Yorkshire Water

Draft DWMP24

June 2022

Contents

Executive Summary

Our draft DWMP24 is the first iteration of our new strategic plan for drainage and wastewater that seeks to establish a baseline of the existing drainage and wastewater network and its components and takes a long-term view of the risks and issues that may impact our drainage and wastewater network in the future. Our DWMP considers all aspects of our wastewater networks (foul, combined and surface water) as well as our wastewater treatment works.

The 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.

We have utilised hydraulic models, established processes and statistical analysis of data to predict the expected changes in drainage and wastewater system performance by 2050. This helps us to plan what we need to do to manage our current and emerging risks.

Our draft DWMP uses the latest guidance, scientific understanding, and modelling techniques to evaluate our levels of risk in relation to:

- Hydraulic internal and external sewer flooding of customers properties. Hydraulic flooding is caused by the capacity of the sewer being exceeded.
- The operation of storm overflows.
- Compliance with our wastewater treatment works permits.

Our draft DWMP has been produced following an industry developed national framework. This includes a series of screening stages and risk assessments which use existing performance data and hydraulic modelling results. We will look to build and refine our plan between draft and final publication, and in future cycles based on; consultation feedback, the enhanced details of the Storm Overflow Discharge Reduction Plan, and further certainty on rates of climate change and population growth.

The building blocks of our draft DWMP are the 617 Level 3 wastewater treatment works catchments in Yorkshire, which are grouped into 17 larger Level 2 strategic planning areas which make up the Level 1 Yorkshire Water area. This hierarchy allows us to identify, focus and develop options for the catchments with the highest levels of immediate and emerging risk.

We have developed four scenarios to address the risks we have identified. These are detailed below:

- **Scenario 1:** Annual average of <u>no more than 10</u> spills per storm overflow and <u>reduced</u> 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.
- **Scenario 2:** Annual average of <u>no more than 10</u> spills per storm overflow, plus <u>no environmental harm</u> from storm overflows and <u>reduced</u> 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.
- **Scenario 3:** Annual average of <u>no more than 10</u> spills per storm overflow and <u>maintain</u> regional level 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.

- **Scenario 4:** Annual average of no more than 10 spills per storm overflow, plus no environmental harm from storm overflows and maintain regional level 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.

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

- Increase the capacity of our network through traditional 'grey' solutions, i.e. building bigger pipes, storage tanks and upgrading our existing assets.
- 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 still necessary.

We have taken a catchment-based approach to allow us to take a holistic view and achieve efficiency in our long-term plan by reducing all identified risk within the catchment rather than focusing on the triggered risks only. Our solutions will look to address the increasing pressures on the sewer and drainage networks as a result of climate change, population growth and development by 2050.

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 have identified a minimum and maximum cost range for each scenario across a 25-year timeframe. Our corporate Decision-Making Framework tool has selected a combination of blue-green and grey solutions for each high priority catchment to address the issues we have identified.

These costs are based on a best value plan for each of the four scenarios

Level 1 – 25-Year Best Value Plan – Cost Ranges+/-25%		
Scenario 1	£28.8 billion	£47.9 billion
Scenario 2	£30.1 billion	£50.1 billion
Scenario 3	£23.1 billion	£38.5 billion
Scenario 4	£24.3 billion	£40.5 billion

These costs show our least cost approach for each of the four scenarios

Level 1 – 25-Year Least Cost – Cost Ranges +/-25%		
Scenario 1	£21.2 billion	£35.3 billion
Scenario 2	£22.8 billion	£37.9 billion
Scenario 3	£9.7 billion	£16.2 billion
Scenario 4	£11.8 billion	£19.6 billion

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

In the short-term, we will be working on our final plan, which is due for publication in March 2023, by continuing to develop our plan and incorporating feedback from the consultation process that will run until the 23 September 2022. We will be working closely with Defra and the EA to ensure that our final

DWMP accurately reflects the evolving requirements for storm overflows. We would welcome your comments on our draft DWMP24 and you can access the consultation via our website link:

https://www.yorkshirewater.com/about-us/drainage-and-wastewater-management-plan/

In the medium-and long-term we will commence work on the next cycle of DWMP development, which will start in April 2023. This will make use of newly available datasets, including climate change projections and we will incorporate learning and feedback from the completion of our first DWMP. 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 water's role in making Yorkshire a brilliant place to be – now and always. 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.

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 near 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:

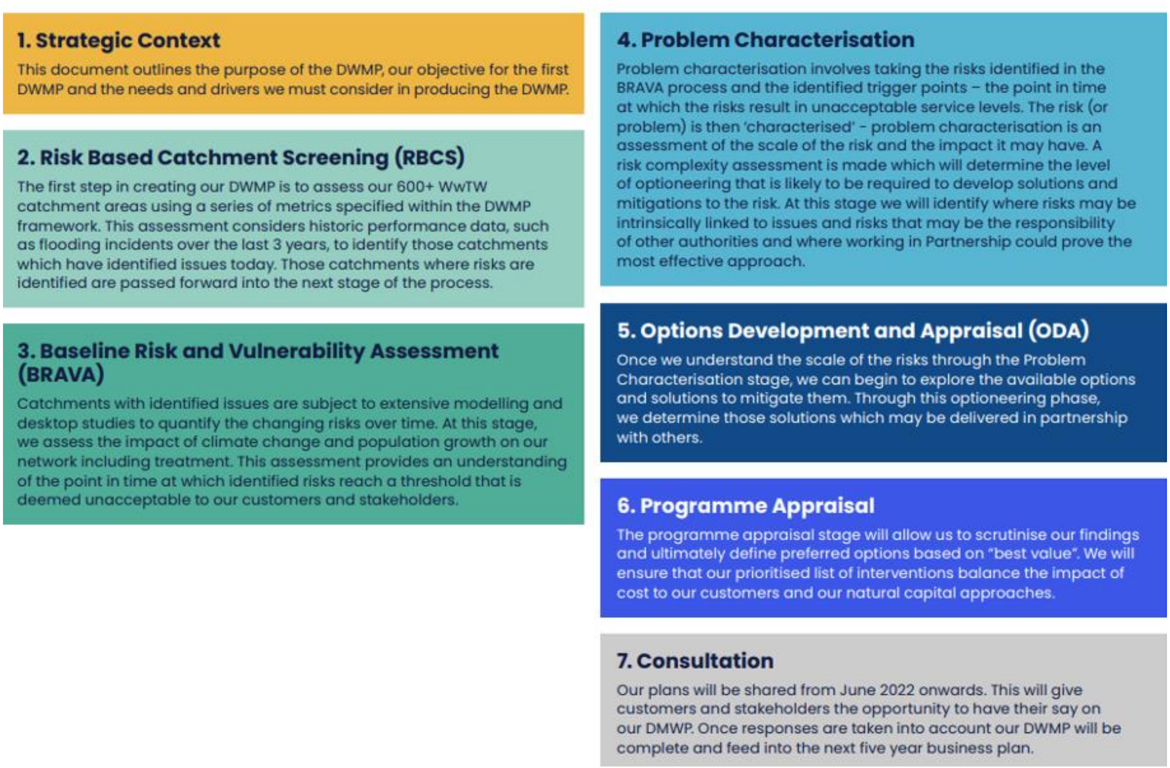
- Show how long-term plans support economic growth, resilient communities and how they protect and enhance the environment in a sustainable way.
- Provide a systematic understanding of service and wastewater system risks and vulnerability.
- Demonstrate a structured and auditable approach to identifying 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 1 below.

Figure 1: 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 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

---

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

wastewater treatment works compliance, as a result of factors such as population growth and climate change. We have concentrated on these areas as we have established business as usual processes for tackling blockages, collapses, and associated campaigns to address unsuitable materials in the sewer network.

1.4 DWMP and WRMP similarities and differences

The equivalent of a DWMP for our clean water network is the 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 grid systems 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 both the previous WRMP (WRMP19 for the regulatory period 2020-25) and WRMP24 which is currently under development (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.

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. We will seek to align the DWMP with our PR24 planning process.

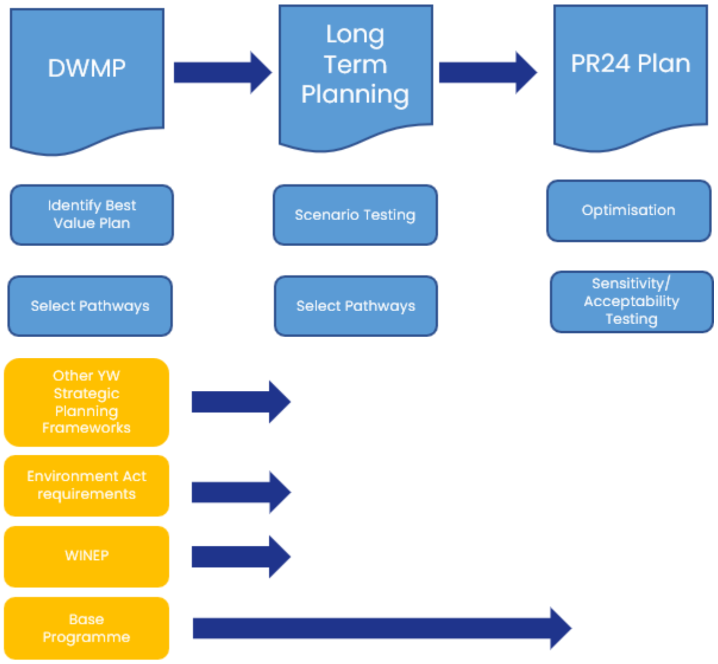
2.1 The price review process

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 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: Addressing climate change, changing societal expectations and affordability of bills alongside many other pressing challenges, will require long-term delivery strategies. The price review will therefore be significantly influenced by the direction established within various Strategic Planning Frameworks. See Figure 2 below.

Figure 2 – 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 concerning storm overflows. In comparison, there is limited interaction between the DWMP and WRMP. This is because the WRMP focuses on a long-term plan to continue to deliver drinking water to meet future forecast demand as described previously in Section 1.4.

2.3 Water Industry National Environment Programme (WINEP) and DWMP

As the DWMP and WINEP development for PR24 is happening concurrently, there is limited opportunity for the DWMP to include delivery of environmental improvements identified through the WINEP planning process. The main area of expected overlap will be the delivery of storm overflow improvements, where it is anticipated the DWMP will provide the evidence required for WINEP development. Section 3 of this document covers this in more detail.

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 WINEP is the most important and substantial programme of environmental investment in England. 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 PR24 WINEP is under development and water companies must submit optioneering evidence for solutions to address environmental risks and issues identified with the EA by 30 November 2022.

The WINEP for 2025-2030, is anticipated to implement some aspects of the first delivery phase of the DWMP24, for example the government's Storm Overflow Discharge Reduction Plan. This is expected to be alongside the supply-demand and capital maintenance elements of the water company's business plans.

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. YW have 2246 permitted storm overflows.

We monitor spills from 97% of them, with a plan to have 100% monitoring coverage by the end of 2023. In 2021, there were 70,062 spills from storm overflows in Yorkshire totalling 406,131 hours.

3.2 Changing expectations and the Environment Act

The sewer system was originally 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 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 this contained three new target areas:

1. Protecting the environment: Water companies shall only be permitted to discharge from a storm overflow where they can demonstrate that there is no local adverse ecological impact. This must be achieved for all storm overflow sites by 2050.
2. Protecting public health in designated bathing waters: For storm overflows discharging into and near designated bathing waters, water companies must significantly reduce harmful pathogens by either applying disinfection, such as with ultraviolet radiation, or reduce the frequency of discharges to meet EA spill standards by 2035.
3. Ensuring storm overflows operate only in unusually heavy rainfall events: Storm overflows must not discharge above an average of 10 rainfall events per year by 2050.

---

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

Further details of these target areas can be found in Section 3.6 below. The consultation closed on 12 May 2022 and the Secretary of State has until 1 September 2022 to publish the final Storm Overflow Discharge Reduction Plan.

3.3 Tackling storm overflows in Asset Management Plan 7 (AMP7) 2020-2025

We are investing £137 million by 2025 in storm overflow improvements, investigation, and increased monitoring.

Over the next few years, we are increasing 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 into a watercourse. We are also making improvements to 14 overflows that will improve over 24km of river and reduce spills by over 750 hours on average a year. In addition to this, by 2025 we are going to significantly reduce spills on a further 15 of our most frequently spilling overflows from 2021.

We are also investigating the environmental impact of 158 frequent spilling overflows as part of the Water Industry National Environment Programme (WINEP). By March 2022 we had completed 30 of these investigations, with a further 30 to be completed by September 2022. This has resulted in three storm overflows identified for improvement.

In 2021 we started a programme of installing 58 solar-powered cameras on wastewater outfalls, with plans to install more as part of a pilot scheme to improve the visibility of our network. This is one of many initiatives, as part of our Dynamic Asset Maintenance transformation programme. Whilst outside of the DWMP remit, it offers mutual benefits for storm overflows. The installation phase commenced across assets that discharge to watercourses including the River Wharfe and other key locations across the region. These cameras will allow us to quickly assess the performance of our assets and mobilise our response more effectively. This is in addition to the 97% overflows already monitored by telemetry.

3.4 PR24 and beyond: DWMP and storm overflows

A healthy and resilient natural environment is vital if we are to address the biodiversity crisis (Dasgupta review 2021) 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 proud to play water's role in making Yorkshire a brilliant place to be – now and always and we share the government's ambition for a significant reduction in the use of storm overflows.

Addressing storm overflows is a key element of the DWMP and a core planning objective. Our DWMP scenario targets are aligned within the Storm Overflow Discharge Reduction Plan consultation. The DWMP scenarios do not include reference to priority storm overflows, coastal or inland bathing targets or any of the screening or monitoring requirements in the Storm Overflow Discharge Reduction Plan consultation. This is due to evolving position on requirements and we will reflect an updated position based on the latest regulatory direction in our final DWMP.

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

- Improvements to drainage infrastructure by only increasing capacity (for example by constructing network storage tanks or storm tanks at wastewater treatment works, such as grey infrastructure).
- A hybrid scenario utilising retro fit sustainable drainage solutions (SuDS) to manage and reduce the amount of rainfall entering our network and capacity improvements.

Two different policy scenarios to be achieved by 2050, have been considered:

- Applying a universal annual average spill frequency due to rainfall of no more than 10 spills per year.
- Applying a universal annual average spill frequency due to rainfall of no more than 10 spills per year plus eliminating ecological harm from storm overflows.

3.5 Details of the Storm Overflow Reduction Plan in our DWMP

DWMP24 has required significant hydraulic modelling undertaken within the 5-year DWMP cycle. All storm overflow improvements within the DWMP are reported at a wastewater treatment works (WwTW) catchment level rather than individual overflow assets. Improvements have focused on delivering an annual average spill frequency due to rainfall of no more than 10 spills per year and then eliminating ecological harm from storm overflows. The Risk Based Catchment Screening was undertaken in 2019 so only those storm overflows within catchments triggering through to the BRAVA stage have been included with a sub-set of these progressing through to optioneering.

Further work will be required between draft DWMP due in June 2022 and final DWMP24 due in March 2023. During that time, we will develop the WINEP for PR24 in line with the Storm Overflow Discharge Reduction Plan which will be confirmed by 1 September 2022. This will determine the long-term delivery strategy for storm overflows in line with the DEFRA guidance as set out below. This will include priority overflows, designated bathing waters (including our recent inland bathing designation at Ilkley) and screening of storm overflows.

3.6 DEFRA Storm Overflow Discharge Reduction Plan

The Storm Overflow Discharge Reduction Plan[3] that was published for consultation by DEFRA in March 2022 sets out three targets which are summarised in the following sections:

3.6.1 Target 1: Protecting the Environment

Water companies shall only be permitted to discharge from a storm overflow where they can demonstrate that there is no local adverse ecological impact. This must be achieved for all storm overflow sites by 2050.

Sub target areas:

- By 2035 – 75% of priority overflows
- By 2045 – 100% of priority overflows
- By 2050 – 100% of overflows

High priority sites will include Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), eutrophic sensitive areas, chalk streams and waters currently failing our ecological standards due to storm overflows.

Desired Outcome: No water body fails to achieve good ecological status due to storm overflows – results in “complete elimination of ecological harm from storm overflows”.

3.6.2 Target 2: Protecting public health in designated bathing waters

Sub Target areas:

- For storm overflows discharging into and near designated bathing waters, water companies must significantly reduce harmful pathogens by either applying disinfection, such as with ultraviolet radiation, or reduce the frequency of discharges to meet EA spill standards by 2035.

---

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

- This will only be applied to those storm overflows close enough to affect a single monitoring point for each bathing water. The EA spill targets are 3 discharges per bathing season for "good", 2 discharges per season for "excellent" and <2 for inland river spill standard.

Desired Outcome: Water companies must significantly reduce or eliminate pathogens harmful to human health being discharged by storm overflows to allow the bathing water to meet the required standard.

3.6.3 Target 3: Storm overflows must not discharge above an average of 10 rainfall events per year by 2050

Ensuring storm overflows operate only in unusually heavy rainfall events

Sub Target areas:

- By 2050 – storm overflows must not discharge above an average of 10 rainfall events per year.
- By 2050 – must have "screening controls" to limit the discharge of persistent inorganic material (as well as faecal and organic solids), and they must be well maintained. This means the screen must be designed and maintained so that it always effectively achieves the solid separation and flow rates that it was designed for.

Desired outcome: To protect public health and wellbeing in areas that are not designated bathing waters.

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 3. 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 3: 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.

Our sewer network interacts with this legacy. 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.
- For new building developments, there is an automatic right to connect to the sewer network regardless of its local capacity.
- 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.

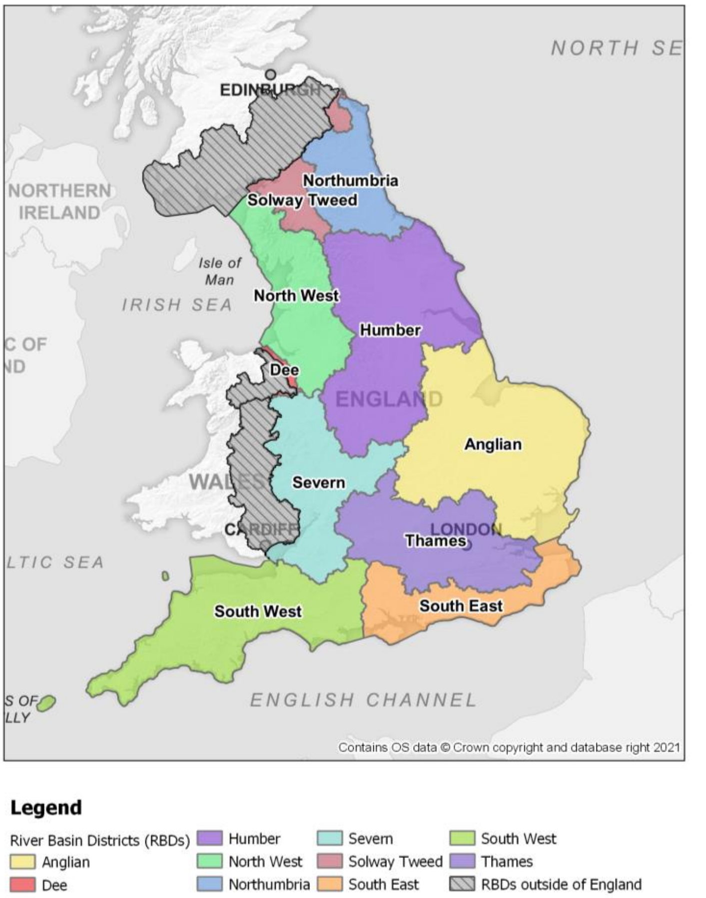
The county of Yorkshire is very diverse from an environmental perspective, and this is highlighted in Table 1 below. We have a vast array of critical areas that need environmental protection.

