was generated for each indicative solution. Required storage volumes were calculated based on the average M30-480minute winter rainfall depth for 2050 across the region. Conveyance features used indicative lengths based on the required area for removal. This provided an indicative £/ha to deliver a blended set of SuDS interventions which varies based on housing density and available green space.

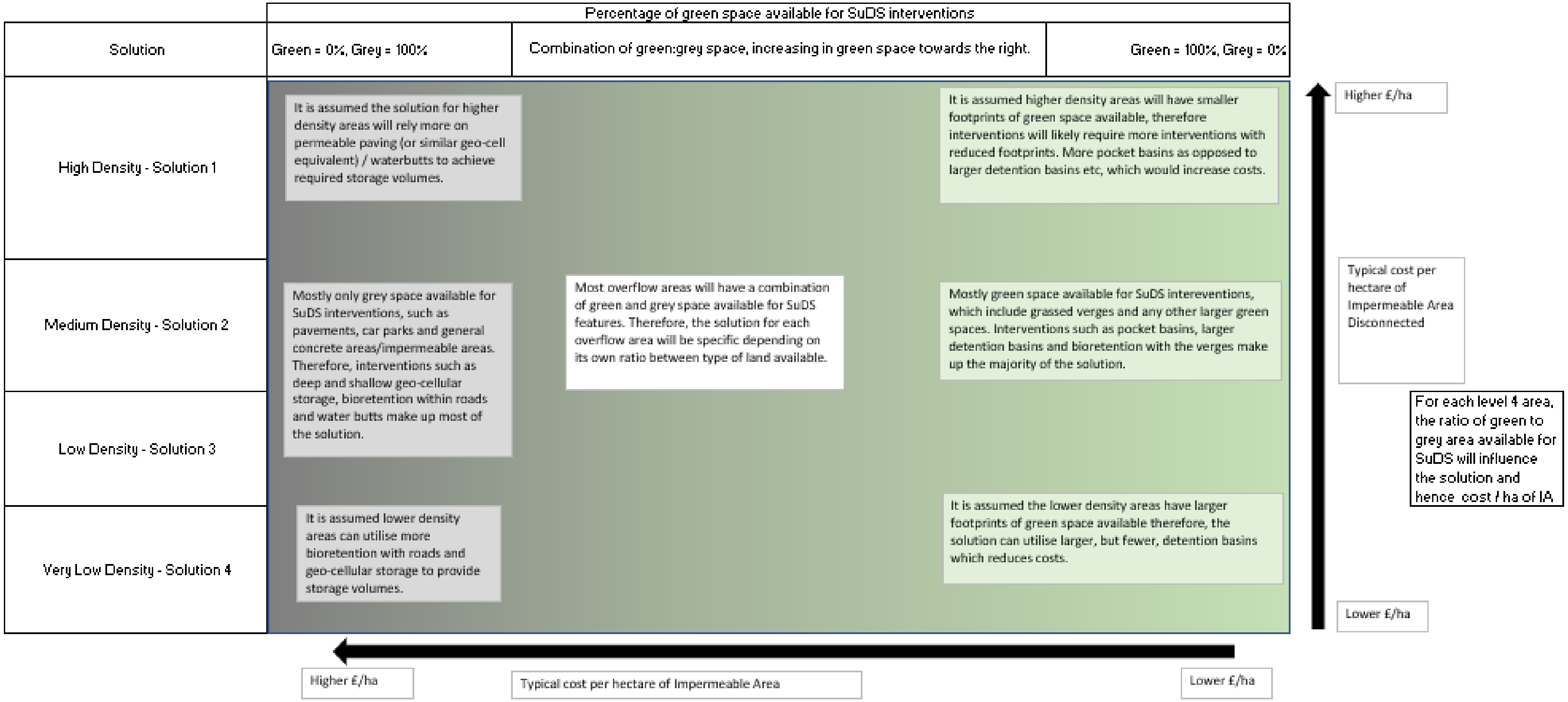
Each Level 4 was split into a 100m x 100m grid and each grid square queried to determine:

- The proportion of grid square covered by impermeable area
- The proportion of impermeable area assigned to the hydraulic model
- The housing density within the grid square
- The proportion of available green space within the grid square

Each grid square has been assigned to an indicative solution and the impermeable area removal within the model is used to factor the solution cost per hectare up or down. An area weighted average has then been used to determine a final £/ha for each Level 4.

No allowance of system type within the Level 4 has been made. An estimate of operational costs has been made using nationally available unit costs. Estimates of embodied and operational carbon have been made using adapted in-house models.

Figure 74: SuDS solution definition matrix



It is assumed the solution for higher density areas will rely more on permeable paving (or similar geo-cell equivalent) / waterbutts to achieve required storage volumes.

It is assumed higher density areas will have smaller footprints of green space available, therefore interventions will likely require more interventions with reduced footprints. More pocket basins as opposed to larger detention basins etc, which would increase costs.

Mostly only grey space available for SuDS interventions, such as pavements, car parks and general concrete areas/impermeable areas. Therefore, interventions such as deep and shallow geo-cellular storage, bioretention within roads and water butts make up most of the solution.

Most overflow areas will have a combination of green and grey space available for SuDS features. Therefore, the solution for each overflow area will be specific depending on its own ratio between type of land available.

Mostly green space available for SuDS intereventions, which include grassed verges and any other larger green spaces. Interventions such as pocket basins, larger detention basins and bioretention with the verges make up the majority of the solution.

It is assumed lower density areas can utilise more bioretention with roads and geo-cellular storage to provide storage volumes.

It is assumed the lower density areas have larger footprints of green space available therefore, the solution can utilise larger, but fewer, detention basins which reduces costs.

For each level 4 area, the ratio of green to grey area available for SuDS will influence the solution and hence cost / ha of IA

Source: Stantec methodology

**Solution 5 is based upon a commercial area. Therefore, typically expect larger areas of impermeable area suitable for geo-cellular storage and larger sized water butts.*

10.7.3.4.5 Connected area disconnection: Additional benefit

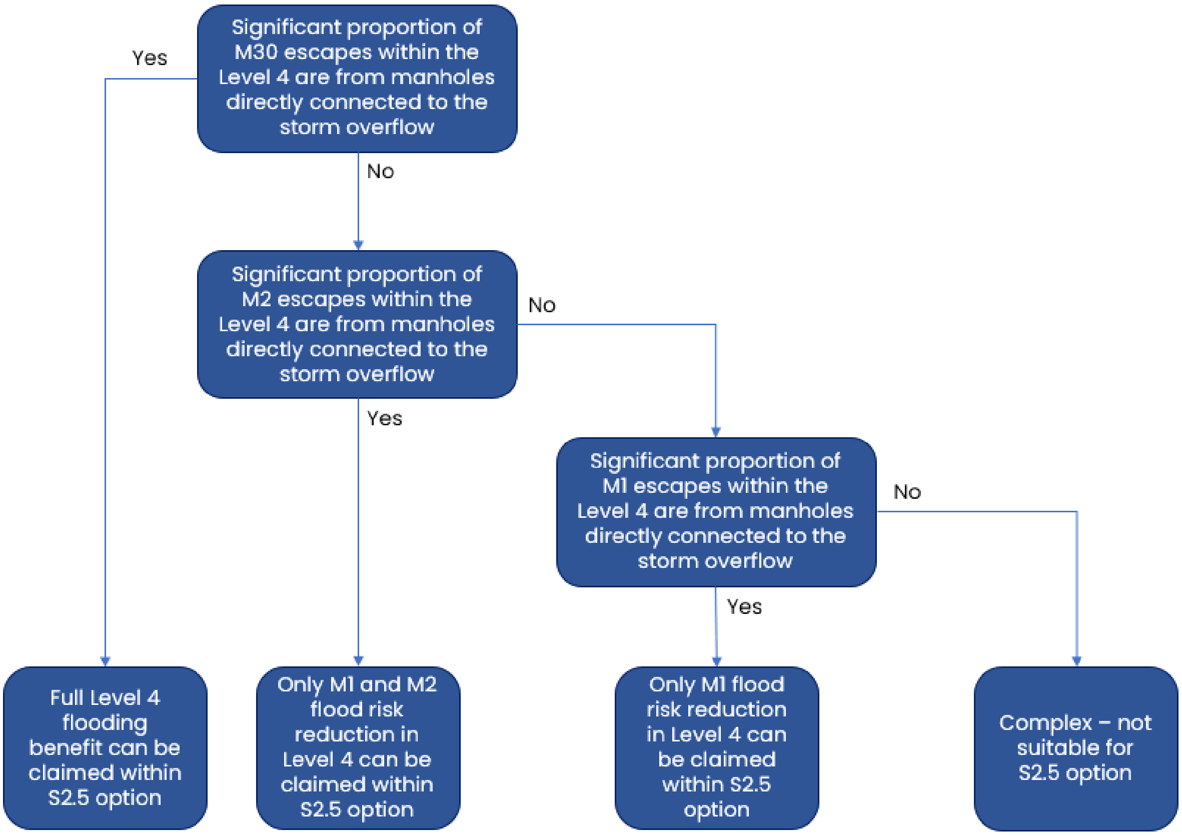
To prevent double counting of area disconnection, where possible, area for disconnection has been assigned against a storm overflow option or, where there is no storm overflow within the Level 3 against a Level 3 strategy. The flooding benefit that could be delivered by area disconnection is assigned against the storm overflows.

Flooding benefit was calculated as a reduction in internal and external annualised score between the baseline model and the impermeable area reduction model within the Level 4. This forms the basis of the S3 options and is described below and summarised in Table 72.

In some instances, an independent storm network may intersect the Level 4 and reduction of impermeable areas connected to the independent system may act to increase costs without driving additional flooding benefit. A check was undertaken to determine if the Level 4 would benefit from the creation of an intermediary option, in which only impermeable area directly connected to the storm overflow is costed as being reduced.

As the impermeable area reduction model reduced all area within the wider Level 4 this intermediary option may subsequently require a reduction in returned flooding benefit. If the majority of the escape volume within the Level 4 is linked to the network directly connected to the storm overflow it is reasonable to assume that a reduction in area directly connected to the storm overflow would therefore yield a reduction in flood risk. Therefore, the full Level 4 benefit could be claimed within the intermediary option. The resulting option forms the basis of the S2.5 options. However, if flooding is occurring from both the connected and independent network within the Level 4 then apportionment of the flood risk benefit is likely to be too complex and no intermediary option would be generated. The process is summarised in Figure 75 below.

Figure 75: S2.5 option assessment and associated flood risk benefit



Note that M1 refers to a design storm of a 1-year return period event and M2 refers to a design storm of a 2-year return period event.

10.7.3.4.6 Screens

An allowance for screening provision has been made at every storm overflow.

Where intervention is required, as part of the SODRP, an allowance for a screen and screening chamber has been made within the solution cost for both Enhance and Reduce + Enhance options.

Where no intervention is required to achieve the SODRP target spill frequency a standard allowance for a screen and screening chamber has been made.

The assumptions below have been applied in both situations:

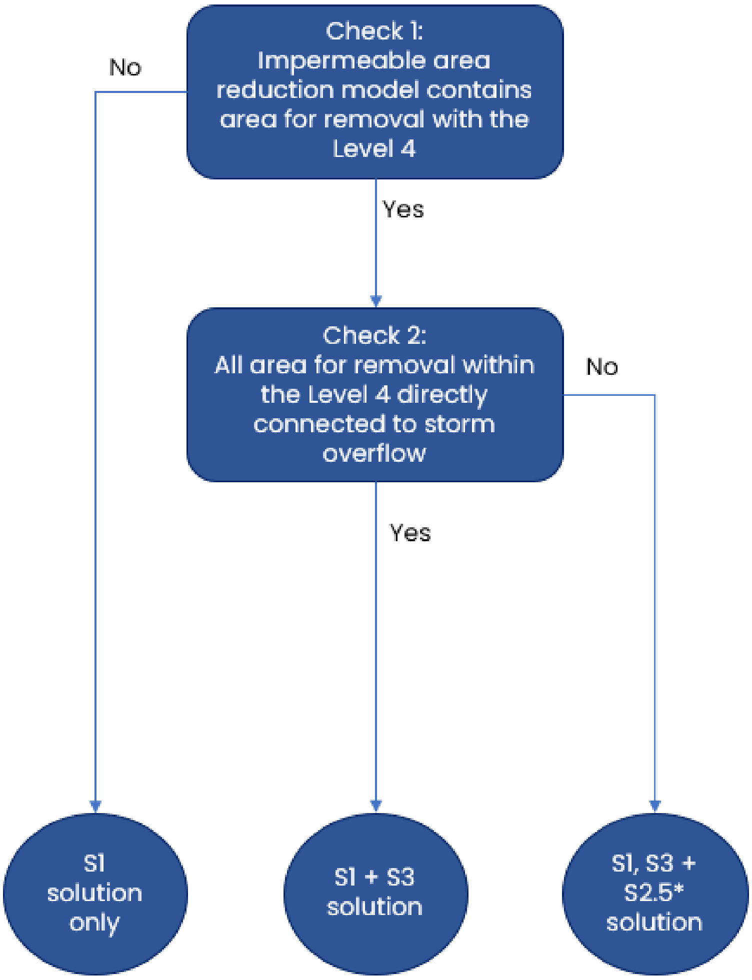
- a minimum of 2D 6mm screening provision will be made.
- all screens are to be powered.
- the screening chamber can be located adjacent to the storm overflow.

The utilisation of a standard set of assumptions could present a risk as this may not be representative of the sites resulting in an under or over-estimate of cost.

10.7.3.4.7 Solutions for DMF

For the majority of modelled storm overflow needs, more than one option will be entered into our DMF. An overview of the checks undertaken and how these influence the solutions that are generated for each storm overflow is shown in Figure 76 below.

Figure 76: Storm overflow solution generation



**Assuming benefit apportionment check passed*

All of the options are expected to deliver an average target spill performance of ≤10 per annum (or 2 or 1 for a bathing site). Achievement of this target is a requirement of the SODRP and the benefits assessment has focused on the additional benefits offered by the Reduce + Enhance solutions (S2.5 or S3) when compared to the Enhance only solution (S1).

For the S2.5 and S3 solutions the following service measures have been populated:

- Area of green space
- Surface water separated from combined
- Surface water intercepted/harvested

These metrics are all assessed around a quantification of area when compared to the 2050 baseline.

The reduction in impermeable area contributes to the following service measures:

- Internal flooding of a habitable area of a property
- External flooding within the property boundary inhibiting access

These metrics are all quantified based on the predicted reduction in annualised number of incidents when compared to the 2050 baseline.

The generated options and benefits are summarised in Table 72 below:

Table 72: Summary of storm overflow options

Option Ref	**S1**	**S2.5**	**S3**
Generic option	Enhance	Reduce + Enhance	Reduce + Enhance
Unconstrained option description	Offline storage tank	Blended SuDS sized for 50% of unique impermeable area connected to storm overflow Offline storage tank	Blended SuDS sized for 50% of unique impermeable area within defined Level 4 Offline storage tank
Storm overflow benefit	Alignment to SODRP targets	Alignment to SODRP targets	Alignment to SODRP targets
Surface water separation	None	50% of unique area connected to storm overflow	50% of unique area within Level 4
Creation of green space	None	Varies based on applied blend of SuDS features and total impermeable area disconnected	Varies based on applied blend of SuDS features and total impermeable area disconnected
Flood risk benefit	None	Calculated reduction in internal and external annualised score between the baseline model and the impermeable area reduction model within the Level 4 where escapes are connected to the storm overflow	Calculated reduction in internal and external annualised score between the baseline model and the impermeable area reduction model within the Level 4*

**It is expected the 50% area reduction will reduce but not remove flood risk to the target level. Further mitigation would be required to deliver the remaining flood risk reduction.*

10.7.3.4.8 Extrapolation

In a limited number of instances, a hydraulic model is not available a storm overflow consequently, the CAPEX, OPEX, carbon and associated benefits linked to solutions for the modelled storm overflows has been used to extrapolate values to the remaining sites.

An average scheme cost was developed for each scenario listed below:

- S1 Enhance solution
- S1 Enhance solution at a bathing water
- S3 Reduce + Enhance solution
- S3 Reduce + Enhance solution at a bathing water

Averages were derived using the available costed solutions. The top 10 most expensive schemes were removed from the averages as these were considered to bias the results. In the bathing water cases only the top three most expensive schemes were removed from the calculation.

A relationship between the costed CAPEX and OPEX in each of the four scenarios above was determined. The extrapolated CAPEX could then be used in each case to infer the associated OPEX.

A similar approach was taken to extrapolating embodied carbon from capex and operational carbon from OPEX.

It is likely that the storm overflows not covered by our existing modelling stock are in smaller catchments, therefore this approach may overestimate the assigned cost.

For the Reduce + Enhance solutions the existing modelled data was used to form a relationship between CAPEX expenditure on SuDS and flood risk benefit and the typical CAPEX split between the investment on SuDS to that on grey infrastructure. These relationships were used to estimate a flood risk benefit. The calculation was undertaken separately for internal and external risk mitigation.

The extrapolated solutions were not entered into DMF but costs and benefits are included within our overall costed plan.

10.7.3.4.9 Assumptions and limitations

The high-level nature of the assessment and uncertainty provides a constraint on the level of optioneering detail that can be completed.

The analysis is based upon a single year assessment. Additionally, for bathing water locations, the in-season bathing target and associated spill volume was mapped back to the annual spill performance. This has been used to generate an annual proxy which has been utilised within the assessment. This approach aligns with the approach taken within the SOEP. Further analysis will be undertaken in scheme development to expand the bathing season and annual spill assessments across a greater number of years.

The actual solution form is unknown and location will depend on local factors and agreements that can be created with local authorities and residents.

Land purchase costs are not allowed for within the assessments undertaken. No consideration of land ownership, access or presence of buried or overhead services, ground conditions or groundwater levels has been made within the strategic option assessment.

No consideration of tank emptying has been made in the assessment to date and the evaluated storage volume has not been tested within the model. This presents three risks.

1. The required volume of storage to achieve the solution target may be larger than estimated through this process dependent on the grouping of storm events and the realistic tank emptying rate.

2. Local network enhancement or reinforcement maybe required in order to empty the tank. This may be considered to some extent within the unit cost.
3. The combined impact of emptying multiple tanks within a catchment has not been assessed. Wider network reinforcement maybe required to transfer flows to treatment. There is also potential the treatment works may not have capacity to accept the tank emptying flows within constraints of existing permits.

Where storage requirements are particularly large or small, the standard assumptions (i.e. circular shaft tank assumption) used within this process may not be appropriate. Consequently, in a minority of instances, the standardised approach is limited, and the automated design used for costing may not be appropriate. This will be refined during solution development and future DWMP cycles.

Impermeable area reduction has not been targeted within the Level 4 to risk hotspots. Costs may be evaluated that are providing minimal benefit locally. There is likely to be a benefit on reduced volumes to be treated. Efforts have been made to minimise this with the introduction of the S2.5 scenario. Additionally, no assessment of the feasibility of the 50% reduction has been made at this stage. These factors should be considered in more detail in any subsequent delivery phase.

Storm water disconnection may mean that management of storm water is required. Consideration of where the water will discharge to, and any associated mitigation this may require, is not considered within our developed plan.

The high-level solution nature means that there is a limitation in the operational costs and carbon assessments that can be completed. This is further limited by a limited volume of regional data on which to develop these relationships. Future cycles of the DWMP will benefit from increased data availability from our existing and for planned blue-green schemes.

The costs and benefits determined during the development of the DWMP are intended to give an indication of anticipated direction of travel only and final delivered solution costs and benefits are likely to vary from these.

10.7.3.5 Flood risk management

A flood risk target position is set out within Section 10.6.2. Where a property's 2050 risk does not satisfy this target an investment need is identified. It is anticipated that in some instances needs will be grouped and could be addressed with a single solution and flooding clusters have been generated. Each cluster will contain a differing number of properties for intervention and each cluster will be addressed by a single solution approach.

Where possible two generic option approaches have been considered:

1. Reduce + Enhance: Impermeable area reduction and offline tank solution
2. Enhance: An offline tank solution

To prevent double counting of area disconnection, where possible this has been assigned against a storm overflow option.

Each cluster is considered independently and is described in more detail below.

10.7.3.5.1 Cluster generation

The cluster process was automated. This was due to the number of hydraulic models that are being reviewed. It was considered infeasible to manually review all locations and define grouping based on hydraulic link or mechanism. The addition of the area disconnection solution would mean this process would have to be done twice as the risk position, and system hydraulics, are altered by the 50% area reduction.

This cluster process is limited but for the purposes of a strategic study it allows increased granularity of optioneering compared to the approach taken for the dDWMP.

The worst case 2050 M30 (30-year return period event) 2D flood extents produced as part of the dDWMP were utilised as the basis of the cluster definition. Properties identified as being at greater risk than that set out by the scenario definition in 2050, have been mapped and assigned to the relevant cluster.

Properties predicted to be at 1D risk only, may not spatially sit within a cluster. Earlier processes within the DWMP made an assumed connection between each property and the foul/combined network. This allowed some 1D only at-risk properties to be assigned to clusters where the cluster contains or intersects the same associated sewer reference.

All remaining 1D only at-risk properties were grouped into new clusters based on combining uninterrupted sewer lengths that are predicted to surcharge in the worst case M2 storm in the 2050 epoch.

For the Enhance option, flood clusters were generated using the baseline model predictions. For the Reduce + Enhance option, flood clusters were generated using a model with 50% of the connected impermeable area removed (model described in Section 10.7.3.3).

Where the flooding cluster is within a storm overflow Level 4, the selection of the flooding solution is dependent upon the selected storm overflow solution. An exercise was undertaken to create a link between storm overflow Level 4s and the generated flood clusters. The following was noted:

- Multiple flooding clusters can exist within any storm overflow Level 4.
- Some flooding clusters are noted to span multiple Level 4s.
- A number of flooding clusters sit wholly or partially outside of a storm overflow Level 4.

Where a cluster sits wholly within a Level 4 a link can easily be established. Where a cluster spans multiple Level 4s a primary Level 4 has been assigned, based on the Level 4 containing the largest escape volume within the cluster.

10.7.3.5.2 Offline tank solutions: Method

This approach is common to both generic options.

Hydraulic modelling completed for the dDWMP predicted total modelled escapes in 2050 for the simulated M30 rainfall events.

For the Enhance option, the storage volume was calculated based upon the baseline model predictions. For the Reduce + Enhance option, the calculation was conducted on a model with 50% of the connected impermeable area removed (model described in Section 10.7.3.3) from the model. It should be noted that impermeable area removal was modelled at a Level 3, this may not directly correspond to benefit at a Level 4.

A below ground storage tank will be required to accommodate more than the total M30 cluster escape volume. Consequently, some high-level model sensitivity testing was undertaken to determine a global uplift factor to translate from cluster escape volume to required storage volume. This assessment assumed a spill level 700mm below cover level. Once outliers were removed, a common uplift factor of 1.88 (i.e. storage volume is 88% higher than the escape volume) was established as an average of the remaining dataset. The test data shows a variance in uplift factor from 1 - >4. In some instances, the notional storage volume may present an over or underestimation of required storage. The limited data set used for this analysis is a limitation. Future cycles will seek to expand this assessment to a larger dataset and determine bespoke metrics that might influence the relationship.

The automated GIS routines used for the storm overflow tank optioneering (refer to Section 10.7.3.4.1) to identify suitable tank locations and pipe routing were adapted and utilised for the flood cluster mitigation. The following adaptions were made:

- Conveyance pipe routine starting point was taken from the manhole within the cluster with the largest escape volume.
- Conveyance pipe diameter was based on the maximum pipe diameter within the flooding cluster. If no pipe intersects the cluster a 300mm diameter was assumed based on the average from the clusters where a size could be found. A minimum diameter of 150mm was used and diameters larger than 2500mm were assigned twin 1050mm diameters.

10.7.3.5.3 Offline tank solutions: Costing

As per the approach for tank solutions at storm overflows (Section 10.7.3.4.2), a high-level outline design was generated and used to populate a high-level BoQ for each flood cluster.

The generated BoQ was supplied to our in-house costing team to allow company cost models to be applied. This provided total CAPEX, OPEX, embodied carbon and operational carbon values for each.

For 1D only clusters where there is no escape volume on which to size a storage tank cost model data was used to provide a CAPEX, OPEX and carbon value for a pumped NRV solution. This has been multiplied by the number of at-risk properties within the cluster.

10.7.3.5.4 Connected area disconnection: Method

This approach is applicable to the Reduce + Enhance generic option only.

Where there is no storm overflow within the Level 3, a Level 3 blue-green strategic option has been developed for flood risk reduction. This assumed 50% of the model connected impermeable area is reduced.

10.7.3.5.5 Connected area disconnection: Costing

Indicative SuDS costing for flood risk reduction was undertaken using the same approach as that used for area disconnection relating to storm overflows.

10.7.3.5.6 Solutions for DMF

Solutions were generated for all identified flooding clusters (those developed from the baseline model predictions and those from the impermeable area reduction model).

The generated options are summarised in Table 73 below:

Table 73: Summary of flood cluster options

Option Ref	**S1**	**S1**
Generic option	Enhance	Reduce* + Enhance
Unconstrained option description	Offline storage tank	Blended SuDS sized for 50% of unique impermeable area within defined Level 4 Offline storage tank
Surface water separation	None	50% of unique area within Level 4*
Creation of green space	None	Varies based on applied blend of SuDS features and total impermeable area disconnected*
Flood risk benefit	Reduced to target level within cluster	Calculated reduction in internal and external annualised score between the baseline model and the impermeable area reduction model within the Level 4* Reduced to target level within cluster

**Only the offline tank is entered into our DMF as the SuDS costs (and associated benefits) are covered by the storm overflow option entry or Level 3 strategy.*

The additional flooding mitigation is always an offline tank solution. Hence both option references are denoted 'S1'. The option selection is for a larger tank where the flood volume is derived from the baseline model. Or for a smaller tank where the flood volume is derived from the impermeable area reduction model, and SuDS work is being carried out within the Level 4.

The following service measures have been populated for the benefit assessment within the DMF:

- Internal flooding of a habitable area
- External flooding within the property boundary inhibiting access

These metrics are all quantified based on the predicted reduction in annualised number of incidents when compared to the 2050 baseline.

10.7.3.5.7 Extrapolation

A number of BRAVA catchments had no hydraulic model available; these are considered to represent <3% of the forecast 2050 population equivalent. Analysis of these Level 3s indicated the vast majority had individual population equivalents of 3500 or less in 2050.

A review of the modelled and costed Level 3s, of the same population equivalent indicated 43% had zero intervention cost assigned. The majority of these were for Level 3s of 250 PE or less. Consequently, where there is no hydraulic model available and the population equivalent is <250, zero cost and benefit has been assumed.

For the remaining BRAVA Level 3s without a hydraulic model, a Level 3 total cost has been extrapolated. As the risk distribution is unknown it is not possible to undertake the analysis at a Level 4. A cost of intervention has been extrapolated using the average cost of enhance only interventions per PE from those modelled Level 3s between 250 and 3500 PE. The top and bottom 10% have been removed from the average.

OPEX, carbon and flooding benefits have been extrapolated using CAPEX expenditure.

The extrapolated solutions were not entered into DMF but are included within our overall costed plan alongside the associated benefits assessment.

10.7.3.5.8 Assumptions and limitations

The solutions have not been modelled and therefore there is a risk that the proposed storage volumes are an over or under-estimate.

The high-level nature of the assessment and uncertainty provides a constraint on the level of optioneering detail that can be completed. The actual solution form is unknown and location will depend on local factors and agreements that can be created with local authorities and residents.

There is potential for the under reporting of benefits, for instance external flood risk could be reduced at properties outside of the flooding cluster but not be reduced to the level required by the target. At present this would not be reflected in the service measure assessment. Additionally, a reduction in wider area flooding may occur, the risk linked to this has not been assessed for cycle 1, therefore the benefit is not quantified. Similarly, pollution risk arising from flood routing has not been assessed for cycle 1. We will look to include assessments on this in cycle 2 where possible.

The analysis is based upon three winter rainfall durations for each return period only.

Land purchase costs are not allowed for within the assessments undertaken. No consideration of land ownership, access or presence of buried or overhead services, ground conditions or groundwater levels has been made within the strategic option assessment.

No consideration of tank emptying has been made in the assessment to date and the evaluated storage volume has not been tested within the model. This presents three risks.

1. The required volume of storage to achieve the solution target may be larger than estimated through this process dependent on the grouping of storm events and the realistic tank emptying rate.
2. Local network enhancement or reinforcement maybe required in order to empty the tank. This may be considered to some extent within the unit cost.
3. The combined impact of emptying multiple tanks within a catchment has not been assessed. Wider network reinforcement maybe required to transfer flows to treatment. There is also potential the treatment works may not have capacity to accept the tank emptying flows within constraints of existing permits.

Where storage requirements are particularly large or small, the standard assumptions (i.e. circular shaft tank assumption) used within this process may not be appropriate. Consequently, in a minority of instances, the standardised approach is limited, and the automated design used for costing may not be appropriate. This will be refined during solution development and future DWMP cycles.

The high-level solution nature means that there is a limitation in the operational costs and carbon assessments that can be completed.

Extrapolations have relied on Enhance investment solutions only. Future cycles will look to improve this analysis to consider a blended set of interventions.

The costs and benefits determined during the development of the DWMP are intended to give an indication of anticipated direction of travel only and final delivered solution costs and benefits will vary from these.

10.7.4 Wastewater Treatment Works ODA

10.7.4.1 Overview of Draft Approach

For our dDWMP, options were developed for catchments identified as 'Promote' through the WwTW compliance problem characterisation process.

Catchments progressed through a series of screening questions, as described in Section 10.7.4.3.1, to generate an initial list of potential options to be considered for future option development. For the purposes of the DWMP, further development of options was focussed on treatment modification only, utilising our existing design and valuation tool (DAVE) to identify cost and process modifications, as described in Section 10.7.4.3.2.

10.7.4.2 Key changes in approach for final

10.7.4.2.1 Inclusion of WINEP

Following feedback provided during the consultation on our dDWMP, we have included a number of elements of the WINEP within our final plan, as discussed in Section 2.3. A number of drivers relating to investments in WwTW performance are included within the WINEP and have therefore been through the WINEP option development process as described in Section 2.3. These drivers are summarised in Table 74:

Table 74: PR24 WINEP Driver Guidance WwTW Improvements

Driver	Description	Obligation Date(s)
25YEP_IMP	Locally significant environmental measures not eligible under any other driver, but with clear evidence of customer support	31/03/2030

Table 74: PR24 WINEP Driver Guidance WwTW Improvements

Driver	Description	Obligation Date(s)
U_IMP2	Actions to reduce total phosphorus and/or total nitrogen levels in qualifying discharges (from agglomerations >10,000pe) associated with the next review of freshwater Sensitive Areas (Eutrophic)	TBC
U_IMP7	Providing secondary treatment capable of achieving 40:60 BOD:suspended solids where a septic tank discharges to surface water	31/03/2028
BW_IMP1	Actions to improve waters with a current planning class of Poor	31/03/2026
BW_IMP4	Actions to improve non-designated waters where there is evidence of customer support	31/03/2030
WFD_IMP	Implementation of actions to improve water quality in terms of relevant WFDR status objectives	31/03/2030
WFD_ND	Actions to meet requirements to prevent deterioration	31/03/2026 & 31/03/2030
EnvAct_IMP1	Actions to reduce phosphorus loading from treated wastewater by 80% by 2037 against a 2020 baseline	31/03/2037

The solutions identified through the WINEP option development process have been entered in to EDA and optimisation completed as required for the WINEP submission, prior to inclusion in the final DWMP costs.

10.7.4.2.2 PR24 and availability of new data

During the development of the business plan for PR24, an updated assessment to identify the risk of DWF non-compliance at WwTW due to growth in the short term was undertaken. This has supported the assessments undertaken during the development of the DWMP. This was based on newly available data since the completion of BRAVA during the dDWMP, notably new measured Q90 data and the more recent population projections discussed in Section 10.3.1.6.1. This assessment involved the identification of sites at risk of DWF compliance failure based on Q90 values in 2019, 2020 and 2021. Based on this, a further review of the predicted DWF compliance in 2030 was undertaken. Where consultation with local authorities has flagged areas of particular concern from a development point of view, risk to compliance at the relevant WwTW has been assessed individually and investment proposed where necessary.

The sites identified as requiring investment through this assessment have been reviewed alongside the schemes identified through the DWMP. This has confirmed the sites requiring investment during AMP8. This review considered the newly available data and anticipated enhancement expenditure for AMP8 and beyond. Some sites originally identified as requiring investment within the dDWMP no longer require investment following this review.

Where additional sites have been identified as requiring investment during AMP8, these have not progressed through the DWMP ODA process. However solutions have been developed using either the DAVE tool utilised in the production of the dDWMP solutions, or a bespoke solution has been developed by our strategic planning partner. These solutions have been entered in to EDA for optimisation. The proposed investment in AMP8 is representative of the position at the time of writing, further changes may occur prior to the publication of our draft and final business plan for PR24.

For all catchments that triggered Promote for treatment in the dDWMP, this was as a result of risks materialising by 2030 and therefore requiring investment in the short term. This is influenced by the differing trigger thresholds used for the different time epochs in Problem Characterisation, due to the level of uncertainty increasing as we progress further into the future, as discussed in Section 10.5.2. Whilst this level of uncertainty remains, in order to provide an indication of anticipated expenditure for the Final DWMP in later AMPs, the DWF growth assessment that has been completed for PR24 has been repeated to assess compliance at 5-year intervals: 2035, 2040, 2045 and 2050. Where a potential future risk is identified, a PE (population equivalent) adjusted unit cost has been derived from the planned AMP8 schemes. Whilst these costs have been included in the fDWMP, the uncertainty in future performance remains and we will continue to review our risk position and required levels of investment through future investment and DWMP cycles.

10.7.4.3 DWMP Wastewater Treatment Works ODA Process

10.7.4.3.1 Initial option screening

Several of the generic options detailed within Section 10.7.1 of this report can be considered when looking to address risks associated with wastewater treatment works compliance; these are summarised below.

- WwTW rationalisation / centralisation, Wastewater transfers
- Reduce Wastewater and Trade Effluent
- Reduce rainfall induced flow
    - Reduction or removal of inflows and / or infiltration
    - Surface water system disconnection / flow separation
    - Strategic blue / green corridors
    - Surface water source control measures
- Treatment decentralisation
- River catchment / flexible permitting
- Treatment modification

A series of screening questions, shown in Figure 77 to Figure 84 have been developed for each of these options to establish the potential suitability of the option to address the identified risks. For "Treatment Modification" rather than using screening questions we have utilised our Design and Value Engine (DAVE) which includes a series of process selection matrices and has been used to identify and cost process modifications. The use of this tool is discussed in more detail in Section 10.7.4.3.2.

Figure 77: Initial WwTW option screening part 1

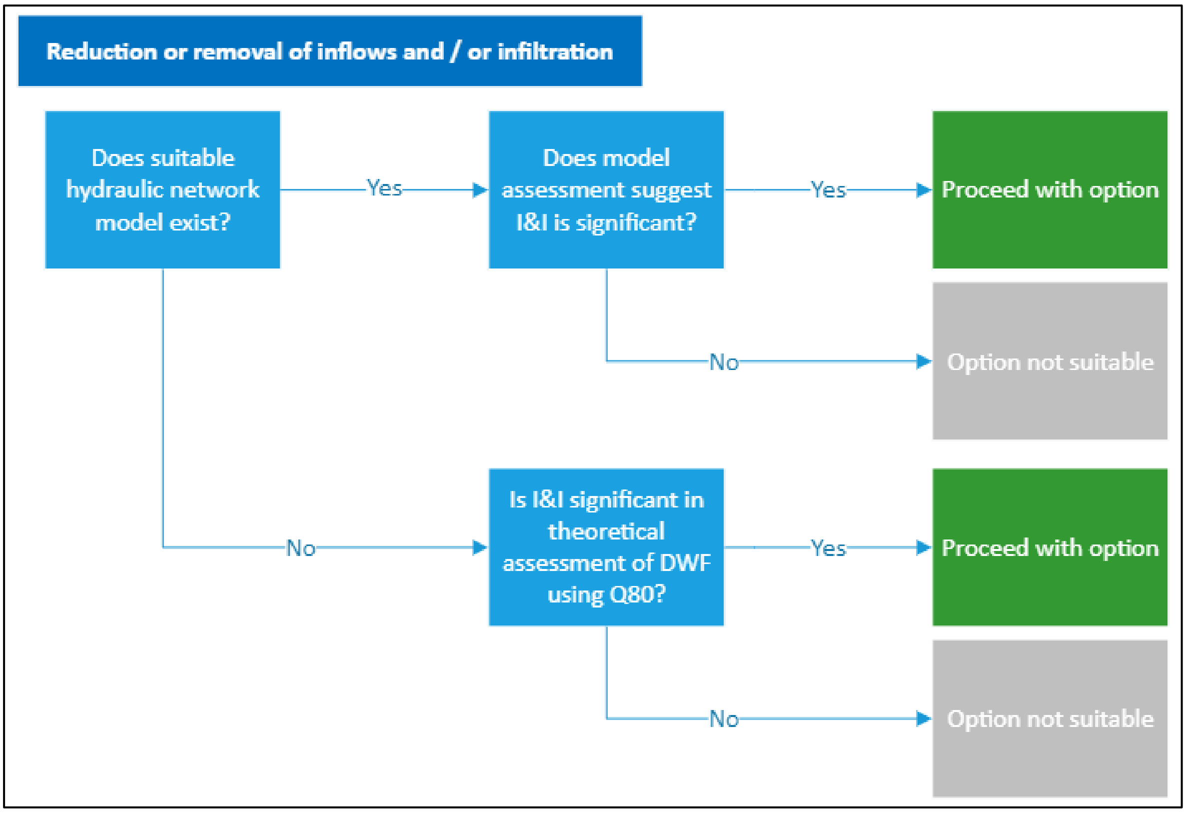


Figure 78: Initial WwTW option screening part 2

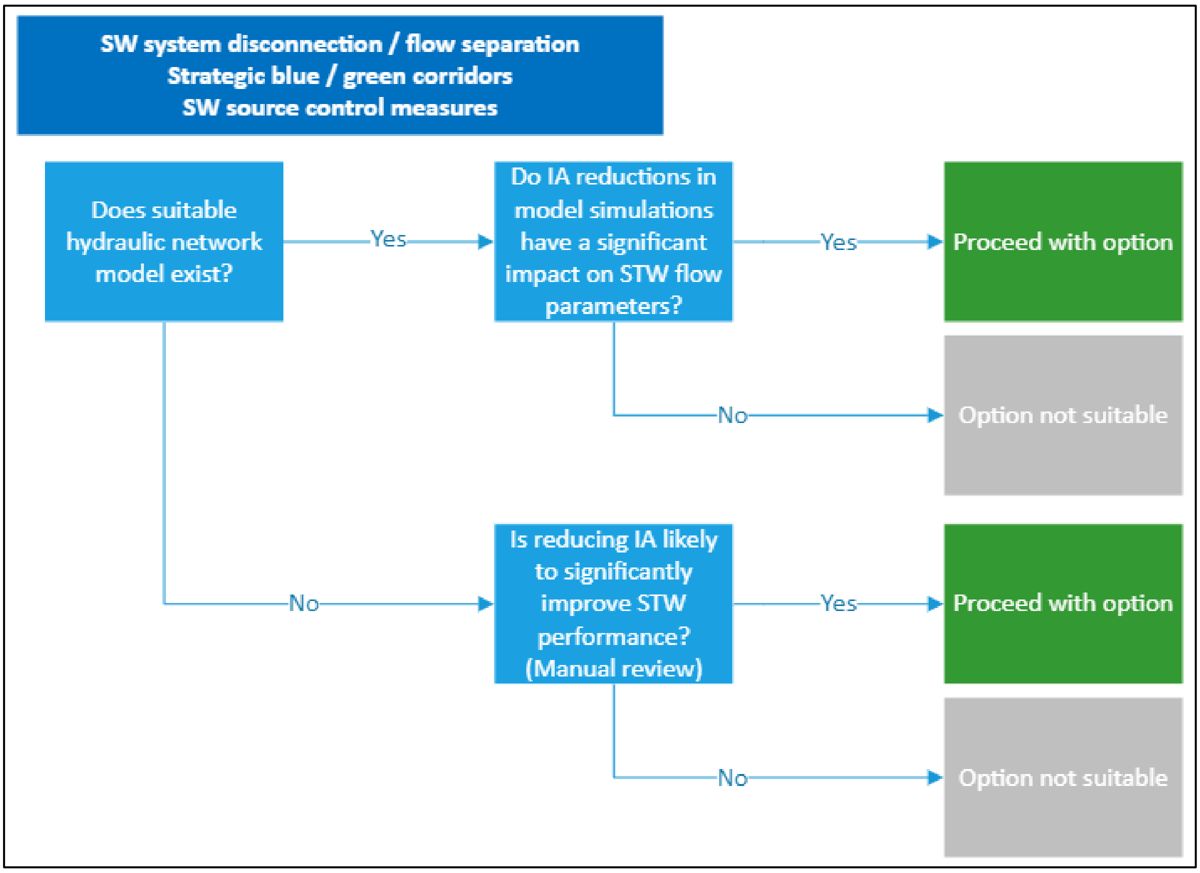


Figure 79: Initial WwTW option screening part 3

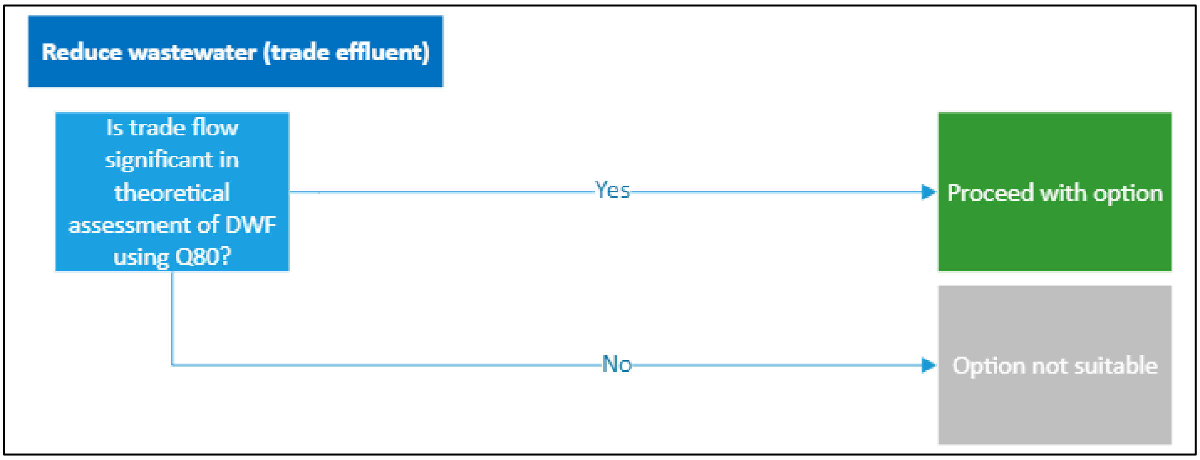


Figure 80: Initial WwTW option screening part 4

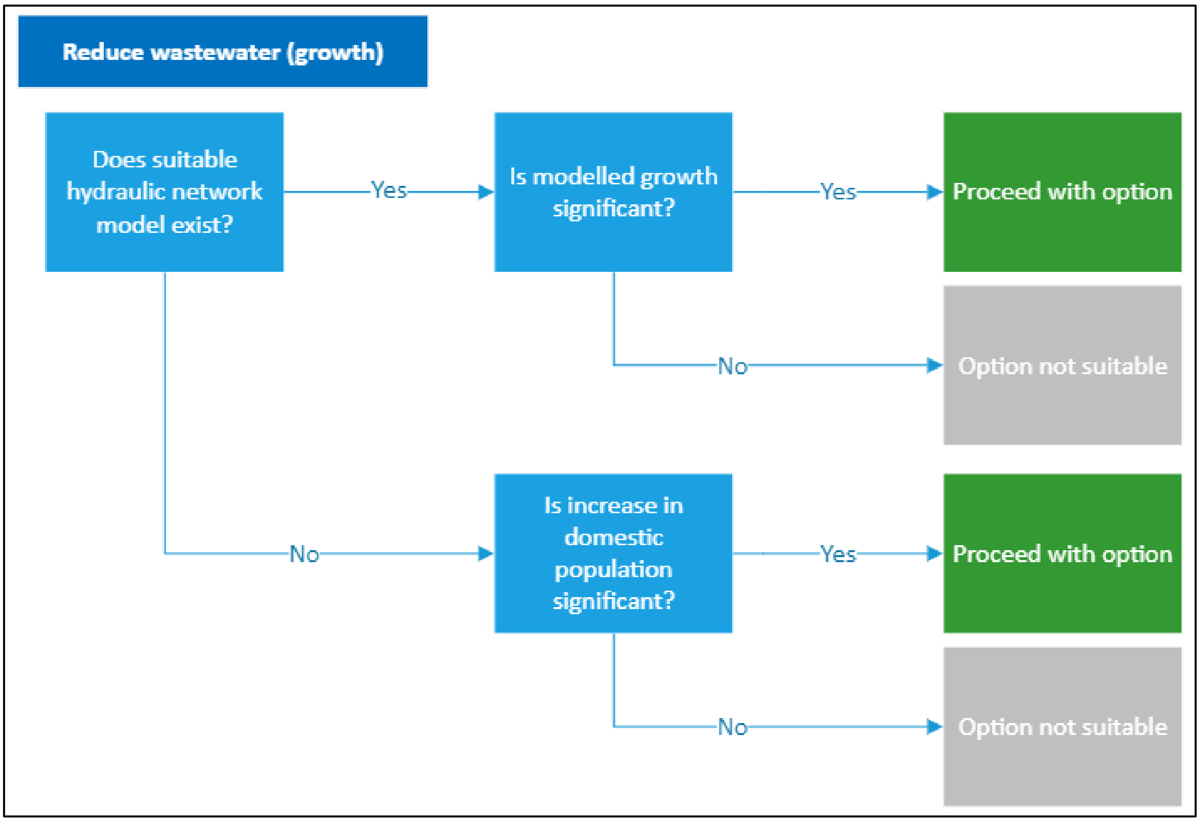


Figure 81: Initial WwTW option screening part 5

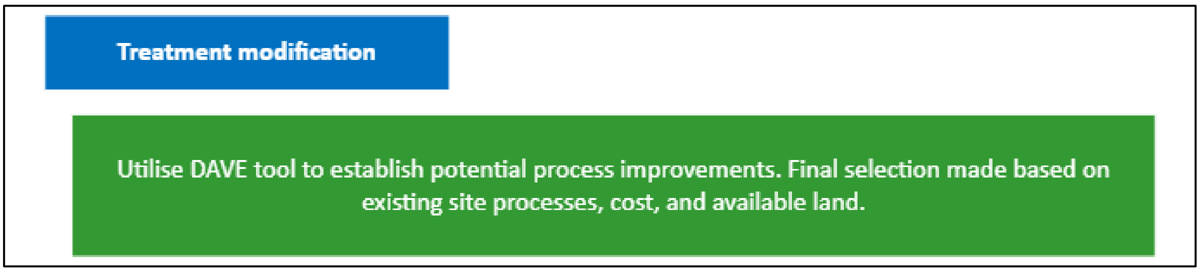


Figure 82: Initial WwTW option screening part 6

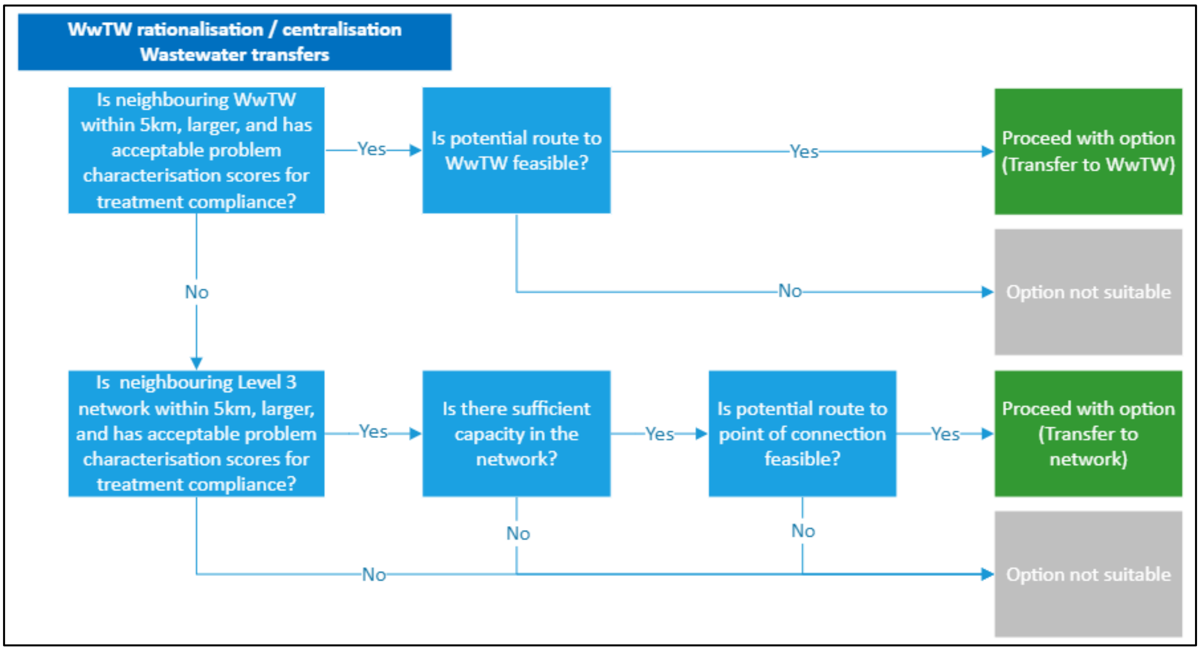


Figure 83: Initial WwTW option screening part 7

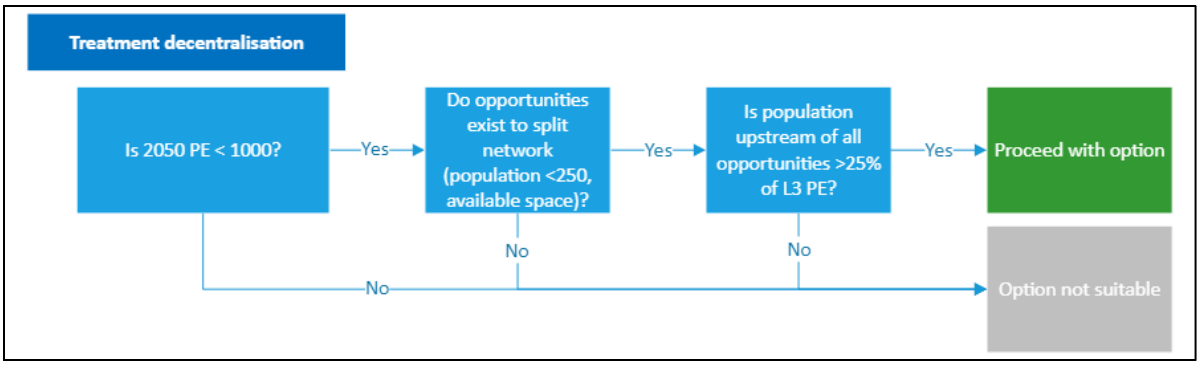
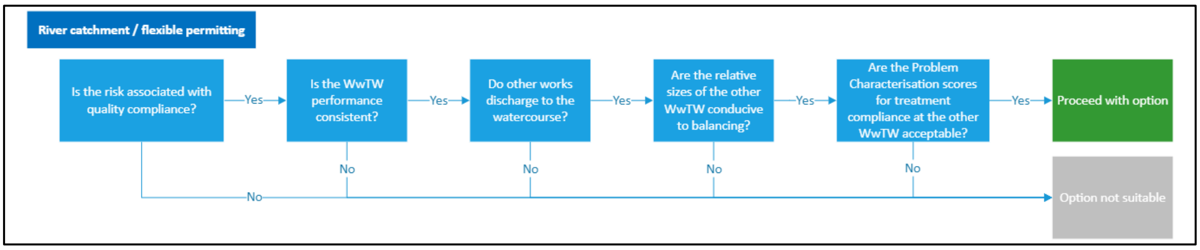


Figure 84: Initial WwTW option screening part 8



The application of these screening questions has provided us with an initial list of potential options to be considered for future option development. For our DWMP, we have focussed further development of our options on treatment modification only. The decision to focus option development on treatment modification was driven by programme constraints coupled with the limited scope for reliable cost and benefit appraisal as discussed in Section 10.7.1 of this report. However, this approach has allowed all options to be developed using an existing design and valuation tool, ensuring that standard business processes and costings are applied consistently across the catchments.

The options that have been identified as potentially suitable through the screening process but that have not progressed for further option development will be recommended for consideration during any future option development and appraisal, outside of the DWMP. The costs and benefits determined during the development of the DWMP are intended to give an indication of anticipated direction of travel only and final delivered solution costs and benefits will vary from these.

10.7.4.3.2 Further option screening: Treatment modification

We have utilised our existing option selection, sizing and costing tool, Design and Value Engine (DAVE), to identify, size and cost the most appropriate treatment modification option for each of the catchments requiring optioneering. The spreadsheet tool is an established part of our strategic planning capability and has been in use for a number of years, undergoing numerous upgrades over that time. The most significant recent upgrade being the incorporation of the capability to deal with P removal ahead of PR19/WINEP3.

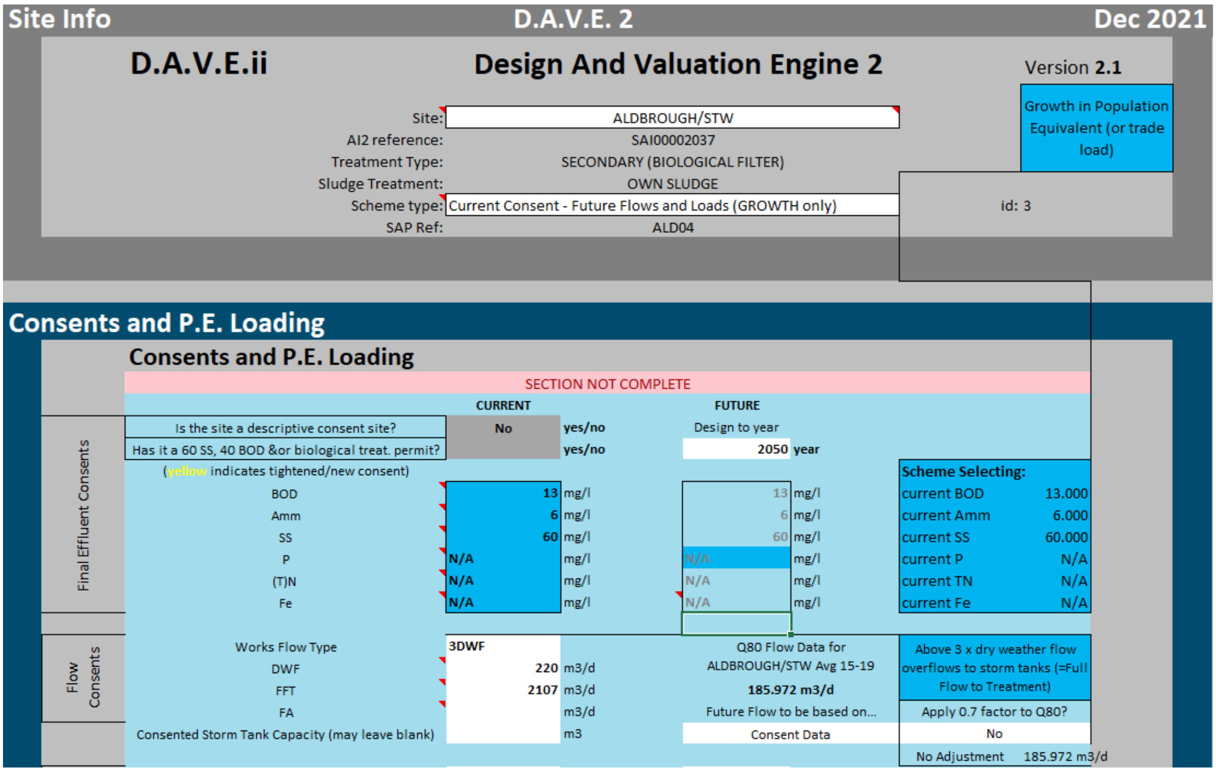
The Design and Value Engine has three key components:

- Inputs – relating to the existing works and required capabilities.
- Calculations and logic pathways.
- Outputs – individual asset elements.

Inputs

The key inputs comprise information about the existing WwTWs; the relevant consent values, flow parameters and existing processes. These inputs establish the 'as is' position. This data is supplemented with information on the new requirements at the site i.e., new consents, predicted growth in population, or other pressures in the future. All solutions have been developed for the design horizon of 2050. The population data used is consistent with the dataset used during the BRAVA assessment. Where the growth in population would result in tightening of the consent limits to ensure no detriment, this has been taken into account in the sizing of the solution. We have utilised a combination of measured and consented trade flow data to establish current and future flows. PCC values are consistent with those utilised in the hydraulic network modelling. Figure 85 provides an example partial view of the input sheet for ALDBROUGH/WwTW.

Figure 85: Screenshot of Design and Valuation Engine input sheet



Site Info D.A.V.E. 2 **Dec 2021**

D.A.V.E.ii **Design And Valuation Engine 2** Version **2.1**

Site: ALDBROUGH/STW
AI2 reference: SAI00002037
Treatment Type: SECONDARY (BIOLOGICAL FILTER)
Sludge Treatment: OWN SLUDGE
Scheme type: Current Consent - Future Flows and Loads (GROWTH only)
SAP Ref: ALD04

Growth in Population Equivalent (or trade load)

id: 3

Consents and P.E. Loading

Consents and P.E. Loading

SECTION NOT COMPLETE

Final Effluent Consents

	CURRENT		FUTURE			
Is the site a descriptive consent site?	**No**	**yes/no**	Design to year			
Has it a 60 SS, 40 BOD &or biological treat. permit?		**yes/no**	**2050**	**year**		
(yellow indicates tightened/new consent)					**Scheme Selecting:**	
BOD	**13**	mg/l	13	mg/l	current BOD	13.000
Amm	**6**	mg/l	6	mg/l	current Amm	6.000
SS	**60**	mg/l	60	mg/l	current SS	60.000
P	**N/A**	mg/l	N/A	mg/l	current P	N/A
(T)N	**N/A**	mg/l	N/A	mg/l	current TN	N/A
Fe	**N/A**	mg/l	N/A	mg/l	current Fe	N/A

Flow Consents

Works Flow Type	**3DWF**		Q80 Flow Data for ALDBROUGH/STW Avg 15-19	Above 3 x dry weather flow overflows to storm tanks (=Full Flow to Treatment)
DWF	**220**	m3/d		
FFT	**2107**	m3/d	**185.972 m3/d**	
FA		m3/d	Future Flow to be based on...	Apply 0.7 factor to Q80?
Consented Storm Tank Capacity (may leave blank)		m3	Consent Data	No
				No Adjustment 185.972 m3/d

Calculation

The spreadsheet contains built in logic that applies the Asset Standard for a specific parameter. This identifies the individual assets needed to deliver the new consent level as well as calculating the required size and scale of these assets. It identifies the major civils, mechanical and electrical assets required together with ancillary assets such as instrumentation and SCADA. Application of the Asset Standard in this way ensures that the requirements are met and there is consistency between one solution and another.

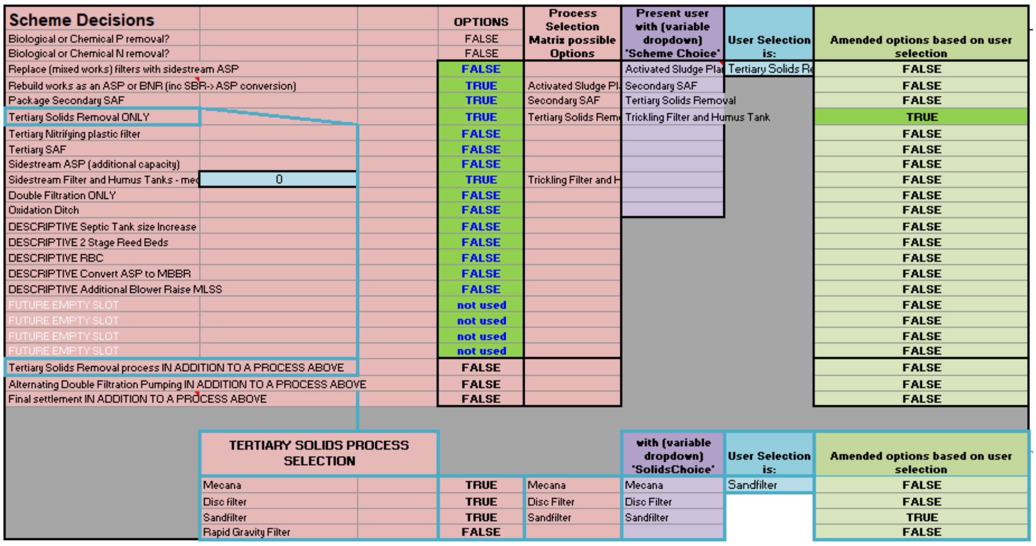
Outputs

Based on the input values, the tool generates an output which describes the recommended process to use and breaks down the asset level components required to solution element level, with associated size, scale and estimated costs. These solution elements have associated Unit Cost Model References which we can use to replicate the notional solution and its estimated costs in our Decision-Making Framework (DMF). Where the solution could be achieved through a variety of different processes, the user of the tool selects the final process/solution to be used. The selection of the final solution has been made based on an individual assessment of TOTEX, the existing processes on site and land availability. Table 75 summarises the potential processes included within the tool. A combination of these processes may be required dependent on the solution.

Table 75: Potential process types included within design and valuation engine
Septic tank
2 stage passive reedbeds
Primary settlement
Secondary/tertiary trickling filters
Secondary/tertiary settlement
Activated sludge plant (ASP)
Secondary/tertiary submerged aerated filter (SAF)
Chemical dosing
Rotating biological contactor (RBC)
Moving bed biofilm reactor (MBBR)
Tertiary solids removal (Sandfilter, disc filter etc)
Double filtration pumping

Figure 86 and Figure 87 show screenshots of the decision-making process built into the tool and an example of the solution sizing outputs.