Table 1: 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

Our Level 1 region is contained within the EA's Humber River Basin District (RBD). This can be seen below in Figure 4. 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 5 you can see the entire Humber basin river structure including the key rivers within our Level 1 area.

Figure 4: Humber RBD location



Source: Environment Agency[4]

---

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

Figure 5: Key features of the Humber RBD

Source: Environment Agency[5]

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 6.

---

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

Figure 6: Level 2 SPAs

Table 2 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 7.3).

Table 2: 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 2: 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 7 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 story boards 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 7: 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, 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, multiple Level 3 catchments drain to the same WwTW or WwTWs with shared processes, as summarised in Table 3. 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.

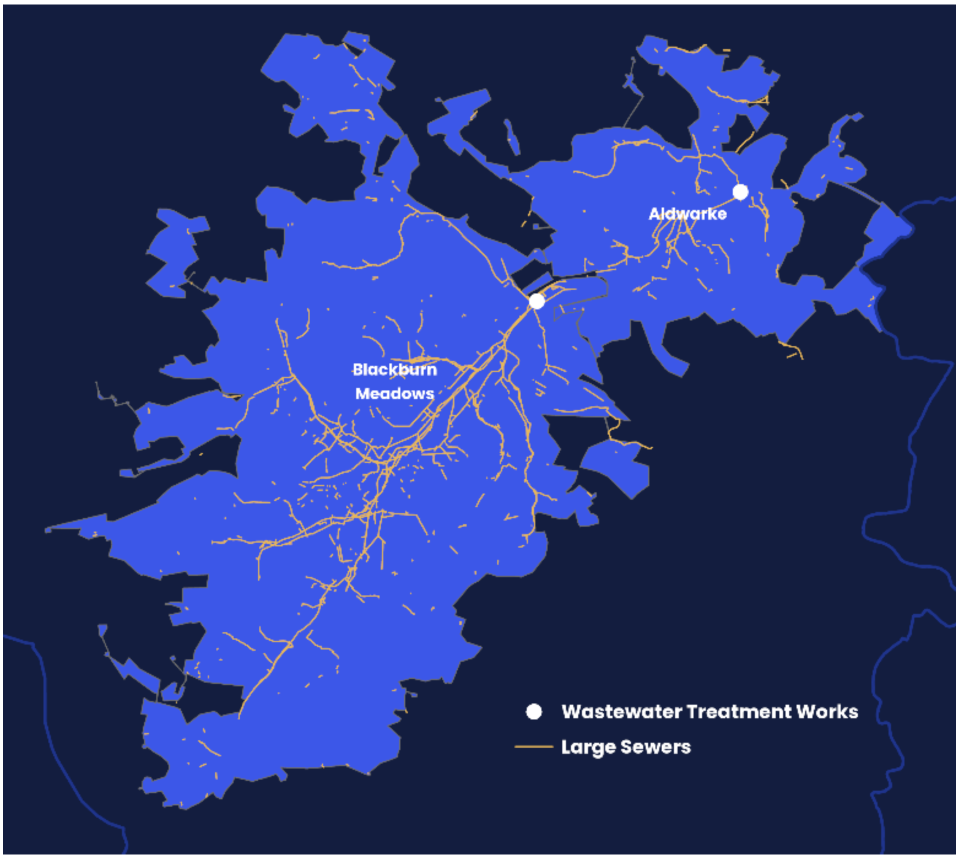
Table 3: Level 3 Catchments with Shared WwTWs:

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 story boards, we have also produced these for each of our Level 3 catchments. Please see Appendix D for individual catchment story boards.

Figure 8 below illustrates two Level 3 catchments, Aldwarke and Blackburn Meadows which fall within the Sheffield Level 2 SPA.

Figure 8: Two catchments within a Level 2 SPA



We did not sub divide any catchments into smaller planning units (Level 4) for this initial cycle. We plan to review and create these smaller drainage communities for our larger urban areas within future DWMP cycles.

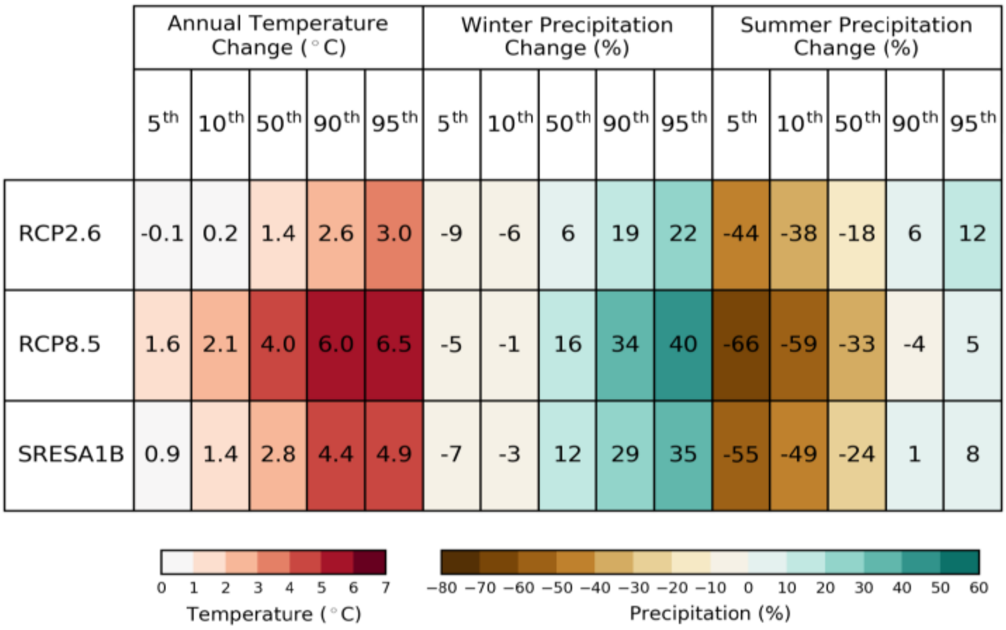
4.4 Climate change projections for our region

Our climate is already changing. We have seen a 1.1 degree rise in global temperature since the last century[6] and rainfall in the UK has become more intense[7], 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 future is very bleak as the planet warms by around 4 degrees by 2100, making vast swathes of the world too hot for human beings to physically 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 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 9 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 9: 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[8]

---

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

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

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

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.

4.5 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 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 focussed on the high emission scenario, aligning with the guidance from the Environment Agency for flood risk assessments[9]. We have considered a number of the wider impacts discussed above within our wider BRAVA resilience assessment (Section 7.4) 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.

4.6 Role of other stakeholders

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, 2014 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

---

[9] https://www.gov.uk/guidance/flood-and-coastal-risk-projects-schemes-and-strategies-climate-change-allowances

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.

5. Partnership working

Partnerships are formed by interested parties who come together to deliver projects that have benefits for all concerned 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 whilst delivering community and environmental benefits in Yorkshire.

We have a performance commitment measure - Working with Others (WWO) which has recently delivered in partnership, a number of different schemes, as detailed below in Appendix A, Section 1.1. We also have three larger 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.

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, ourselves, and regulators. Our vision is that by maturing partnerships which are a range of sizes, alongside other organisations, and communities we will:

- co-invest in time and commitment

- 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 approaches. We believe that we can resolve many of these problems, either fully or in part, through partnerships and working with communities. It is particularly important when looking at surface water flooding, 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[10].

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 for our customers, communities, and the environment. Our experiences show that many continuous funding streams are mis-aligned and require greater effort to enable co-funding to align. 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[11]

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.

We will be seeking to continue to strengthen our existing partnerships and identify opportunities to develop new partnerships in the future where working in partnership increases the value we deliver for customers. As one of our strategic aims within the DWMP is to remove surface water from the network, the cross organisational nature of this challenge, means we are likely to need to work in partnership to do this.

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).

---

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

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

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/

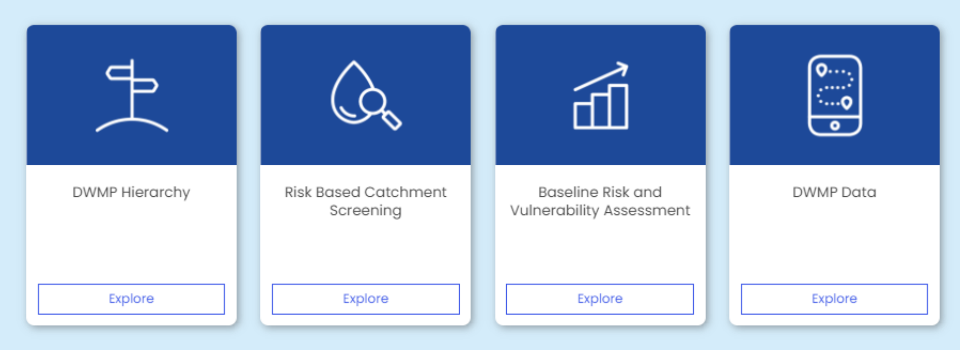
We have designed the Hub to be flexible, allowing it to evolve over time and enabling us to ensure suitability for individual stakeholder groups. Stakeholders have their own space within the Hub within which they can see the area relevant to them. This allows engagement on a more bespoke level as the 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 10:

Figure 10: Hub Structure



6.1.1 DWMP hierarchy

Figure 11 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 **12** and Figure 13 below.

Figure 11: Visual representation of Level 1, 2 and 3 information from YW Hub

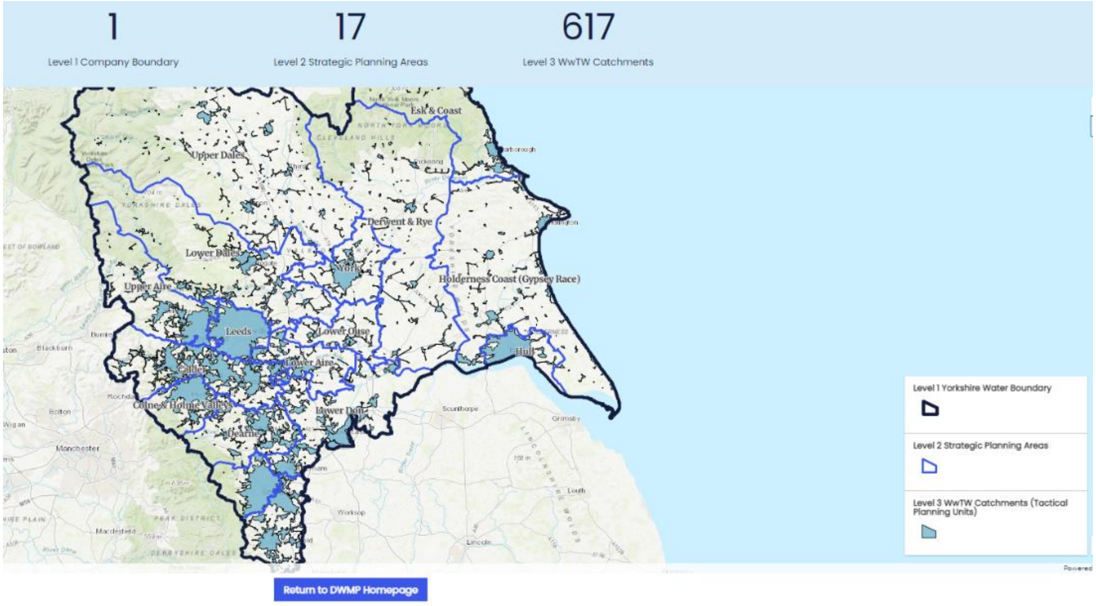


Figure 12: Example of visual representation of Level 2 and 3 catchment detail from YW Hub

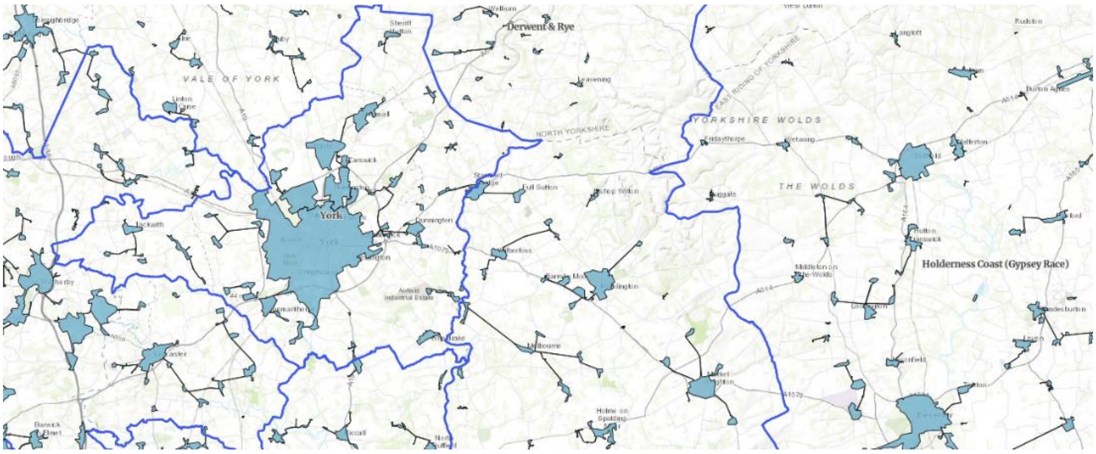
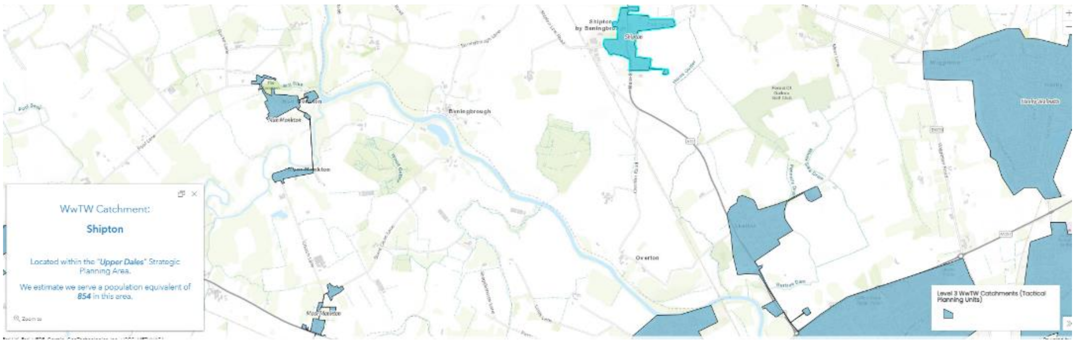


Figure 13: Example of visual representation of Level 3 catchments from YW Hub



WwTW Catchment:

Shipton

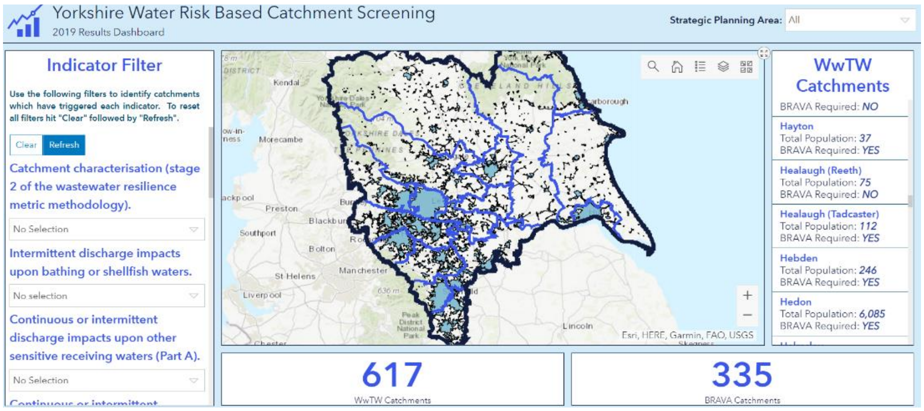
Located within the "*Upper Dales*" Strategic Planning Area.

We estimate we serve a population equivalent of **854** in this area.

6.1.2 Risk Based Catchment Screening (RBCS)

A dashboard, shown in Figure 14 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 14: 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

Continuous or intermittent

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*

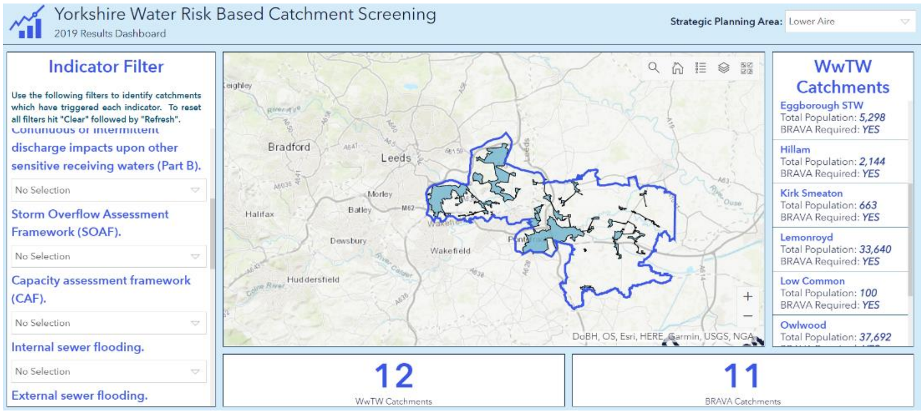
Hedon
Total Population: *6,085*
BRAVA Required: *YES*

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 15 below:

Figure 15: Lower Aire Level 2 SPA



Yorkshire Water Risk Based Catchment Screening
2019 Results Dashboard

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*

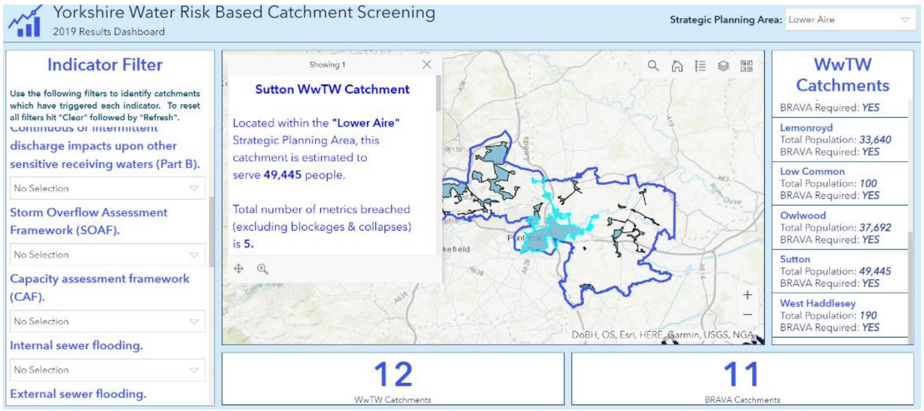
Owlwood
Total Population: *37,692*

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 16. 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 7.1 and 7.3 respectively.