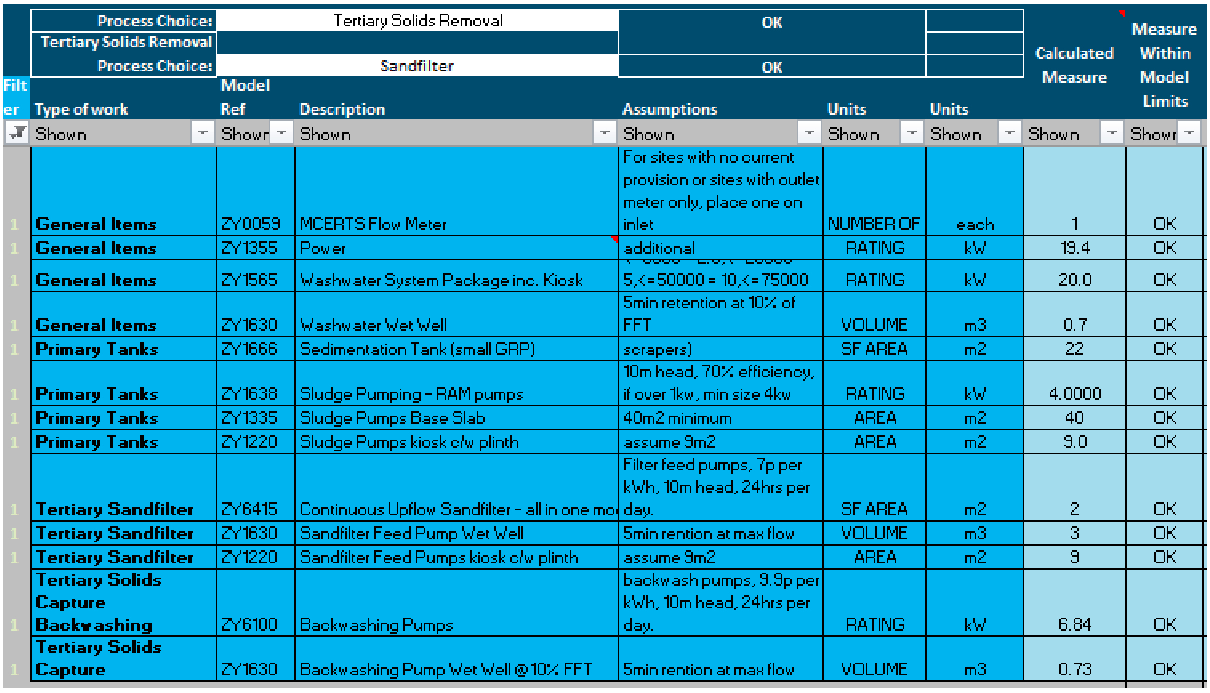
Figure 86: Screenshot of Design and Valuation Engine decision making process



Scheme Decisions		**OPTIONS**	**Process Selection Matrix possible Options**	**Present user with (variable dropdown) 'Scheme Choice'**	**User Selection is:**	**Amended options based on user selection**
Biological or Chemical P removal?		FALSE				
Biological or Chemical N removal?		FALSE				
Replace (mixed works) filters with sidestream ASP		FALSE		Activated Sludge Pla	Tertiary Solids Re	FALSE
Rebuild works as an ASP or BNR (inc SBR-> ASP conversion)		TRUE	Activated Sludge Pl	Secondary SAF		FALSE
Package Secondary SAF		TRUE	Secondary SAF	Tertiary Solids Removal		FALSE
Tertiary Solids Removal ONLY		TRUE	Tertiary Solids Rem	Trickling Filter and Humus Tank		TRUE
Tertiary Nitrifying plastic filter		FALSE				FALSE
Tertiary SAF		FALSE				FALSE
Sidestream ASP (additional capacity)		FALSE				FALSE
Sidestream Filter and Humus Tanks - mec	0	TRUE	Trickling Filter and H			FALSE
Double Filtration ONLY		FALSE				FALSE
Oxidation Ditch		FALSE				FALSE
DESCRIPTIVE Septic Tank size Increase		FALSE				FALSE
DESCRIPTIVE 2 Stage Reed Beds		FALSE				FALSE
DESCRIPTIVE RBC		FALSE				FALSE
DESCRIPTIVE Convert ASP to MBBR		FALSE				FALSE
DESCRIPTIVE Additional Blower Raise MLSS		FALSE				FALSE
FUTURE EMPTY SLOT		not used				FALSE
FUTURE EMPTY SLOT		not used				FALSE
FUTURE EMPTY SLOT		not used				FALSE
FUTURE EMPTY SLOT		not used				FALSE
Tertiary Solids Removal process IN ADDITION TO A PROCESS ABOVE		FALSE				FALSE
Alternating Double Filtration Pumping IN ADDITION TO A PROCESS ABOVE		FALSE				FALSE
Final settlement IN ADDITION TO A PROCESS ABOVE		FALSE				FALSE

TERTIARY SOLIDS PROCESS SELECTION			**with (variable dropdown) 'SolidsChoice'**	**User Selection is:**	**Amended options based on user selection**
Mecana	TRUE	Mecana	Mecana	Sandfilter	FALSE
Disc filter	TRUE	Disc Filter	Disc Filter		FALSE
Sandfilter	TRUE	Sandfilter	Sandfilter		TRUE
Rapid Gravity Filter	FALSE				FALSE

Figure 87: Screenshot of Design and Valuation Engine solution sizing



Process Choice:	Tertiary Solids Removal	OK	
Tertiary Solids Removal			
Process Choice:	Sandfilter	OK	

Filter	Type of work	Model Ref	Description	Assumptions	Units	Units	Calculated Measure	Measure Within Model Limits
	Shown	Shown	Shown	Shown	Shown	Shown	Shown	Shown
1	**General Items**	ZY0059	MCERTS Flow Meter	For sites with no current provision or sites with outlet meter only, place one on inlet	NUMBER OF	each	1	OK
1	**General Items**	ZY1355	Power	additional	RATING	kW	19.4	OK
1	**General Items**	ZY1565	Washwater System Package inc. Kiosk	5,<=50000 = 10,<=75000	RATING	kW	20.0	OK
1	**General Items**	ZY1630	Washwater Wet Well	5min retention at 10% of FFT	VOLUME	m3	0.7	OK
1	**Primary Tanks**	ZY1666	Sedimentation Tank (small GRP)	scrapers)	SF AREA	m2	22	OK
1	**Primary Tanks**	ZY1638	Sludge Pumping - RAM pumps	10m head, 70% efficiency, if over 1kw , min size 4kw	RATING	kW	4.0000	OK
1	**Primary Tanks**	ZY1335	Sludge Pumps Base Slab	40m2 minimum	AREA	m2	40	OK
1	**Primary Tanks**	ZY1220	Sludge Pumps kiosk c/w plinth	assume 9m2	AREA	m2	9.0	OK
1	**Tertiary Sandfilter**	ZY6415	Continuous Upflow Sandfilter - all in one mo	Filter feed pumps, 7p per kWh, 10m head, 24hrs per day.	SF AREA	m2	2	OK
1	**Tertiary Sandfilter**	ZY1630	Sandfilter Feed Pump Wet Well	5min rention at max flow	VOLUME	m3	3	OK
1	**Tertiary Sandfilter**	ZY1220	Sandfilter Feed Pumps kiosk c/w plinth	assume 9m2	AREA	m2	9	OK
1	**Tertiary Solids Capture Backwashing**	ZY6100	Backwashing Pumps	backwash pumps, 9.9p per kWh, 10m head, 24hrs per day.	RATING	kW	6.84	OK
1	**Tertiary Solids Capture**	ZY1630	Backwashing Pump Wet Well @ 10% FFT	5min rention at max flow	VOLUME	m3	0.73	OK

Cost and service measures

Each of the solutions developed within the Design and Valuation Engine and their associated capital costs have been uploaded into our DMF. Operational expenditure to cover energy, maintenance, chemical usage and rates has been estimated for each solution utilising the operational costs calculator within the DMF system which utilises standard business values. Estimates of embodied and operational carbon have been made using in house models for each asset type.

The following service measures have been populated for the benefit assessment within the DMF:

- Final Effluent Compliance (Numeric)
  - Amber sample trigger failure
  - Red sample trigger failure
  - LUT consent standard exceedance (inc. 95%ile fails for sanitary and iron)
  - Discharge permit compliance impacting failure (UV, annual P, heavy metals, WTW discharge failures, single UT failures and cumulative LUT failures)
  - Sample failure due to nutrients or hazardous pollutants
- Flow Compliance (WWTW)
  - Failing DWF

These metrics are quantified based on the number of failures, either individual samples, works or annually dependent on the specific service measure.

Assumptions and limitations

The process undertaken has established a preliminary solution to address the identified risk only, with a focus on treatment modification. Further refinement and solution development is required prior to implementation of any final solution.

The treatment solutions have been considered and developed independently of the network solutions, with the exception of consideration as to whether the impermeable area reductions in the network may resolve the treatment works risk. Costs may be over or under-estimated as a result.

11. Programme optimisation and appraisal

Following generation of the modelled and costed options summarised in Sections 10.7.3.4.7 and 10.7.3.5.6 above, the following steps in the process and decisions are required in order to generate a plan:

- Determine which solution form to be selected (Reduce + Enhance or Enhance only) to address each Need where it has been possible to provide a choice.
- Determine how the solutions should be phased throughout the planning period.

These decisions were applied in different ways to create three different economic plan assessments and options:

- Core Plan
- Preferred Plan
- Least Cost Plan

These are summarised below in Table 76.

Table 76: Plan Summary

Plan	Delivery Ambition
Core	Delivers regulatory requirements (SODRP, WINEP) Delivers the company blue-green ambition for SODRP
Preferred	Delivers regulatory requirements (SODRP, WINEP) Delivers flooding ambition Delivers the company blue-green ambition for SODRP
Least Cost	Delivers regulatory requirements (SODRP, WINEP) Delivers least cost interventions

For the storm overflow programme, the core plan and the preferred plan are the same in terms of timing of delivery and method of delivery.

It was not possible to generate a true ‘best value plan’ by following a ‘free optimisation’ approach – this is because the requirements of the SODRP and the WINEP require delivery of prescribed interventions to defined timescales. The SODRP programme was developed from a ‘free optimisation’ with constraints then applied based on SODRP targets, deliverability and affordability. The AMP8 core and preferred plan elements are the same, apart from some expenditure for flooding risk reduction in Hull, linked to our LWW programme.

In order to meet the requirements of the SODRP, meet stakeholder expectations around the deployment of blue-green infrastructure and deliver interventions to WINEP prescribed dates we have developed a preferred plan. This is not strictly a best value plan due to the fact that we have taken the best value plan (BVP) for our storm overflows and applied the SODRP targets to it manually. This is because in the optimisation system, it has not been possible to constrain the system such that it runs a best value optimisation and achieves the requirements of the SODRP – meeting the overall target for the number of assets addressed and meeting the requirements of the high priority overflows and bathing water targets. We have also applied the company ambition for the delivery of blue-green interventions – the optimisation based on best value only selected a very low proportion of blue-green interventions. This does not align with the expectations of regulators, or the preferences identified in the consultation process. In addition, it is not possible to freely optimise the components of the WINEP programme as these have fixed regulatory delivery dates.

We recognise that we could have produced a BVP that would not have been statutory compliant. This step will be included in cycle 2 of the DWMP so it will be clearer to see how a future preferred plan compares to an unconstrained best value plan. It remains likely that any future preferred plan will continue to have constraints that will need to be mandated into the optimisations process.

11.1 Storm overflow offline programme appraisal

The storm overflow programme was prioritised for appraisal first, due to the AMP8 WINEP submission requirements in January 2023.

An unconstrained optimisation was run in the DMF to determine which generic option (Reduce + Enhance or Enhance only) should be selected for the different economic options.

The WINEP submission contained a prioritised programme for intervention in AMP8 and this contained a total of 211 storm overflows. This is discussed further in Section 3.4.

The remaining storm overflows identified for intervention were then reviewed and the logic in Table 77 below was applied to provide preliminary phasing for delivery across AMPs 9-12. It has been necessary to undertake the phasing outside of our DMF to allow alignment to the SODRP targets. Additionally, it allows a pragmatic approach to be taken, where possible prioritising waterbodies with a high number of storm overflows, to support the utilisation of strategic catchment-based initiatives, or to focus on storm overflows at the upstream end of a river reach; to benefit the specific waterbody and associated downstream sections. This phasing assessment includes the storm overflows where modelled solutions are not available.

Table 77: Preliminary storm overflow phasing logic

Screening description	Completion AMP
Focus on bathing sites and high priority sites	AMP8
Remaining bathing water storm overflows Storm overflows highlighted as requiring intervention following the outputs of no local adverse ecological harm investigations completed by 31 March 2027	AMP9
Remaining storm overflows highlighted as requiring intervention following the outputs of no local adverse ecological harm investigations completed by 31 March 2030 Storm overflows within the upper reaches of a WFD waterbody or waterbodies with a high number of storm overflows discharging to it	AMP10
Any remaining storm overflows discharging to high priority waterbodies Storm overflows discharging to a waterbody where one or more scheme has been completed in an earlier AMP	AMP11
All remaining storm overflows	AMP12

The phasing of the sites is unchanged for each economic scenario; however, the generic option selected was changed.

Where a storm overflow was not contained within a hydraulic model, Reduce + Enhance solutions were prioritised for all storm overflows within Level 3s:

- with descriptive WwTW consents and
- where the predicted Q90 for 2050 (see Section 10.3.3.4) indicated capacity at the treatment works may be limited.

Enhance only solutions were then proposed at the remaining non-modelled storm overflow locations.

Within the Least Cost Plan, the lowest CAPEX solution has been selected by the Decision-Making Framework (DMF) with the same phasing as the other plans to deliver the SODRP targets. No post-optimisation refinement was carried out on this economic plan.

For the Core and Preferred Plan, the outputs of the original unconstrained run were used, and the phasing logic applied. This run contained a high proportion of Enhance only solutions. Consequently, the option selection was reviewed, and solutions that were selected to be delivered by Reduce + Enhance (S3) where:

- Enhance only solutions were selected in the unconstrained optimisation
- Alternative solutions were available
- Proposed tank storage volumes were either very small or very large, or
- The theoretical tank drain-down (assuming a 24hour emptying period) is a significant proportion of the gap between the treatment works DWF consent and FFT consent.

Following the above post-optimisation refinement, the solution split within the Preferred Plan had greater alignment to our company ambition to deliver 20% of the AMP8 storm overflow programme with a scheme that contains a blue-green component and 50% per AMP thereafter. It should be noted that this is a delivery target and at this stage the solutions proposed within the DWMP are strategic.

The DMF was updated to reflect the revised solution selection and phasing within the three economic scenarios. As part of the project lifecycle, all solutions will be reviewed again prior to delivery.

11.2 Flooding cluster offline programme appraisal

The process applied is the same for the Preferred Plan for storm overflows. Flood clusters are not included within the Least Cost or Core Plan.

Where flooding clusters have been linked to a primary Level 4 the solution form of the cluster is linked to the selection made in Section 11.1. The applied logic for selection of the flood cluster generic option is summarised in Table 78 below:

Table 78: Alignment of storm overflow and flood risk solutions

Storm overflow solution	Flooding solution
Enhance (S1)	Enhance
Reduce + Enhance (S3)	Reduce* + Enhance
Reduce + Enhance (S2.5) AND flood risk is driven predominantly from foul/combined system	Reduce* + Enhance
Reduce + Enhance (S2.5) AND flood risk is driven from foul/combined and surface water systems	Enhance

*No entry into DMF for this aspect to prevent double counting

Where a flood cluster sits outside of a storm overflow Level 4, but there are storm overflows within the Level 3, then it is assumed the Enhance solution must be selected for the flood cluster. Future DWMP cycles will seek to refine this assumption.

If there are no storm overflows within the Level 3 then a catchment strategy solution selection has been made. This selection was made based on comparing the cost of delivering:

- all flood cluster mitigation via the Enhance option
- all flood cluster mitigation via the Reduce + Enhance option

Selection of generic option for the Level 3 was assigned based on a comparison of cost.

With regard to the solution phasing, where Enhance solutions are selected, the flooding and storm overflow solutions are considered independent as the construction of one solution is not expected to affect or alter the construction of the other. Where Reduce + Enhance is selected, the storm overflow element of the scheme must be constructed alongside or prior to the flooding mitigation. A pragmatic approach may be to construct the SuDS (associated with the storm overflow) and then pause and monitor the risk reduction offered by the SuDS work. Additional flooding mitigation could be added at a point in the future if still required. This approach is considered to align to an adaptive pathway approach.

The final solution timing of the flooding clusters was selected by the DMF for each economic scenario. However, the logic below was used to constrain the permissible years in which the system was allowed to schedule the solution:

- Flood cluster is outside of storm overflow level 4 – use cluster derived start
- Flood cluster is within storm overflow Level 4 using S1 solution – use cluster derived start
- Flood cluster is within storm overflow Level 4 using S2.5 or S3 – use latest from cluster derived start and storm overflow scheme starting year

Where the cluster derived start date was determined based on five metrics:

- Consequence of flooding
- Model confidence at a flood cluster level
- Definition of the flood cluster
- Timing of risk occurrence
- Deliverability of the flooding cluster

Each metric was assigned either high, medium or low. Where;

- High = 0 year delay
- Medium = 1 year delay
- Low = 4 year delay

Resulting in a minimum delay of 0 years from 2025 and a maximum delay of 20 years from 2025.

The solution selections and timing constraints were updated in DMF for the respective economic scenarios.

11.3 WwTW programme appraisal

For each solution identified through the ODA process described in Section 10.7.4 the number of years over which the required investment could be phased has been assumed based on the derived capital cost.

Timeframes for delivery have been determined to ensure completion prior to WINEP regulatory dates or the point at which the risk of permit compliance failure materialises. Additional refinement of in-AMP delivery timescales is anticipated during PR24 optimisations taking into consideration the wider business plan.

11.4 Decision Making Framework

As discussed throughout the ODA section of this report our developed solution costs and benefits have been entered into EDA (Enterprise Decision Analytics) which is the IT system used in our Decision-Making Framework (DMF). This system underpins all decisions made in relation to assets and investment within Yorkshire Water.

Here is a short YouTube clip on our Decision-Making Framework and a link to more details:
https://www.youtube.com/watch?v=iZ6CixsmPSA

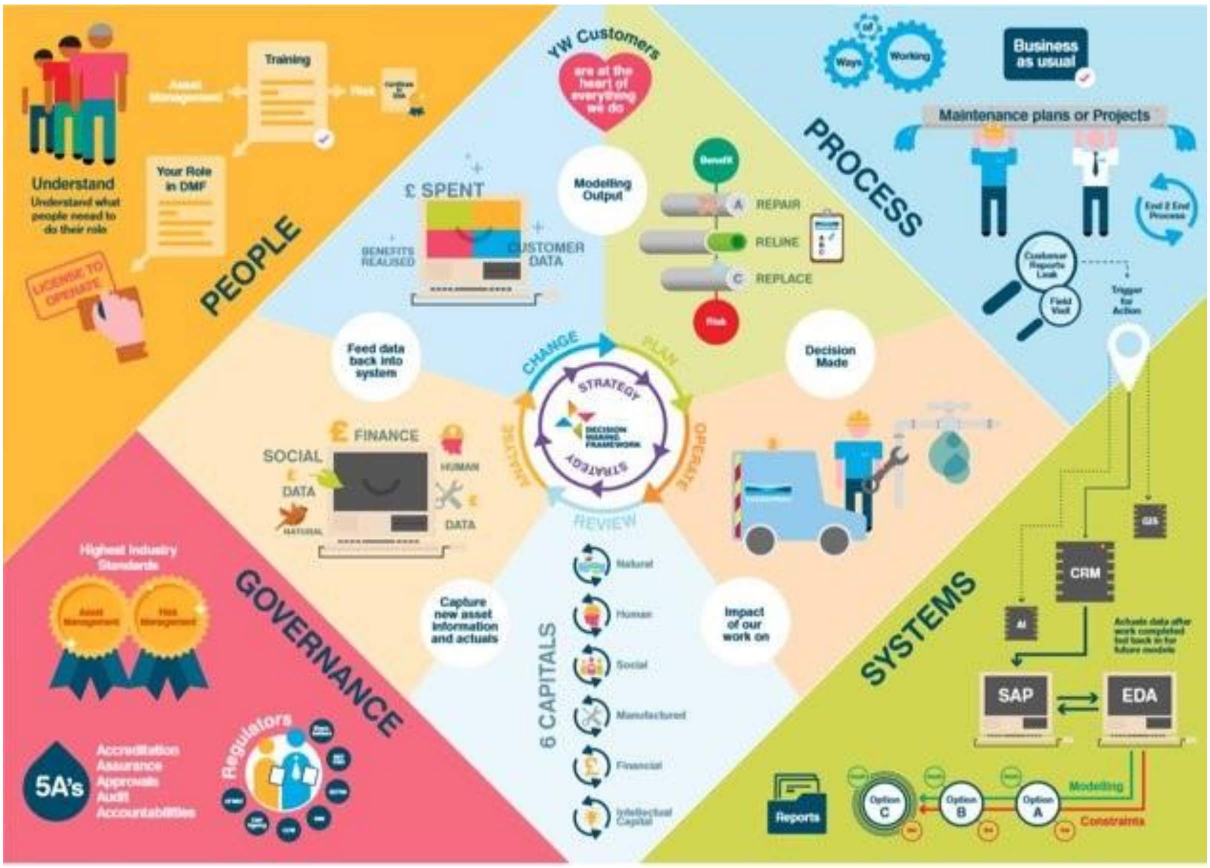
https://www.yorkshirewater.com/media/yvjfkhqd/yorkshire_water_dmf_website_case_study.pdf

This software enables us to undertake complex and large-scale calculations such as optimisations. Within the DWMP, our DMF is supporting:

- Solution selection for the different economic options
- Timing of investment throughout the planning period
- Creation of investment profiles
- Creation of benefit profiles

Figure 88 below shows the components of the DMF process:

Figure 88: How our DMF works



11.4.1 6 Capitals approach to investment decision-making

We utilise the 6 Capitals approach to our investment decision making and in sustainable accounting[30], and this is built into our Decision-Making Framework. The 6 Capitals as applied in YW are outlined in Figure 89 below.

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[30] See this link for more information: https://www.yorkshirewater.com/about-us/capitals/

Figure 89: The 6 Capitals in Yorkshire Water

Six capitals

Financial capital
Our financial health and efficiency

Manufactured capital
Our pipes, treatment works, offices and IT

Natural capital
The materials and services we rely on from the environment

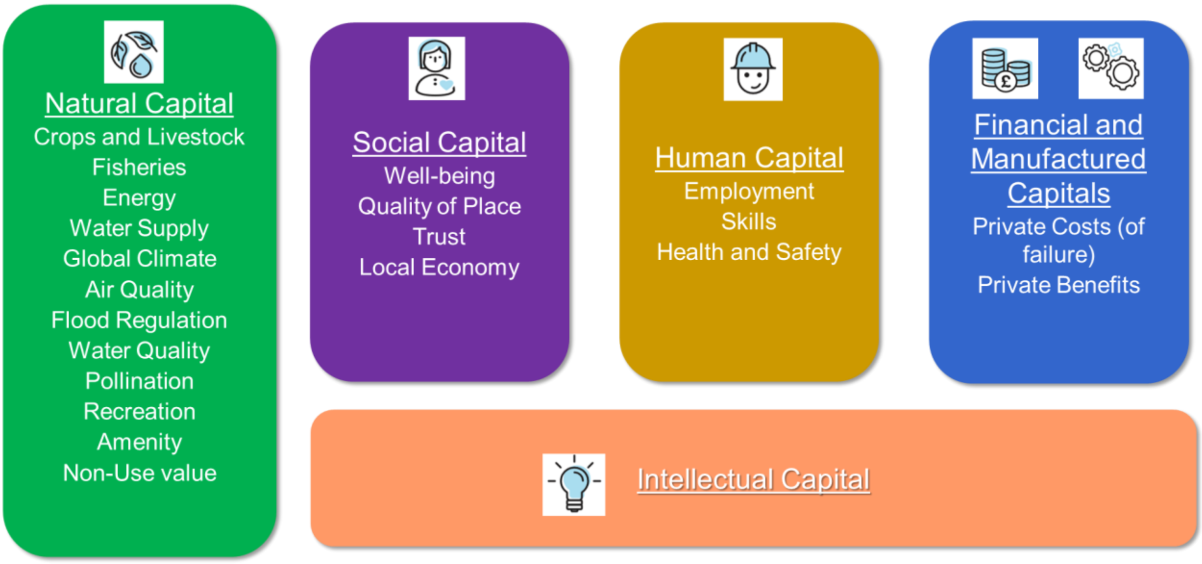
Human capital
Our workforce's capabilities and wellbeing

Intellectual capital
Our knowledge and processes

Social capital
Our relationships and customers' trust in us

Each capital is disaggregated into different metrics which helps us to better understand risks and opportunities and how it creates or reduces value, dependant on the actions we take. As an extension of this, we are also able to put a monetary value onto impacts of actions or non-actions, which express a cost or benefit, where practicable. The different metrics considered under each of the 6 capitals are shown below in Figure 90.

Figure 90: Metrics considered within the 6 capitals



11.4.2 Our service measures

Service Measures capture the different risks and impacts of investing as well as not investing. Our Service Measures cover different areas of clean and wastewater services and other impacts including those on land use and health and safety. These Service Measures are then further divided into Impact Categories which measure the extent or type of service failure/improvement. See Table 79 below for examples, although note that this is not a complete list and not exclusive to investments for wastewater assets.

Table 79: Sample list of Service Measures and Impact Categories in Yorkshire Water's Decision-Making Framework

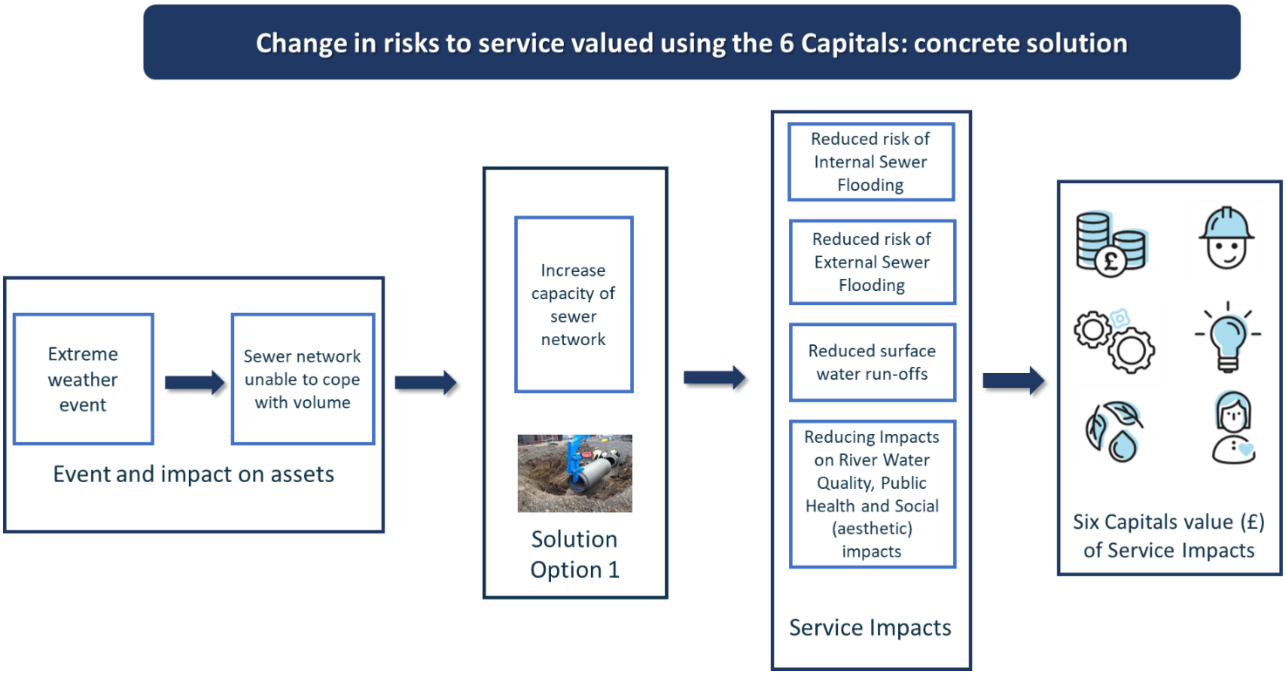
Service Measure	Impact Category	Metric Quantity
Leakage	Leakage	Ml/d
Internal Sewer Flooding	Internal sewer Flooding of a habitable area	Nr of Incidents
	Internal Sewer Flooding of a cellar	Nr of Incidents
Land Use	Area of green space	Hectares
	Area of bare ground	Hectares

Our Service Measures and Impact Categories are mapped to our Capitals metrics. This mapping represents an impact or dependency relationship between the Capitals metrics and our activities and services.

Where an impact or dependency relationship exists, we consider if there is an equivalent monetised value. By doing so, we are able to express the costs or benefits from an increase or decrease in service risks given the action to 'do the minimum' (or 'do nothing') or to implement a solution. These can then be compared to the financial and carbon costs of the action. The logic for this benefit valuation is described below with an example, and illustrated further in Figure 91 and Figure 92 below:

1. There is an event that causes an impact to service, e.g. an extreme rainfall event which overwhelms the sewer network. This causes issues such as sewer flooding of customers' properties.
2. There is a solution option to mitigate these impacts, e.g. increasing the capacity of the sewer network through concrete-based or traditional 'grey' solutions (e.g. concrete tanks to store surface water).
3. The monetised benefit is the present value benefit of the change in risk, multiplied by the 6 Capitals value of this change in risk.

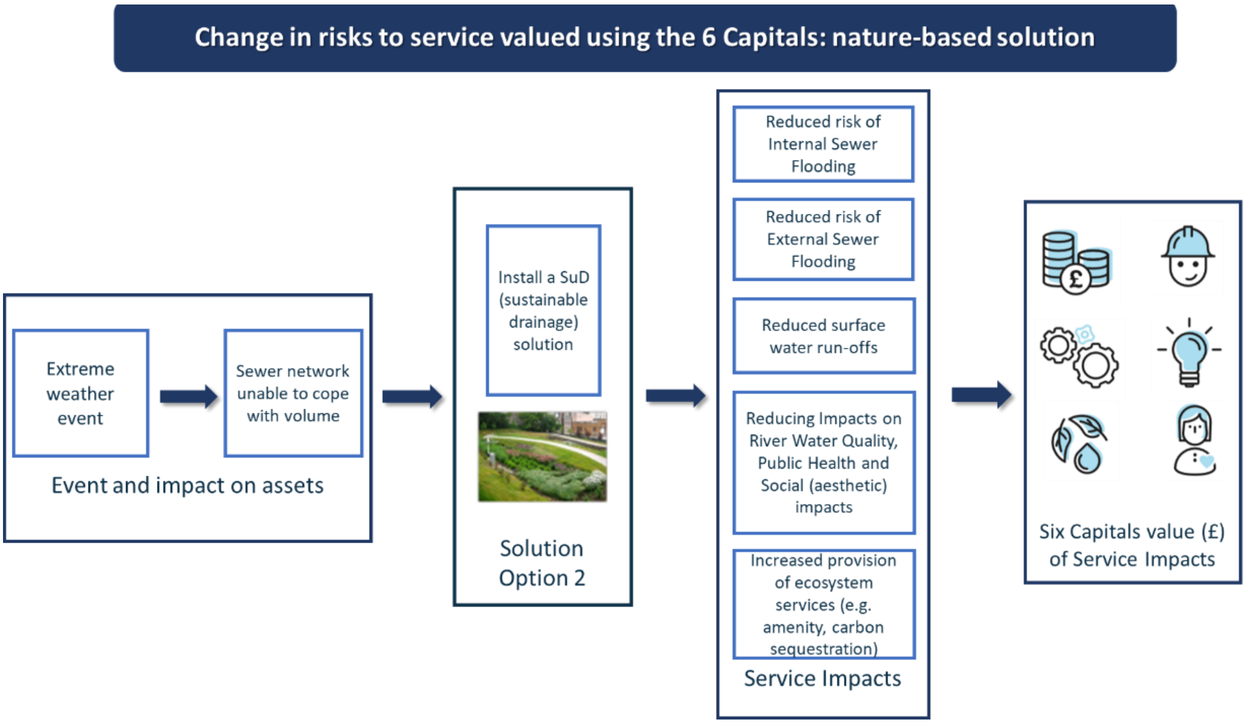
Figure 91: Capturing and valuing the impacts of a DWMP solution option: concrete-based solution



An alternative to a grey concrete solution is also generated. Figure 92 (below) shows a nature-based solution. In addition to reducing surface water runoff and lowering flows within the sewer network, blue-green infrastructure solutions deliver additional benefits such as reducing the volume of wastewater that needs pumping and/or treatment, therefore reducing carbon emissions. These solutions also bring benefits that you can't see. These include benefits from green space creation which are related to carbon sequestration, air quality, amenity and to non-use values.

A direct comparison of both solutions can then be made, using the 6 Capitals framework. This enables us to make informed cost-benefit investment decisions.

Figure 92: Capturing and valuing the impacts of a DWMP solution option: nature-based solution

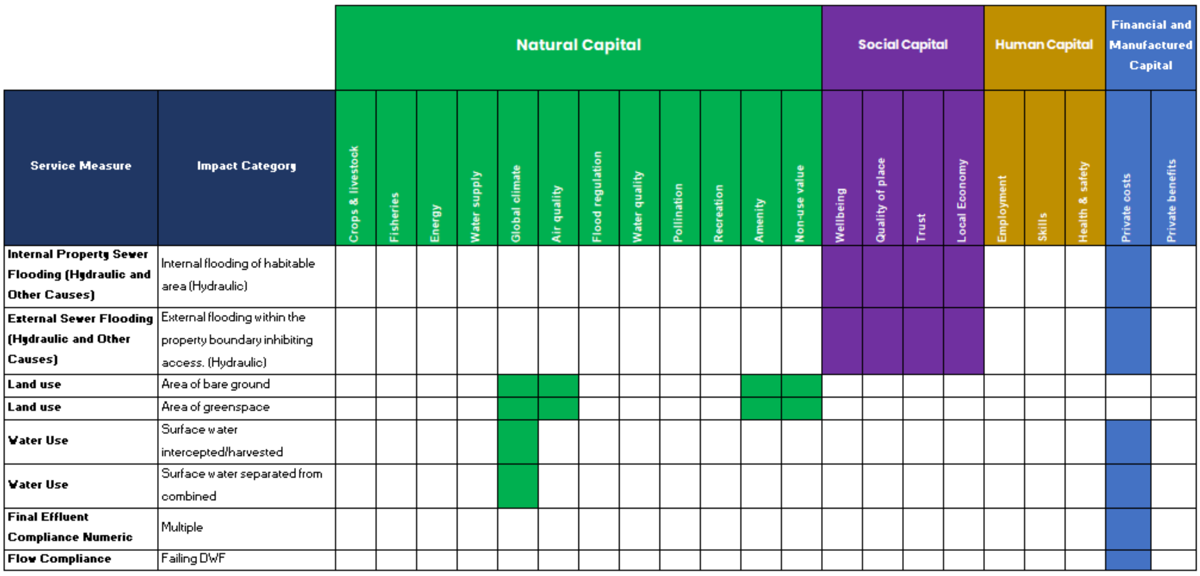


As discussed in Section 10.7.3.4.7, 10.7.3.5.6 and 10.7.4.3.2 our DWMP solutions have evaluated the following service measures:

- Area of green space
- Surface water separated from combined sewer systems
- Surface water intercepted/harvested
- Internal flooding of a habitable area of a property
- External flooding within the property boundary inhibiting access
- Final Effluent Compliance (Numeric)
    - Amber sample trigger failure
    - Red sample trigger failure
    - LUT consent standard exceedance (inc. 95%ile fails for sanitary and iron)
    - Discharge permit compliance impacting failure (UV, annual P, heavy metals, WTW discharge failures, single UT failures and cumulative LUT failures)
    - Sample failure due to nutrients or hazardous pollutants
- Flow Compliance (WWTW)
    - Failing DWF

Figure 93 below, shows the mapping relationship between the service measure, impact category and capital metric.

Figure 93: Service measure, impact category and six capital mapping



		Natural Capital												Social Capital				Human Capital			Financial and Manufactured Capital	
Service Measure	**Impact Category**	Crops & livestock	Fisheries	Energy	Water supply	Global climate	Air quality	Flood regulation	Water quality	Pollination	Recreation	Amenity	Non-use value	Wellbeing	Quality of place	Trust	Local Economy	Employment	Skills	Health & safety	Private costs	Private benefits
Internal Property Sewer Flooding (Hydraulic and Other Causes)	Internal flooding of habitable area (Hydraulic)													🟪	🟪	🟪	🟪				🟦	
External Sewer Flooding (Hydraulic and Other Causes)	External flooding within the property boundary inhibiting access. (Hydraulic)													🟪	🟪	🟪	🟪				🟦	
Land use	Area of bare ground					🟩	🟩					🟩	🟩									
Land use	Area of greenspace					🟩	🟩					🟩	🟩									
Water Use	Surface water intercepted/harvested					🟩															🟦	
Water Use	Surface water separated from combined					🟩															🟦	
Final Effluent Compliance Numeric	Multiple																				🟦	
Flow Compliance	Failing DWF																				🟦	

The final assessment that has been used is to calculate the carbon impact of a solution. This can be capital carbon which has been built up using YW cost models. This represents the modelled relationship between costs and embodied carbon from historical capital asset delivery. Or this can be operational carbon. This is estimated based on multipliers which estimate for every £1 of operational expenditure, including labour, energy, chemical, vehicles etc, the associated carbon volume.

11.5 Partnership for Yorkshire Project Lifecycle

The Partnership for Yorkshire (P4Y) is our capital delivery partnership consisting of over 60 different organisations. The purpose is to work collaboratively to optioneer, design and deliver the best value solutions for our customers. P4Y includes our Asset Planning teams who work closely with our technical experts in P4Y, from Gate 2 onwards, to investigate all the options for meeting a desired outcome. The P4Y Project Lifecycle is a project control and governance process based on

Association of Project Management (APM) best practice[31]. The Project Manager is accountable for taking the project through this process and they report to the Project Sponsor (Asset Planning) who is accountable for ensuring the project delivers the expected benefits. It enables effective planning, management, and control of a project from concept through to completion. Figure 94 shows how the DWMP fits into the Project Lifecyle and how solutions move from generic solutions through to feasible interventions. The DWMP outputs are part of the concept phase and the Strategic Planning team work closely with Asset Planning to move the outputs of the DWMP from generic solutions through to unconstrained solutions.

The Project Lifecycle has 5 stages

1. Concept Phase
2. Definition Phase
3. Delivery Phase
4. Handover and Closure Phase
5. Benefits Realisation

A solution will go through a series of Gates (go/no go decisions) and key meetings as part of this process. The Project Lifecyle includes optioneering of solutions and multiple technical and benefits reviews, as well as assurance against our design standards. Table 80: Project Lifecyle gates and key meetings Table X summarises the purpose of the different Gates and Key Meetings in the lifecycle of a solution. Each Gate and key meeting has a specific list of documents required for review that cover all parts of the project: for example, Biodiversity, Environmental Permits, CDM Regulations, Planning, Requirements and Design Specifications.

A key element of our Project Lifecycle is to evaluate options that deliver reductions in embedded and operational carbon emissions. We undertake whole life carbon assessments aligned to PAS2080:2016 and have been using a TOTEX hierarchy of no build, low build, nature-based solutions and grey solutions with lower carbon concrete or other low carbon materials or construction methods to achieve our target reductions. Options are modelled using our company decision-making tool with data drawing on material quantities and associated emissions using the Bath ICEv2 [32](Bath University – Inventory of Carbon Emissions.) We follow this through the life of projects and use data at key gateways from design through to practical completion to refine and reduce carbon as far as possible.

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[31] **https://www.apm.org.uk/**

[32] **https://researchportal.bath.ac.uk/en/publications/embodied-energy-and-carbon-in-construction-materials**

Figure 94: Project Lifecycle and solution interactions

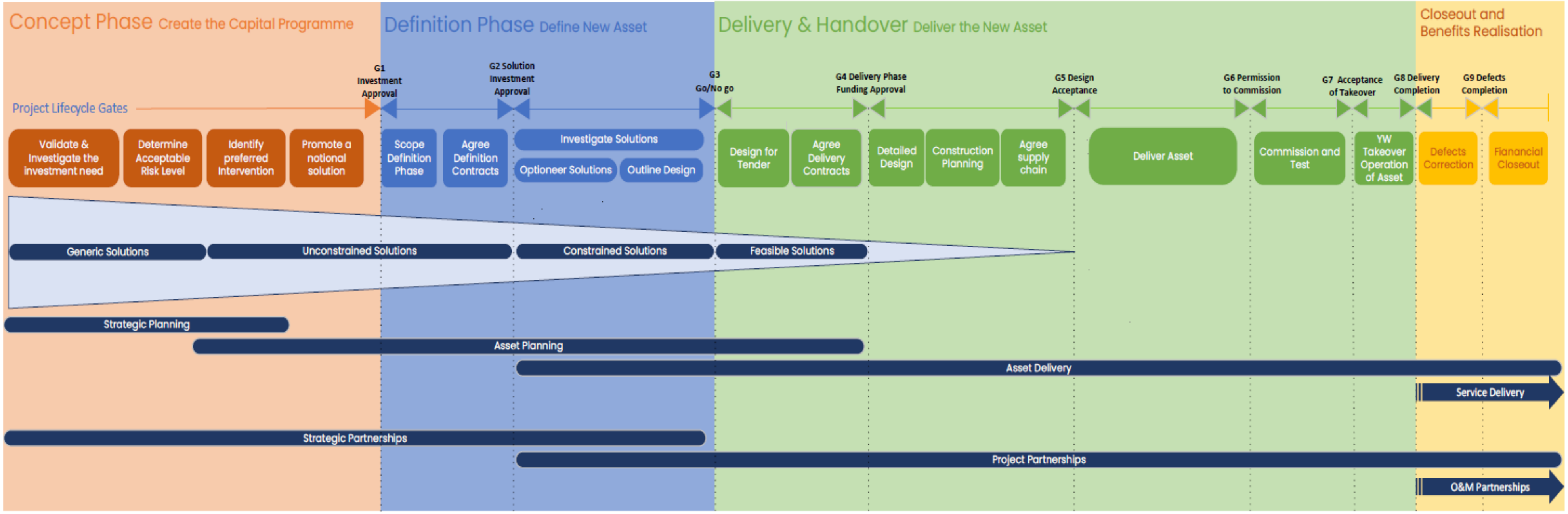


Table 80: Project Lifecyle gates and key meetings

Gate or KM	Phase	Purpose	Key Approval Document (Gates only)
Gate 1	Definition	Approval to investigate the Need/Risk.	Business Case including cost-benefit assessment.
Key Meeting 1	Definition	Define the scope of the Definition Phase.	-
Gate 2	Definition	Funding Approval for the Definition Phase.	Project Management Plan including a cost and forecast for investigation phase.
Key Meeting 2	Definition	Decide the preferred solution to progress to promote for delivery.	-
Key Meeting 3	Definition	Agreement of outline design of preferred solution.	-
Gate 3	Definition	Approval to progress the project to Delivery Phase.	Business Case including cost benefit assessment and Project Management Plan.
Key Meeting 4	Delivery & Handover	Scope agreement of Delivery Phase.	-
Gate 4	Delivery & Handover	Delivery Phase Funding Approval.	Business Case and Project Management Plan including costs, schedule and risks.
Key Meeting 5	Delivery & Handover	Delivery Contract Kick Off.	-
Key Meeting 6	Delivery & Handover	Commissioning Planning.	-
Key Meeting 7	Delivery & Handover	Design Review.	-
Gate 5	Delivery & Handover	Design Acceptance.	Design Package as defined in the Project Management Plan.
Key Meeting 8	Delivery & Handover	Pre-Start on Site.	-
Key Meeting 9	Delivery & Handover	Performance Trials Planning.	-
Gate 6	Delivery & Handover	Permission to Commission.	Commissioning and Testing results.
Key Meeting 10	Delivery & Handover	Handover Readiness.	-
Gate 7	Delivery & Handover	Acceptance of Takeover.	Health and Safety File, O&M Manuals and As Built Drawings.

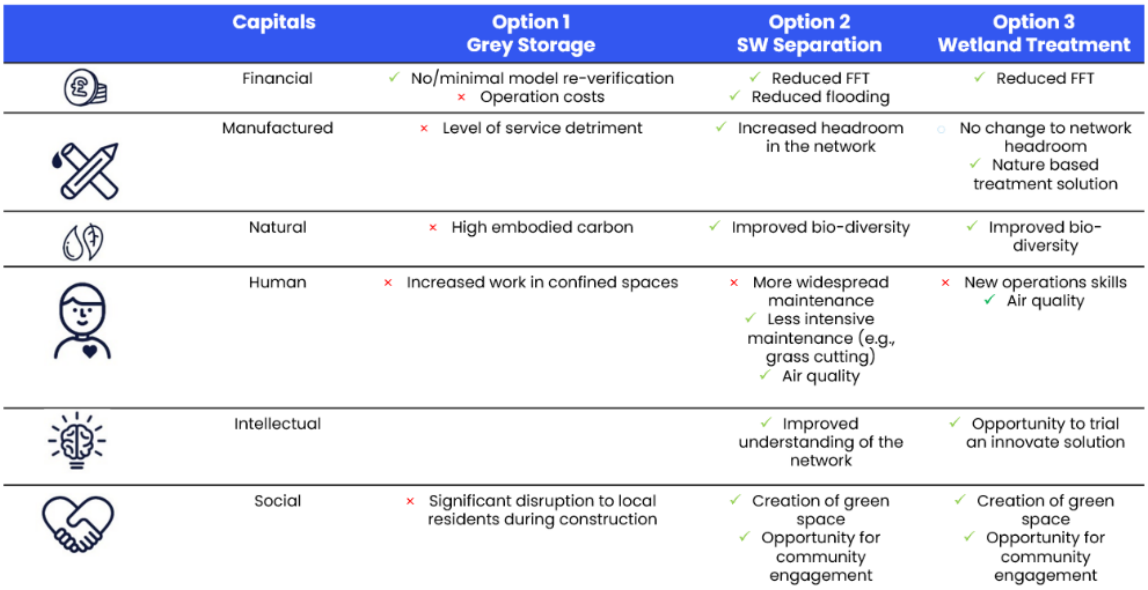
Table 80: Project Lifecyle gates and key meetings

Gate or KM	Phase	Purpose	Key Approval Document (Gates only)
Gate 8	Delivery & Handover	Delivery Completion.	Financial Data Capture.
Gate 9	Closeout and Benefits Realisation	Defects Period Complete.	Final Invoice.

We use our corporate Decision-Making Framework (DMF) to review the cost, carbon and benefit of each proposed solution at each Gate and key meeting: Taking the project from unconstrained optioneering in the concept phase through to feasible design in the delivery phase.

Figure 95 is an example of a Key Meeting 2 review of solutions against our 6 Capitals Sustainable Accountancy Framework.

Figure 95: Key Meeting 2 review example



	Capitals	Option 1 Grey Storage	Option 2 SW Separation	Option 3 Wetland Treatment
	Financial	✓ No/minimal model re-verification × Operation costs	✓ Reduced FFT ✓ Reduced flooding	✓ Reduced FFT
	Manufactured	× Level of service detriment	✓ Increased headroom in the network	○ No change to network headroom ✓ Nature based treatment solution
	Natural	× High embodied carbon	✓ Improved bio-diversity	✓ Improved bio-diversity
	Human	× Increased work in confined spaces	× More widespread maintenance ✓ Less intensive maintenance (e.g., grass cutting) ✓ Air quality	× New operations skills ✓ Air quality
	Intellectual		✓ Improved understanding of the network	✓ Opportunity to trial an innovate solution
	Social	× Significant disruption to local residents during construction	✓ Creation of green space ✓ Opportunity for community engagement	✓ Creation of green space ✓ Opportunity for community engagement

12. Adaptive planning

An adaptive planning framework is one which is recognised as best practice when there is uncertainty in the planning period. It allows for consideration of multiple programmes or activities that could be deployed depending on variable future circumstances. This facilitates optimal investment decisions based on a low or no regrets approach. An adaptive plan sets out how we will decisions will be made within the framework. We consider an adaptive planning solution within the DWMP where there is:

- Significant uncertainty
- A strategic decision in the plan's medium term, which has a long lead-in time; and,
- Large long-term uncertainty which might lead us to consider different preferred solutions.

This approach will help us move towards long-term adaptive planning and this will be undertaken in line with regulatory guidance and internal YW practices.

Ofwat published guidance on their expectations on planning for the long-term in April 2022, PR24 and beyond: Final guidance on long-term delivery strategies[33]. This set out how Ofwat expected companies to set PR24 business planning decisions within the context of a long-term delivery strategy, with DWMPs being some of the key inputs to a company's long-term strategy (alongside other plans such as WRMP and WINEP).

Adaptive planning is expected to be 'at the heart of the long-term delivery strategy'. Notably, this guidance also sets out the need to test strategies against 'common reference scenarios'; specifically high and low climate change trajectories, slow and fast technological development, high and low demand forecasts, and high and low reductions in abstraction. Companies are also encouraged to test against wider scenarios where these may be local or company specific. Our approach to testing against the common reference scenarios is described in more detail in Section 12.2.

Adaptive pathways are well suited to the dynamic changing nature within drainage catchments, where there are several uncertain externalities that influence risk and opportunities. For example, whilst the scale of actual change in rainfall patterns will not be known for some time (due to the variation in confidence and extremes expected within existing forecasts) there will be a need to make investment decisions now, through the adoption of no and/or low regrets approaches and the management of uncertainty. Identification of appropriate decision nodes is critical in the adaptive planning process to ensure that the time required to introduce solutions is sufficient, for example, to consider the time it takes to introduce retrofit nature-based solutions into the urban network and retrofit at scale.

We have developed an approach to adaptive pathway methodologies that takes account of regulatory reporting requirements, regulatory outputs as well as balancing internal business needs. This will consider affordability of plans, links to PR24 and WINEP deliverables and outputs, deliverability of the plan and our company ambitions and long-term goals. Processes will be tracked to ensure timeliness of decision making for consideration of alternative pathways.

12.1 Our DWMP and adaptive pathways

Our DWMP is based on an adaptive planning approach which enables the development of strategies in the context of different future scenarios. It aims to optimise the profile of key interventions across time, establishing the investment that is needed now and where decision points can be scheduled in the future.

At the outset of our DWMP process, we set out a range of ambitions that we wished to achieve in respect of modelled hydraulic sewer flooding, the operation of storm overflows and ensuring future compliance with our wastewater treatment works permits. Following consultation on the draft DWMP24, we have focussed on an enhanced version of Scenario 2 (as described in Section 10.6).

Within Ofwat's guidance on long-term delivery strategies, they reference the adaptive planning concept of a 'core scenario'. This scenario reflects no or low regret investment, investments required in both benign and adverse scenarios, and across a wide range of plausible scenarios. The core scenario also includes investment that is needed to keep future options open (for example, enabling works for a potential future scheme), or is required to minimise the cost of future options.

We have included a core pathway within our DWMP. The core pathway we have defined ensures we meet all of our 'must do' regulatory requirements however doesn't include all of our aspirations. In addition to the core pathway, we have identified a series of alternative pathways to meet a range of differing future scenarios.

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[33] **https://www.ofwat.gov.uk/publication/pr24-and-beyond-final-guidance-on-long-term-delivery-strategies/**

12.2 Common reference scenarios and sensitivity testing

Within their guidance, Ofwat also detailed a series of common reference scenarios, against which scenario testing should be undertaken. The common reference scenarios are a set of plausible bounds or extremes for key uncertainty areas for testing and are summarised in Table 81:

Table 81: Ofwat common reference scenarios

	Climate Change	Technology	Demand	Abstraction
Adverse Scenario	High (UKCP18 RCP8.5)	Faster development of new technologies	High Growth	Environment Agency's 'enhanced' scenario
Benign Scenario	Low (UKCP18 RCP2.6)	Slower development of new technologies	Low growth	Current legal requirements

'Compound' scenarios, which group low or high scenarios together are generally discouraged by Ofwat's guidance, because they represent an aggregation of more than one unlikely scenario occurring simultaneously (although they may be used to complement the process).

We have endeavoured to align with the common reference scenarios when developing our adaptive pathways, focussing on those which have a demonstrable impact on the risk profile and expenditure requirements identified within the DWMP, whilst also considering our level of ambition with regards to risk reduction and the delivery of blue-green solutions.

It should be noted that due to the extensive timescales associated with hydraulic modelling assessments and the lack of availability of tools to represent different scenarios, particularly with regards to rainfall, complete alignment with the common reference scenarios has not been possible for this cycle of the DWMP. This is explained further in Sections 12.1.1.1.1 to 12.1.1.1.4. Sensitivity testing to provide an indication of variations in the scales of investment required has however been completed.

12.2.1 Climate change

As discussed in Section 10.3.1.7.2, the BRAVA hydraulic modelling work and subsequent development of options to address storm overflows and flood risk was undertaken using the data available and adopted for YW modelling purposes at the time. For design events (to assess flooding risk), climate change uplifts were applied based on a high emissions scenario utilising UKCP09 projections. For time series rainfall (to assess storm overflow performance) we utilised the UKWIR 'RED-UP v2' tool which incorporates climate change adjustments utilising UKCP09 projections for the RCP8.5 scenario. The release of UK Climate Projections 2018 (UKCP18), has been followed by the release of two updated methodologies for applying climate change projections to rainfall for use in sewer modelling:

- FUTURE-DRAINAGE: Guidance for Water and Sewerage Companies and Flood Risk Management Authorities: Recommended uplifts for applying to design storms[34] which provides new uplift factors to be applied to design rainfall events. These factors vary by return period, event duration and spatially and correspond to the UCKP18 RCP8.5 scenario. The regional average 50th percentile 2050 uplift for the design events used within the DWMP hydraulic modelling is 20%.
- The release of RED-UP v3 which has been updated to allow the generation of time series rainfall utilising the UKCP18 projections, again for the RCP8.5 scenario.

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[34] https://artefacts.ceda.ac.uk/badc_datadocs/future-drainage/FUTURE_DRAINAGE_Guidance_for_applying_rainfall_uplifts.pdf

Both of these new methodologies align with the high climate change (RCP8.5) common reference scenario provided by Ofwat. There is not currently any industry wide guidance or tools available to support the production of rainfall representative of the low climate change (RCP2.6) scenario.

The UKWIR Technical Report[35] supporting the release of RED-UP v3 discusses the differences between the alternative pathways and the potential impact on rainfall, highlighting that the projected change in temperature between the two scenarios is significantly less when comparing the time horizon centred on 2050 against the time horizon centred on 2090. It also states, "while we would expect to see some reduction in the impact of rainfall intensity increase shown in RED-UP version 3.0 that used RCP8.5, we would not expect to see this as particularly significant for the time horizon of 2050". Potential methodologies to update RED-UP to incorporate the RCP2.6 scenario are discussed, however, as yet have not been implemented.

It is also noted that there are concerns as to the likelihood of the RCP2.6 scenario which predicts a change in temperature of 1.6°C by the end of the century. The United Nations 2022 Emissions Gap Report[36] "shows that updated national pledges since COP26 – held in 2021 in Glasgow, UK – make a negligible difference to predicted 2030 emissions and that we are far from the Paris Agreement goal of limiting global warming to well below 2°C, preferably 1.5°C.

We have undertaken sensitivity testing for the 2050 epoch on a select number of catchments to understand the impact of differing climate change projections and associated methodologies for application to rainfall for modelling could have on the risk position and therefore investment requirements identified through the DMWP ODA work. This is summarised in Table 82 and Table 83.

Table 82: Climate change sensitivity testing: Flooding

Scenario	Rainfall Uplift from 2020 Baseline	Cost Impact	Comments
BRAVA/ODA (UKCP09 RCP8.5)	+16%	N/A	
2050 model simulated with 2080 rainfall (UKCP09 RCP8.5)	+25%	+11% compared to original BRAVA/ODA outputs	Model simulations completed using 2080 rainfall as proxy and ODA process re-run to establish estimated variation in cost.
2050 FUTURE-DRAINAGE (UKCP18 RCP8.5)	+20%	+5% compared to original 2050 BRAVA/ODA outputs	Cost impact is interpolation between modelled scenarios described above.
UKCP RCP2.6	N/A	N/A	Not directly assessed due to lack of industry guidance.

Table 83: Climate change sensitivity testing: Storm overflows

Scenario	Cost Impact	Comments
BRAVA/ODA (RED-UP v2 UKCP09 RCP8.5)	N/A	

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[35] https://ukwir.org/eng/final-report-for-climate-change-rainfall-for-use-in-sewerage-design-design-storm-profiles-antecedent-conditions-redup-tool-update-and-seasonality-impacts

[36] https://www.unep.org/resources/emissions-gap-report-2022

Table 83: Climate change sensitivity testing: Storm overflows

Scenario	Cost Impact	Comments
BRAVA/ODA (RED-UP v3 UKCP18 RCP8.5)	+6% compared to original BRAVA/ODA outputs	Model simulations completed using rainfall generated using RED-UP v3 2050 rainfall as proxy and ODA process re-run to establish estimated variation in cost.
2050 model simulated with 2080 rainfall (RED-UP v2 UKCP09 RCP8.5)	+6% compared to original BRAVA/ODA outputs	Model simulations completed using RED-UP v2 2080 rainfall as proxy and ODA process re-run to establish estimated variation in cost.
UKCP RCP2.6	N/A	Not directly assessed due to lack of available industry tool.

A benign climate change scenario aligned with the common reference scenario has not been tested due to the current lack of available guidance on uplifting rainfall to represent RCP2.6. To provide an indication of a potential lower climate change scenario, additional sensitivity testing was undertaken simulating the 2050 design horizon model with the design rainfall produced during BRAVA for the 2020 and 2030 design horizons (UKCP09 RCP8.5). This suggested a potential impact on the 2050 costs of -31% and -15% respectively for flooding and -4% and -3% respectively for storm overflows.

The sensitivity testing discussed above has focussed on the impact of climate change on rainfall and the resultant impact this has on the performance of our sewer network with regards to storm overflows and flood risk, as this is where we see climate change having the greatest impact on our levels of risk and future investment requirements.

There is the potential for variations in climate change to impact our systems in other ways, including through variations in river flows and sea levels. Future changes in both the magnitude and temperate of river flows may affect water quality and therefore the impact that both our storm overflow and WwTW discharges have. As local adverse ecological harm and water quality impact has not been modelled or assessed as part of the DMWP, no sensitivity testing of this has been undertaken. As no costs have been included within our DMWP relating to the impact of sea level rises, we have not undertaken sensitivity testing or made allowances for this within our DMWP.

There is also a developing understanding around the impact changes in temperature may have on the performance of wastewater treatment processes. Whilst not assessed within this cycle of the DMWP, this is something we will be looking to explore further in future cycles.

12.2.2 Technology

The adverse and benign technology common reference scenarios provided by Ofwat describe scenarios where new technologies become available and adoptable at different epochs. The most relevant provided example to the DWMP is the adoption of a new wastewater approach, essentially smart wastewater networks, by 2040 in the faster technology scenario and by 2045 in the slower technology scenario.

As discussed in Section 8 we are undertaking a number of innovation projects during AMP7 and will be continuing this in to AMP8 and beyond. Our innovation approach includes pilots and trials which can then be expanded and embedded, upon detailed review of costs and benefits. The outcomes of these will create an evidence base which dictates the rate at which new technologies are adopted.

As our ODA process has focussed on the development of solutions with a design horizon of 2050, it is assumed that new technologies will be available by that point in both scenarios. We have not undertaken any sensitivity testing of different rates of technology for this cycle of the DWMP however anticipate progression of this during future cycles as our evidence base for new technologies grows.

12.2.3 Demand

Demand is considered to encompass population growth and the impact of building regulations and product standards on Per Capita Consumption (PCC). The Ofwat common reference scenarios indicate that the following two growth scenarios should be used, with the highest of these for the adverse scenario and the lowest for the benign:

- population, property and occupancy forecasts derived from local plans published by the local council or unitary authority. Referred to as local plan projections.
- population, property and occupancy forecasts derived from Office for National Statistics (ONS) population and household projections. Referred to as ONS projections.

As discussed in Section 10.3.1.6.1 our hydraulic modelling work utilised the latest available population predictions at the time the modelling work was completed, provided by our external supplier for PR19. This incorporated a proportional population uplift based on local plan forecasts, further supplemented by reviewing individual development information and representing major planned developments within the models where appropriate.

Whilst the latest population projections available at the time of the assessments was utilised, ahead of PR24 and WRMP24 we have worked with our external supplier to develop a series of new population growth forecasts for a range of scenarios (including both local plan and ONS projections), utilising updated data. Given the timescales required to undertake BRAVA and the subsequent phases of DWMP development, particularly where hydraulic modelling was required, we were unable to fully utilise this updated dataset within our DWMP assessments.

The local plan forecasts produced for PR19 and used in the DWMP modelling work predict a regional 2050 population which is greater than the equivalent local plan forecast produced for PR24. This in turn is greater than the 2050 population within the ONS prediction scenario.

Whilst this indicates that the model assessments that we have undertaken and subsequent solutions that we have developed are representative of a high growth scenario, the impact of this on flooding and storm overflow solutions is not anticipated to be significant. A review of the increase in modelled impermeable area following the modelling of new development indicated that the increase in impermeable area contributing to the foul combined system is zero in >99% of catchments due to adoption of the connection hierarchy (connection of surface water to the foul combined system as a last resort). The increase in impermeable area contributing to the surface water system is zero in 92% of modelled catchments. Considering the minimal increase in contributing area to the sewer network, given that attenuation systems will be incorporated as part of the new development to reduce peak flows, this supports the expectation that the impact of growth on storm overflow operation and flood risk is expected to be minimal.

Sensitivity testing has also been undertaken to understand the impact of including new development in the models on DWF at storm overflows. In an assessment of 757 storm overflows, at 89% of the overflows, new development resulted in a reduction of the existing headroom between DWF and PFF at first spill of less than 10%. For those sites where new development does have a notable increase in DWF the effect is anticipated to be an increase in spill frequency, acknowledging that the majority of our overflows already exceed the SODRP target, this would not necessarily result in an increase in required storage volume and therefore cost.

In summary, investment to address the storm overflow and flooding elements of the DWMP are not anticipated to vary with differing growth forecasts. As such, further sensitivity testing to establish cost variations between the high and low common reference scenarios has not been undertaken.

The assessments of WwTW performance undertaken during BRAVA and in the dDWMP utilised the same PR19 local plan population projections used in the hydraulic modelling work. As discussed in Section 10.7.4.2.2 updated growth assessments have been undertaken utilising the newly available population forecasts. The risk assessment and subsequent identification of investment requirements has been repeated using both the ONS and local plan population forecasts for inclusion in the appropriate pathways. Where specific risks have been identified following consultation with local authorities, these have been included for both high and low growth scenarios.

The Ofwat common reference scenarios indicate that the following two PCC scenarios should be considered alongside the variations in population growth:

- High - Building regulations and product standards: assume no change over the period to 2050.
- Low - Building regulations and product standards: assume the introduction in 2025 of a mandatory government-led scheme to label water-using products, linked to tightening building regulations and water supply fittings regulations.

As discussed in Section 10.3.1.6.3 the future PCC rates in the hydraulic modelling work were aligned to values within our WRMP19, which was the latest available data at the time. As PCC is a small proportion of total flow during rainfall events, the impact of PCC reductions on storm overflow and flooding solutions is unlikely to be significant and therefore further modelling work to align with more recent WRMP predictions and associated sensitivity testing has not been undertaken.

The impact of PCC on WwTW performance is more significant however and scenario testing has been completed for this metric. As discussed in our draft WRMP24, forecast future levels of PCC are influenced by a combination of reduction measures, including the planned introduction of labelling on water-using products. Rather than sensitivity testing the impact of each of these reduction measures individually, particularly given the challenges associated with disaggregating the benefits of water labelling from the other measures, for the purposes of the DWMP we have adopted two PCC scenarios. The first, a high scenario, assumes an initial reduction from baseline by the end of AMP8, which is retained throughout future AMPs. The second, a low scenario, assumes PCC in line with the WRMP24 Normal Year Annual Average (NYAA) final plan.

12.2.4 Abstraction

Whilst abstraction rates may influence the water quality of the waterbody, and therefore the impact of both our storm overflow and WwTW discharges, as harm and water quality impact has not been modelled or assessed during the development of our plan, no sensitivity testing of varying abstraction scenarios has been undertaken for the purposes of the DWMP.

12.3 Our pathways

Through programme appraisal and the sensitivity testing of the common reference scenarios, we have defined the alternative pathways summarised in Table 84.