Figure 16: RBCS Metrics Information for Sutton Level 3 Catchment



Yorkshire Water Risk Based Catchment Screening
2019 Results Dashboard

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.

Showing 1

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

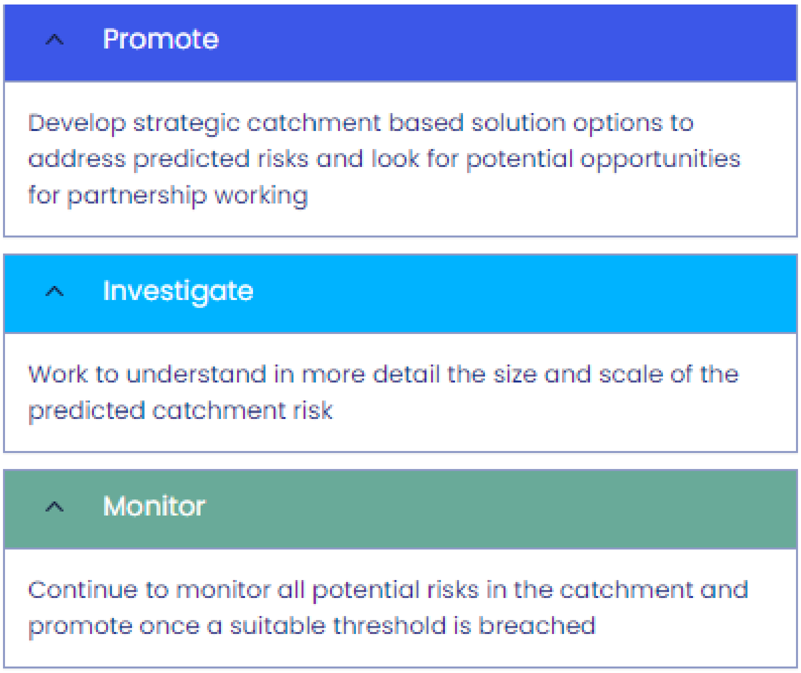
11
BRAVA Catchments

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 7.3 and 7.5 respectively. The definitions are shown below in Figure 17 and examples of how this looks on the Hub are shown in Figure 18, Figure 19, Figure 20 and Figure 21.

Figure 17: Problem Characterisation Definitions



Promote

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

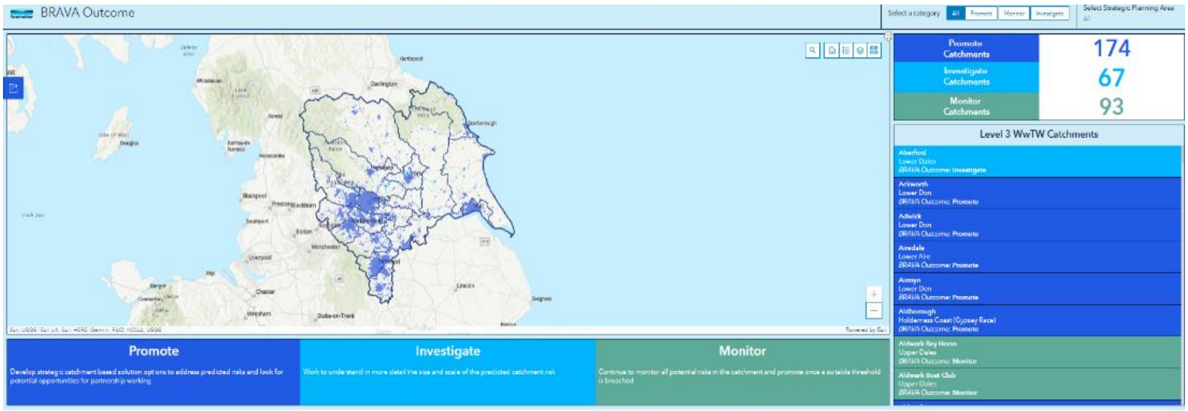
Investigate

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 18: Region Split of Problem Characterisation Catchments from YW Hub



Aberford
Lower Dales
BRAVA Outcome: Investigate

Ackworth
Lower Don
BRAVA Outcome: Promote

Adwick
Lower Don
BRAVA Outcome: Promote

Airedale
Lower Aire
BRAVA Outcome: Promote

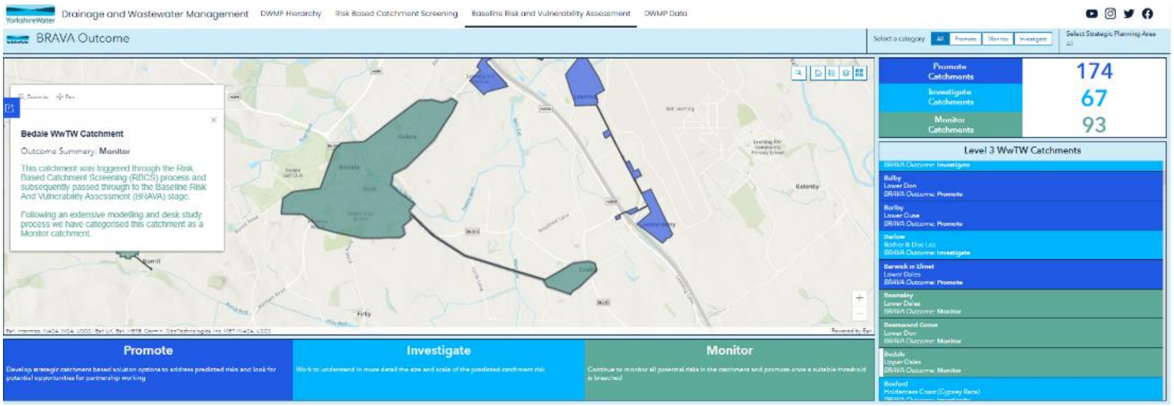
Airmyn
Lower Don
BRAVA Outcome: Promote

Aldbrough
Holderness Coast (Gypsey Race)
BRAVA Outcome: Promote

Aldwark Bay Horse
Upper Dales
BRAVA Outcome: Monitor

Aldwark Boat Club
Upper Dales
BRAVA Outcome: Monitor

Figure 19: An Example of the Information Available for a 'Monitor' Catchment – Bedale



Bedale WwTW Catchment

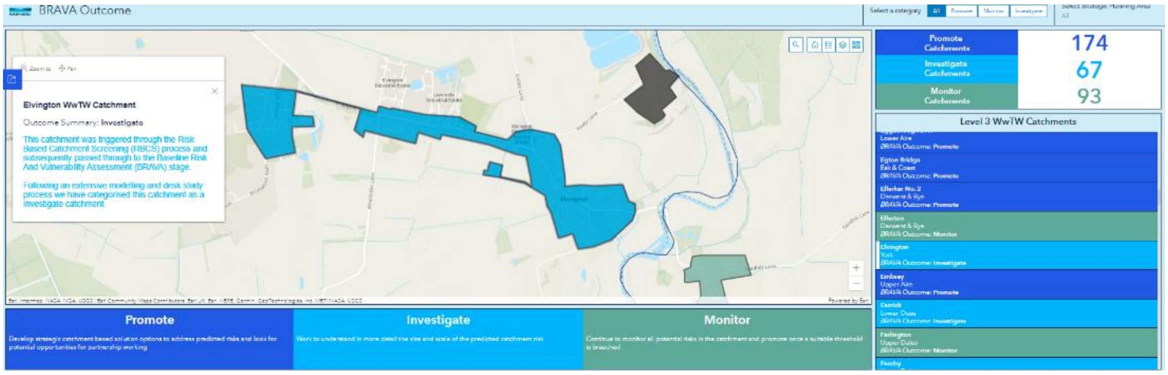
Outcome Summary: **Monitor**

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.

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

Figure 20: 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

Esrick
Lower Ouse
BRAVA Outcome: Investigate

Farlington
Upper Dales
BRAVA Outcome: Monitor

Feetby

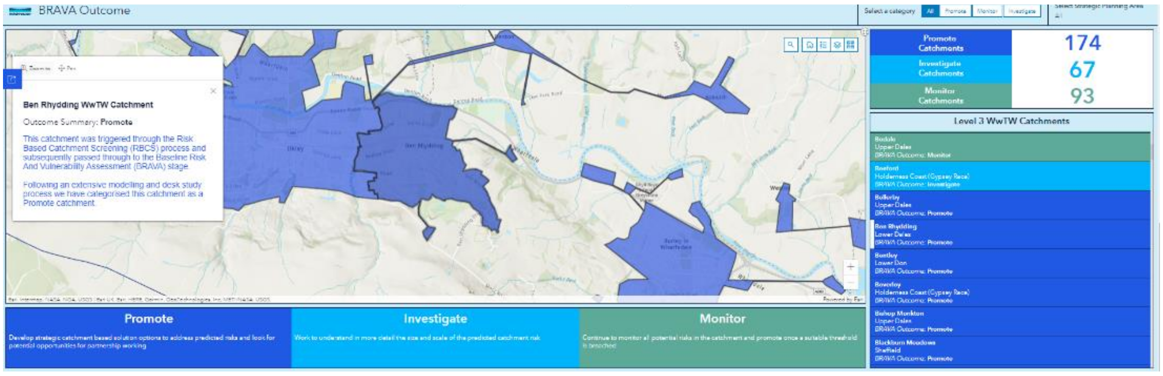
Promote
Develop strategic catchment based solution options to address predicted risks and look for potential opportunities for partnership working

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 21: 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 draft 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.

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.

The FRMP measures created were deemed successful for local authorities as we achieved a commitment to support FRMP's through our DWMP and vice versa. This included specific measures where the DWMP was referenced, and support was given.

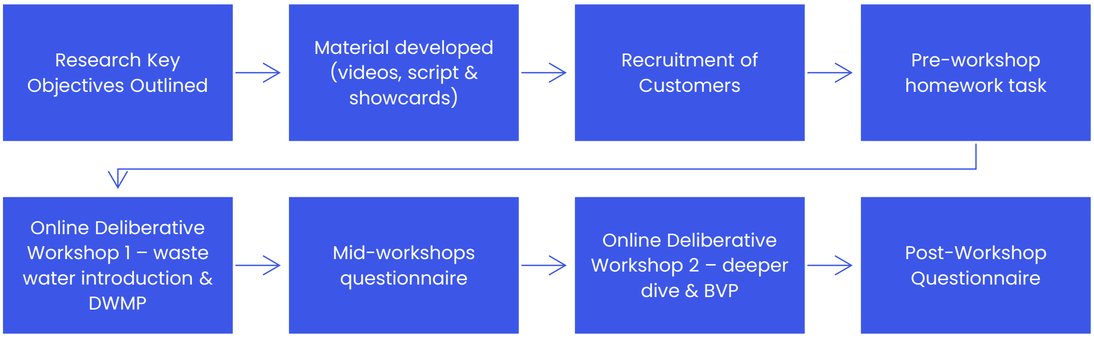
6.4 Customer research

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 22 **Error! Reference source not found.**below shows how the project was built.

Figure 22: Customer market research plan



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

<u>Wastewater Services:</u>

- 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.

<u>Drainage and Wastewater Issues:</u>

- 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

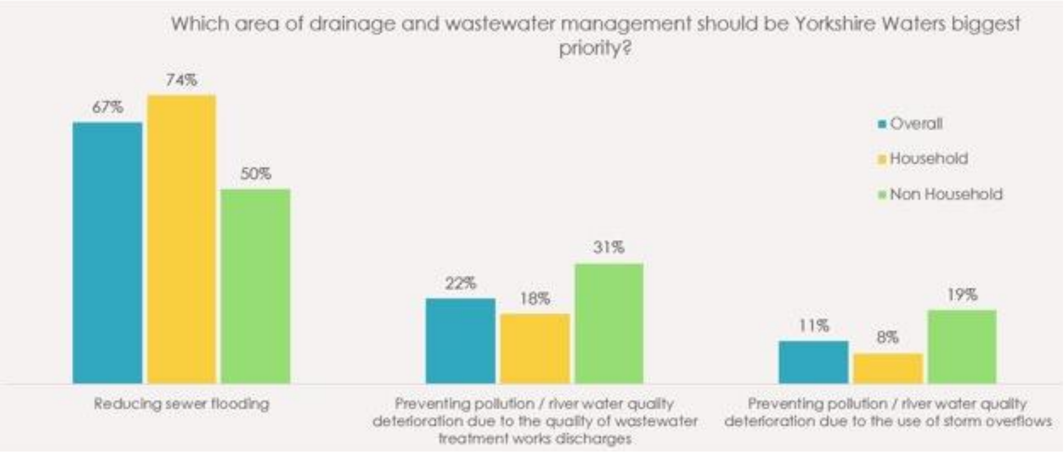
Consistent with other research that has been conducted within the water industry, generally, customers took water for granted. They rarely gave any thought to the water that came out of their taps or the wastewater that leaves their properties. When asked to think about the wastewater leaving their homes, 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 23 and Table 4:

Figure 23: Summary of workshop outputs: Risk prioritisation



Source: Turquoise on behalf of Yorkshire Water

Table 4: 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.

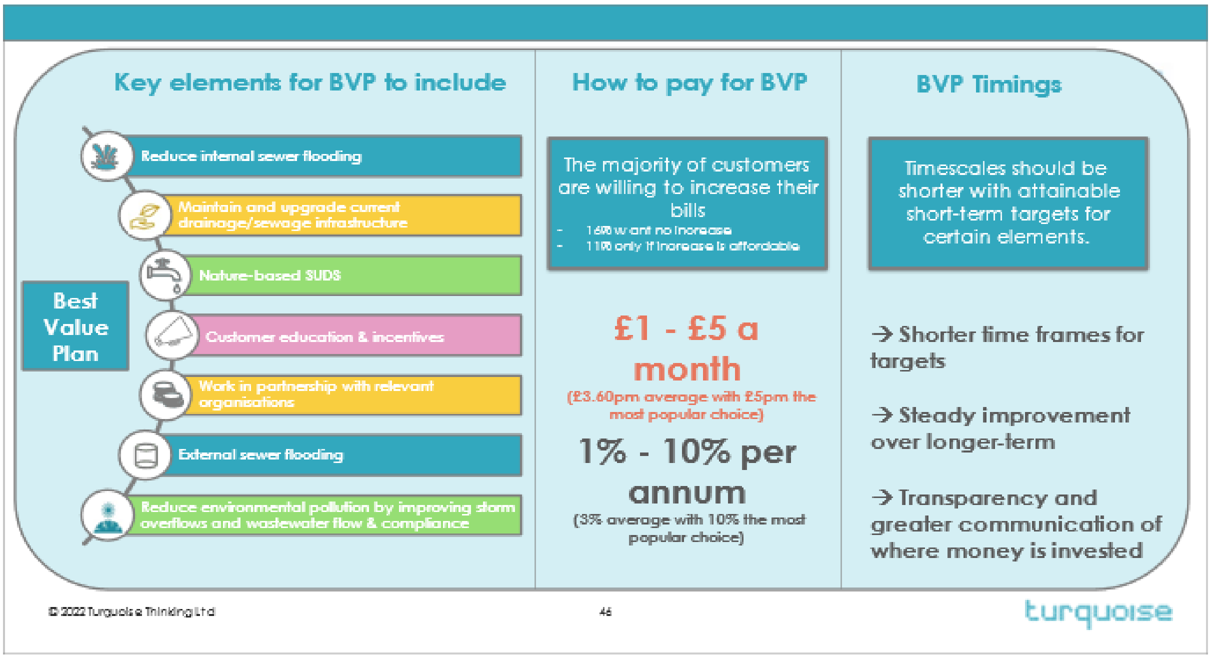
Source: Turquoise on behalf of Yorkshire Water

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.

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 24.

- 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 24: 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

© 2022 Turquoise Thinking Ltd

46

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. We have also met with the Environmental sub-committee of this forum. The Yorkshire Forum for Water Customer 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:

- challenging the quality of our processes for involving customers
- challenging how well our proposed outcomes and outcome delivery incentives reflect our customers' views and priorities
- monitoring progress against our performance commitments, and
- providing an independent evaluation to the YW Board through the Public Value Committee on how well we have reflected our customers' priorities in our business plans.

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, Rivers Trust, EA, and other community leaders.

7. Process steps and methodology

7.1 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.

7.1.1 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)[12]:

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.

---

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

- 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.

7.1.2 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.

7.1.2.1 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 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.

7.1.2.2 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.

7.1.2.3 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.

7.1.2.4 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.

7.1.2.5 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.

7.1.2.6 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[13]. 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.

7.1.2.7 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,

---

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

    - 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.
- 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.

7.1.2.8 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.

7.1.2.9 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.

7.1.2.10 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.

7.1.2.11 WwTW Dry Weather Flow (DWF) compliance

For all treatment works where appropriate flow measurement is undertaken, measured Q90[14] 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.

7.1.2.12 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.

7.1.2.13 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

---

[14] 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.

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.

7.1.2.14 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'*[15].

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.

7.1.2.15 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.

7.1.2.16 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

---

[15] **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 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.

7.1.2.17 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 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.

7.1.3 RBCS screening results

The number of Level 3 catchments that triggered against each of the indicators is summarised in Table 5. We have used the results of each indicator and applied the tiered approach as described in Section 7.1.1 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 5: 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.

7.2 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.

7.2.1 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[16], produced by Water UK. A summary of the national planning objectives is provided in Table 6 below.

Table 6: 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.

---

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

Table 6: National planning objectives summary

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 7.3.2.

7.2.2 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 7. 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 7: 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.