Table 84: Alternative pathways summary

Pathway	Delivery Ambition	Climate Change Scenario		Demand Scenario	
		Storm Overflows / Flooding	WwTW	Storm Overflows / Flooding	WwTW
Core	Delivers regulatory requirements (SODRP, WINEP). Delivers the company blue-green ambition.	UKCP09 RCP8.5	Not included in assessment	High	Low growth, low PCC
Preferred	Delivers regulatory requirements (SODRP, WINEP). Delivers flooding ambition. Delivers the company blue-green ambition.	UKCP09 RCP8.5	Not included in assessment	High	Low growth, high PCC

Table 84: Alternative pathways summary

Pathway	Delivery Ambition	Climate Change Scenario		Demand Scenario	
		Storm Overflows / Flooding	WwTW	Storm Overflows / Flooding	WwTW
AP1 Least Cost	Delivers regulatory requirements (SODRP, WINEP). Delivers least cost interventions	UKCP09 RCP8.5	Not included in assessment	High	Low growth, low PCC
AP2 High Climate Change	Delivers regulatory requirements (SODRP, WINEP). Delivers flooding ambition. Delivers the company blue-green ambition.	High - UKCP18 RCP8.5	Not included in assessment	High	Low growth, high PCC
AP3 High Growth	Delivers regulatory requirements (SODRP, WINEP). Delivers flooding ambition. Delivers the company blue-green ambition.	UKCP09 RCP8.5	Not included in assessment	High	High growth, high PCC

As discussed in Section 12.2, not all of the common reference scenarios as defined by Ofwat have been included in sensitivity testing or the DWMP alternative pathways due to reasons including lack of applicability, lack of data availability and constraints associated with extensive modelling re-work. However, the pathways that we have included in our DWMP demonstrate a range of alternative futures which allow for variations in the realisation of our ambition and potential variations in the external factors which have the greatest impact on the individual elements of our plan, ensuring we are using data which we have confidence in.

Our preferred plan goes above and beyond the core plan to deliver a reduction in model predicted hydraulic flooding in addition to meeting our regulatory requirements and incorporating our ambition to deliver an increasing number of schemes incorporating blue-green elements. This plan aspires to meet both our ambitions and the expectations of our customers and regulators. It is built upon scenarios which ensure we are suitably prepared whilst also able to adapt to future challenges.

We will update our delivery plan as we gain better knowledge of implementing blue-green and nature-based solutions, increasing our certainty around the costs and benefits associated with this approach. This will be particularly relevant for increasing our understanding of the role that blue-green solutions can play in urban areas over the next five years in response to the challenges of reducing the operation of storm overflows and reducing the risks of flooding. The inclusion of a least cost pathway provides an alternative approach if required in light of an adverse economic climate or the encountering of significant challenges during the rollout of blue-green infrastructure.

Alternative Pathway 2 and Alternative Pathway 3 will allow us to meet the potential increasing requirements of a high climate change or high growth situation, through additional investment, should monitoring of population growth and new climate change science indicate that this is necessary.

Given the limitations associated with the low climate change common reference scenario discussed in Section 12.2.1, no alternative pathway aligned to this scenario has been included within our DWMP. The sensitivity testing that has been undertaken indicates the greatest potential impact of this low climate change scenario would be on our degree of predicted flood risk and associated solutions. As the majority of the investment to reduce flood risk within our preferred plan is delayed until later AMPs we have time to react if required. This also provides us with time to utilise new rainfall guidance aligned to this scenario if and when it becomes available.

The costs of each alternative pathway are provided in the data tables.

There are a number of influencing factors and trigger points which could result in a change between the presented alternative pathways, or potentially the introduction of other alternative pathways where new information becomes available, these include but are not necessarily limited to:

- Subsequent cycles of the DWMP bringing about changes based on the latest information and data sets available to apply to our models and assets.
- Changes introduced by regulators or the government, including new requirements and drivers through the WINEP.
- The outcomes of the SODRP investigations into no local ecological harm.
- The 2027 government review into the targets of the SODRP.
- Data provided by EDM (including real-time EDM) and continuous water quality (WQ) monitoring around storm overflow and WwTW discharges as required by the Environment Act.
- Increased certainty and confidence in the delivery and success of blue-green solutions and other innovation projects.
- The materiality of partnership and co-funding opportunities.
- The release of new ONS growth forecasts and local authority local plans.
- The release of new climate change science and/or best practice, including future iterations of UK Climate Projections and the influence of global emissions.
- The AMP7 investment may change the SODRP delivery
- Opportunity identified in our Business Planning cycles to deliver a more ambitious profile to expediate the reduction of storm overflow operation.
- Further development of the flood clusters informing the scale and types of future interventions

We have set out our approach to storm overflows in line with the requirements of the SODRP. When considering the expectations of our customers and stakeholders, the importance placed on reducing the operation of storm overflows in significant. For this reason, we have considered going beyond the timescales of the SODRP. We have explored potential alternative programmes for more ambitious plans that expediate the delivery of the programme of work. The more ambitious plan assumes we start all and deliver the majority of bathing water interventions in AMP8 and start all high priority overflow interventions in AMP9, with completion in AMP9 and 10. This would involve bringing forward c£1.4bn of activity into AMP9 and c£300m of activity into AMP8. This ambitious plan is considered plausible but has significant challenges associated with deliverability, financeability and affordability. Whilst delivery of this more ambitious plan is attractive in respect of meeting stakeholder expectations, there are significant risks that have not been sufficiently mitigated. We continue to develop this option, as we finalise our PR24 business plan in the round, but do not consider this option to have a high enough level of confidence to include it in an alternative pathway at this stage.

We recognise and have been demonstrating through Living with Water that partnership working has a significant role to play in long-term planning and the delivery of retrofit blue-green infrastructure. Maintaining the opportunity for this way of working through an adaptive and flexible approach will be critical to the success of long-term planning and delivery. Partnerships are unique to the local context, organisations and people. Each partnership is likely to evolve in a unique way -building trust and maturing in ways of working. Where it makes sense to do so, we will seek to establish new partnerships identifying joint needs and opportunities through collaboration and understanding.

13. Level 1 and 2 output summaries

13.1 Level 1 costs and benefits

We have selected our preferred plan as our main pathway to deliver the DWMP24. This is based on the consultation feedback, as discussed in Section 9.1, which showed a preference for delivering the SODRP and to reduce sewer flooding risk to our customers. It also now incorporates all the regulatory targets we must achieve via WINEP.

Our core plan serves to offer a low or no regrets approach to delivery of the regulatory targets and incorporates our company ambition to move away from traditional grey storage solutions to more blue-green and partnership lead solutions over time. The first five years of our long-term plan is largely interventions that are required to meet statutory requirements as such is deemed to be a low or no regrets approach.

We have included a least cost plan and determined our constrained preferred plan as “best value” as due to the optimisation constraints such as the SODRP, the WINEP and the application of the company ambition for blue green infrastructure interventions, it has not been possible to produce a ‘freely optimised’ best value plan, as described in Section 11.

Our short-term plan is aligned with our PR24 business plan and incorporates accelerated schemes, SODRP and WINEP. All sites are modelled and have a high quality of data driving the solutions, resulting in high levels of certainty in the AMP8 period.

This is the same for AMP9 although the results of the water quality monitoring and the AMP8 EnvAct_INV4 outcomes will provide further detail to allow for our medium-term plan to be updated and amended as required for cycle 2.

Our long-term plan for AMPs 10-12 contains decreasing levels of certainty in respect of the risks and interventions due to lower quality models, the requirement for more detailed investigations and the need to review the water quality and ongoing EnvAct_INV4 investigations. These AMPs will see the most change in terms of costs as a result of updated data and information and experience gained in delivery of the earlier years of the plan.

With each five-year cycle of the DWMP, WINEP and periodic review business planning we will see updated and latest information regarding climate change and growth rates and an assessment will be made of how this will impact the solutions required as we move towards 2050 and beyond.

As described in our asset management lifecycle all our schemes are continually assessed for cost benefit and tested against a wide range of environmental and ground-truthed information to ensure we are delivering the optimal solution for the situation and issues presented.

The below tables seek to demonstrate the overall plan costs and benefits and potential bill impacts to our customers. This is then further presented as our short-, medium- and long-term plans, further detail is provided in Table 85.

This information has been produced in our data tables which accompany this document. This information will also be reflected in our LTDS tables which will be submitted with our PR24 documentation in October 2023.

Monitoring of DWMP delivery will be critical and we intend to be transparent in our delivery progress. In the early years of the plan, the requirements are largely statutory outcomes associated with the SODRP and WINEP. Progress towards these outcomes will be monitored annually and reported to our regulators.

Table 85: Level 1 plan capital costs – CAPEX (price base 2020-21)

	Short-Term by 2030	Medium-Term by 2035	Long Term by 2050	Total
Preferred Plan	£1.47b	£4.32b	£36.71b	£42.49b
Core Plan	£1.39b	£4.06b	£11.41b	£16.87b
Least Cost Plan	£1.31b	£2.21b	£6.62b	£10.14b

Figure 96: Preferred Plan costs and benefits

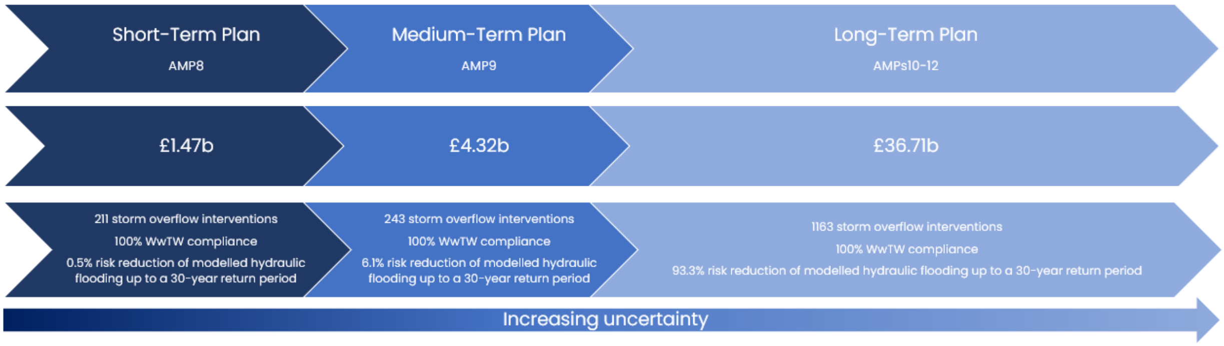


Figure 97: Core Plan costs and benefits

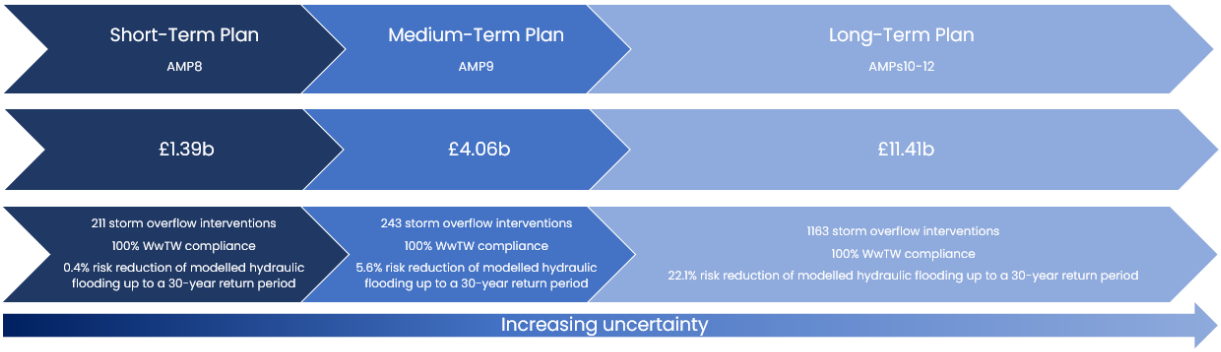
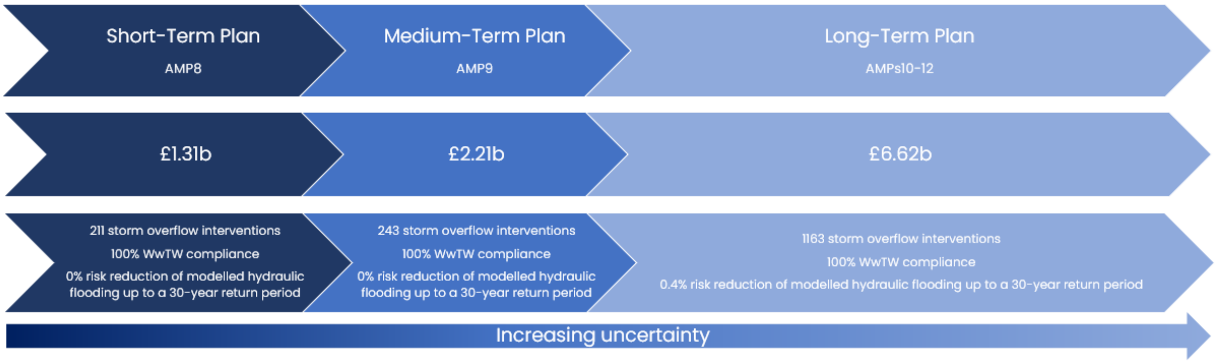


Figure 98: Least Cost Plan costs and benefits



The associated bill impacts of our DWMP plans, by AMP, are shown below in Table 86.

In setting out our plans for the future, we recognise the huge part we have to play in supporting a thriving Yorkshire. We talk to our customers every day and understand our customer and stakeholder priorities. For us to meet these priorities and the broader statutory requirements, we have prepared a challenging long-term plan, where uncertainty increases in future years. We have considered the impact that these plans will have on the average water bill each year in Yorkshire for whole planning period.

Table 86 : Bill impacts by AMP (taxable)

Plan	AMP8	AMP9	AMP10	AMP11	AMP12
Preferred Plan	£28.20	£108.02	£225.86	£345.56	£671.15
Core Plan	£27.22	£102.98	£215.23	£274.67	£316.27
Least Cost Plan	£26.09	£78.98	£144.34	£174.23	£195.63

In the early years of the plan, nearly all of our activity is required to meet the statutory requirements of the WINEP and the SODRP. Delivering these activities will have a minimum impact of £26.09 on the average bill each year in AMP8. The additional benefits delivered within our preferred plan will result in an increase of £28.20 on the average bill each year in AMP8. The bill impact is forecast to increase significantly over the planning period and in further cycles, we will work to reduce this impact by further optimisation of interventions and applying the benefits of experience gained in the early part of the planning period, and the efficiencies gained through deployment of technology and innovation. The bill impacts will therefore be reviewed at each cycle of the DWMP, and we will give particular consideration to inter-generational fairness and as part of our activity in cycle 2.

Customers who are struggling to pay, will be supported through a range of interventions including our social tariff, payment plans and holidays. We will provide full details of our plans to support those customers who are struggling to pay in our PR24 business plan submission in October 2023.

13.2 Level 2 costs and benefits

Below in Figure 99 to Figure 115 are the preferred plan costs and benefits for each of our Level 2 SPAs. The costs do not include any investigations, monitoring or EnvAct_IMP1 costs as these have been applied at Level 1 only, as these relate to regional investment or span multiple Level 2s.

Figure 99: Level 2 Calder Preferred Plan costs and benefits

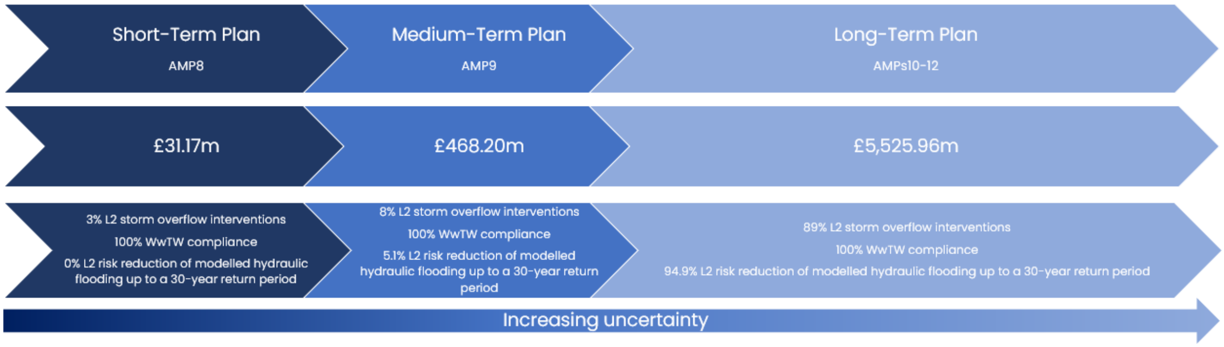
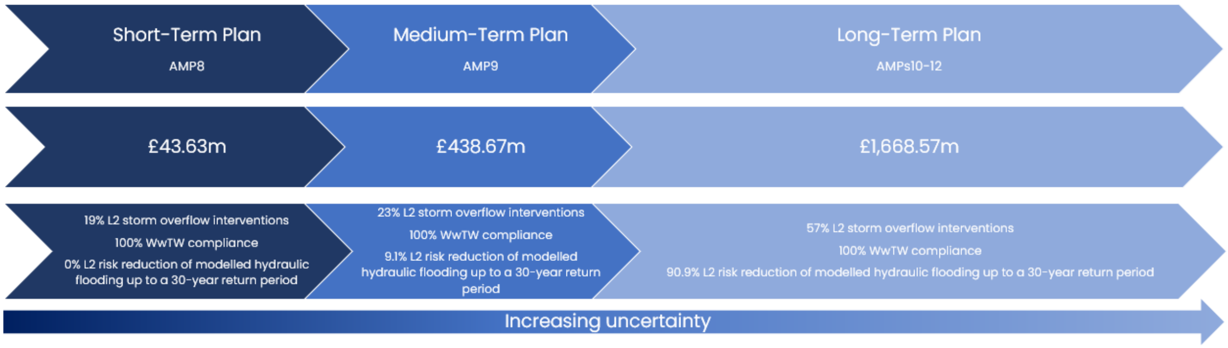
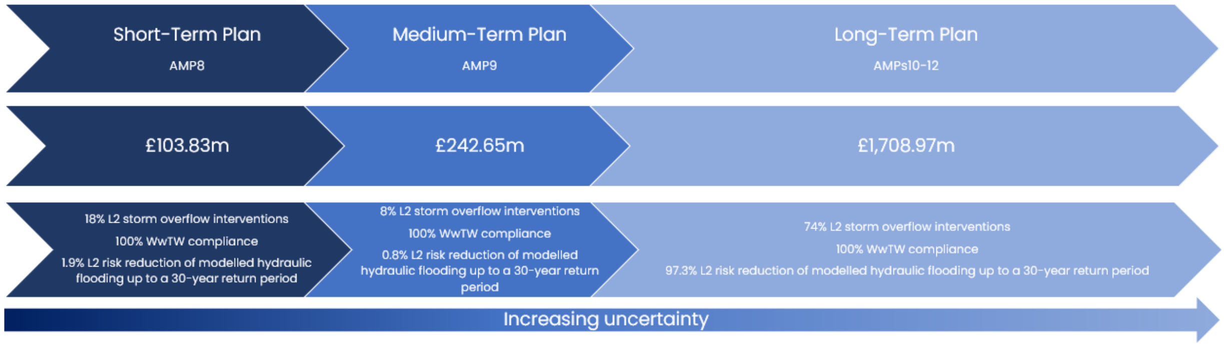


Figure 100: Level 2 Colne and Holme Valley Preferred Plan costs and benefits



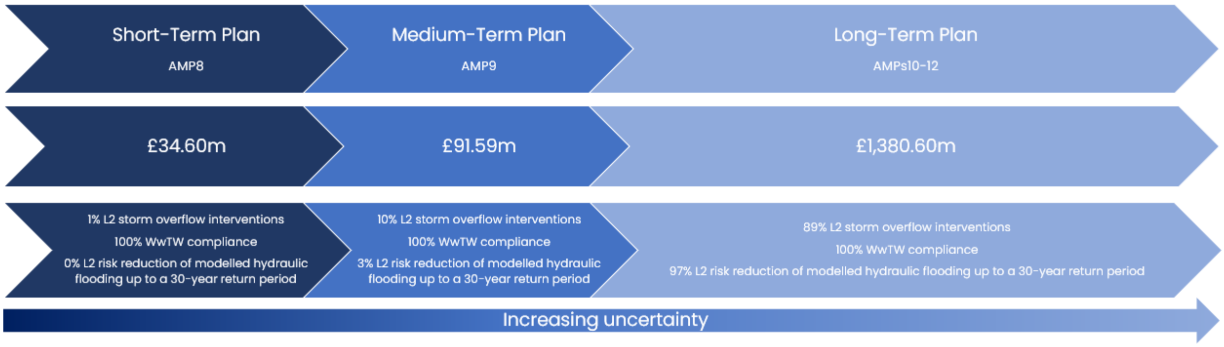
Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£43.63m	£438.67m	£1,668.57m
19% L2 storm overflow interventions 100% WwTW compliance 0% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	23% L2 storm overflow interventions 100% WwTW compliance 9.1% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	57% L2 storm overflow interventions 100% WwTW compliance 90.9% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Figure 101: Level 2 Dearne Preferred Plan costs and benefits



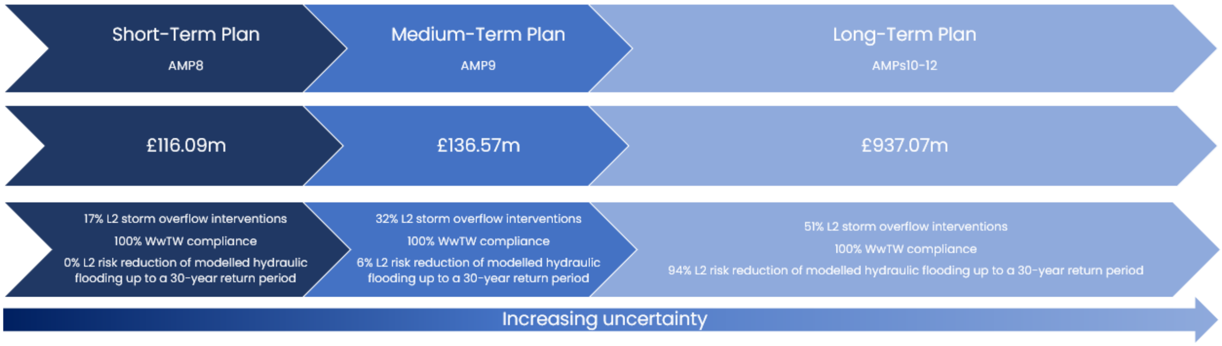
Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£103.83m	£242.65m	£1,708.97m
18% L2 storm overflow interventions 100% WwTW compliance 1.9% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	8% L2 storm overflow interventions 100% WwTW compliance 0.8% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	74% L2 storm overflow interventions 100% WwTW compliance 97.3% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Figure 102: Level 2 Derwent and Rye Preferred Plan costs and benefits



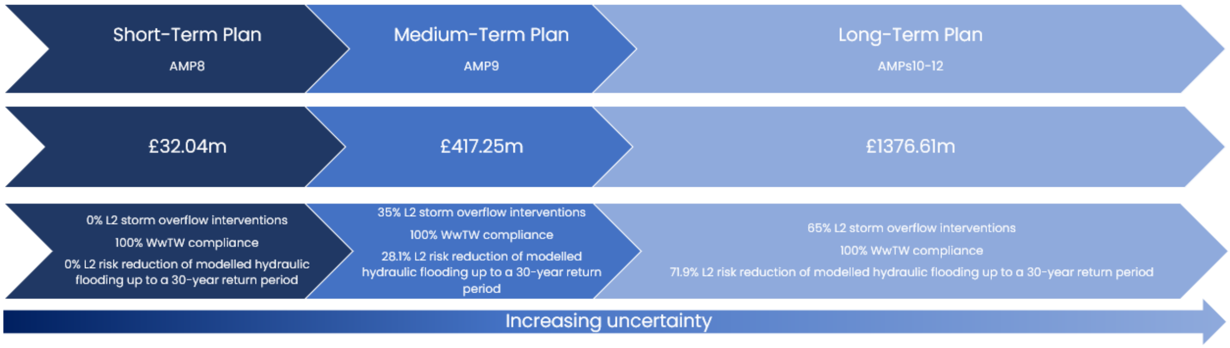
Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£34.60m	£91.59m	£1,380.60m
1% L2 storm overflow interventions 100% WwTW compliance 0% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	10% L2 storm overflow interventions 100% WwTW compliance 3% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	89% L2 storm overflow interventions 100% WwTW compliance 97% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Figure 103: Level 2 Esk and Coast Preferred Plan costs and benefits



Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£116.09m	£136.57m	£937.07m
17% L2 storm overflow interventions 100% WwTW compliance 0% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	32% L2 storm overflow interventions 100% WwTW compliance 6% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	51% L2 storm overflow interventions 100% WwTW compliance 94% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

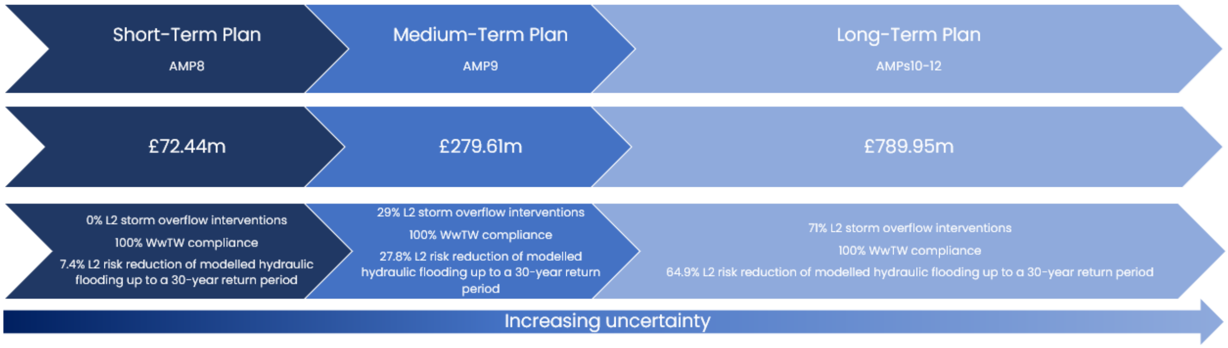
Figure 104: Level 2 Holderness Coast (Gypsey Race) Preferred Plan costs and benefits



Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£32.04m	£417.25m	£1376.61m
0% L2 storm overflow interventions 100% WwTW compliance 0% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	35% L2 storm overflow interventions 100% WwTW compliance 28.1% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	65% L2 storm overflow interventions 100% WwTW compliance 71.9% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

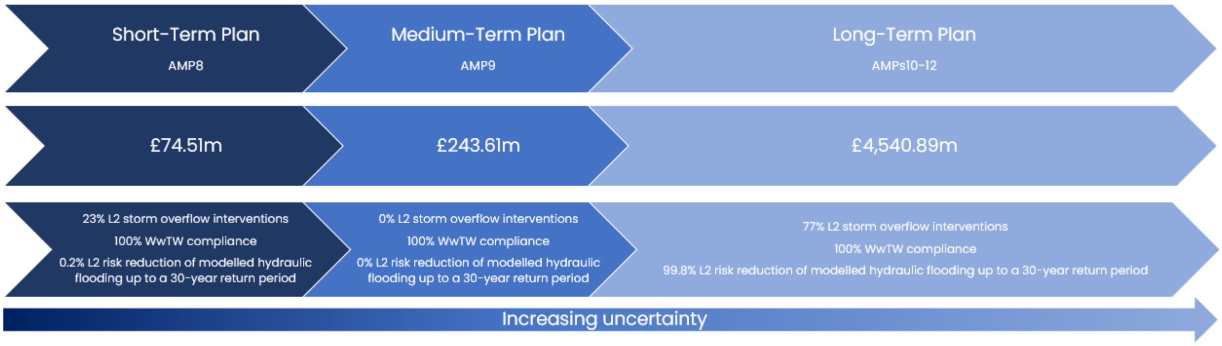
Figure 105: Level 2 Hull Preferred Plan costs and benefits



Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£72.44m	£279.61m	£789.95m
0% L2 storm overflow interventions 100% WwTW compliance 7.4% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	29% L2 storm overflow interventions 100% WwTW compliance 27.8% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	71% L2 storm overflow interventions 100% WwTW compliance 64.9% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

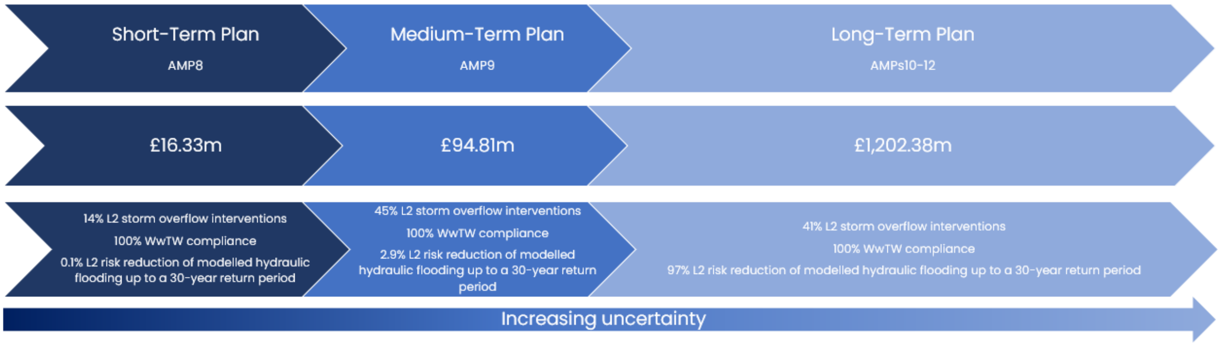
Figure 106: Level 2 Leeds Preferred Plan costs and benefits



Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£74.51m	£243.61m	£4,540.89m
23% L2 storm overflow interventions 100% WwTW compliance 0.2% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	0% L2 storm overflow interventions 100% WwTW compliance 0% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	77% L2 storm overflow interventions 100% WwTW compliance 99.8% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

Figure 107: Level 2 Lower Aire Preferred Plan costs and benefits



Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£16.33m	£94.81m	£1,202.38m
14% L2 storm overflow interventions 100% WwTW compliance 0.1% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	45% L2 storm overflow interventions 100% WwTW compliance 2.9% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	41% L2 storm overflow interventions 100% WwTW compliance 97% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

Figure 108: Level 2 Lower Dales Preferred Plan costs and benefits

Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£248.66m	£103.44m	£1,783.63m
27% L2 storm overflow interventions 100% WwTW compliance 0.5% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	15% L2 storm overflow interventions 100% WwTW compliance 1.3% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	59% L2 storm overflow interventions 100% WwTW compliance 98.2% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

Figure 109: Level 2 Lower Don Preferred Plan costs and benefits

Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£78.90m	£387.15m	£2,749.07m
24% L2 storm overflow interventions 100% WwTW compliance 0.4% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	31% L2 storm overflow interventions 100% WwTW compliance 7.8% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	45% L2 storm overflow interventions 100% WwTW compliance 91.8% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

Figure 110: Level 2 Lower Ouse Preferred Plan costs and benefits

Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£6.09m	£48.33m	£448.94m
0% L2 storm overflow interventions 100% WwTW compliance 0% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	13% L2 storm overflow interventions 100% WwTW compliance 10.8% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	87% L2 storm overflow interventions 100% WwTW compliance 89.2% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

Figure 111: Level 2 Rother and Doe Lea Preferred Plan costs and benefits

Short-Term Plan AMP8	Medium-Term Plan AMP9	Long-Term Plan AMPs10-12
£71.24m	£169.24m	£2,158.27m
16% L2 storm overflow interventions 100% WwTW compliance 1.3% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	20% L2 storm overflow interventions 100% WwTW compliance 1.3% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period	64% L2 storm overflow interventions 100% WwTW compliance 97.4% L2 risk reduction of modelled hydraulic flooding up to a 30-year return period

Increasing uncertainty

Figure 112: Level 2 Sheffield Preferred Plan costs and benefits

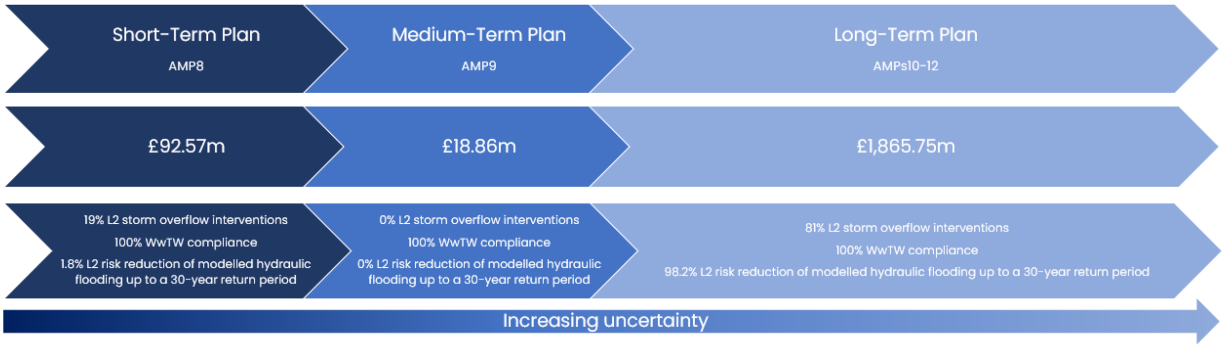


Figure 113: Level 2 Upper Aire Preferred Plan costs and benefits

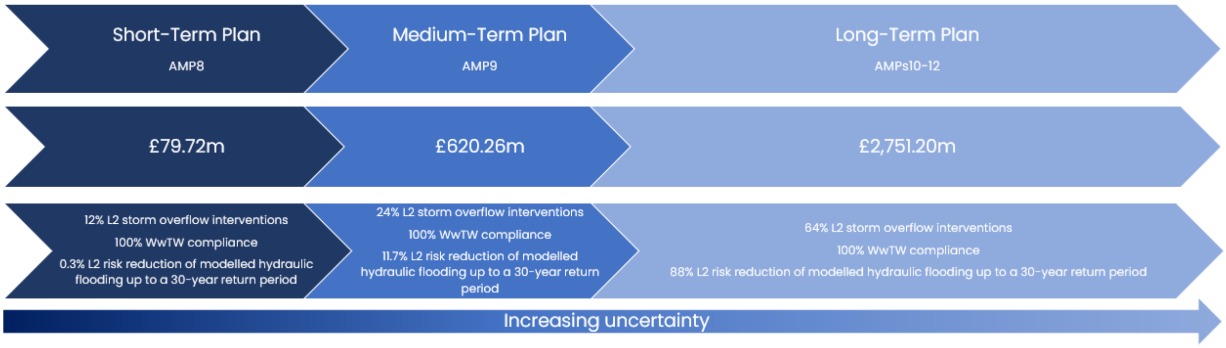


Figure 114: Level 2 Upper Dales Preferred Plan costs and benefits

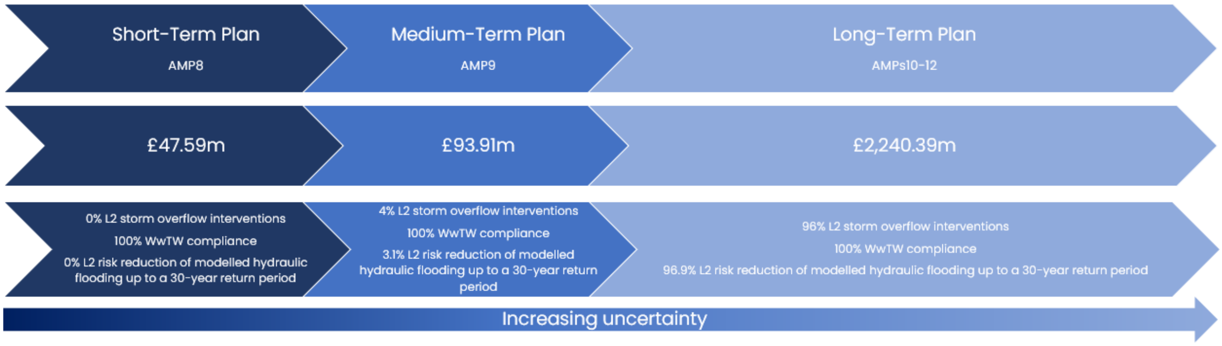
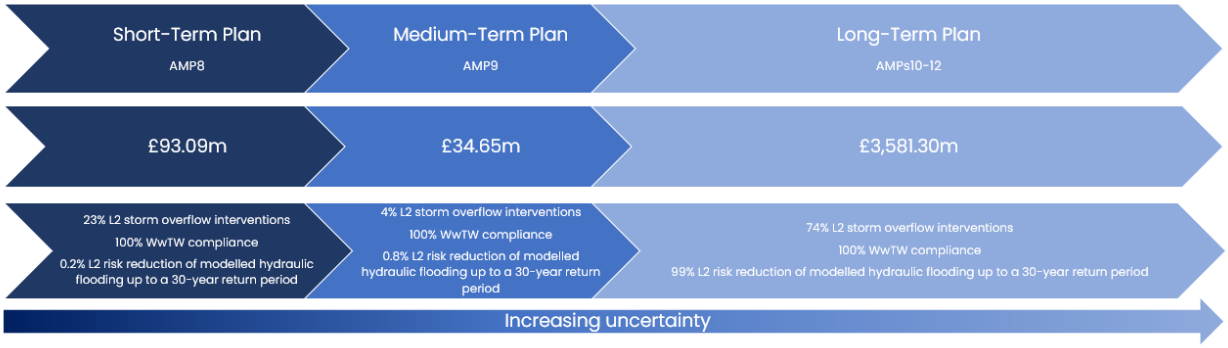


Figure 115: Level 2 York Preferred Plan costs and benefits



13.3 Data tables

Ofwat have issued a set of data tables to accompany the final DWMP24. The data tables for the final DWMP were issued in December 2022, with the requirement that these are submitted and published with the final DWMP24 by 31 May 2023. The tables utilise data that is synonymous with many elements of the broader wastewater PR24 business plan and have links to the Long-Term Delivery Strategy tables with reference to adaptive planning and pathways linked to the common reference scenarios. If changes that impact the data tables occur between publication of the DWMP in May 2023 and the PR24 Business Plan in October 2023 the DWMP tables will be amended and resubmitted with the PR24 Business Plan. We have published our data tables and accompanying commentary document.

These are available at:

https://www.yorkshirewater.com/about-us/drainage-and-wastewater-management-plan

13.4 Next steps

Following final publication of the DWMP24 and its associated data tables, we will continue to work with our PR24 team to incorporate the needs of the DWMP into our PR24 business plan and also reflect our longer-term plans in the associated LTDS tables. This will set out in detail how we will manage all aspects of our wastewater service. It will contain a detailed view of how we plan to deliver the first five years of the long-term 25-year ambition set out within our DWMP.

Through our established partnerships we will continue to work with others to collaboratively develop and deliver solutions and will proactively identify opportunities for new partnerships. This will help to lay the foundations for future collaborative working and successes for our customers and the environment. Through continued engagement with our customers and stakeholders we will ensure that we deliver the best value solutions to customers and the environment.

We will commence work on the next cycle of DWMP development in Summer 2023 working with Defra and other regulators and a cross water industry task and finish group. This will incorporate learnings taken from cycle 1 and any changes required for cycle 2 to ensure there is clarity on scope, outputs and remit for DWMP29. Cycle 2 will allow us to make use of newly available datasets, including climate change and growth projections and ensure we can incorporate learning and feedback from the completion of our first DWMP through our audit feedback and internal review.

We have identified the potential levels of investment required in the medium and long-term to reduce our risks and achieve our long-term targets. Through subsequent cycles of our DWMP, we will review and refine this based on the outcomes of investigations, installations of WQ monitors and live EDM data, alongside innovation pilots and improvements in technology. Alongside this, continued monitoring of solution impacts, emerging risks and increased monitoring and certainty about the impacts of climate change and population growth will increase certainty in each planning cycle. We will also consider new and emerging technologies and innovation that offer opportunities to provide best value.

14. Strategic Environmental Assessment

We have undertaken a Strategic Environmental Assessment (SEA) and a Habitats Regulations Assessment (HRA) on our Level 1 plan. These are available at:

https://www.yorkshirewater.com/about-us/drainage-and-wastewater-management-plan

15. Assurance

YW appointed Atkins as the 3rd line assurance provider for the development of the draft and final DWMP. The approach to assurance that Atkins has undertaken is two-fold:

- Methodology audits: To assess whether YW's methodology and modelling aligns with appropriate guidance, reporting requirements or industry practice and whether appropriate checks, controls and explanatory documents exist.
- Data audits: To assess whether processes and procedures are applied as indicated as well as validating the quality and reliability of the base data and the accuracy of the reported information.

Following on from the draft consultation feedback our auditors have also been asked to ensure that we have where practicable responded to within our narrative the points raised by our regulators, customers and stakeholders.

From December 2022 until May 2023 a monthly governance paper has been published and circulated to allow oversight and steer of the production of the final DWMP24. This has been shared with governance groups such as the PR24 Steering Group, the Executive Committee, the PR24 Bord sub-group and the Yorkshire Water Board. The DWMP team and Head of Asset Strategy and Policy also had monthly update sessions with the Director of Strategy and Regulation. In December 2022 we covered the dDWMP consultation response feedback from our regulators, stakeholders and customer, and set out intentions to produce a Statement of Response at the end of January 2023. In January we shared the Statement of Response, an update on draft to final progress for the DWMP and ongoing activities to satisfy the regulators feedback and to discuss the Ofwat data tables. In February and March 2023, we provided a further update on progress with the final DWMP and data table requirements. This included an update on SODRP costs and profile of costs and asset delivery to 2050 and how our company ambition of 50% blue-green delivery has also been applied to the plan and also detailed work on flood clusters. We also included at this stage a more ambitious plan for delivery of the SODRP. The updates included progress on data tables, links to LTDS tables for PR24 and links and sensitivity testing relating to the common reference scenarios. April 2023s board paper was a summary of key risks and decisions and a general DWMP and data table update prior to May when these will be provided to board alongside our 3rd party assurance to allow sign off of the final DWMP24.

Our models, which underpin the development of our DWMP, undergo a series of key checks and assurances through their development. We undertake a concept stage where the project is planned out and datasets are analysed. Surveys are then developed to improve the model confidence. The data from this stage of the model build process has a detailed checking process. As the project develops a formal signoff is required with a presentation back to key stakeholders within the business to ensure that all risks are accounted for. Through the model build and verification process, a rigorous 48 stage checking process is undertaken. The model is then independently audited to ensure suitability for use prior to being used in further studies and detailed design work.

15.1 Drainage and Wastewater Management Plan Board Assurance Statement

Yorkshire Water
Western House
Halifax Road
Bradford
BD6 2SZ

31 May 2023

Drainage and Wastewater Management Plan

Board Assurance Statement

The Yorkshire Water Board confirms that the DWMP programme has been presented to the Board and the Board has approved the plan that will be published on the 31 May 2023.

The Board notes that this is the first time the industry has produced a DWMP. The DWMP is not a statutory process, and since the inception of the DWMP framework, which was published in 2018, regulator's expectations have grown and evolved. The evolving expectations of the process, that moved beyond the requirements set out in the original DWMP framework, have proved challenging to meet. The Board is satisfied that the DWMP has been developed, as closely as possible, in line with the DWMP Framework and reasonable adjustments to the process have been made to allow appropriate alignment to the changing expectations of our regulators, customers and stakeholders.

The Board has been made aware that there is an action plan in place to improve methodologies and alignment for cycle two of the DWMP and where practicable actions will be completed ahead of cycle two. The independent auditors' comments in respect of this have been shared with the Board.

The Board notes that it has previously provided Board Assurance of a number of material components of the DWMP for AMP8, namely the Storm Overflow Discharge Reduction Plan and other wastewater WINEP components. The Board recognises that the review processes of the Environment Agency in respect of the WINEP may result in changes to the proposed programme and that Ofwat's price review assessment in respect of funding will affect the company's ability to deliver this programme. The Environment Agency review will result in an update to the WINEP tables to accompany the PR24 Business Plan submission.

The Board recognises that the DWMP is a long-term plan and whilst the actions and costs presented in the plan are produced using robust data and evidence, it is noted that whilst there is a high degree of certainty associated with the AMP8 components of the plan, uncertainty increases in AMPs 9-12. Confidence will progressively increase as further cycles of the DWMP are completed. It is anticipated that factors beyond management control may alter some of the material assumptions, data or proposed pathways before the end of the planning period. Whilst steps have been taken to produce an adaptive plan with trigger points for change, it may not be possible to foresee all eventualities. The Board will take funding decisions for each five-year programme and these decisions will be informed by customer, government and regulatory support, which will be clearer as each cycle is undertaken.

Yorkshire Water remains committed to protecting the environment and enhancing wastewater services for customers. Ensuring that the right interventions are delivered at the right time is more important than it has ever been to ensure an appropriate balance of risk for existing customers and future generations. The Board recognises the important role that the DWMP plays in Yorkshire Water's approach to long-term planning and provides assurance of the DWMP plan in the expectation that it will become embedded in Yorkshire Waters Long Term Delivery Strategy (LTDS).

As the WINEP, including the Storm Overflow Discharge Reduction Plan, is such a significant constituent of the DWMP, the Board reiterates the following points on the consideration of risk and it should be noted that the Yorkshire Water Board has carefully considered a number of significant risks relating to the overall scale and scope of the requirements for PR24, and that notably:

1. The scale and scope of the WINEP programme, including the Storm Overflow Discharge Reduction Plan, across the industry is likely to place significant pressure on supply chains and there remains a shortage of skills and capacity to deliver such a sizable increase in activity.

2. The scale and scope of the WINEP programme and the timescales for delivery will result in lost opportunity for use of innovation, particularly deployment of nature-based solutions, and the development of co-design and co-delivery partnerships.

3. There remains real potential for a lack of alignment between net zero targets and the requirements of WINEP.

The Yorkshire Water Board welcomes the introduction of the DWMP long-term planning framework and is committed to on-going development of our activities in this respect.

Vanda Murray

Vanda Murray
Independent Chair

Nicola Shaw
Chief Executive Officer

Registered office Yorkshire Water Services Limited Western House Halifax Road Bradford BD6 2SZ
Registered in England and Wales No 2366682 yorkshirewater.com

Paul Inman
Chief Financial Officer

Andrew Merrick
Independent Non-Executive Director

Ray O'Toole
Non-Executive Director

Andrew Wyllie
Independent Non-Executive Director

Julia Unwin
Independent Non-Executive Director

Scott Auty
Non-Executive Director

Andrew Dench
Non-Executive Director

Russ Houlden
Non-Executive Director

Wendy Barnes
Independent Non-Executive Director

(Via email)

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Appendices

1. Appendix A

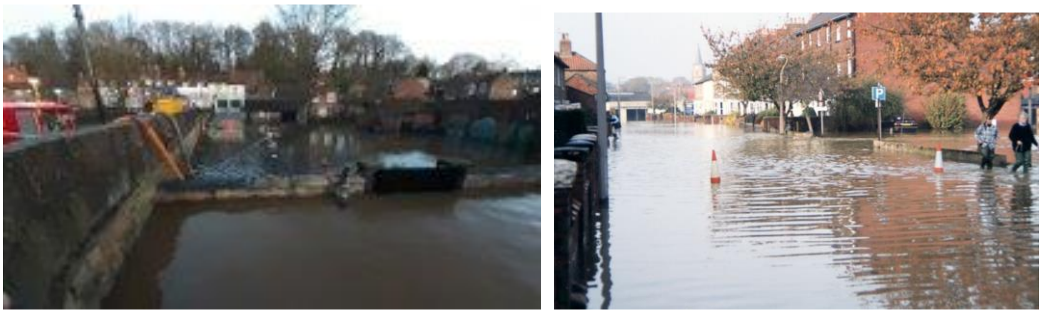
1.1 Working with others partnership working projects

1.1.1 Malton and Norton

Following the reoccurring flooding events in the towns of Malton and Norton, a multi-agency temporary over-pumping plan was put in place to remove surface water that could not freely discharge from the sewers due to the high levels in the river Derwent. There were many limitations with this temporary fix, as it required careful coordination not to disrupt road and rail services whilst the pumping was in place.

We worked in Partnership with North Yorkshire County Council (NYCC) and Network Rail to design and install permanent over-pumping infrastructure from the public sewer system, under the highway and under the railway line, to discharge into the river Derwent at a high level. This work enables the main road and railway line to remain open at times of high river level and prevent extensive flooding to properties from the surface water sewer. Network Rail contributed to the design and delivery of works beneath the railway, which required specialist skills and Health and Safety permits. Working together meant that the project was financially viable and successfully delivered. The photographs in Figure 116 show the work in progress to install the pumps and also showing the extent of flooding in Malton and Norton.

Figure 116: Installing the pumps (left), extent of flooding in Malton and Norton (right)



1.1.2 Calderdale Flood Partnership Board

The Calderdale Flood Partnership Board includes the EA & YW joint working and has delivered flood alleviation schemes for Mytholmroyd, Hebden Bridge & Brighouse. Figure 117 below show the extent of flooding that can occur in the area.

Figure 117: Extent of area flooding

1.1.3 Hebden Bridge

We have been working in partnership with the EA and their consultants in reducing flood risk in Hebden Bridge. The area suffers from flooding from both fluvial and pluvial sources and the man-made urban drainage and natural catchment systems interact at numerous points. From sharing the models that each party has produced, namely Drainage Area Plan (DAP) model, EA's pluvial 'Tu-flow' model and the fluvial models of the river Calder and Hebden Water, we have been able to merge these models, along with our system-understanding to produce an integrated model of the catchment. We have been able to use the integrated model to understand the source apportionment of flows entering the system. This helps us to understand the potential make up of flows in the solution and allow for apportionment of future operational costs / expenditure, to ensure that all parties paying their fair share. We have invested a significant amount of time in working together in developing potential solutions for the best intervention for the residents and business of Hebden Bridge. The options have been developed in collaboration with all parties and the process has been rolled out into other schemes along the Calder Valley. The principle for the scheme is that the EA would be funding the capital investment, with the ownership and operation of the assets switching to YW. This agreement in principle has been reached, with YW being best place to own and operate the assets. The design teams have shared the related asset standards to assist in handover between organisations.

1.1.4 Masborough fish pass

A historic manmade weir on the river Don previously posed a barrier to migrating fish. The Masborough Fish Pass (shown below) was therefore installed as a partnership scheme and has removed the last barrier to fish on the river Don between the North Sea and Sheffield. The partnership approach developed included the following partners; YW, Don Catchment Rivers Trust (delivery), Canal and River Trust (weir owner and part-funder), EA (part-funder), Heritage Lottery Fund (part-funder).

Figure 118: Installed fish pass at Masborough

1.1.5 Pollution predictor coastal model

YW, EA and East Riding of Yorkshire Council (ERYC) have delivered two separate but identical projects, to improve the EA's Pollution Predictor Model at Scarborough and Bridlington beaches The model is used to warn the public when bathing water quality is poor. Previously, the model was based on only 20 water samples taken across the whole bathing season. In this project, YW paid to take and analyse 1600 samples and feed this data into the EA's pollution predictor. This meant having more data, and a much more enhanced understanding of what factors cause poor water quality, meaning the public can be better informed. This contributes to public health but also helps the EA understand the sources of poor water quality. A partnership approach was needed to mesh the different models together.

1.1.6 The Mobilising Citizens for Adaptation (MOCA) flood resilience project

This project has involved our partners LWW (see Appendix A, Section 1.2) and Sheffield University. The MOCA project has delivered two community engagement events, where active engagement with community activists and residents has allowed the project team to discuss flood resilience and how people have a key part to play in flood mitigation. These events in Derringham (Hull City Council) and Bilton (ERYC), generated a total of 24 requests for residential 200 litre rainwater harvesting installations. Additionally, two public rainwater harvesting installations at Bilton Primary School (see Figure 119 below) and Derringham Baptist Church were also carried out. As a direct result of the MOCA project and associated findings, the project team has secured £759,103 National Environment

Research Council (NERC) funding for a follow up project called MAGIC (Mobilising Adaptation, Governance & Infrastructure through Co-Production). This will provide a further two years additional research and development of the works already undertaken.

Figure 119: Rainwater harvesting installation within the community

1.1.7 Lundwood

Flooding to approximately 27 properties in the Burton Grange area of Lundwood resulted in YW working with Barnsley council to clear a longer stretch of drainage ditch in Lunwood (see Figure 120 below). The ditch was previously overgrown and silted up and beyond the sole responsibility of YW. Although the condition of the dyke is not thought to be the cause of the flooding, (the formal investigation confirmed this was due to heavy rainfall exceeding the capacity of the river network), the work will ensure maximum capacity. This will allow the adjacent surface water sewer outfall to freely discharge, thus reducing surface water flooding in the area.

This partnership scheme has led to more benefits delivered for flood risk reduction. Material excavated from the channel was used to create a re-profiled bank and this negated to the need to send material to landfill.

A steering group has also been set up to coordinate ground (YW) and modelling (EA) investigations with the aim of developing a partnership approach to managing the risk of flooding from surface water, watercourses, and the public sewer network in this area. This will include an assessment of the impact of Lundwood Dyke in a low and high-water level scenario, and how this should be managed by the partnership moving forward.

Figure 120: Lundwood ditch clearance, before and after

1.1.8 iCASP telemetry project

An early warning tool to promote an improved operational response to flood events, working alongside LWW partners, has developed a set of tools to compile and analyse telemetry data and instrument data in advance of flooding. The model can generate forecasts for individual locations based upon historical rainfall, water level, and slope of water level change. The findings show that the model can be used to forecast flooding from a watercourse (Setting Dyke, Hull) 3-4 hours before the event occurred and provide a 1-hour warning for sewer flooding.

1.2 Living with Water working in partnership case study

Hull and the surrounding area is at risk from extreme flood events and the communities here are amongst the most vulnerable to climate risks in the UK. In June 2007, very high rainfall led to surface water flooding in Hull which damaged approximately 8,600 residential properties, 1,300 businesses and 91 schools. The national economic impact of the 2007 floods was £3.2bn, Hull and East Riding were two of the four local authority areas in Yorkshire which suffered major damage and disruption.

In Hull 88% of all surface water drains into the combined sewer system and the complexity of the drainage network means that it is difficult to determine the responsibilities of each authority. Over the last nine years, YW has worked with the partners to develop tools to better understand the risk of flooding in the Hull area. Advanced modelling has provided a basis to develop and test multiple solutions to manage surface water. The 2D urban drainage multi-agency model has also helped authorities to better understand risk ownership within the area. It is clear that a comprehensive solution to address surface water management can only be achieved by working together. Our approach has been to work collectively across multiple disciplines within the partnership to develop the Living with Water Blue-Green Plan. This is a 25-year strategy to address flood risk in Hull through investment in infrastructure, adaptation and policy change, underpinned by a cultural alignment across the partners to deliver a shared vision.

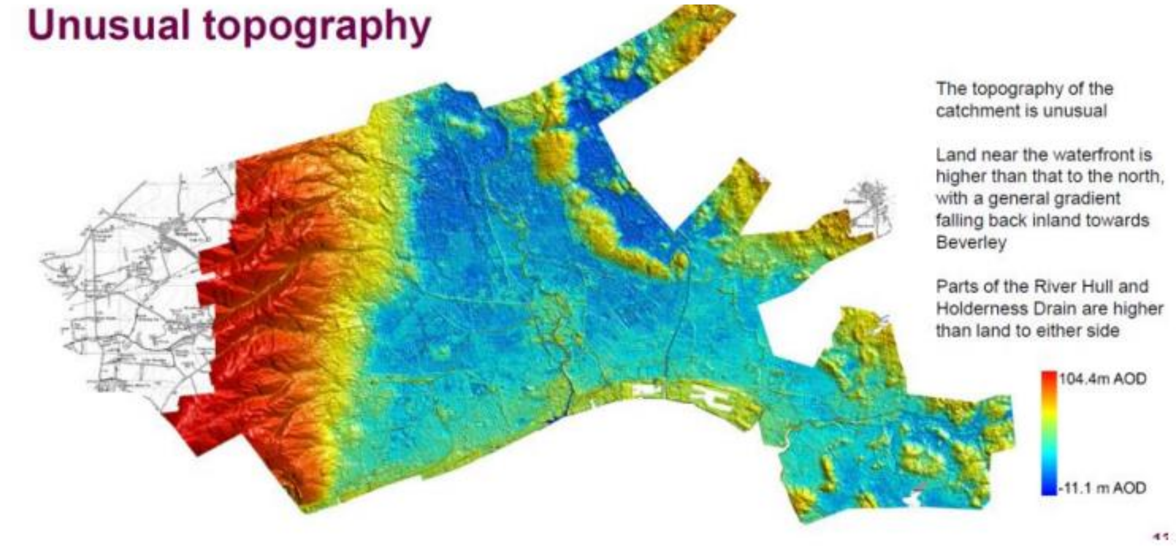
1.2.1 Geographical context

The combination of topography, geology and an interconnected drainage system makes Hull unique in terms of flood risk.

1.2.2 Topography

The topography around the Hull catchment forms a landscape like a bowl which inhibits the natural flow of surface water to the estuary. Parts of the river Hull and Holderness Drain are higher than the land to either side and the reclaimed land near the waterfront is higher than that to the north. Over 90% of the City of Hull is below sea level at high tide and creates this unique risk position. See Figure 121 below:

Figure 121: Map showing height of land in Hull and Haltemprice



Unusual topography

The topography of the catchment is unusual

Land near the waterfront is higher than that to the north, with a general gradient falling back inland towards Beverley

Parts of the River Hull and Holderness Drain are higher than land to either side

(low lying areas are shown in blues; note that the rivers and coastal frontage are generally higher than surrounding land)

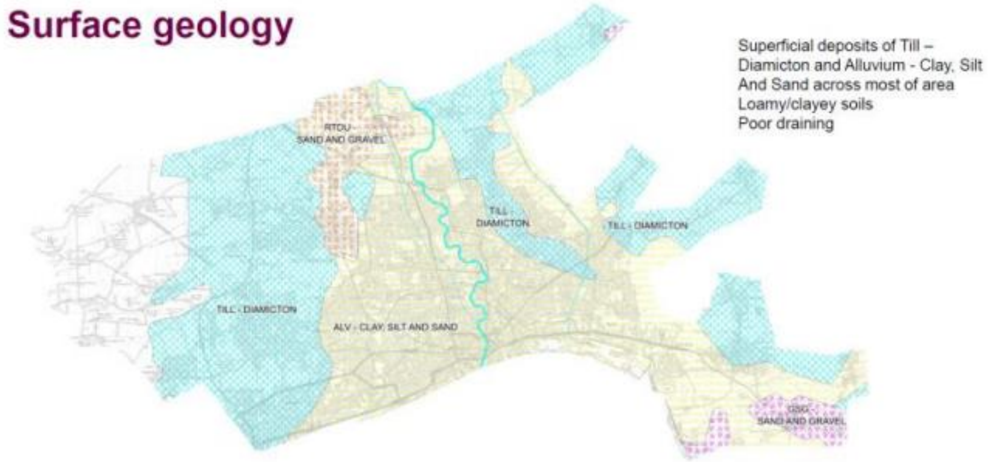
1.2.3 Complex and integrated drainage system

A high proportion of surface water flows (88%) from the Hull catchment enter the combined sewer network. In Hull, unlike most drainage systems, there are minimal relief points on the drainage network. The topography of the catchment and the historic introduction of several significant watercourses into the sewers increases pressure on the sewer network. This leads to increased risk of property flooding in the city. All flows entering the sewer network must be pumped out of the city.

1.2.4 Challenging environment for traditional Sustainable Drainage System (SuDS)

The Hull catchment has a combination of poor soil type and high groundwater levels that means infiltration solutions (that allow water to drain into the underlying soil for storage) are often not practical to install. Clay soils which prevent water from passing through them, a lack of surface water systems into which SuDS features could drain and limited land availability all significantly limit the viability and cost of SuDS implementation, shown below in Figure 122. Archaeological significance, unexploded ordnances and a history of contaminated land are also known to drive higher costs of development in the Hull catchment.

Figure 122: Surface geology showing extent of clay soils



Clay soils shown in off white

1.2.5 Socio-economic status

In 2015, Hull was identified as the third most deprived Local Authority (LA) area in the UK. The average Gross Disposable Household Income (GDHI) is equivalent of £13,380 per head, compared to £16,365 per head regionally and £19,878 nationally. This means communities are less able to access and afford flood mitigation measures to protect their properties and to be able to respond and recover when flood events and damage occur.

1.2.6 Background of the partnership

The unique challenges faced in the Hull catchment underpin the essential need for Risk Management Authorities (RMA) to work together. The Living with Water Partnership (LWW) is a collaboration between YW, Hull City Council, East Riding of Yorkshire Council and the EA who each have responsibilities for managing different aspects of flood risk in the area. The University of Hull is LWW's academic partner and have a position on the Board.

The aspiration of the LWW partnership is to create a city that thrives with water. Key to achieving this is the introduction of sustainable solutions that manage water visibly on the surface. The long-term ambition of LWW is to deliver holistic, integrated solutions that balance blue-green and grey infrastructure to manage surface water in the city alongside wider local priorities. The most optimal solution for the communities that live here is one which is co-developed and co-delivered. However, the way in which each authority is governed and funded does not easily align to make this possible.

Historic legislation and policy have separated the responsibilities for managing surface water between RMAs, each with differing funding, regulation and drivers. Surface water is defined by where the rain falls: local authorities are responsible for managing overland flows; water companies for water that falls within property boundaries and historic arrangements determine elements such as road drainage. Typically, RMAs seek opportunities to work together but differing or conflicting needs and targets, availability and timing of funding can lead to independent delivery of benefits.

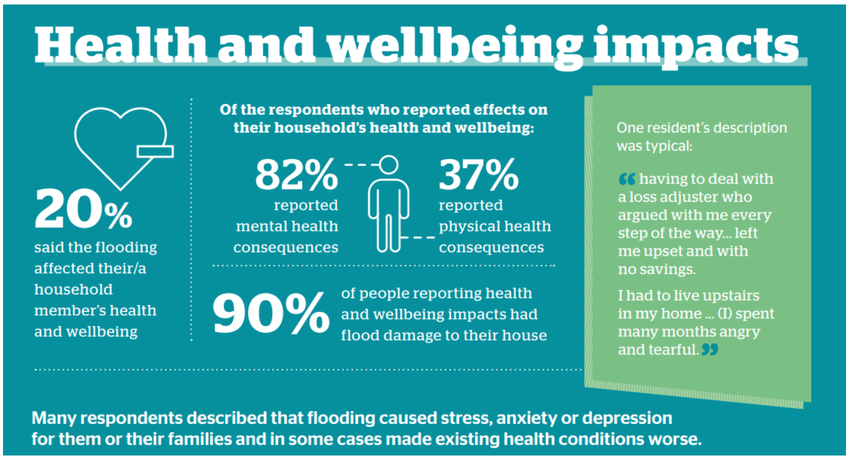
LWW is now a well-established partnership that has matured over the last five years. The complexity and interconnected nature of the catchment set out above has focused the partnership to work to overcome the disconnected and independent drivers of the different sectors. It aims to seek out a substantial partnership programme for delivery in AMP7, as well as a holistic and comprehensive future focused plan.

This has not been a simple or straight forward process. It has taken a dedicated core team and supporting members years of work to create a culture of collaboration and co-working within each organisation. Underpinning this has been work to develop and promote a strong and trusted brand with customers and communities. LWW can demonstrate the benefits of this new joined up partnership approach. Significant learning and development is being shared to ensure effective partnerships can be created in the future.