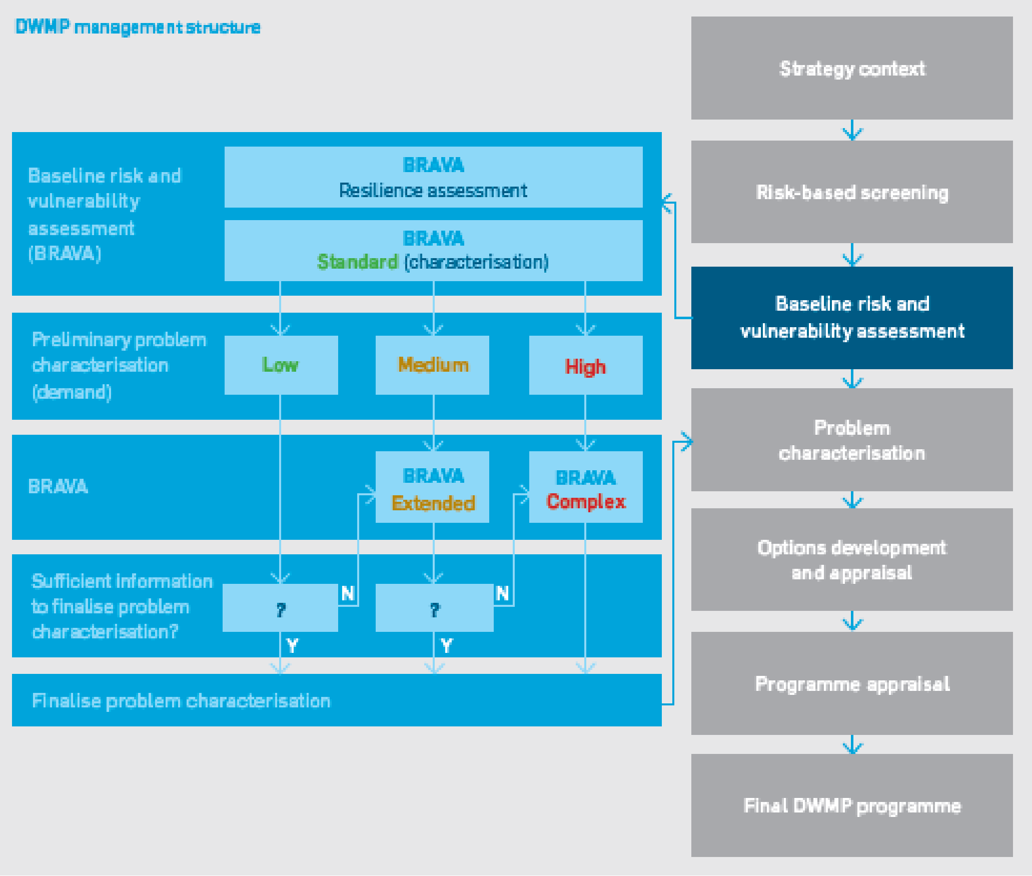
Further detail on the assessment of the bespoke Planning Objectives is provided in Section 7.3.3.

7.3 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 7.2.

The Water UK framework outlines the process shown in Figure 25 for undertaking BRAVA.

Figure 25: Schematic of the DWMP BRAVA process



Source: Water UK[17]

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.

7.3.1 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.

---

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

- Catchment characteristics such as slope and soil type

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).

7.3.1.1 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.

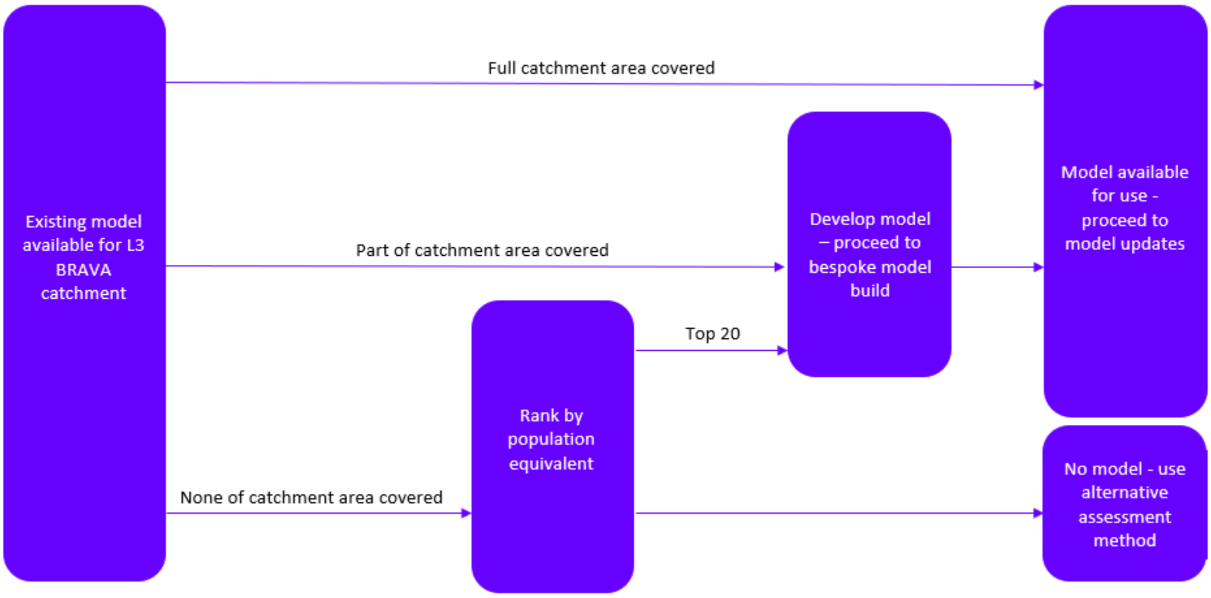
7.3.1.2 Model availability

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 7.3.1.3. 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 26, below:

Figure 26: Model availability for use in DWMP



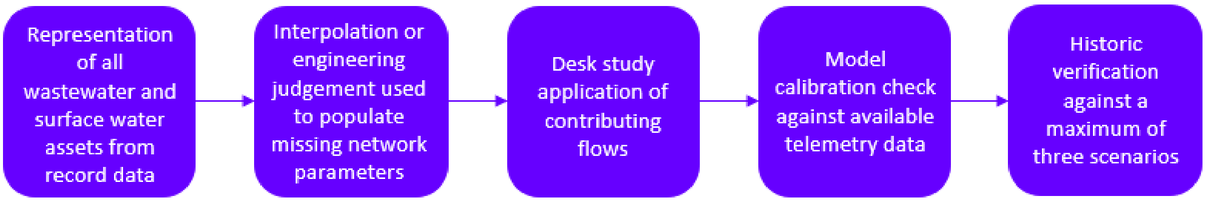
7.3.1.3 Bespoke DWMP model build

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 27, 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 27: 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.

7.3.1.4 Model updates

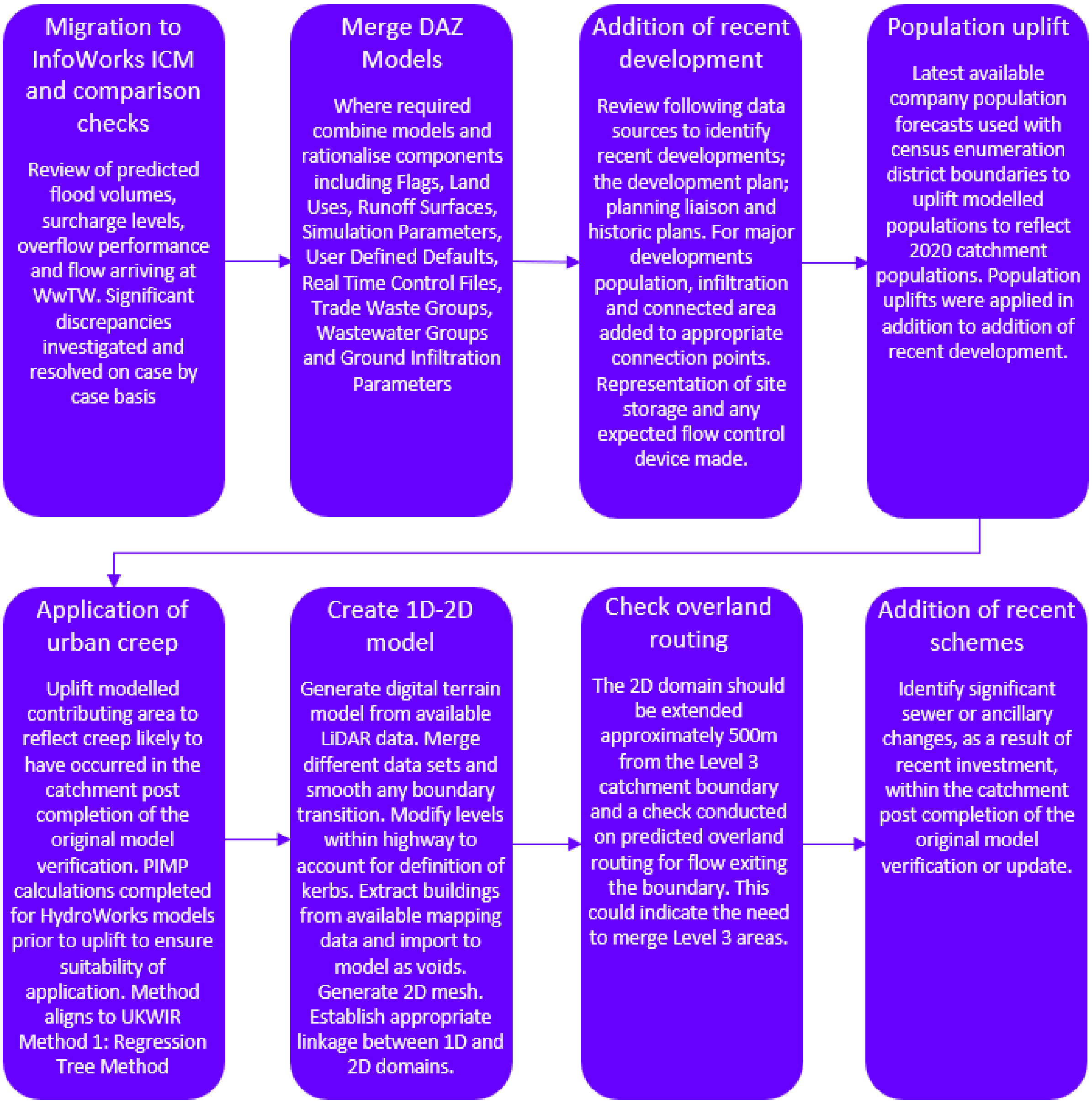
As noted above, the available models have previously been built to investigate specific needs or for drainage area planning and therefore follow the modelling procedures of that time.

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.

7.3.1.5 Creation of the baseline model

The process used to create the baseline 2020 model is summarised in Figure 28 below:

Figure 28: 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.

7.3.1.6 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.

7.3.1.6.1 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 utilise this updated dataset within our DWMP assessments. We will look to incorporate this dataset and subsequent revisions of it as part of our adaptive planning processes.

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.

7.3.1.6.2 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.

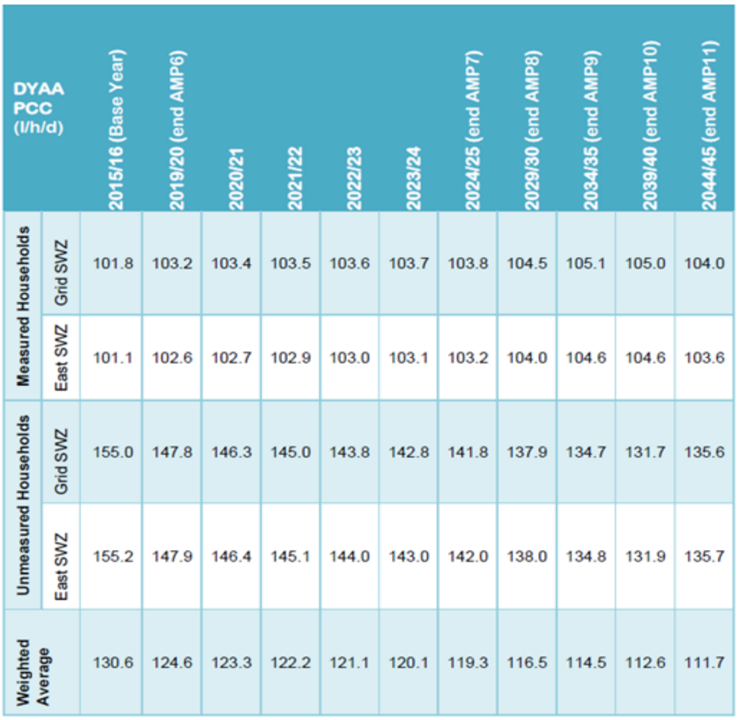
7.3.1.6.3 Wastewater consumption reduction

The future per capita consumption (PCC) rates were aligned to values within our WRMP19[18], 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 29 below, the weighted average has been utilised. The 2044/2045 consumption rate has been utilised within the 2050 and the 2080 epoch models.

---

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

Figure 29: 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

7.3.1.7 Modelled rainfall

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

7.3.1.7.1 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[19]. 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).

7.3.1.7.2 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 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

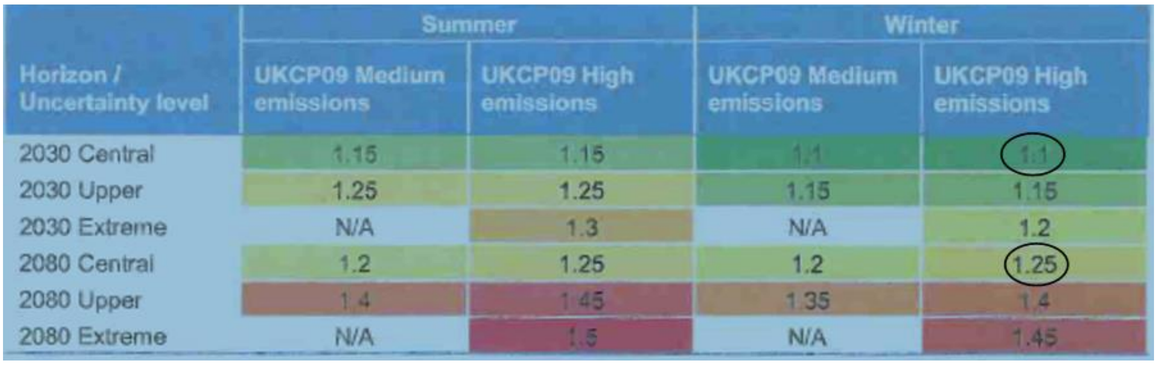
---

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

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 30 below.

Figure 30: 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 make use of this revised data for our second round of DWMPs. 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.

7.3.1.7.3 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 8.

Table 8: 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

7.3.1.7.4 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 'Redup' 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.

7.3.2 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.

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

As noted in Section 7.3.1.5, 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 9.

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 9: 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
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 10:

Table 10: 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.

7.3.2.2 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 11, it should be noted these are defined within the national guidance.

Table 11: 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 12 below.

Table 12: 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 13 have been applied.

Table 13: 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.

7.3.2.3 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.

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

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:

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

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 14 have been applied.

Table 14: 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.

7.3.2.4 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 15:

Table 15: 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.

7.3.2.5 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 16:

Table 16: 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.

7.3.2.6 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 17:

Table 17: 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.

7.3.2.7 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 18.

Table 18: 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

Table 18: 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
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

7.3.3 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.

7.3.3.1 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 7.3.1.5, 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 31 below:

Figure 31: 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 19 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 19 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 19: 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 20 below, the final annualised score for the property would be 0.333.

Table 20: 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 21 below.

Table 21: Catchment performance band for internal 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. For example, if the band for the absolute score is 1 and the percentage is 2, the final score would be 1.5.

7.3.3.2 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 22 below:

Table 22: 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.

7.3.3.3 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 23.and Table 24.

Table 23: 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 24: 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 25 below:

Table 25: 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 26 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 26: 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

7.3.3.4 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 27.

Table 27: 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.

7.3.3.5 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:

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

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 7.3.3.4.

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 28

Table 28: 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.

7.3.3.6 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 29 below shows the annualised score for the different return periods assessed as part of this planning objective.

Table 29: 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 30 below:

Table 30: 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.

7.3.3.7 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 31:

Table 31: 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.

7.3.3.8 Summary of bespoke BRAVA planning objectives outputs

The results of BRAVA stage using the bespoke planning objectives are summarised in Table 32 - Table 38 below:

Table 32: 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 33: 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 34: 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 35: 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 36: 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 37: 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 38: 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

7.3.4 Comparison between national and bespoke planning objectives

As discussed in Section 7.3.3 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 39.

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 39: 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 39: 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

7.3.5 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 40. 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 40: 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

7.3.6 BRAVA outputs

The results of the planning themes are summarised in Table 41 - 44 below:

Table 41: 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 42: 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 43: 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 44: 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 7.4.

7.3.7 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.

7.4 Wider resilience

In addition to the detailed baseline risk and vulnerability assessments (BRAVA) discussed in section 7.3 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.

7.4.1 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[20] 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.

---

[20] 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 45:

Table 45: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 46 and Table 47 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:

Table 46: Existing Resilience Measures in Place Score

No	1
Yes	0.5

Table 47: Mitigation Plan or VAP Score

No	1
Yes	0.8

7.4.2 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 48, Table 49 and Table 50 below.

Table 48: Probability of Power Failure Score

High	5
	4
	3
	2
Low	1

Table 49: Asset Criticality Score

A – Very High	5
B – High	4
C – Medium	3
D – Low	2
A – Very High	5

Table 50: Mitigation Plan Score

No Existing Mitigation Plan	1
Existing Mitigation Plan	0.8

7.4.3 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 51, Table 52, Table 53 and Table 54 the formula detailed below:

Table 51: SCADA Score

Yes	3
No	0

Table 52: RTS Score

Yes	2
No	0

Table 53: No Telemetry Present Score

Yes	5
No	0

Table 54: Asset Criticality Score

A – Very High	5
B – High	4
C – Medium	3
D – Low	2
E – Very Low	1

$$Asset\ Remote\ Communication\ Risk\ Score = (SCADA + RTS + No\ Telemetry) * Asset\ Criticality$$

7.4.4 Overall resilience scoring

For all WwTWs and wastewater pumping stations within the region we have determined an overall "Asset Resilience Risk Score" as follows:

$$Asset\ Resilience\ Risk\ Score = Asset\ Flood\ Risk\ Score + Asset\ Power\ Risk\ Score + \\ Asset\ Remote\ Communications\ Risk\ Score$$

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. The results of this assessment are provided in the Level 3 story boards provided in Appendix D.

7.4.5 Our response to incidents

Our approach to flood resilience follows the Cabinet Office's guidance[21] 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 to flood but enable it to be recovered quickly afterwards, for example by ensuring critical electrical equipment is above flood levels. See Figure 32 below:

---

[21] https://www.gov.uk/government/publications/keeping-the-country-running-natural-hazards-and-infrastructure

Figure 32: YW Infrastructure resilience four box model[22]

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.

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.

---

[22] 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

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.

7.4.6 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.

7.5 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 the Section 7.3.5.

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 7.4.4) for each catchment as noted on the Level 3 catchment story boards 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.

7.5.1 Confidence assessment

To each of the themes, a confidence level was established for each Level 3 catchment, as outlined in Table 55.

Table 55: 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 7.3.1.3 or those built before 2009. Any 2D only models, developed for the assessment of PO-01 were considered low confidence and scored appropriately.

7.5.2 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.