1.2.7 Key partnership achievements

The Living with Water partnership's ambition is to build flood resilience, engage with communities, improve place, enhance the local economy and share knowledge. The Hull Household Survey was undertaken by LWW and Hull University in 2018. This aim was to help build a picture of the city's current level of flood resilience as well as a series of indicators with regards to wellbeing, socio-economic status and other key data so that this could be periodically reviewed over time to understand the impact of the LWW programme. 450 households were surveyed and the outputs are summarised in Figure 123 below.

Figure 123: Summary of outputs from Hull Household Survey



Health and wellbeing impacts

20% said the flooding affected their/a household member's health and wellbeing

Of the respondents who reported effects on their household's health and wellbeing:

82% reported mental health consequences

37% reported physical health consequences

90% of people reporting health and wellbeing impacts had flood damage to their house

One resident's description was typical:

"having to deal with a loss adjuster who argued with me every step of the way... left me upset and with no savings.

I had to live upstairs in my home ... (I) spent many months angry and tearful."

Many respondents described that flooding caused stress, anxiety or depression for them or their families and in some cases made existing health conditions worse.

Collectively, the LWW Partnership has already successfully implemented policy change, namely greater restriction on surface water discharges from new (building) development in the Hull catchment. The Supplementary Planning Document that resulted from this work is the first of its kind in the country, a link to this document is provided below:

Living with water SPD Final (hull.gov.uk)

LWW has worked with YW's education team to develop the Key Stage 2 Living with Water lessons for 7–11-year-olds. This resource introduces the concept of flooding and flood risk, including solutions, to children across Hull. Over the last 4 years, the partnership has delivered over 1,200 hours of education hours to local school children. The partnership has now expanded their offering to include a Flood Awareness scout badge, shown in Figure 124 below, which is available for local youth groups.

Figure 124: Flood awareness Scout badge

In addition to lessons which can be delivered in school, the Living with Water Lab, provides a facility for local schools to visit. In collaboration with Wilberforce College and Yorkshire Flood Resilience, a previously disused wing of the college has been repurposed as a one-of-a-kind facility providing an inspiring and interactive space for schools, students and the wider community. Below is a link to the Community Hub.

YW – The Living with Water Community Hub

Hull University have introduced a Living with Water PhD cluster and a Flood Risk Management MSc which reflects the interest locally and addresses skills gaps across the industry.

In 2018 LWW hosted the Hulltimate Challenge, a subsidised mass participatory event which involved over 2000 people (including 1000 school children). A series of water themed obstacles showcased the city from a water viewpoint in a fun and exciting way. A total of 200 volunteers who had been given a LWW masterclass lined the streets and supported the event offering flood risk advice and education along the way. The event was a huge success with over 1.5million customer touch points.

In 2018 Hull was one of five global cities selected by the Rockefeller Foundation and Resilience Shift to develop the City Water Resilience Approach. This focusses on the shocks and stresses cities face with regards to water and aims to create a long-term city focussed action plan to increase resilience. Living with Water have continued to work with our consultants to access the current level of resilience in the city and beyond across a great number of indicators.

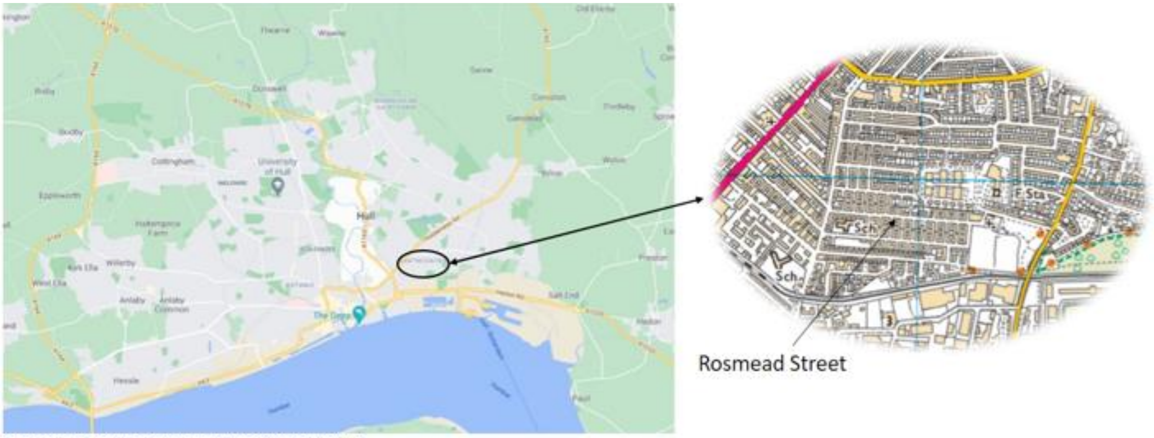
1.2.8 AMP7 (Regulatory period 2020-25)

LWW is co-investing during 2020-25 to deliver flood resilience to over 800 properties. YW was allocated £23m to invest in schemes in the LWW area and the partnership is working hard to access match funding and ensure value for money by co-delivering alongside other major local investments.

Alongside the maturation of the partnership, significant developments to the integrated catchment model have improved the technical understanding of the partnership. The 2020-25 programme has benefitted hugely from the advance in partnership relations and model improvements. This is improving value for money to customers by prioritising schemes based on areas of significant flood risk, opportunities to align wider investment/refurbishment and SuDS opportunity areas. The partnership is now aligning programmes beyond water management and looking at opportunities to merge housing, highways and other regeneration projects with surface water management solutions.

Our project at Rosmead Street, shown in Figure 125 and Figure 126 is a key example of this co-ordination in practice. In this example, Hull City Council are improving the frontages to a large number of homes and through LWW coordination and collaboration, downpipe alterations will now be made at the same time enabling a surface water disconnection scheme. The housing scheme will be enhanced by a complimentary LWW project to introduce new sustainable drainage measures. Working in this way is efficient in terms of both time and cost and critically, minimises disruption for customers

Figure 125: Location of Rosmead Street

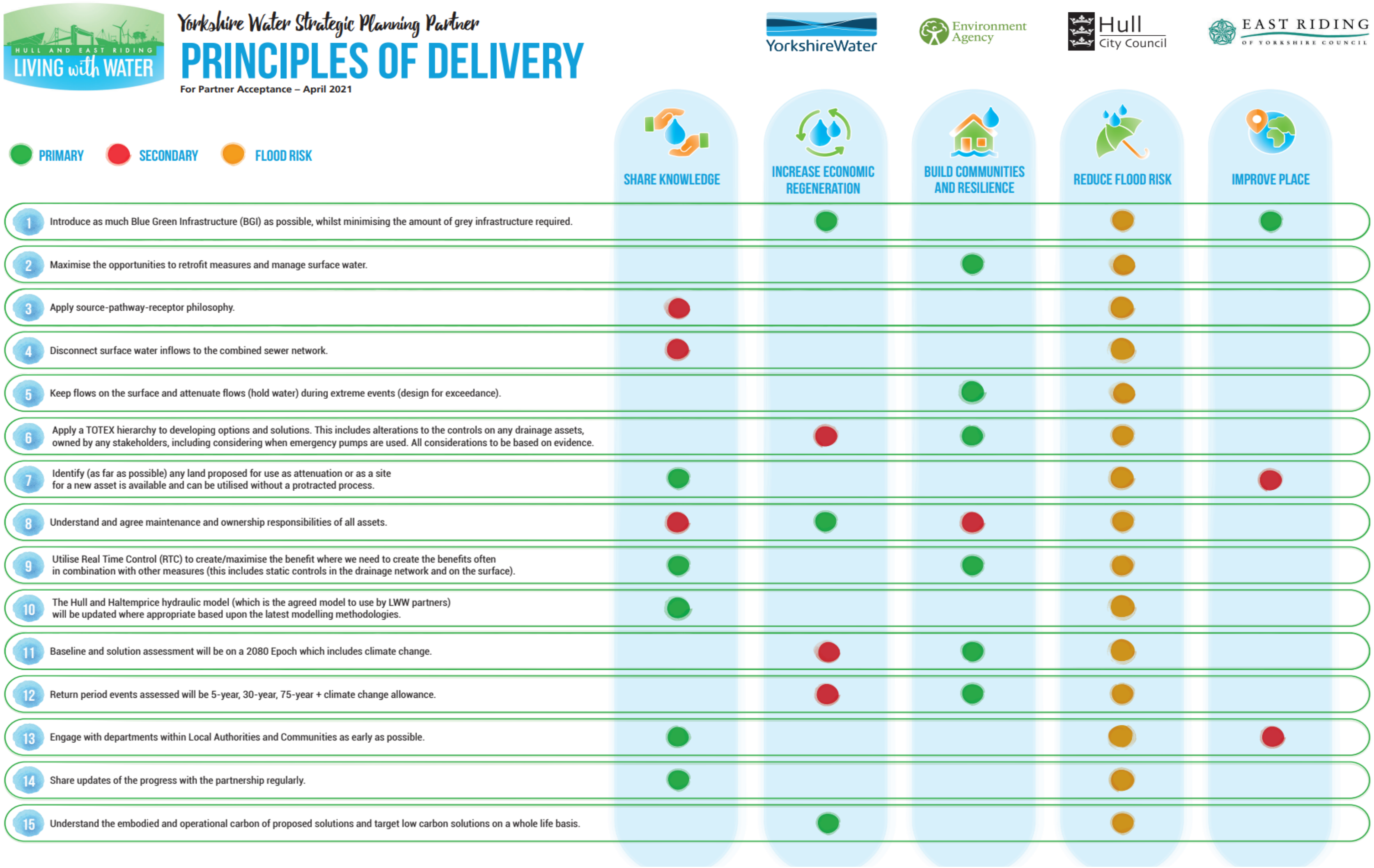


Ssource of images: Google Maps and Microsoft Bing data 2021

Figure 126: Rosmead Street before (left) and after (right)

LWW collectively created and signed up to 'principals for delivery' during 2020-25 (see Figure 127) at the outset of the programme to guide the partnership approach. Alongside the programme, the partnership has been progressing the development of the co-funded Living with Water Blue-Green Plan, a long-term strategic approach to surface water management. This concurrent approach ensures that all 2020-25 schemes have been considered as part of a longer-term plan which focusses on surface water disconnection. The schemes are therefore adaptive, following principals such as keeping blue-green retention areas shallow so that in the future they can be easily disconnected from the combined sewer when a new surface water system is created.

Figure 127: LWW principles of delivery



HULL AND EAST RIDING LIVING with WATER

Yorkshire Water Strategic Planning Partner

PRINCIPLES OF DELIVERY

For Partner Acceptance – April 2021

🟢 PRIMARY 🔴 SECONDARY 🟠 FLOOD RISK

		SHARE KNOWLEDGE	INCREASE ECONOMIC REGENERATION	BUILD COMMUNITIES AND RESILIENCE	REDUCE FLOOD RISK	IMPROVE PLACE
1	Introduce as much Blue Green Infrastructure (BGI) as possible, whilst minimising the amount of grey infrastructure required.		🟢		🟠	🟢
2	Maximise the opportunities to retrofit measures and manage surface water.			🟢	🟠	
3	Apply source-pathway-receptor philosophy.	🔴			🟠	
4	Disconnect surface water inflows to the combined sewer network.	🔴			🟠	
5	Keep flows on the surface and attenuate flows (hold water) during extreme events (design for exceedance).			🟢	🟠	
6	Apply a TOTEX hierarchy to developing options and solutions. This includes alterations to the controls on any drainage assets, owned by any stakeholders, including considering when emergency pumps are used. All considerations to be based on evidence.		🔴	🟢	🟠	
7	Identify (as far as possible) any land proposed for use as attenuation or as a site for a new asset is available and can be utilised without a protracted process.	🟢			🟠	🔴
8	Understand and agree maintenance and ownership responsibilities of all assets.	🔴	🟢	🔴	🟠	
9	Utilise Real Time Control (RTC) to create/maximise the benefit where we need to create the benefits often in combination with other measures (this includes static controls in the drainage network and on the surface).	🟢		🟢	🟠	
10	The Hull and Haltemprice hydraulic model (which is the agreed model to use by LWW partners) will be updated where appropriate based upon the latest modelling methodologies.	🟢			🟠	
11	Baseline and solution assessment will be on a 2080 Epoch which includes climate change.		🔴	🟢	🟠	
12	Return period events assessed will be 5-year, 30-year, 75-year + climate change allowance.		🔴	🟢	🟠	
13	Engage with departments within Local Authorities and Communities as early as possible.	🟢			🟠	🔴
14	Share updates of the progress with the partnership regularly.	🟢			🟠	
15	Understand the embodied and operational carbon of proposed solutions and target low carbon solutions on a whole life basis.		🟢		🟠	

Source: Stantec

1.2.9 The Blue-Green Plan

The LWW Blue-Green Plan proposes a catchment scale approach for surface water management in Hull and the surrounding area. Each of the LWW partners has a responsibility to manage the different inputs into the sewer network; these include land drainage (Local Authority), water courses (EA or Local Authority), road (Local Authority) and property drainage (YW). The aim of the Blue-Green Plan is to work holistically in partnership, to address the challenges that the current drainage network poses.

The Plan has been developed with LWW partners and wider stakeholders:

- Over 70 members of the partner organisations attended two LWW Blue-Green Plan charettes digitally in 2021, which enabled key stakeholders to understand the need and to help shape the plan for the future.
- Three councillor engagement sessions have provided the opportunity for over 30 council members to input into the Blue-Green Plan's creation.
- 48 young people attended a Hull Youth Parliament in February 2022 which collected views and feedback on Hull's Blue-Green Plan for the future. This is critical to the expectation of the partnership.
- 8 key local businesses attended a Business Breakfast event in March 2022, to understand the direction of the Blue-Green Plan and how local business leaders can support this plan going forwards. Our University partner will continue this work with businesses to ensure the momentum is not lost of businesses forging a way forward towards a sustainable future too.

The Blue-Green Plan goes beyond developing short, medium and long-term interventions and provides a long term Blue-Green Vision for the partnership and its pillars. The vision and pillars have been developed with the LWW Board to ensure that there is alignment across the wider priorities for the city into the future.

1.2.10 DRAFT Blue-Green Vision and Pillars

Our vision is to live with and embrace water in a green and climate adaptive place. Through effective place making in urban and rural locations, we will enable sustainable and healthy lifestyles, and provide attractive places to live and work. We will embed managed change through our public and private partnerships that align our needs and delivery plans. Ultimately, we will improve flood resilience by safely managing, storing, moving and reusing water to benefit our communities, the environment and society. This can be seen in Figure 128 below.

Figure 128: Living with Water Pillars

OUR VISION

Our vision is to live with and embrace water in a green and climate adaptive place.

- Through effective place making in urban and rural locations, we will enable sustainable and healthy lifestyles, and provide attractive places to live and work.
- We will embed managed change through our public and private partnerships that align our needs and delivery plans.
- Ultimately, we will improve flood resilience by safely managing, storing, moving and reusing water to benefit our communities, the environment and society.

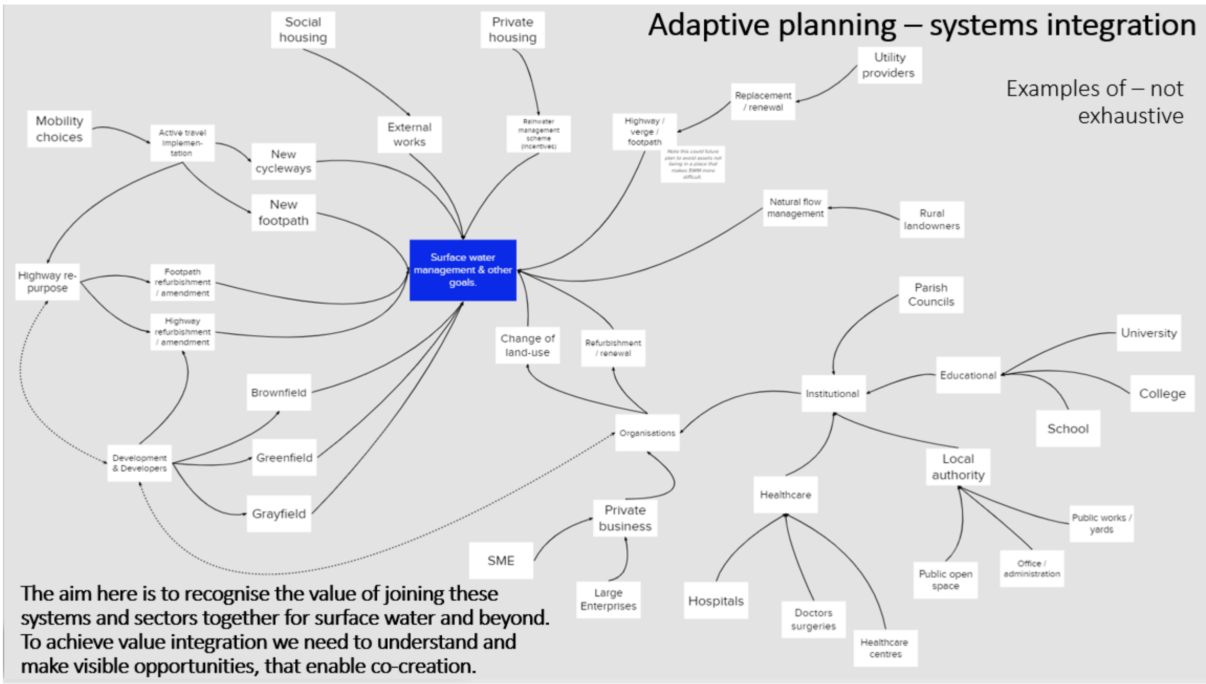
OUR PILLARS

The Blue-Green Plan proposes a series of measures over the short, medium and long-term focussed on source control and surface water disconnection to reduce flood risk. The solution focuses on creating new blue-green corridors throughout the city to move surface water through the city to the Humber estuary. The estimated costs of implementing the full long-term solution is approximately £1.5billion. Co-investing and co-delivering alongside other local priorities would lower this cost estimate.

To unlock the value for money opportunities provided through co-investing and co-delivering, an adaptive planning framework is suggested as the most effective delivery method. This approach keeps under constant review local opportunities for investment and change across a broad spectrum, considering co-deliver and the impact of missing an opportunity – for instance, from being able to disconnect a highway during regeneration works, to being unable to disconnect a major site for a significant number of years. This approach also addresses one of the most substantial co-funding challenges that the LWW programme has encountered: Infrastructure and other regeneration projects are often not prioritised until new government funding announcements are made. This creates significant challenges for the development of long term, fixed programmes of work. An adaptative planning framework would enable a portfolio of surface water management interventions to be prioritised within each five-year regulatory period, based upon local economic priorities.

Figure 129, Figure 130 and Figure 131 provide an overview of the scale and benefits that an adaptive planning framework provides.

Figure 129: Systems integration

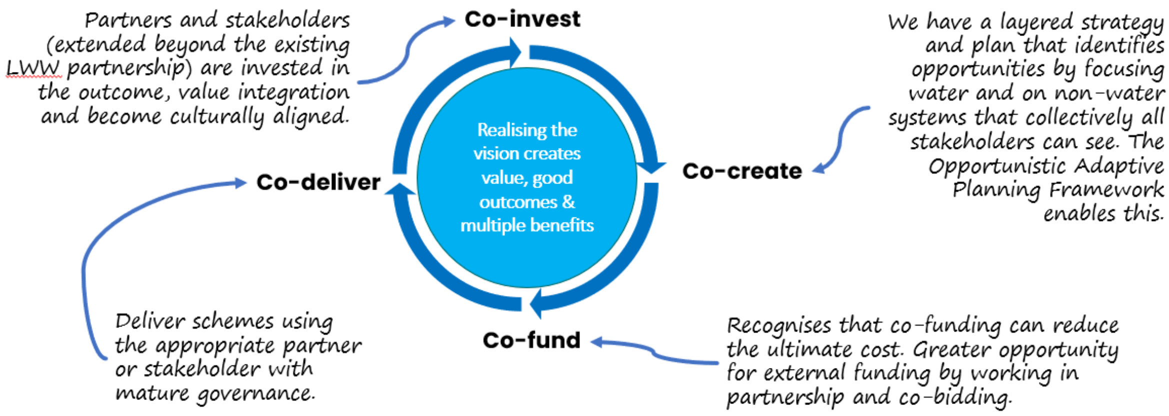


Adaptive planning – systems integration

Examples of – not exhaustive

The aim here is to recognise the value of joining these systems and sectors together for surface water and beyond. To achieve value integration we need to understand and make visible opportunities, that enable co-creation.

Figure 130: Co-creation and delivery



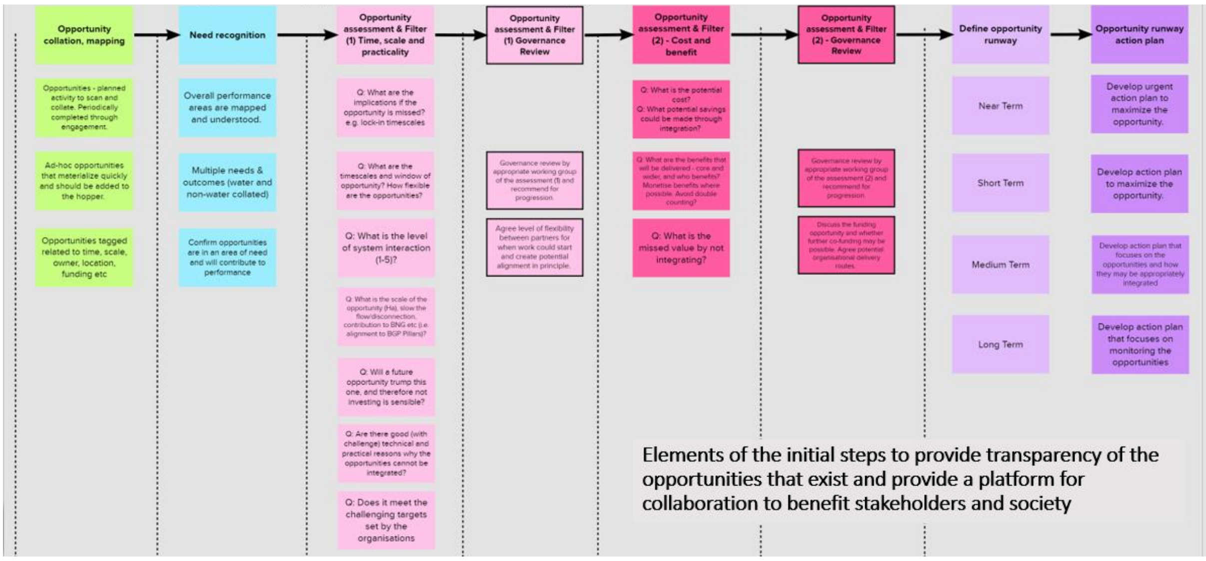
Partners and stakeholders (extended beyond the existing LWW partnership) are invested in the outcome, value integration and become culturally aligned.

We have a layered strategy and plan that identifies opportunities by focusing water and on non-water systems that collectively all stakeholders can see. The Opportunistic Adaptive Planning Framework enables this.

Recognises that co-funding can reduce the ultimate cost. Greater opportunity for external funding by working in partnership and co-bidding.

Deliver schemes using the appropriate partner or stakeholder with mature governance.

Figure 131: Governance



Opportunities - planned activity to scan and collate. Periodically completed through engagement.

Ad-hoc opportunities that materialize quickly and should be added to the hopper.

Opportunities tagged related to time, scale, owner, location, funding etc

Overall performance areas are mapped and understood.

Multiple needs & outcomes (water and non-water collated)

Confirm opportunities are in an area of need and will contribute to performance

Q: What are the implications if the opportunity is missed? e.g. lock-in timescales

Q: What are the timescales and window of opportunity? How flexible are the opportunities?

Q: What is the level of system interaction (1-5)?

Q: What is the scale of the opportunity (Ha), slow the flow/disconnection, contribution to BNG etc (i.e. alignment to BGP Pillars)?

Q: Will a future opportunity trump this one, and therefore not investing is sensible?

Q: Are there good (with challenge) technical and practical reasons why the opportunities cannot be integrated?

Q: Does it meet the challenging targets set by the organisations

Governance review by appropriate working group of the assessment (1) and recommend for progression.

Agree level of flexibility between partners for when work could start and create potential alignment in principle.

Q: What is the potential cost?
Q: What potential savings could be made through integration?

Q: What are the benefits that will be delivered - core and wider, and who benefits? Monetise benefits where possible. Avoid double counting?

Q: What is the missed value by not integrating?

Governance review by appropriate working group of the assessment (2) and recommend for progression.

Discuss the funding opportunity and whether further co-funding may be possible. Agree potential organisational delivery routes.

Develop urgent action plan to maximize the opportunity.

Develop action plan to maximize the opportunity.

Develop action plan that focuses on the opportunities and how they may be appropriately integrated

Develop action plan that focuses on monitoring the opportunities

Elements of the initial steps to provide transparency of the opportunities that exist and provide a platform for collaboration to benefit stakeholders and society

1.2.11 Challenges

There are still challenges to address, predominantly co-funding and the changing landscape of accessible funding following Brexit. Historically, individual projects could access large scale contributions of European grants for resilience and blue-green infrastructure investments, providing millions of pounds of funding for flood resilience schemes. There is currently nothing which directly replaces this.

In addition to this, because Hull is impacted by multiple sources of flooding, Flood Defence Grant in Aid (FDGiA) is potentially limited in this location. A number of tidal and fluvial schemes have already been delivered within Hull and Haltemprice, providing resilience from river and tidal flooding for a large number of properties. FDGiA rules mean that funding is not available to protect those same properties from other sources of flooding such as surface water. An additional challenge in accessing FDGiA is that once a property is moved from one risk band to another e.g., very significant to significant, the same properties may not benefit from further works to increase their level of protection in the future. This may be limiting when taking an opportunistic adaptive approach.

Surface water schemes need to integrate with legacy drainage infrastructure to create capacity in existing networks. Most often this is in densely populated areas with higher land costs and complex infrastructure and services which presents additional construction challenges. The delivery of SuDS is an effective long-term approach for adapting to climate change. This approach needs significant planning time, investment, customer understanding and engagement.

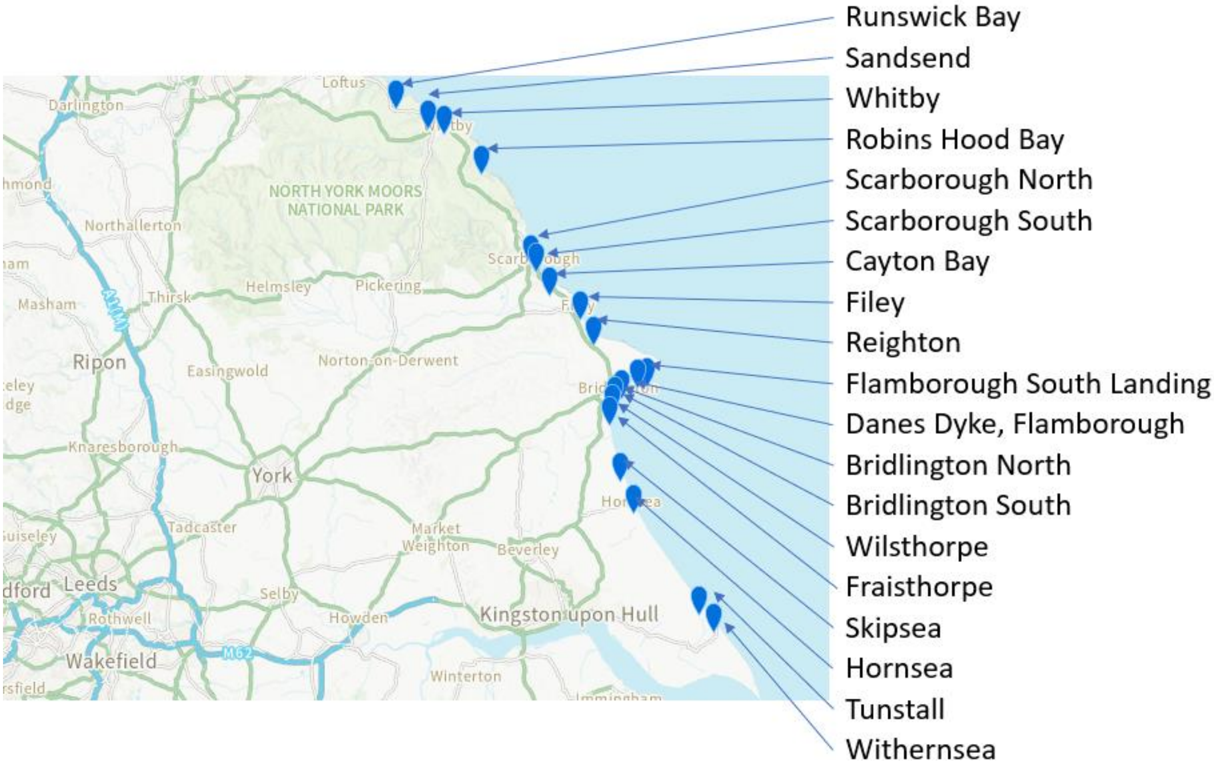
As we begin to move away from the approach of creating capacity in combined sewers by providing storage, to a more adaptive approach of source control and surface water separation, a wide reaching cultural and economic shift is needed. This shift will need to embrace an adaptive programme to ensure integrated and timely investment. An example could be disconnecting surface water during a council housing regeneration scheme. Or providing match funding to facilitate an SME (small and medium enterprise) to create large area disconnection as part of the council housing expansion plans. If assessed individually, these projects may not independently achieve the cost benefit ratio required by funding sources such as FDGiA. However, when reviewed as part of a holistic and comprehensive programme, they provide value for money as part of a long-term plan, as well as delivering wider societal and environmental benefits. A programme approach also allows the offsetting of large complex solutions with those which are more simple and low cost in nature. This allows more customers to be resilient, rather than just those simple solutions that are best.

1.3 Yorkshire's Bathing Water Partnership case study

1.3.1 Background and partnership

Yorkshire's Bathing Water Partnership was established in 2013 and focusses on the 19 coastal designated bathing waters in Yorkshire, shown below in Figure 132. These stretch from Runswick Bay in the North to Withernsea in the South. The partnership was initially established to jointly oversee, monitor and evaluate delivery of the requirements of the revised European Bathing Water Directive 2015 (rBWD). The partnership continues to operate to promote collaborative working along the Yorkshire coast, ensuring good communication and mutual trust between partners.

Figure 132: Showing our designated bathing waters



In 2021/22 the partnership refreshed their vision, objective and purpose to continue to demonstrate their commitment to the Yorkshire Coast. The vision of the partnership is to support the development of a thriving and prosperous coastline in Yorkshire to unlock the benefits of excellent bathing water quality. The ambitious objective of the partnership is to achieve excellent bathing water status at all of Yorkshire's coastal designated bathing waters.

The partnership includes the following organisations:

- Environment Agency
- YW
- East Riding of Yorkshire Council
- Scarborough Borough Council & Harbour Commissioner

The Yorkshire Wildlife Trust and the University of Hull are also involved in working on specific projects with the partnership.