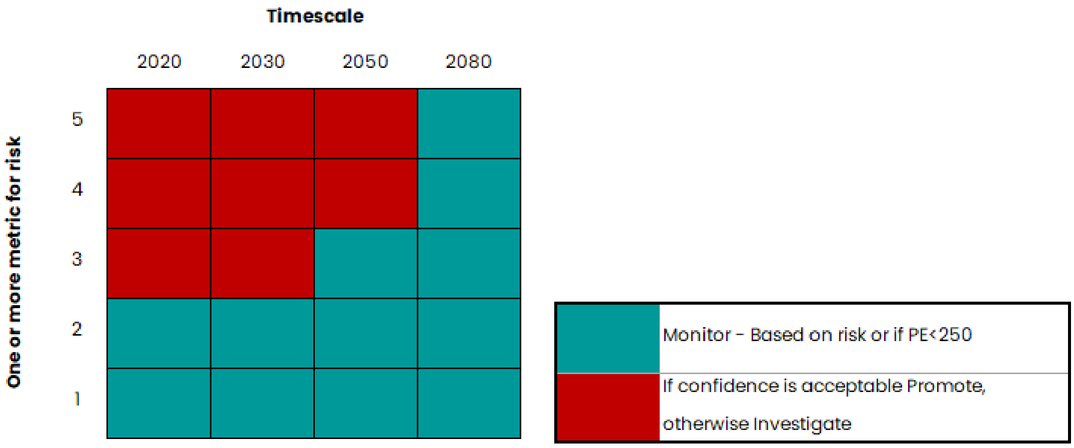
Where monitor and investigate are assigned this should not be interpreted as there being no risks present within the catchment. Risks may be present and therefore mitigation may be required. The same is true of catchments that did not trigger within RBCS. For instance, there could be a storm overflow 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 33 below:

Figure 33: YW problem characterisation matrix



	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.

7.5.2.1 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 56 below shows the breakdown of network assignments between Monitor, Investigate and Promote and the reason for the assignment based on the above matrix.

Table 56: 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

7.5.2.2 WwTW treatment 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 57: Problem characterisation runway assignment: Treatment

Runway	Nr of Level 3 Catchments
Monitor	288
Investigate	7
Promote	40

7.5.3 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 58 below:

Table 58: 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 33, 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.

7.5.4 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

7.5.4.1 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%

7.5.4.2 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%

7.5.4.3 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.

7.5.4.4 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.

7.5.4.5 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%

7.5.4.6 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 59:

Table 59: 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.

7.6 Scenarios

The previous stages of DWMP development have so far evaluated current and future risk within the catchments that triggered BRAVA against the national and bespoke planning objectives. The highest risk catchments have been identified and have been through preliminary screening to understand potential drivers within each catchment and will now progress through to Option Development and Appraisal (ODA).

The developed options will need to drive to a target level of service by 2050. It is likely that different levels of service will require different solutions which will in turn change the investment requirement and potential cost benefit assessment.

We have developed four different plans to deliver four sets of targets, identified as different scenarios.

- **Scenario 1**: Annual average of no more than 10 spills per storm overflow 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.
- **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.
- **Scenario 3**: Annual average of no more than 10 spills per storm overflow and maintain regional level 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.
- **Scenario 4**: Annual average of no more than 10 spills per storm overflow, plus no environmental harm from storm overflows and maintain regional level 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.

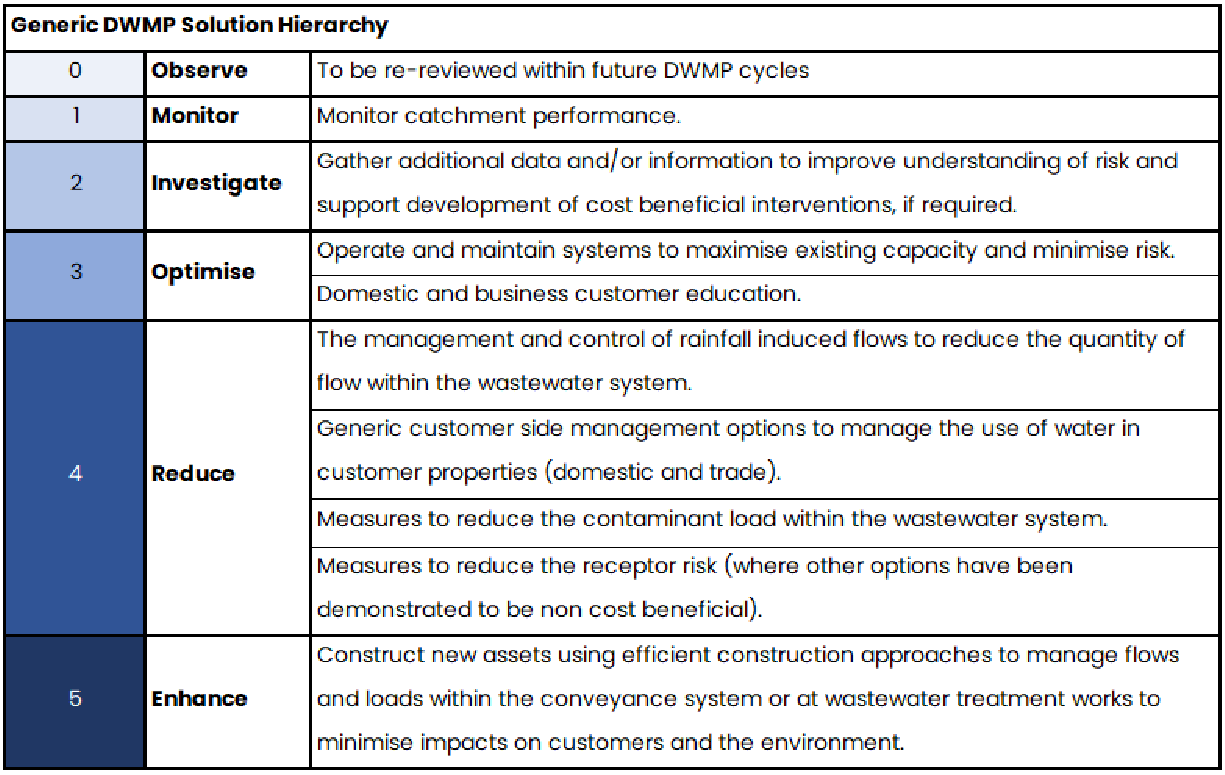
As noted within Section 7.5.2, we have taken a catchment-based approach. If one network planning theme is triggered and Promote assigned, then both planning themes will be considered within the options development stage for the network. This allows us to take a holistic approach and achieve efficiency in our long-term plan by reducing all identified risk within the catchment rather than focusing on the triggered risks only. The ODA stage for treatment has only been completed in those catchments that were assigned Promote for the treatment planning theme.

7.7 Options development and appraisal

The main aims 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. A key principle in the development of the DWMP is that the ODA process should be undertaken for any Level 3 catchment assigned Promote as a result of the Problem Characterisation stage.

We developed a generic solution hierarchy, show in Figure 34 below:

Figure 34: Generic DWMP solution hierarchy



Generic DWMP Solution Hierarchy		
0	**Observe**	To be re-reviewed within future DWMP cycles
1	**Monitor**	Monitor catchment 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 maintain systems to maximise existing capacity and minimise risk.
		Domestic and business customer education.
4	**Reduce**	The management and control of rainfall induced flows to reduce the quantity of flow within the wastewater system.
		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**	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.

This is a hierarchical process to stage the level and nature of intervention we need to deploy within the catchment.

As discussed in Section 7.1.3, Observe is automatically assigned to all catchments that did not trigger within the RBCS process. Monitor and Investigate are assigned outcomes from the Problem Characterisation stage and are dependent on the catchment size, risk level and data confidence.

Optimise, Reduce and Enhance are all steps to be evaluated for those catchments that were assigned Promote within the Problem Characterisation stage. A list of generic options has been created which has been aligned to each of the stages within our DWMP solution hierarchy.

7.7.1 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 the DWMP solution hierarchy shown above in Figure 34**Error! Reference source not found.**. 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. Optioneering, solutions and costs for the strategic plan are presented at a Level 3 catchment level and not for specific assets or risk locations within these catchments.

7.7.1.1 Monitor

In addition to reviewing the catchment performance there are a number of generic options to be taken forward and considered for all catchments, these are set out in Table 60, 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 60: 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)

7.7.1.2 Investigate

In some instances, further information is needed to improve our understanding of risk and to support the development of cost beneficial interventions. These investigations have not been included in our costed plan at this stage.

7.7.1.3 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 61 summarises the generic options falling within the Optimise category.

Table 61: 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 – this is BAU
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

Table 61: Generic option screening: optimise

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, including a project in Ilkley where smart monitoring, analytics and control solutions will be used to manage the flow of sewage from homes to treatment works and a project in Holbeck, Leeds which will focus on predicting sewer network problems before they occur using increased monitoring and rainfall data. We will be looking to undertake more trials in the 2025 – 2030 regulatory period (AMP8). 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.

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.

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.

7.7.1.4 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.

7.7.1.4.1 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 62 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 62: 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)

Table 62: Generic option screening: reduce wastewater and trade effluent

Generic Option	Description	Comment
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
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 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.

7.7.1.4.2 Rainfall induced flow

Measures to reduce the quantity of rainfall induced flow within the system are shown below in Table 63.

Table 63: 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
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 a further investigation for those Promote catchments where the preliminary screening suggested inflow and infiltration was high. A study cost has been developed and built into the proposed plan. The study will aim to identify inflow and infiltration sources, develop bespoke solutions and quantify the benefit that could be achieved. Only investigation costs have been considered at this stage, however it should be noted that the Promote catchment has still been subject to the full ODA process. It is anticipated that the findings from the proposed investigation would result in any delivery plan for the Level 3 catchment achieving an improved cost benefit compared to the strategic plan developed for this cycle of the DWMP.

7.7.1.4.3 Contaminant load

Measures to reduce the contaminant load entering the network are shown below in Table 64.

Table 64: 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.

7.7.1.4.4 Receptor risk

Measures to reduce the risk to the receptor are shown below in Table 65.

Table 65: 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	Reject – further work needed to understand customer acceptability
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.

7.7.1.5 Enhance

Measures where we can look to add to our assets to improve performance and reduce risk can be seen below in Table 66 .

Table 66: 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

7.7.2 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.

We have assessed flooding and storm overflow risks at a catchment level, with optioneering also undertaken at a catchment level. Recent or planned investment is generally at a localised or asset level and therefore any reduction in flooding or storm overflow risk as a result of this investment has not been accounted for when developing our options for the DWMP. Recent schemes will be taken into consideration when further developing options at a localised level for PR24 and beyond.

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. Following the review of existing schemes, the number of Level 3 catchments requiring option development for WwTW compliance reduced from 40 to 10.

7.7.3 Networks ODA

A number of the generic options detailed within Section 7.7.1 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

For each of our network Promote catchments, we have considered two main potential approaches in order to achieve our scenario targets by 2050: These are outlined below where 'X' denoted the Scenario number:

X.1 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.

X.2 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 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 still necessary. This option approach considers a reduction in rainfall induced flow and network modification.

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. The service measures are pre-defined and linked to planning themes in Table 67 below. For each option approach, each service measure has been evaluated as the change in expected performance when compared to a baseline 2050 position.

For each of our four scenarios, the DMF will be making the following selections:

- Solution approach to utilise within each Promote catchment (X.1 or X.2).
- How many years to phase the estimated catchment investment over (based on the developed delivery options).
- When to commence the estimated catchment investment between 2020 – 2050.

We have also undertaken 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. This is discussed further with the Programme Optimisation and Appraisal section of this report, Section 0.

Table 67 below gives a summary of the outline options that have been developed for each of the network planning themes and the linked service measures that have been evaluated:

Table 67: Network solution overview

Planning Themes	Approach X.1	Linked Service Measures	Approach X.2	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

Table 67: Network solution overview

Managing Storm Overflow Performance	Based upon the approach used within the National SOEP report[23]	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

As a reduction in connected impermeable area has the potential to benefit both flood risk and storm overflow operation, catchments are considered holistically i.e., there is a single evaluation of cost and benefit for each option approach (X.1 and X.2) for each catchment.

Additionally, it is acknowledged that there may be some crossover in benefits arising from traditional 'grey' schemes to mitigate the impacts of flooding and storm overflow operation. At present these schemes have been assessed independently and therefore the cost build-ups may be refined in the future as we increase certainty in respect of our understanding of interventions which may deliver multiple benefits.

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 scenario targets. 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.

7.7.3.1 Impermeable area reduction

7.7.3.1.1 Method

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 Promote catchment 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

---

[23] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1030980/storm-overflows-evidence-project.pdf

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 creep rates would not be reduced.

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 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 each scenario provides an assessment of any further ‘grey’ network enhancement that might be required. The process for this is described in Sections 7.7.3.2 and 7.7.3.3 below.

7.7.3.1.2 Cost and Service Measures

The total reduction in connected impermeable area has been determined for each catchment and a standard unit cost per hectare used to derive the overall catchment cost for this component.

An estimate of operational costs has been made using nationally available unit costs.

Estimates of embodied and operational carbon have been made using in-house models.

The following service measures have been populated for the benefit assessment within the DMF:

- 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.

Additionally, the reduction in impermeable area contributes to the following service measures:

- Water quality change in receiving waterbody due to storm overflow
- Non-swimmable to swimmable classification for a waterbody
- Reduction of volume weighted spill frequency
- Internal flooding of a habitable area of a property
- External flooding within the property boundary inhibiting access

Further details on the quantification of these service measures are provided in Section 7.7.3.2.2 and 7.7.3.3.2 below.

It should be noted that the reduction in area alone is not always sufficient to achieve the scenario target for flood risk and storm overflow performance. However, in some instances, the reduction in connected area is predicted to reduce service measure performance beyond a level required by the scenario target. This is particularly noticeable regarding managing flood risk in scenarios 3 and 4 where further grey enhancement for flood mitigation is not always required. The approach taken to the benefits assessment allows the full benefit to be assessed rather than this being capped at the scenario target level.

Additionally, it should be noted that a reduction in 1 in 50- and 1 in 100-year flood risk as a result of impermeable area disconnection has been evaluated. However, this has not been entered into the service measure assessment as this would be considered to bias the performance of this solution approach. Further detailed modelling on the proposed interventions was unable to be completed within the available time constraints. A comparable assessment could not therefore be completed for the X.1 solution approach for the resilience-based service measures.

7.7.3.1.3 Assumptions and Limitations

A significant limitation of this approach is that area reduction has not been targeted within the Level 3 catchment to risk hotspots. Consequently, cost may be evaluated that is providing minimal benefit locally, however there is likely to be a benefit on reduced volume to be treated. 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 where the X.2 solution approach has been selected by the DMF.

The actual solution form is unknown, this will depend very much upon local factors and agreements that can be created with local authorities and residents. Storm water disconnection may mean a management of storm water is required. Consideration of where the water will discharge to, and any associated mitigation this may require, is assumed to be considered within the unit cost.

A single unit cost rate has been applied to all catchments therefore variation due to local conditions is not considered. There is a reliance on nationally available costing datasets.

The high-level solution nature means that there is a limitation in the operational costs and carbon assessments that can be completed.

The high-level nature of the assessment and uncertainty provides a constraint on the level of optioneering detail that can be completed. It is important to achieve a like for like comparison between the X.1 solution approach and the X.2 solution approach.

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.

7.7.3.2 Managing storm overflows

7.7.3.2.1 Method

Our scenarios have two targets around managing storm overflow performance by 2050:

a. Annual average of no more than 10 spills per storm overflow
b. Annual average of no more than 10 spills per storm overflow, plus no environmental harm from storm overflows

The methodology to assess required storm overflow mitigation to achieve our scenario targets by 2050, aligns closely to the methodology developed for the Storm Overflow Evidence Project (SOEP) undertaken on behalf of Defra.

For each target and each solution approach (X.1 and X.2) the required storage volume has been evaluated. The traditional solution approach (X.1) utilised the model results complied for the BRAVA assessment. The blended solution approach (X.2) utilised model results from the Impermeable Area Reduction model described in Section 7.7.3.1.1; as noted, this analysis has been completed for a single year.

The national SOEP study used a simplistic model to link the baseline predicted performance at an overflow to a likely required reduction in contributing area and the associated reduction in predicted spill volume and frequency. Given our development of the impermeable area reduction model we held specific modelling results pertaining to this assessment criteria and therefore used this data in place of the simplistic national SOEP data. This is the major deviation from the national SOEP methodology and results.

Target A

For each storm overflow within a network Promote catchment, model data has been used to evaluate the theoretical storage required on the spill pipe of the storm overflow. The required volume of storage is based upon a target average annual spill frequency of no more than 10.

Target B

For each storm overflow within a network Promote catchment, model data has been used to evaluate the theoretical storage required on the spill pipe of the storm overflow. The required volume of storage, is based upon the maximum of:

- The volume required to achieve a target average annual spill frequency of no more than 10.
- The volume required to achieve an equivalent waterbody ecological status of good. Further information on how this was assessed is provided in the following section on river health.

7.7.3.2.2 Cost and service measures

A staged unit cost rate per cubic meter of storage has been used to evaluate the solution cost. The unit cost of storage was reduced as the volume increased with a cap at a minimum value per cubic meter.

An estimate of operational costs has been made using data provided by our costing team.

Estimates of embodied and operational carbon have been made using in-house models.

The following service measures have been populated for the benefit assessment within the DMF:

- Water quality change in receiving waterbody due to storm overflow
- Non-swimmable to swimmable classification for a waterbody
- Reduction in volume weighted spill frequency

These are new metrics within our DMF which have been added to support the development of the DWMP and are based around the Storm Overflow Evidence Project published by Defra.

The SOEP report considered three components of performance linked to storm overflow operation:

1. river health
2. public health
3. social impact

Methodologies for the assessment of these have been developed within the SOEP study in order to evaluate the performance of different interventions. We have utilised these methodologies in our DWMP assessment. An overview is given below with further information available within the SOEP Project Report.

River Health

This metric makes a high-level assessment of the storm overflow impact upon the ecological status of the river. This maps to our service measure of water quality change in receiving waterbody due to storm overflow.

The total spill volume and frequency predicted to discharge to a waterbody was calculated for 2050. The volume weighted spill frequency (VWSF) for each waterbody was calculated by dividing the sum of the product of annual spill volume and annual spill frequency by the sum of the annual spill volumes, as shown in the equation below. The VWSF provides a characterisation of the overflow frequency patterns at a waterbody level.

$$VWSF = \frac{\sum(Volume \times Frequency)}{\sum Volume}$$

A storm overflow dilution ratio was calculated by dividing the annual storm overflow spill volume by the diluting river flow, where the diluting river flow was the 70th percentile river flow multiplied by the VWSF multiplied by 4 hours (the average spill duration from the national assessment).

The calculated dilution ratio was mapped to an equivalent ecological status for the waterbody as shown in Table 68 below.

Table 68: Calculated dilution ratio mapped to equivalent ecological waterbody status

Equivalent ecological status	Dilution ratio (spill : river)
High	≤0.1
Good	≤0.15
Moderate	≤0.2
Poor	≤0.5
Bad	>0.5

This assessment was undertaken at a waterbody level. A Level 3 catchment can contain multiple waterbodies, equally multiple Level 3 catchments can contribute to a single waterbody. Consequently, in some instances, a pro-rata method based on the number of overflows contributing to the waterbody, was then applied to transpose the river health assessment back to a Level 3 catchment.

This metric is quantified in DMF as the total length of waterbody predicted to change ecological status when compared to the 2050 baseline. Each classification change is entered separately.

Public health

This metrics makes a high-level assessment of the public health risk due to storm overflows. This maps to our service measure of non-swimmable to swimmable classification and is applied to inland waterbodies only.