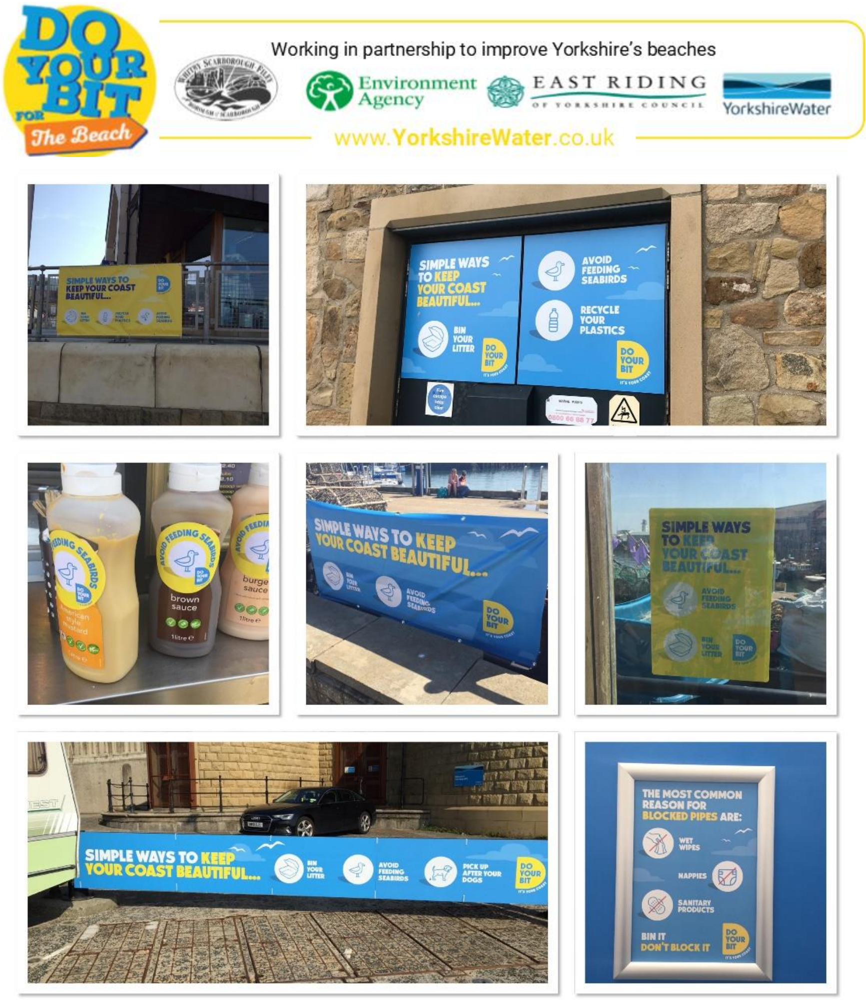
The partnership is overseen by a Partnership Board. This comprises of Executive and Senior Management support from each organisation. A Technical Action Group reports to the Board and carries out day to day activities and projects which aim to achieve the vision and objectives set out by Board. A Stakeholder Forum and Communications Group also form part of the structure as required.

1.3.2 Current partnership projects

Most recently, the partnership has undertaken a refresh of its beach action plans. These are developed through multiagency site walkovers and actions are recorded and addressed by the appropriate organisation(s).

In preparation for the 2022 Bathing Season there has been a large expansion to the 'Do your bit' campaign. This campaign seeks to engage with and educate beach users about ways in which they can help support environmental and bathing water quality improvements. This includes raising awareness of adhering to dog bans, recycling plastics, binning litter and avoiding feeding seagulls.

Figure 133: 'Do your bit' campaign images



In recent years the partnership has also jointly funded a native mussels trial project with the University of Hull. This innovative project sought to understand if the natural cleansing capabilities of native blue mussels (Mytilus edulis) could be used to improve bathing water quality. We have observed experiments in the Baltic and the eastern seaboard of North America and Canada which have demonstrated the efficacy of these filter feeders to improve the quality of the marine water column by removing sediment and pathogens. This nature-based solution has the potential to be a low cost, high result approach. We started this experiment in 2018/19 and placement of these trial lines and anchors is being reviewed for the 2023 season. Figure 134 below shows photographs which illustrate the deployment of these trial lines and anchors.

Figure 134: Native mussel trial images

We have also worked with the partnership to dramatically improve our sampling regime at Bridlington and Scarborough.

1.3.3 Opportunities and challenges

A multiagency approach enables efficiencies in investigations and joint understanding of bathing water quality impacts. This is essential in such a complex and dynamic environment. It allows the causes of poorer bathing water quality to be addressed, where ownership might otherwise be unclear. The benefits of working in partnership have seen an improvement to bathing water quality. Below in Figure 135 is a comparison of observed pre-2015 bathing water quality projections and the most recent classifications in 2021. This quantifies the outcomes of the multi-agency approach:

Figure 135 : Bathing water classifications

There are of course many challenges posed by working in partnership across various public and private organisations. Varying levels of resource and funding availability can pose a challenge to planning and delivering project work, as levels can significantly vary year on year. It is essential to have Partnership Board level buy-in and governance to help to overcome the challenges faced by different business drivers and priorities. This will ensure that the partnership vision of a thriving and prosperous coastline and excellent bathing water quality can be achieved.

1.4 Connected by Water Partnership case study

1.4.1 Background and partnership

Flooding in November 2019 was the catalyst for the creation of the South Yorkshire Alliance and production of the Connected by Water Plan (CBW). One of the wettest autumns on record led to unprecedented river levels and widespread flooding across South Yorkshire. Communities and businesses were devastated, infrastructure severely disrupted, and people were unable to return to their homes for many months following the flooding.

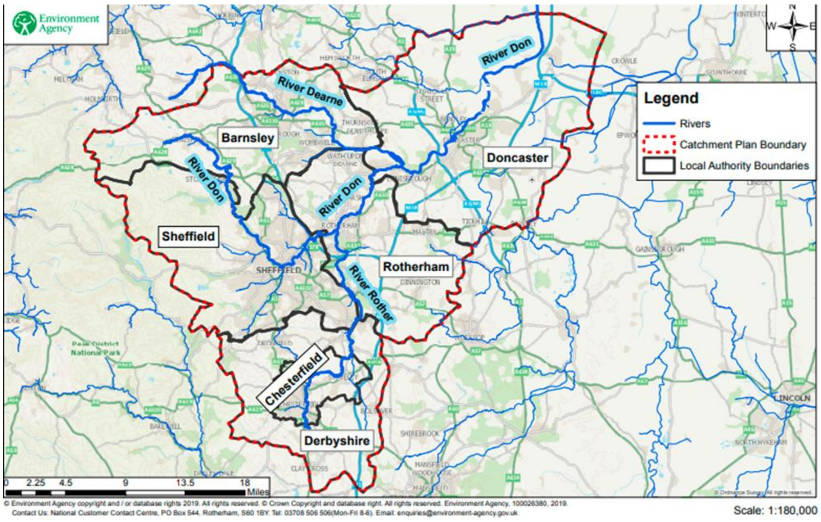
Figure 136: Connected by Water partnership logo

Connected
by Water

The CBW partnership has been established to work collaboratively to meet the challenges of climate change in the South Yorkshire region, shown in Figure 137 below. Climate change is leading to wetter winters with more intense rainfall which raises the risk of flooding from the rivers, surface water and the public sewer network across South Yorkshire.

The aim of the partnership is to work to reduce both the risk and impact of flooding in the future.

Figure 137: Connected by Water area map



Source: https://connectedbywater.co.uk/

The last serious flooding event was experienced in South Yorkshire in 2007. Since then, work has been done to better protect communities across the region from flooding. However, the extent of the 2019 floods linked to the reality of climate change, has led to the formation of the South Yorkshire alliance. This alliance is made up of partners from: South Yorkshire Mayoral Authority, Rotherham Council, Doncaster Council, Sheffield City Council, Barnsley Council, YW and the Environment Agency.

Since November 2019, the partners have been working together to deliver flood risk management schemes on the ground, but also to plan catchment-wide measures for the future to help meet the challenges of climate change. The South Yorkshire alliance will work with communities and partners to deliver this plan. It outlines the actions that the alliance will take to reduce the risk of flooding and develop more resilient communities who can adapt to the future impacts.

At YW, we have a unique opportunity to align the DWMP with the EA Adaptation Pathways project via CBW. This project will predict how climate change scenarios will affect the South Yorkshire region and drive decision making to mitigate the impacts. This opportunity will enable extensive stakeholder engagement and partnership working for the long term.

1.4.2 Current partnership projects

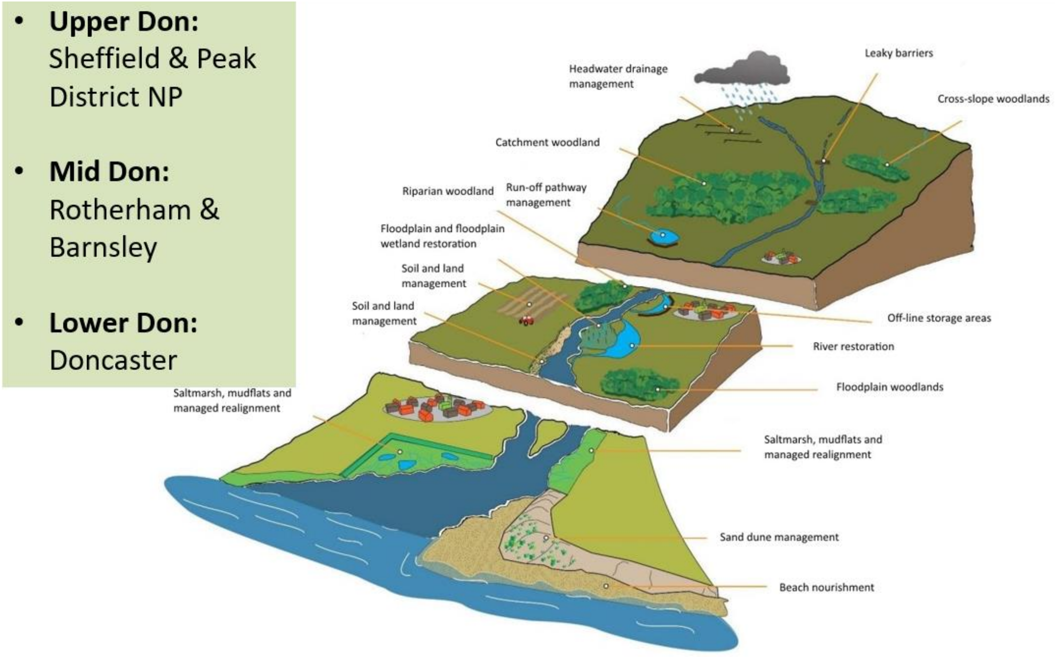
The South Yorkshire Flood Risk Investment tool will bring together flood risk data and evidence from across the region to inform future investment in flood risk management. This will ensure targeted investment to maximise flood risk benefits in the region. The tool will collate information on wider investment and funding opportunities, to help align investment streams and integration of projects.

A Source to Sea programme in the river Don catchment, shown below in Figure 138, is currently under development. The programme is split into three projects:

- Upper Don (Peak District National Park and Sheffield)
- Middle Don (North East Derbyshire, Rotherham and Barnsley)
- Lower Don (Doncaster).

Each project will look to review existing projects, partnerships, local strategies, and initiatives. CBW will ensure a joined-up approach and build on the strong foundations of existing local initiatives. The result is likely to be a variety of nature-based solutions which slow the flow and create more effective space for water.

Figure 138: Source to Sea catchments river Don



Source: https://connectedbywater.co.uk/

1.4.3 Opportunities and challenges

Working in partnership at a catchment scale offers a wide range of opportunities to address multiple sources of flooding together and deliver wider societal and environmental benefits. Integrating studies and strategies for addressing fluvial flooding alongside surface water management, ensures that resilience principals are embedded and strategic. It also means that stakeholders can work together to collaborate and deliver outcomes that reduce risk and maximise benefits for South Yorkshire communities. For example, by creating natural landscapes that alleviate flooding with the added benefit of providing high amenity areas for communities to enjoy.

Obtaining an integrated understanding of risk and responsibility at this scale will be challenging. It will require a step change in technical understanding across the partnership, as well as working together to share information and undertake further strategic hydraulic modelling. Developing a partnership to this level of maturity will require time and resource commitments from all stakeholders in order to deliver the outcomes. This is critical to the success of the plan and ensuring that the partnership's aim to reduce the risk and impact of flooding in the future is fulfilled.

1.5 Thriving Yorkshire: Maintenance partnerships

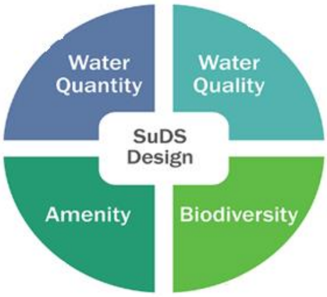
1.5.1 Case study: Gosforth Valley detention basin, Dronfield

Gosforth Valley detention basin is located in Dronfield, South Yorkshire. This became a Yorkshire Water (YW) legacy asset that transferred ownership during privatisation in 1999. It was originally constructed in the 1970s as a flood alleviation scheme to support the development of, at the time, the biggest housing development in Europe. It has a prominent position with homes and business overlooking the basin, as seen below in Figure 139.

Figure 139: Gosforth Valley detention basin

Today, the 2-hectare basin, which can hold over 10,000m^3 of water, not only helps protect Dronfield from flooding, but it is also an innovative example of how we can manage sustainable drainage assets to deliver all four pillars of good SuDS design, as seen in Figure 140 below.

Figure 140: Pillars of SuDS design



Source: https://www.susdrain.org/delivering-suds/using-suds/background/sustainable-drainage.html

The detention basin accepts surface water from a 2.3km^2 residential catchment and rather than hiding storm water underground in pipes, the basin supports both nature and community to thrive. Although the basin was innovative during its original construction, in 2017 YW and the Lea Brook Valley Charity (LBV) decided it could offer wider benefits and value to the Dronfield area and work began to enhance the basin. This 2-year project included work to excavate deeper ponds, remove silt and widen the inlet channel to increase flows. Volunteers planted hedgerows, meadow, native trees and common reeds creating a diverse habitat and bringing life to the basin, as seen in Figure 141 below. A 25-year partnership management plan was developed following this project.

Figure 141: Dronfield basin improvements

LBV CIO
LEA BROOK VALLEY

The basin was monitored during the summer of 2022 and water, soil and plant samples were collected to understand the potential for phosphorous removal. The results showed that the basin was able to remove phosphate, and that species had a significant effect on the removal of phosphate.

The basin is currently maintained in partnership by both LBV and YW, through a landlord and tenant arrangement. The land supports YW to fulfil our drainage duties while also supporting the vision of the LBV to create a 1km nature corridor for the community benefit. YW maintains responsibility for the engineered structures and LBV undertakes activities in line with the collaborate management plan. Volunteers carry out weekly visual inspections, litter picking, vegetation management and report to YW when any problems are identified. As a charity, LBV, can secure additional funding for community events and biodiversity enhancements which further magnify the value of the asset. LBV frequently organise community events which support skills development and education within the Dronfield community.

This innovative approach to maintaining our drainage assets ensures that the additional multiple benefits of SuDS are maximised and enjoyed by the local community. We believe this type of lease arrangement for managing SuDS is the first of its kind and demonstrates our intention to deliver against our strategy to maintain healthy and resilient assets which support a thriving Yorkshire.

2. Appendix B

2.1 Acronyms & Abbreviations

Term	Description
AMP	Asset Management Plan or Period - Is the term given to the five-year or regulatory period covered by a water company's business plan. AMP1 refers to the first planning period after the water industry was privatised, this covers the period 1990 to 1995. AMP7, covers the period 2020 to 2025. AMP8 covers the period 2025 to 2030.
AMR	Antimicrobial Resistance
APM	Association of Project Management
AONB	Area of Outstanding Natural Beauty - is an area of countryside that has been designated for conservation due to its significant landscape value.
APR	Annual Reporting Review – Yearly process of reviewing Water Company performance against targets agreed with Ofwat.
ASP	Activated Sludge Plant
BAG	Biodiversity Action Group
BAU	Business as Usual activity
Bath Ice v2	Bath University – Inventory of Carbon Emissions
BGI	Blue-Green Infrastructure - Natural and semi-natural assets which aid in surface water management whilst also providing wider environmental benefits.
BNG	Biodiversity Net Gain
BoQ	Bill of Quantities
BRAVA	Baseline Risk and Vulnerability Assessment - An assessment of the baseline position of performance and risk across the sewerage system and understanding of wider resilience issues.
BVP	Best Value Plan
CaBA	Catchment Based Approach - An initiative which aims to work in partnership with Government, Local Authorities, water companies, environmental NGOs and businesses to maximise the natural value of the environment.
CAF	Capacity Assessment Framework - An initiative to develop a standard way to assess how much capacity is available in drainage systems now and what may be available in the future.

Term	Description
Catchment	In natural terms, an area with several water bodies such as rivers, lakes, and streams. In sewerage terms, an area which is drained by a series of interconnecting sewers and assets. Also referred to as a Level 3 WwTW Catchment or Tactical Planning Unit.
CAPEX	Capital Expenditure - Is expenditure to acquire or upgrade physical assets such as property, pipes and treatment works.
CCW	Consumer Council for Water – An executive non-departmental public body which represents the interests of water and sewerage consumers in England and Wales and takes up unresolved complaints.
CDM	Construction (Design and Management) Regulations
Coastal Bathing Water	A designated coastal bathing site
Combined System	A sewerage system consisting of both rainwater and used wastewater from sinks, baths, and toilets.
CSO	Storm Overflows on the sewer network are also known as Combined Sewer Overflows.
DAP	Drainage Area Plan - A single, or series of, hydraulic modelling studies which are developed to explore and understand the performance of the sewerage network.
DAVE	Design and Value Engineering Toll – relates to WwTW
DAZ	Drainage Area Zone - The area drained by a network of sewers and associated assets.
DEFRA	Department for Environment, Food and Rural Affairs.
Descriptive WwTW	A small wastewater treatment site without a numerical discharge consent
Detention Tank	A structure that is designed to store excess wastewater and/or surface for a period of time.
DMF	Decision Making Framework - An innovative set of processes and tools, aimed at making the most efficient expenditure decisions to ensure excellent service and benefit to customers.
DIG	Doncaster, Immingham and Grimsby
DST	Decision Support Tool - A system or process which aids in optimising decision making by quantifying risk and value to optimise investment.
DWF	Dry Weather Flow – The average daily flow to a wastewater treatment works (WwTW) during a period without rain.
DWMP	Drainage and Wastewater Management Plan - A new way for organisations to work together to improve drainage and environmental water quality.
DWMP Hub	Our online Drainage & Wastewater Management Plan stakeholder portal.

Term	Description
EA	EA- A non-departmental public body tasked by the UK government with protecting and enhancing the natural environment. The EA are the environmental regulators responsible for rivers, flooding and pollution.
EDA	Enterprise Decision Analytics - Our programme optimisation tool which supports the decision making process.
EDM	Event Duration Monitoring – monitoring of storm overflows, including whether or not a spill event is happening and how long it lasts.
EPA	Environmental Performance Assessment - Was introduced by the EA(EA) in 2011 as a non statutory tool for comparing performance between water and sewerage companies (WaSCs).
ESF	External Sewer Flooding - Flooding to property curtilage or land such as gardens due to hydraulic incapacity of sewers.
FAS	Flood Alleviation Scheme
FCERM	Flood and Coastal Erosion Risk Management – EA managed programme of investment to mitigate risk due to flood and coastal erosion. Current plan runs from 2021 – 2027.
FDGiA	Flood Defence Grant in Aid
FEH13 rainfall	Flood Estimation Handbook 2013 - Provides catchment level descriptors and rainfall estimation procedures. Used in modelling the impact of rainfall events.
FFT	Flow to Full Treatment
Flood Cluster	Areas of hydraulic flood risk grouped based on proximity.
FOG	Fats, oils and greases
Foul System	A sewerage system consisting of waste from sinks, baths, and toilets.
FRMP	Flood Risk Management Plan – Explains the risk of flooding from; rivers, the sea; surface water; ground water and reservoirs within a River Basin District. Current plan runs from 2021 – 2027. Reviewed by the EA and Lead Local Flood Authority.
FUTURE-DRAINAGE	A Newcastle University led consortium involving the Met Office, JBA Consulting and Loughborough University, funded by the NERC (UKRI) UK Climate Resilience Programme. It has used the new UKCP high resolution 2.2km data (UKCP Local) to derive more robust rainfall uplift estimates for the high greenhouse gas emissions scenario RCP8.5.
FWMA	Flood and Water Management Act 2010 - UK Act of Parliament relating to the management of the risk concerning flooding and coastal erosion. The Act aims to reduce the flood risk associated with extreme weather, compounded by climate change.
GIS	Geographical Information System - A system to capture, store and analyse spatial data.

Term	Description
Grey Infrastructure	Traditional methods of wastewater management such as concrete detention tanks.
GWDTE	Groundwater Dependant Terrestrial Ecosystem
HE	Historic England - Non-departmental public body tasked with protecting the historic environment of England.
HH	Customer household/property
HRA	Habitats Regulations Assessment - Several distinct stages of assessment which must be undertaken in accordance with regulation to determine if a plan or project may affect the protected features of a habitat site.
I&I	Inflow & Infiltration - Terms used to describe two of the ways surface water enters the foul sewer network. Inflow is where surface water enters the system from above ground sources whilst Infiltration is groundwater which seeps into sewers through cracks in pipes.
iCASP	Yorkshire Integrated Catchment Solutions Programme - An academic body which uses research to benefit the environment, economy, and society of Yorkshire.
iWharfe	Multi-agency and community project to understand, monitor and enhance river water quality on the river Wharfe
IDB	Internal Drainage Board
Inland Bathing Site	A designated inland riverine bathing site
ISF	Internal Sewer Flooding - Flooding to the inside of a property's habitable area, either via direct connections to the sewers, such as toilets or by water seeping through doorways.
LBV	Lea Brook Valley Charity
Level 1 Company Plan	The YW region
Level 2 Strategic Planning Area	Aggregation of Level 3 catchments to form the overarching Level 1 strategic plan for the company. Aligned to River Basin Districts and political boundaries.
Level 3 WwTW Catchment	A wastewater catchment including all connected properties which drain to a specific WwTW.
Level 4	The spatial extent of the upstream catchment draining to an individual storm overflow.
LLFA	Lead Local Flood Authority - County councils and unitary authorities, LLFAs lead in managing local flood risks from surface water, ground water and smaller watercourses.
Local Plan	Population, property and occupancy forecasts derived from local plans published by the local council or unitary authority.

Term	Description
LPA	Lead Planning Authority - Usually the planning department of the district or borough council whose duty it is to carry out specific planning functions for a particular area.
LTDS	Long Term Delivery Strategy – tables provided by Ofwat as part of the price review process reviewing predicted enhancement expenditure to 2050.
LNRS	Local Nature Recovery Strategies
LWW	Living With Water - A partnership between YW, Hull City Council, East Riding of Yorkshire Council, the EA and the University of Hull working together to build flood resilience within the region.
MABR	Membrane Aerated Biofilm Reactor
M&E	Maintenance and Electrical
MasterMap	A map dataset of Great Britain's landscape provided by the Ordnance Survey.
MCZ	Marine Conservation Zone - is a type of marine nature reserve in UK waters. They are areas designated with the aim to protect nationally important, rare or threatened habitats and species.
MTP	Medium Term Plan of investment arising from the FCERM programme.
NBS	Nature-based solutions – Solutions which aid in surface water management whilst also providing wider environmental benefits.
NCA	National Character Areas - is a natural subdivision of England based on a combination of landscape, biodiversity, geodiversity and economic activity.
NCERM	National Coastal Erosion Risk Mapping produced by the EA.
NE	Natural England - A non-departmental public body responsible for ensuring that England's natural environment is improved and protected.
NFM	Natural Flood Management
NFU	National Farmers Union - Is a member organisation/industry association for farmers in England and Wales.
NGO	Non-Governmental Organisation – a non-profit organisation, typically with social or environmental aims.
NHH	Non-Household customer – business customers and premises
NNR	National Nature Reserves – in England are designated by Natural England as key places for wildlife and natural features in England. They were established to protect the most significant areas of habitat and of geological formations.
NPV	Net Present Value

Term	Description
Numerical Consented WwTW	A wastewater treatment works with a numerical discharge consent
NWEBS	National Water Environmental Benefit Survey
NYAA	Normal Year Annual Average
OAR	Options Assessment Report
ODR	Options Development Report
ODA	Options Development and Appraisal - A stage of the DWMP process which should enable companies to develop a series of robust "best value" interventions to identified risks across the sewerage network.
Ofwat	Water Services Regulation Authority or Office of Water Services - The economic regulator of water services in England and Wales.
OPEX	Operational Expenditure - The day-to-day spending on running of services such as staff costs and energy bills.
ONS	Office for National Statistics. Producers of population, property and occupancy forecasts.
P4Y	Partnerships for Yorkshire
PA	Programme Appraisal
PAS2080:2016	Global standard for managing infrastructure carbon 2016 version
PCC	Per Capita Consumption – A measure of how much clean water consumed by a person in a day.
PE	Population Equivalent – A measure of the amount of oxygen-demanding materials discharged by one person each day.
PLR	Property Level Resilience
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
PIMP	Percentage Impermeability
POT	Peak over Threshold a recognised approach to model extreme values
PRIP	Pollution Reduction Improvement Plan
PR24	Price Review 2024 - The Ofwat periodic review of price limits to be in 2024 to set prices for the regulatory period 2025-2030.
Q90	The nonparametric 10-percentile value of a time series of measured total daily volume arriving at a WwTW throughout a year. The 10-percentile figure is that value exceeded by 90% of the recorded daily values. It’s also known as the Q90.

Term	Description
RAMSAR	The Ramsar Convention on Wetlands of International Importance, especially as Waterfowl Habitat, is an international treaty for the conservation and sustainable use of wetlands. It is also known as the Convention on Wetlands.
RBCS	Risk Based Catchment Screening – Stage within the DWMP where catchments are screened based on risks.
RBD	River Basin District – Defined by the EA and covers an entire river system, including river, lake, groundwater, estuarine and coastal water bodies.
RBMP	River Basin Management Plan - A process for setting out how organisations, stakeholders and communities will work together to improve the water environment. Current plan runs from 2021 – 2027. Reviewed by the EA in England.
RCP	Representative Concentration Pathway – Utilised within UKCP18 to represent a range of climate outcomes.
RCV	Regulatory Capital Value
RFCC	Regional Flood and Coastal Committee
Rising Main	A type of sewer where wastewater is pumped to another part of the sewerage system
RMA	Risk Management Authority - These are designated under the Flood and Water Act, 2010 as organisations which carry out flood and coastal erosion risk management activities. Water companies are designated RMAs for the purposes of managing flooding from sewers and reservoirs.
RNAG	Reasons for Not Achieving Good – ecological status relating to rivers
ROCC	Regional Operational Control Centre
RoFSW	Risk of Flooding from Surface Water
RTS	Regional Telemetry System – remote viability and alarm system for assets
S24	Section 24 – A drain which serves more than one property which was in existence pre 1 January 1937 and is the responsibility of the Sewage Undertaker.
SAAR	Standardised Annual Average Rainfall - Rainfall averages for the UK over a given period.
SAB	Sustainable Drainage Approving Body
SAC	Special Area of Conservation - Protects one or more special habitats and/or species listed in the Habitats Directive.
SAGIS	Source Apportionment GIS - A discrete ArcGIS-based digital information management and visualisation platform which serves an integrated system for modelling water quality in rivers and lakes.

Term	Description
SCADA	Supervisory Control and Data Acquisition – remote visibility, control and alarm management system for assets.
Schedule 3	Part of the Flood and Water Management Act 2010 – links to sustainable drainage systems for new developments
SEA	Strategic Environmental Assessment - A systematic decision support process, aiming to ensure that environmental aspects are considered appropriately in planning.
Sewer	A conduit designed to transport wastewater or surface water.
Sewerage	A system by which wastewater or surface water is transported.
SgZ	Safeguard Zone
Six Capitals	Financial Capital – Our financial health and efficiency Human Capital – Our workforce's capabilities and wellbeing Manufactured Capital – Our pipes, treatment works, offices and IT Intellectual Capital – Our knowledge and processes Natural Capital – The materials and services we rely on from the environment, especially water Social Capital – Our relationships and customers trust in us
SMF	Service Measure and valuation Framework - A process designed to identify the reasons for investment and value of carrying out such investment.
SOAF	Storm Overflow Assessment Framework - An assessment intended to address the problems caused by discharges from storm overflows which are considered to be operating at too high a frequency.
SPA	Special Protection Area (SPA) – This is land classified under Directive 79/409 on the Conservation of Wild Birds. SPAs are strictly protected sites.
SPZ	Source Protection Zone
SOEP	Storm Overflow Evidence Project - An independent research project that considers options, costs, and benefits for reducing storm sewage discharges in England.
SODRP	Storm Overflow Discharge Reduction Plan
SPA	Strategic Planning Area - A region designated for reporting purposes which contains several WwTW catchments.
SPF	Strategic Planning Framework - These frameworks set a long-term direction of travel for key areas of company activities and usually involve collaboration with other regulators and stakeholders. The outputs from strategic planning frameworks will need to inform, and align with, each company's long-term strategy. Companies already have several long-term strategic planning frameworks. These frameworks include water resources management plans (WRMPs), drainage and wastewater management plans (DWMPs), the water industry national environment programme (WINEP) in England.

Term	Description
SPU	Strategic Planning Unit – our Level 2 areas
SSSI	Site of Special Scientific Interest - A designation denoting a protected area usually due to a rare species contained within or important physiological features.
Storm Overflows	An asset within the sewer network or at a wastewater treatment works that allow discharges of excess wastewater and rainwater to spill flows when its capacity is exceeded (usually when there are heavy storms). They prevent the sewerage system from backing up and flooding properties by discharging untreated but dilute sewage into the receiving river or stream.
SuDS	Sustainable Drainage Systems - A range of techniques for sustainably managing the flow of water run-off from a site on the surface e.g., by storing it in water butts, ponds, or swales, and so reducing the loading on conventional piped drainage systems. Also referred to a blue-green or nature based solutions.
Surface Water System	A sewer system that typically drains rainwater that has fallen on roads and roofs.
TOTEX	Total cost of Expenditure (CAPEX + OPEX) - TOTEX is the mechanism for planning and reporting capital and operational spend. The object is to achieve the optimum combination to deliver the required business plan outcomes. It applies to both water and waste but not to retail.
TPU	Tactical Planning Unit - Catchment area of one or more Wastewater Treatment Works, also referred to as a WwTW Catchment.
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018
UKWIR	UK Water Industry Research - A body responsible for facilitating the water industry's research agenda and programme.
UPM	Urban Pollution Management Manual – A planning guide for the management of urban wastewater discharges during wet weather.
UPS	Uninterruptable Power Supply (UPS – a battery system designed to prevent critical loads losing power).
VAP	Vulnerable Asset Plan – plan to address and temporarily mitigate vulnerability for a named asset.
Wastewater	Water which has been used in a home, business or in an industrial process which requires treating.
Wastewater Pumping Station	Wastewater Pumping Station - An asset which pumps sewage, typically towards a treatment works site.
WaSC	Water and Sewerage Company
Water UK	Engages with companies and regulators to ensure customer receive high quality tap water at a reasonable price and that our environment is protected and improved.

Term	Description
WFD	Water Framework Directive - A European Directive to provide a coordinated approach to water management with the European Union (EU) by bringing together strands of water policy under one piece of framework legislation. Member States must produce plans for river basin management districts that set out a programme of measures aimed at protecting bodies of surface and groundwater.
WINEP	The water industry national environment programme (WINEP) is the programme of work water companies in England are required to complete to meet their obligations from environmental legislation and UK government policy.
WISER	Water Industry Strategic Environmental Requirements - A steer from EA which describes the resilience and flood risk obligations that the water industry must take into account when developing business plans.
WRMP	Water Resources Management Plan - A statutory plan which all water companies must produce every five years. They are designed to set out how the water company intends to achieve a secure supply of water for their customers in the future.
WTW	Water Treatment Works – infrastructure used to produce and treat drinking water.
WWO	Working with Others – a YW Performance Commitment focusing on partnership working.
WwTW	Wastewater Treatment Works – infrastructure used to treat wastewater and rainwater before returning it safely back to the environment.
WYCA	West Yorkshire Combined Authority
YDRT	Yorkshire Dales Rivers Trust
YW	Yorkshire Water

3. Appendix C

3.1 Level 2 storyboards

These are available at:

https://www.yorkshirewater.com/about-us/drainage-and-wastewater-management-plan/

4. Appendix D

4.1 Level 3 catchment storyboards

These are available at:

https://www.yorkshirewater.com/about-us/drainage-and-wastewater-management-plan/