Where there is an inland bathing designation, this public health target is achieved by using a revised target average annual spill frequency of no more than five. If analysis showed a lower spill frequency was required to achieve good ecological status for Target B, then this lower frequency would be used instead of five spills.

A public health risk can be present where there is bathing or immersion in water where bacteria levels are in excess of defined thresholds. Two bacteria standards for faecal indicator organisms are used to indicate if faecal bacteria levels within a waterbody are a risk to public health. Storm overflows can be a potential source of in river faecal bacteria, although it is important to note that there are other potential sources.

For the DWMP it has been assumed that above a maximum VWSF of five per year per waterbody there would be a risk to public health.

This metric is quantified in DMF as the total length of waterbody predicted to present minimal public health risk when compared to the 2050 baseline.

Social impact

This metrics maps to our service measure of reduction in volume weighted spill frequency and is quantified in DMF as the predicted reduction in VWSF when compared to the 2050 baseline.

7.7.3.2.3 Assumptions and limitations

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 scenario 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.

The unit cost applied makes no consideration of land purchase need.

All storage is assumed to be below ground storage. The unit cost applied makes an allowance for mechanical and electrical equipment.

Water quality modelling has not been carried out. The method presented is a proxy assessment that has been used for national strategic assessment and mirrored for use within our DWMP.

The assessment of good ecological status relates to a prediction of ecological status caused by storm overflows alone. This does not mean good water quality status will be achieved as the contribution of other risk sources is not considered. Water quality is the responsibility of the EA and can be dependent on many other, potentially unknown, point and diffuse sources of pollution. This assessment only considers the impact of modelled storm overflows on waterbodies and excludes the impact of all other sources of pollution.

Mapping of storm overflows to waterbodies has been undertaken based upon proximity. Waterbody areas and Level 3 catchment boundaries do not necessarily align. There are often overflows in different Level 3 catchments contributing to a waterbody, or multiple waterbodies in a single Level 3 catchment. Additionally, the assessment considers each waterbody in isolation.

The apportionment of benefit between multiple Level 3 catchments means all overflows contributing to each waterbody are weighted equally. Therefore, the benefit is shared equally between all overflows contributing to the waterbody. This is something we will look to refine for future DWMP cycles.

Only storm overflows in catchments that were assigned Promote for the network have been considered. There may be instances where a waterbody is contributed to from a Promote Level 3 and an Investigate Level 3, no consideration of the impact of the Investigate Level 3 is made, for instance.

Coastal bathing sites and inland bathing locations have been assessed using an annual proxy aligned with the SOEP. Further assessment would be needed to evaluate the within bathing season performance upon finalisation of the required targets within the Environment Act.

The analysis is based upon a single year assessment.

It should be noted there are a number of AMP7 schemes in progress which have been promoted due to WINEP drivers. There is potential these schemes will meet some or all of the required need to achieve the storm overflow scenario targets set out within the DWMP. Consequently, for storm overflows that have WINEP solutions and have been subject to option development within the DWMP, the DWMP options may be considered conservative. This represents less than 5% of the storm overflows that have been subject to DWMP optioneering. It should be noted that the WINEP solutions are based around different drivers and are not funded to meet an average annual spill frequency of no more than 10 spills per year. At the time the DWMP optioneering work was undertaken the form of the WINEP solutions was not always known, therefore quantification of the further need (if any) to achieve the DWMP scenario targets was unable to be made. This will be reviewed for Cycle 2 and processes developed to review the storm overflow DWMP need with future WINEP programmes.

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.

7.7.3.3 Managing flood risk

7.7.3.3.1 Method

Our scenarios have two targets around managing the impact of flooding on properties by 2050:

A. Maintain regional level of property flood risk from hydraulic sewer flooding
B. Reduced level of property flood risk from hydraulic sewer flooding

For each target and each solution approach (X.1 and X.2) the number of properties for intervention is identified using the annualised flooding scores. The traditional solution approach (X.1) utilised the model results complied for the BRAVA assessment. The hybrid solution approach (X.2) utilised model results from the Impermeable Area Reduction model described in Section 7.7.3.1. Where an intervention is required, it is assumed a 1 in 30-year standard of protection would be provided.

Target A

This is a catchment-based assessment whereby the number of properties for intervention is calculated by evaluating the increase in annualised flood score from 2020 to 2050. This increase is then divided by the annualised score for a single property flooding in a 1 in 1-year return period event to provide an assessment of the number of properties for intervention. This process is carried out for internal and external risk separately.

Target B

For this metric a trigger for intervention has been set at a property level. In Section 7.3.3.1, we discussed the two different flooding mechanisms that have been assessed; 2D overland risk and 1D surcharge.

For this target performance level, we have set different triggers for intervention linked to 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 breaches one of the above criteria then investment would be triggered; it is assumed a 1 in 30-year standard of protection is offered by the solution.

The reduced trigger level linked to the surcharge metric 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 metric can be considered a surrogate for lack of capacity within the network in lower return period events.

As our understanding of the private to public transferred network improves, this will help 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.

7.7.3.3.2 Cost and service measures

An average cost per property for mitigation has been applied.

A standard unit cost has been used for any property at risk of overland flooding, be this internal or external. In all cases it is assumed the mitigation would resolve the cause of the escape. This is not expected to vary dependent upon receptor.

A reduced unit cost has been applied where the property is only at surcharge risk.

An estimate of operational costs has been made using data provided by our costing team.

Estimates of embodied and operational carbon have been made using in-house models.

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.

7.7.3.3.3 Assumptions and limitations

The solutions have not been modelled and therefore there is a risk that the average solution costs are an over or under-estimate.

Properties are considered in isolation and no account of clustering is taken. There is potential for efficiencies to be achieved where a scheme can be developed to address multiple properties. This may be considered to some extent within the average unit cost used as historically a scheme will have been developed for multiple properties.

Additionally, there might be additional under reported benefits, for instance flood risk could be reduced at a nearby properties but not fully resolved. 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.

Related to Target A specifically, as the calculated number of interventions is based around properties with a predicted 1 in 1 year flood frequency, there is a risk that more interventions are required than the number of properties predicted to be at 1 in 1-year risk within the catchment. In which case, properties at risk during higher return period events would need intervention, as these have a smaller effect on the annualised score a greater number of properties would need to be targeted for intervention. As a result, the estimated solution cost may be an under prediction. However, this may be mitigated to some extent by the duplication in interventions arising from assessing internal and external risk as being mutually exclusive.

No consideration of the solution form has been made and therefore where tank solutions may be required the ability to empty the tank has not been considered.

The analysis is based upon three winter rainfall durations for each return period only.

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.

7.7.3.4 DMF entered options and delivery options

For each scenario and scenario approach, between 3 and 5 different delivery options have been developed. A maximum and minimum number of years over which the estimated catchment investment could be phased has been assumed based on the derived catchment capital cost.

Consequently, for any Level 3 there could be between 24 and 40 different options within DMF as show in Table 69. In total 6342 options were entered into the DMF for evaluation.

Table 69: Solutions entered into DMF for each Network Promote Catchment

Scenario 1	Solution Approach X.1	3 – 5 delivery options of varying duration
	Solution Approach X.2	3 – 5 delivery options of varying duration
Scenario 2	Solution Approach X.1	3 – 5 delivery options of varying duration
	Solution Approach X.2	3 – 5 delivery options of varying duration
Scenario 3	Solution Approach X.1	3 – 5 delivery options of varying duration
	Solution Approach X.2	3 – 5 delivery options of varying duration
Scenario 4	Solution Approach X.1	3 – 5 delivery options of varying duration
	Solution Approach X.2	3 – 5 delivery options of varying duration

7.7.4 Wastewater Treatment Works ODA

7.7.4.1 Initial option screening

Several of the generic options detailed within Section 7.7.1 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 35, Figure 36, Figure 37, Figure 38, Figure 39, Figure 40, Figure 41 and Figure 42 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 7.7.4.2.

Figure 35: Initial WwTW option screening Part 1

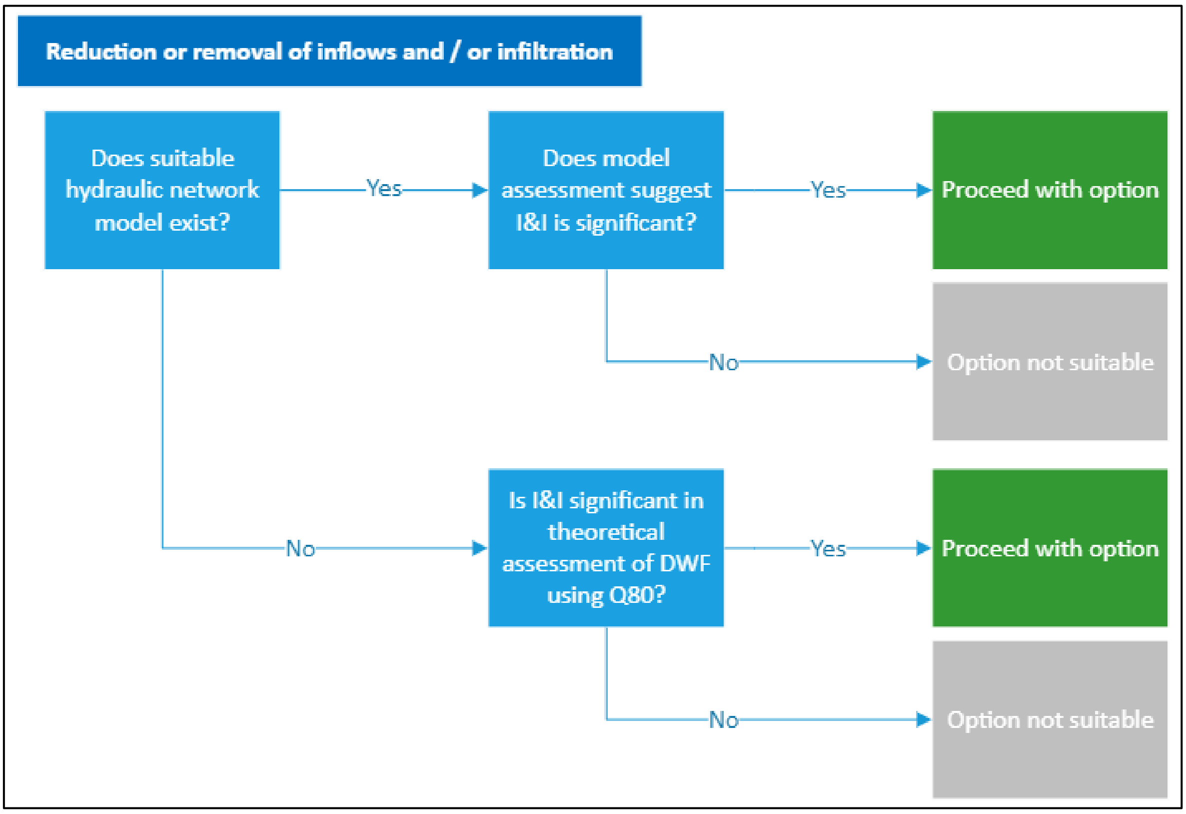


Figure 36: Initial WwTW option screening Part 2

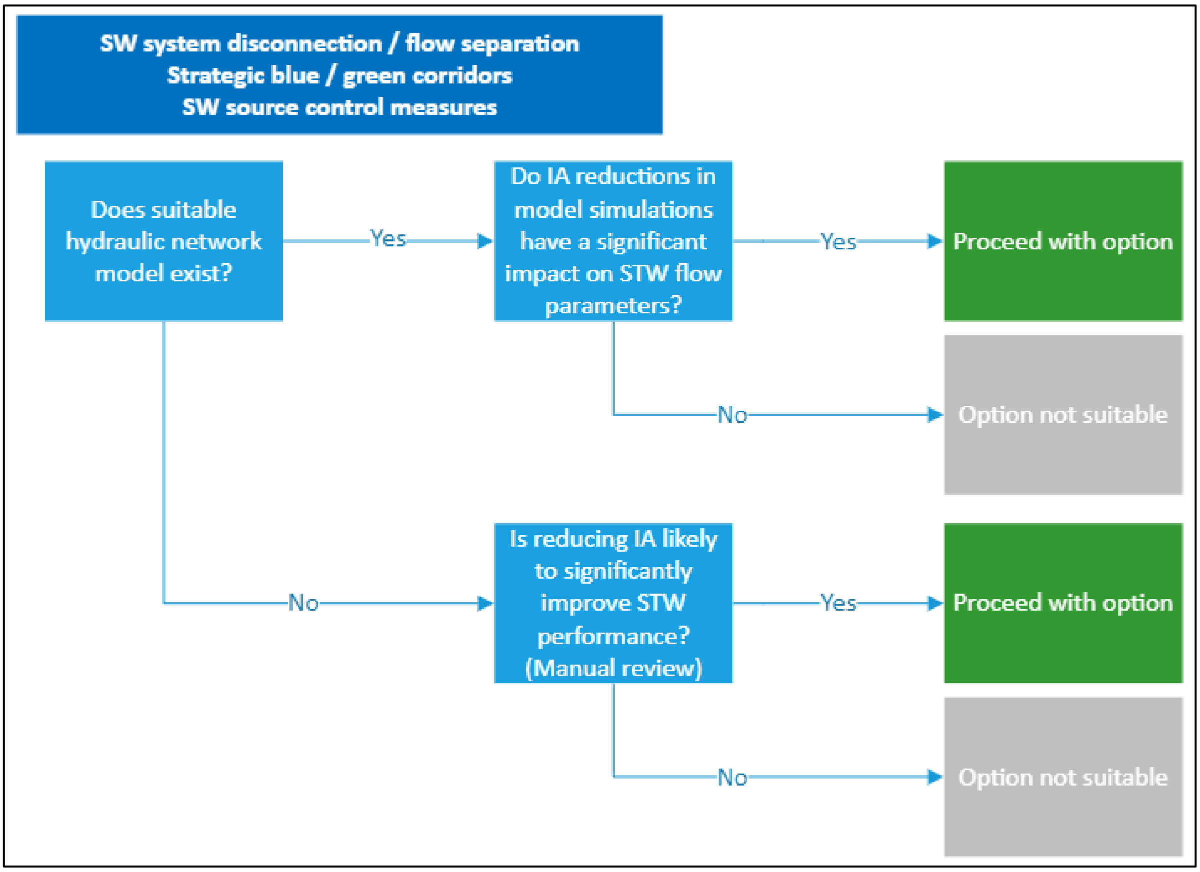


Figure 37: Initial WwTW option screening Part 3

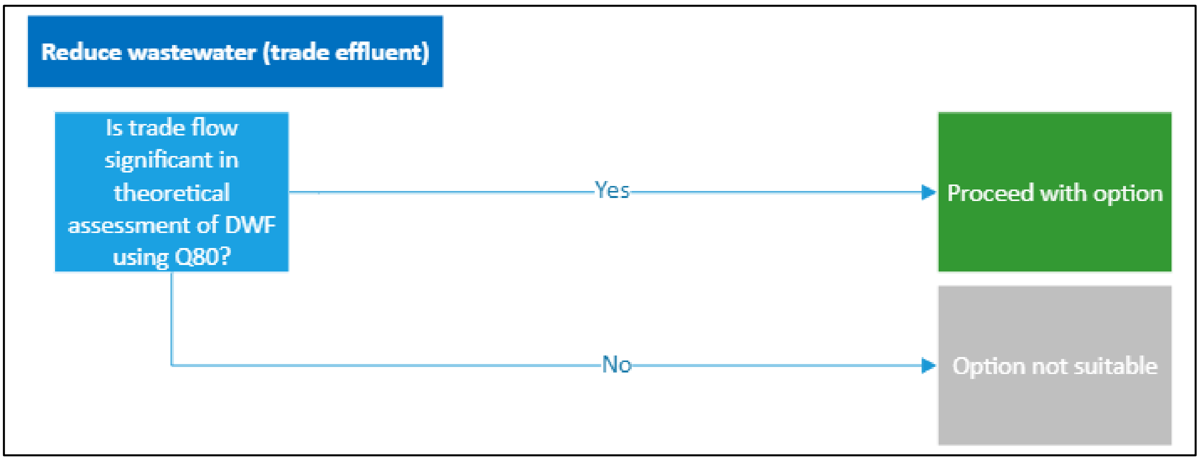


Figure 38: Initial WwTW option screening Part 4

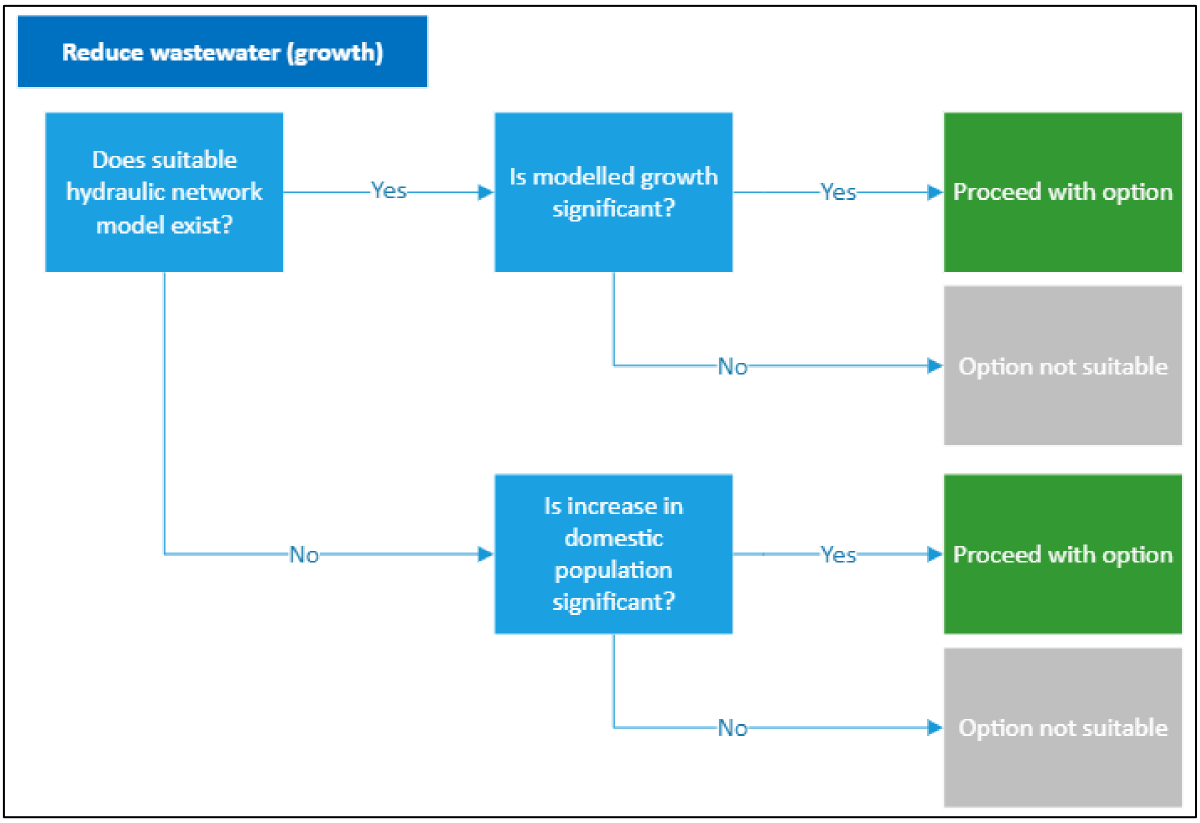


Figure 39: Initial WwTW option screening Part 5

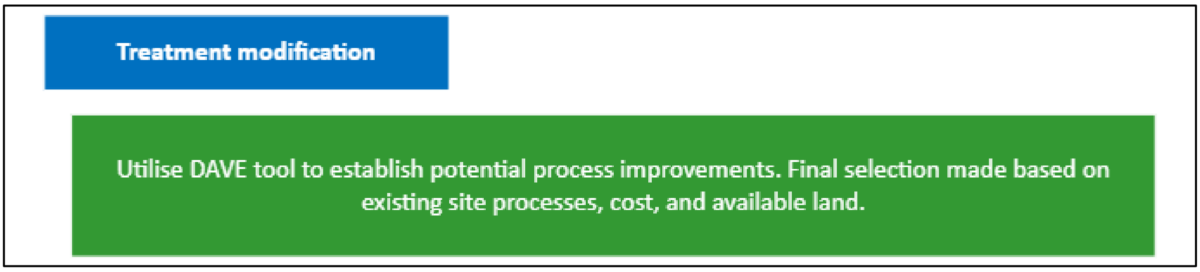


Figure 40: Initial WwTW option screening Part 6

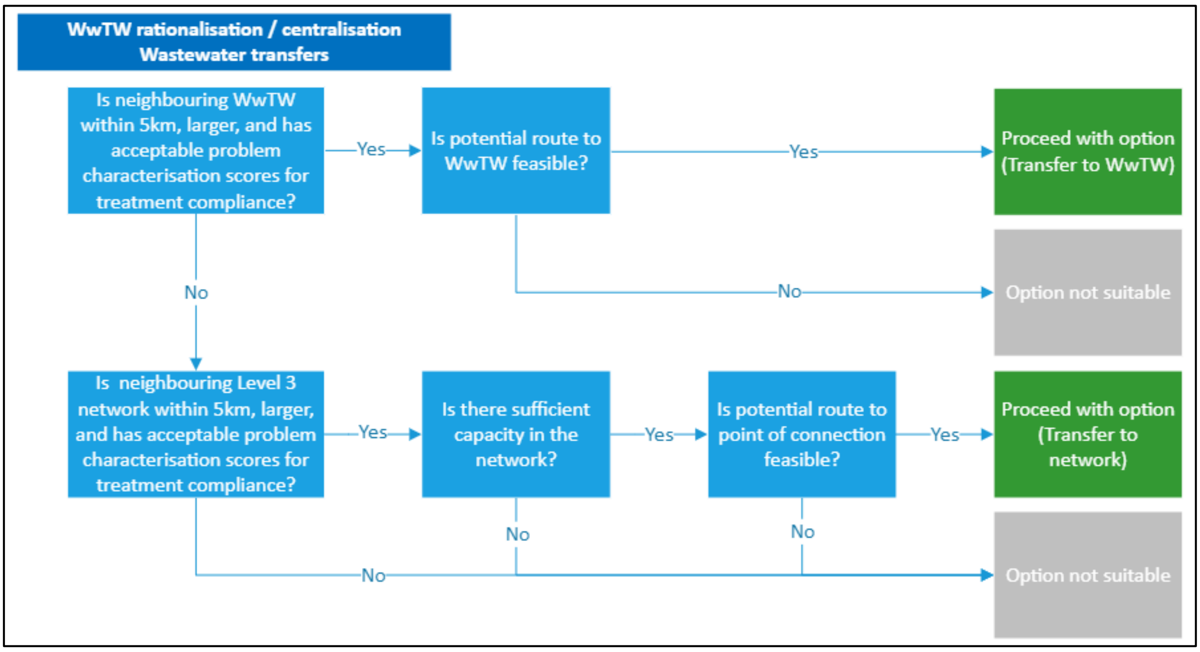


Figure 41: Initial WwTW option screening Part 7

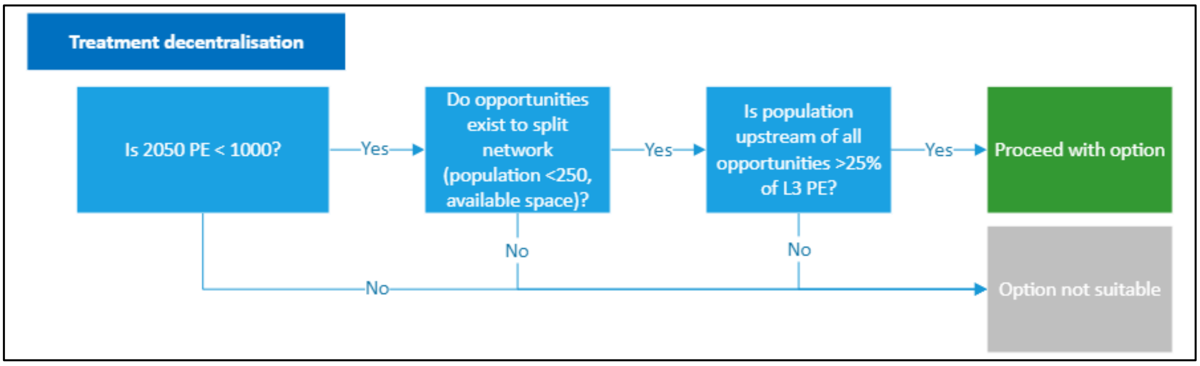
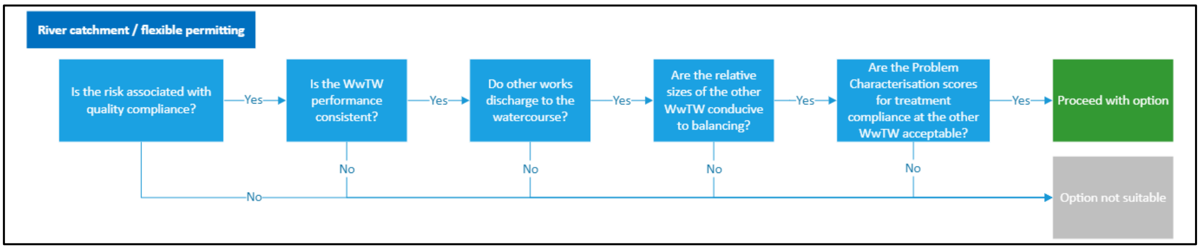


Figure 42: Initial WwTW option screening Part 8



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 7.7.1 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.

7.7.4.2 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 tool is undergoing a further upgrade ahead of PR24 to align with our latest design guidance, this updated version was not available for use during the development of solutions for the DWMP and therefore the solutions developed for the DWMP have been built using the version of the tool available at the time, which was primarily developed for PR19, with some minor improvements since then.

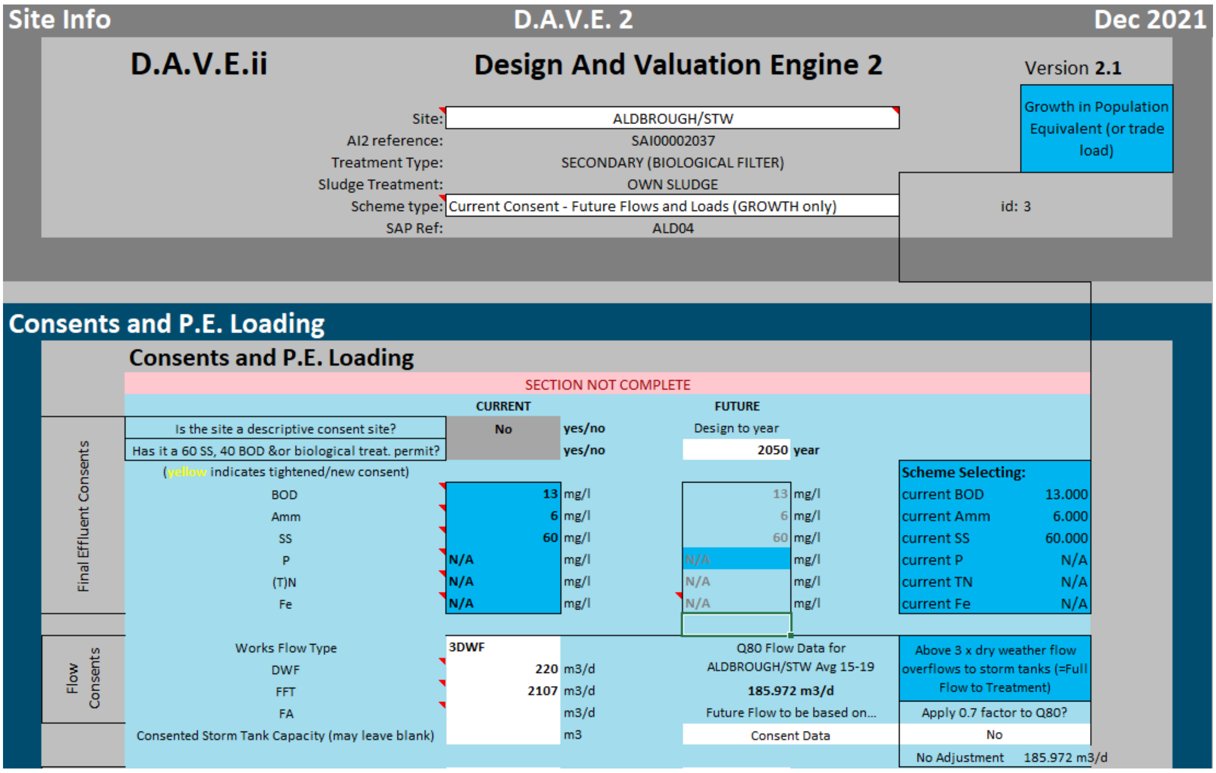
The Design and Value Engine has three key components:

- Inputs – relating to the existing works and required capabilities.
- Calculations and logic pathways.
- Outputs – individual asset elements.

7.7.4.2.1 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 43 provides an example partial view of the input sheet for ALDBROUGH/WwTW.

Figure 43 - 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**

Growth in Population Equivalent (or trade load)

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

id: 3

Consents and P.E. Loading

Consents and P.E. Loading

SECTION NOT COMPLETE

		CURRENT		FUTURE			
Final Effluent Consents	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

7.7.4.2.2 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.

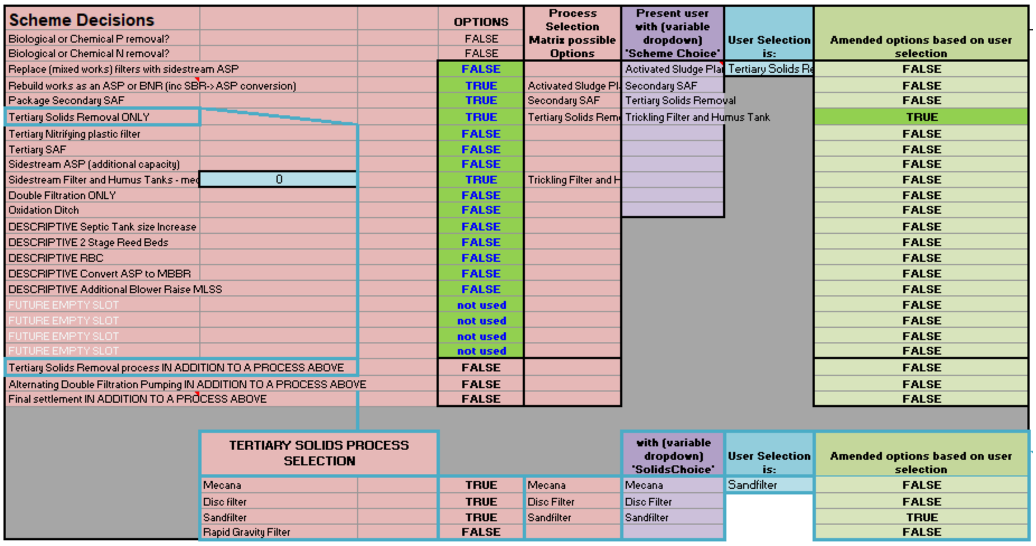
7.7.4.2.3 Outputs

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 70 summarises the potential processes included within the tool. A combination of these processes may be required dependent on the solution.

Table 70: 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 44 and Figure 45 show screenshots of the decision-making process built into the tool and an example of the solution sizing outputs.

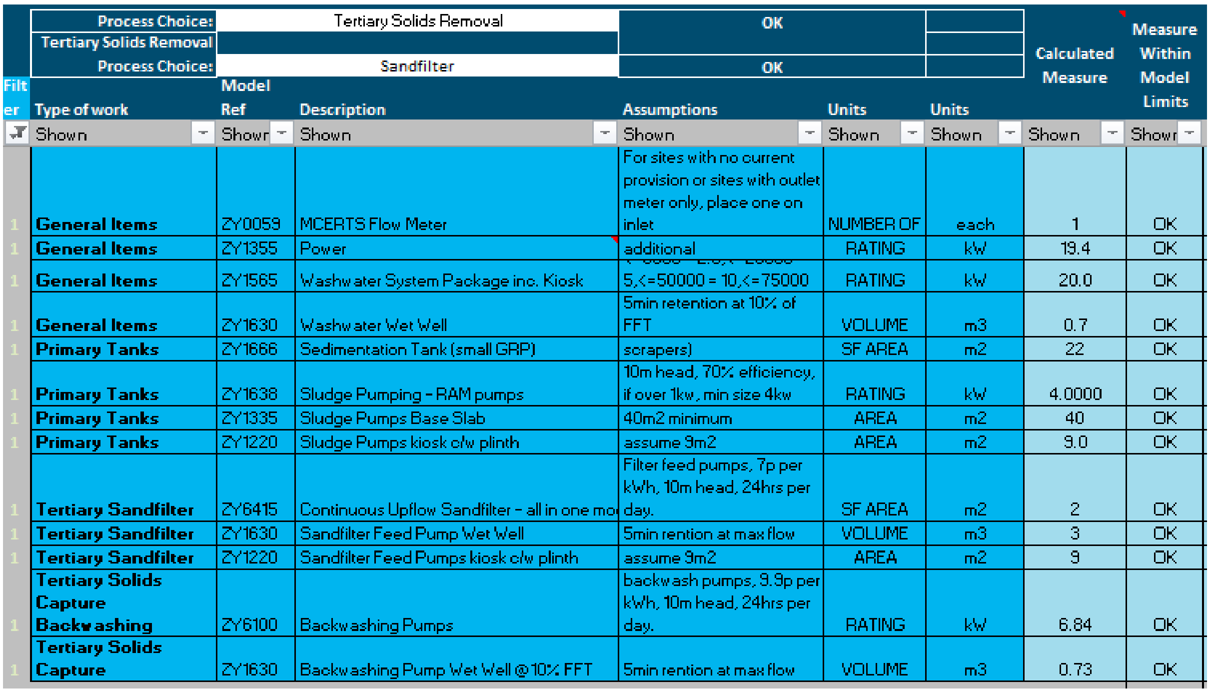
Figure 44 – Screenshot of Design and Valuation Engine decision making process



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 - med	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 45 - 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	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

7.7.4.2.4 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.

7.7.4.2.5 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.

Future WINEP drivers, including those associated with the crossing of UWWTR thresholds have not been included within the development of treatment options for the DWMP, these will be accounted for through future WINEP and price review development.

7.7.4.3 DMF timeframe for delivery

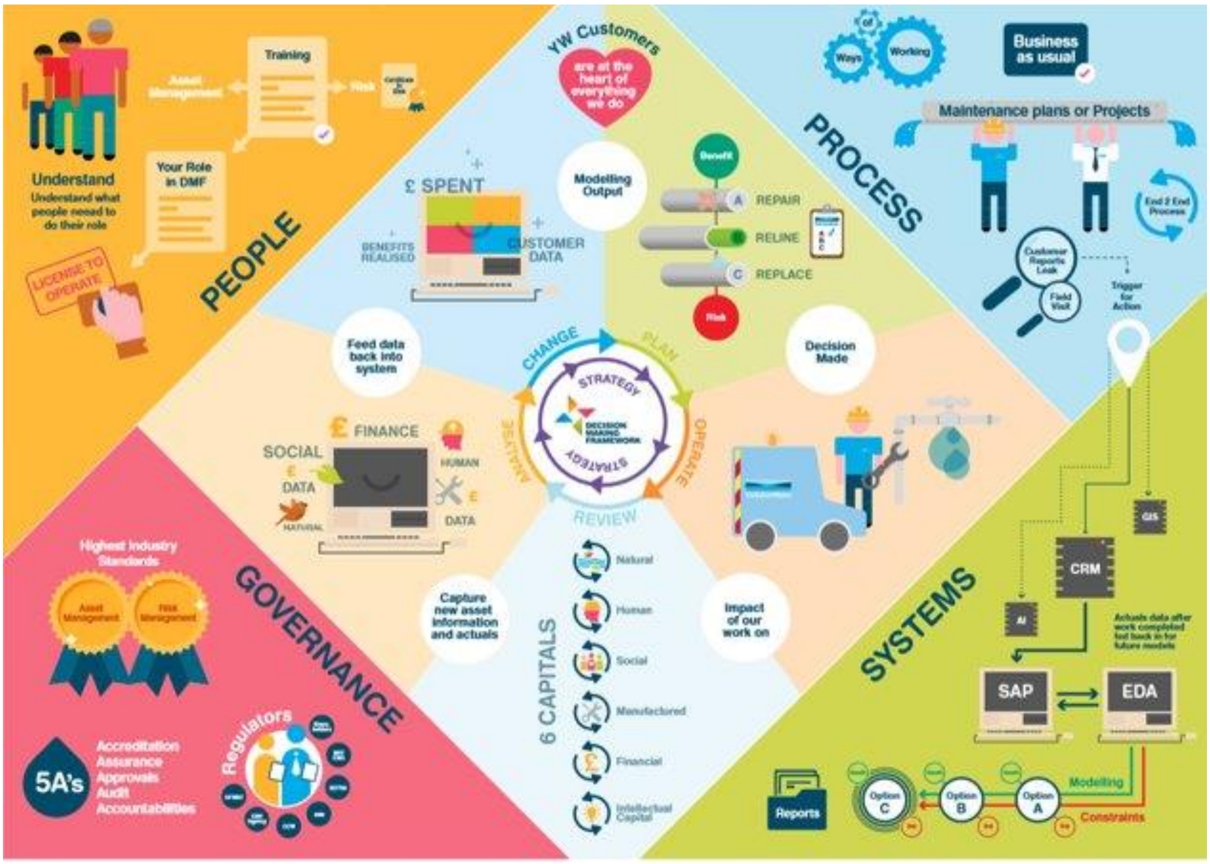
For each solution the number of years over which the estimated catchment investment could be phased has been assumed based on the derived capital cost. Whilst a number of different delivery options have been established for the network solutions, a single timeframe (and therefore delivery option) has been established for each treatment option due to the reduced capital cost when compared to the network options.

8. Programme optimisation and appraisal

Two different datasets were compiled as described in ODA Section 7.7 for wastewater network and treatment solutions. These were input into the system (Enterprise Decision Analytics (EDA)) that supports our Decision-Making Framework (DMF). Here is a short YouTube clip on YW's Decision Making Framework: **https://www.youtube.com/watch?v=iZ6CixsmPSA**

Figure 46 below shows the components of the DMF process and below is a link to more details surrounding our DMF.
https://www.yorkshirewater.com/media/yvjfkhqd/yorkshire_water_dmf_website_case_study.pdf

Figure 46: How our DMF works



YW utilises the Six Capitals approach in investment decision making and is part of the Decision-Making Framework (DMF). The Six Capitals as applied in YW are outlined in Figure 47 below:

Figure 47: Our Six Capitals

By using the Six Capitals approach, we are able to examine our impacts and dependencies on Six Capitals to better understand how we create or destroy value with what we do or don't do. This aligns with the Natural Capital Coalition's Natural Capital Protocol[24].

As an extension of this, we are also able to see a monetary value of impacts where practicable. The Six Capitals approach to investment decision making was applied to DWMP options.

The examination of impacts and dependencies is through the use of our Service Measures Framework. The Service Measures and Six Capitals Framework is part of our DMF. Service Measures capture the different risks and impacts of investing (as well as not investing), and our Service Measures cover different areas of clean and wastewater services and other impacts (e.g., on land use, health, and safety).

These Service Measures are further divided into Impact Categories which measure the extent of service failure/improvement or a specific type of service failure/improvement. These Service Measures and Impact Categories are mapped to the Capitals metrics, and this mapping represents an impact/dependency relationship between the Capitals metrics and YW's activities and service.

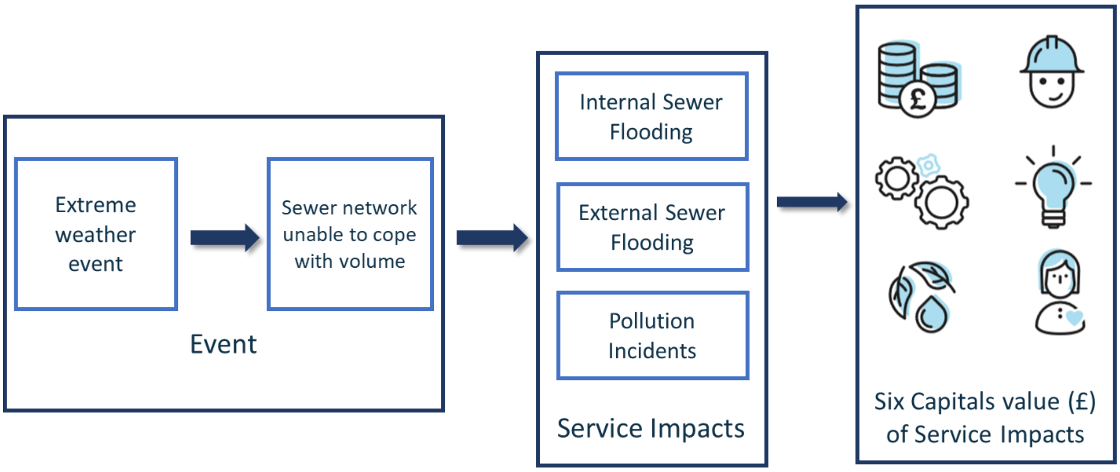
Where this mapping exists, there is an equivalent monetised value, and these monetised values were estimated using different economic valuation techniques. This includes YW's Customer Willingness to Pay studies, benefit transfers (e.g., the benefits captured in the Storm Overflows Evidence Project), and our own estimates of (private) costs.

---

[24] https://capitalscoalition.org/capitals-approach/natural-capital-protocol/?fwp_filter_tabs=training_material

Figure 48 below illustrates the logic of the approach from an investment requirement to a Six Capitals valuation. Changes in the service impact between a baseline position and a potential solution option determines the equivalent Six Capitals benefits of that solution.

Figure 48: Risks to service value using the Six Capitals



To estimate the Six Capitals value from a change in service impacts due to DWMP options, we identified the Service Measures that are relevant to the options. For wastewater, these service measures are ones related to river water quality, pollution incidents, land use and surface water removal. The Land Use service measure is used to capture benefits from blue/green solutions such as amenity, air quality and carbon sequestration. We then quantified the impact against these Service Measures of each DWMP option. This is illustrated below in Figure 49, Figure 50 and Figure 51:

Figure 49: Six Capitals Need

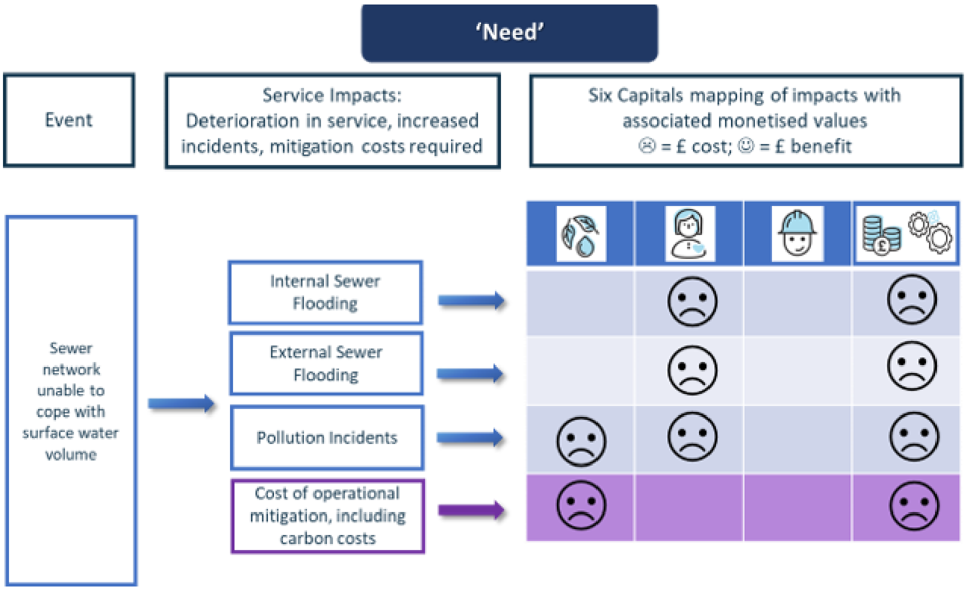


Figure 50: Six Capitals Solution Option 1

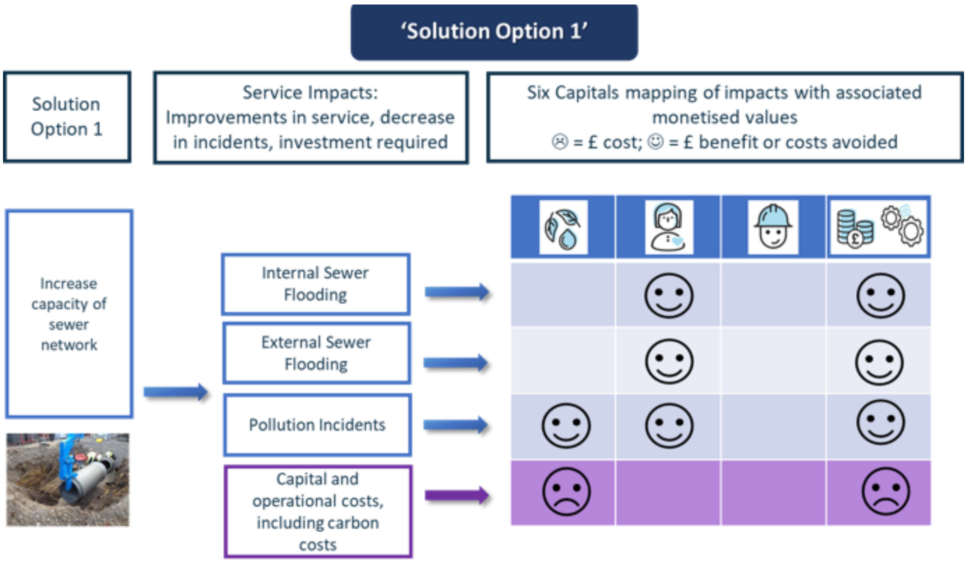
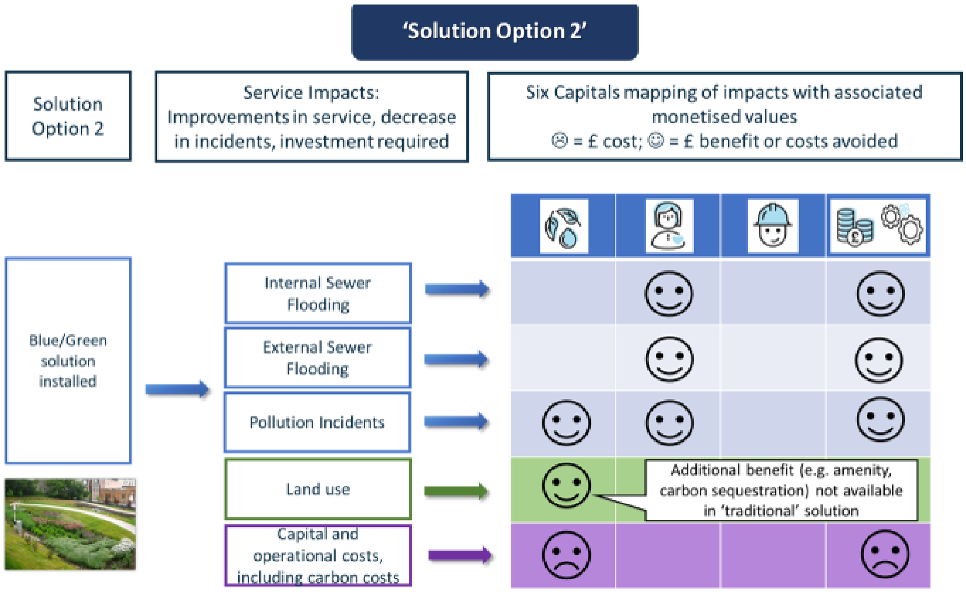


Figure 51: Six Capitals Solution Option 2



Alongside the Service Impacts and associated Six Capital impacts, the capital and operational expenditure resulting from the DWMP option and the associated carbon emissions also fall under the Six Capitals. We classify TOTEX (sum of CAPEX and OPEX, also known as capital and operational expenditure) under Financial and Manufactured capitals. The cost of carbon emissions is classified under Natural Capital. This means that the overall economic evaluation of DWMP options considers different aspects of the Six Capitals given changes in service, TOTEX and carbon.

The EDA optimiser was run for all of our four DWMP scenarios (referenced in Section 7.6). The optimiser selected the preferred solution type for each priority catchment, for each scenario. The optimal scenario was generated by tasking the optimiser with finding the lowest overall Net Present Value (NPV). The NPV is calculated over an economic evaluation period of 40-years using EDA data which is modelled over 25-years. This is then extrapolated for the remainder of the 40-year period. At a catchment level some constraints were added including a year of start of investment with a range of allowable start years reduced in some catchments. This was to allow for the range of solution years per catchment. Start dates for solutions associated with treatment compliance have been restricted based on the epoch during which the risk materialises, with an allowance made for investigations to be undertaken if required.

A list of selected solutions was generated by EDA and these each had a cost including monetised carbon and service benefits profile, all of which are included in the NPV calculation. This is shown in Table 71 below. This has been used to demonstrate the BVP.

Alongside this we ran a lowest possible cost optimisation where EDA selected the lowest TOTEX options for each scenario. This does not then consider the monetised carbon or service benefits.

Table 71: Six Capitals Solution Option 1

NPV Carbon Operational	Monetised operational carbon value £
NPV Carbon E	Monetised embodied carbon value £
NPV Human Embodied	Six Capitals monetised service impact £
NPV Natural	Six Capitals monetised service impact £
NPV Financial and Manufactured	Six Capitals monetised service impact £
NPV Social – 6 caps	Six Capital monetised service impact £
NPV CAPEX & OPEX	True Costs of investment and future operation £

9. Adaptive planning

An adaptive planning framework is one which is recognised by our regulators. It allows for consideration of multiple programmes or activities that could be deployed depending on variable future circumstances. This allows for optimal investment decisions to be made, based on a least regrets approach. An adaptive plan sets out how we will make decisions within this framework. We will consider an adaptive planning solution for DWMPs 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 to shift towards long-term adaptive planning and this will be undertaken in line with regulatory guidance and internal YW practices. We are currently developing an adaptive pathway methodology that will take account of regulatory reporting requirements, as well as internal needs. This will take into account risk appetite and tolerance, long term goals and tracking processes to ensure timeliness of decision making for consideration of alternative pathways.

As part of our DWMP, we have included strategic adaptive pathways that consider using traditional (grey infrastructure) solutions such as storage tanks or alternatively nature based (blue-green infrastructure) solutions such as sustainable drainage systems (SuDS) that drive a best value plan.

We will update our approach and 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.

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 least regret 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, the time it takes to introduce retrofit nature-based solutions into the urban network and retrofit on scale.

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 to work in partnership 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 and 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.

9.1 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 hydraulic sewer flooding, the operation of storm overflows and ensuring future compliance with our wastewater treatment works permits. We identified two core approaches to the delivery of solutions: firstly, the deployment of grey infrastructure and secondly the deployment of a blend of blue-green and nature-based solutions and sustainable drainage features with complementary grey infrastructure where necessary.

The core pathway in our draft DWMP assumes the delivery of storm overflow requirements in line with the Defra Storm Overflow Reduction Plan consultation[25], namely the requirement for an annual average of no more than 10 spills per storm overflow and no environmental harm by 2050. When government's position on these targets is finalised, we will adapt our core pathway to reflect the requirements. For sewer flooding, our DWMP core pathway currently maintains the existing levels of hydraulic sewer flooding risk despite an increasing risk position due to population growth and climate change, whereby the scale of future impact is uncertain. Our core pathway contains both grey infrastructure solutions and a blend of blue-green and grey infrastructure solutions as selected by the DMF optimisation as best value options for each scenario.

Our overall aspiration is to continue to reduce the risk of sewer flooding for customers in Yorkshire. The reason this is not reflected in the core pathway of our DWMP is that there are two main underlying causes for sewer flooding and the DWMP considers only one of these. The first is an exceedance of the hydraulic capacity of the network, and this is considered in our DWMP. The second cause of sewer flooding is operational issues, for example, sewer blockage or collapse or failure of pumping equipment. Sewer flooding caused by operational issues, is more common and accounts for c80-90% of flooding incidents and is not considered in our DWMP. YW will continue to improve our sewer flooding performance through the focus on reducing incidents caused by operational issues.

We have presented two scenarios that reduce the risk of hydraulic sewer flooding as an alternative pathway. We will continue to investigate opportunities to deliver this reduction as our understanding of the benefits to sewer flooding, derived from activity to manage hydraulic capacity to address storm overflows is better understood. At the same time, we hope to increase our understanding and certainty around the impact of growth and climate change on our wastewater systems performance. Our overall sewer flooding performance will continue to improve over time.

We have presented a range of least cost scenarios which will focus on grey traditional solutions. As the water industry experience of deploying blue-green and nature-based solutions increases and we develop and adopt new innovations, we anticipate the cost of delivering green-blue and nature-based solutions will reduce, enabling us to move to this best-value delivery pathway.

We have therefore included the delivery of a blended blue-green and nature-based; sustainable drainage and grey infrastructure solutions as a further alternative pathway. Where specific local

---

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

characteristics mean that nature based, and sustainable drainage solutions can be delivered as 'best value' then this approach will be prioritised as part of the core pathway.

10. Level 1 and 2 output summaries

Our Level 1 Best Value Plans (BVPs) illustrate a range of costs and pathways we can adopt to help us achieve the targets set out in the storm overflow reduction plan and without deteriorating our hydraulic flooding risk position to properties we can invest to hold firm on our position or invest to reduce the hydraulic flooding risk position to properties. This also includes investing at WwTW's to ensure our WwTW's have sufficient capacity to allow us to remain compliant with our current environmental permits. The costs for our Level 1 have been compiled and represent a combination of blue-green and grey only solutions as selected by our optimiser. These cost ranges are set out in Table 72.

Table 72: Level 1 – 25-Year Best Value Plan – Cost Ranges+/-25%

Scenario 1	£28.8 billion	£47.9 billion
Scenario 2	£30.1 billion	£50.1 billion
Scenario 3	£23.1 billion	£38.5 billion
Scenario 4	£24.3 billion	£40.5 billion

Our Level 1 least cost plan considers the most cost-effective way to deliver the outcomes required. These least cost option cost ranges represent considerably more grey solutions than the BVP and deliver less overall benefit. This is seen in Table 73 below.

Table 73: Level 1 – 25-Year Least Cost – Cost Ranges +/-25%

Scenario 1	£21.2 billion	£35.3 billion
Scenario 2	£22.8 billion	£37.9 billion
Scenario 3	£9.7 billion	£16.2 billion
Scenario 4	£11.8 billion	£19.6 billion

The nature of what our 2025-2030 (AMP8) investment programme may look like, given the requirement to deliver priority storm overflow solutions within tight deadlines and affordability and deliverability considerations will potentially mean we have to start on a core pathway of least cost investment. This will drive mainly grey solution options e.g., storage tanks but we would still look, where practicable, to invest in blue-green solutions and use adaptive planning to move away from the grey-only approach in the future. As cost certainty and the rates of climate change and population growth become clearer, then the gap between our BVP's and the least cost plans should start to converge. This will mean we can adapt and change our plan to deliver most efficient and beneficial outputs for all.

As described, we have approached our DWMP as a strategic plan that outlines the needs and requirements of drainage, wastewater and environmental water quality for the next 25 years and beyond. We have taken a catchment-based approach to identify the risks and potential risk mitigations associated with the hydraulic aspects of our wastewater service. This catchment-based approach means we have chosen to present the potential costs as a range as, in this phase of the plan development, there remains significant uncertainty. As we progress towards our final DWMP and our PR24 submission, we will develop a more granular view of the necessary interventions and their associated costs. For the draft DWMP we have presented our Level 1 plan costs with a 25% certainty band. When this is considered at a Level 2 catchment level, the cost certainty band is 50%. This increased range at this more granular catchment level arises from uncertainties associated with storm overflow requirements, specifically the definition of priority overflows, changes to catchment-based delivery methods and the externalities of climate change and population growth.

Our BVP cost range is shown below in Table 74 for each Level 2 and for the four evaluated scenarios.

Table 74: Level 2 BVP costs – all scenarios +/- 50%

Level 2 Calder 25-Year BVP Cost Range		
Scenario 1	£2.6 billion	£7.7 billion
Scenario 2	£2.8 billion	£8.3 billion
Scenario 3	£2.1 billion	£6.3 billion
Scenario 4	£2.3 billion	£7.0 billion
Level 2 Colne & Holme Valley 25-Year BVP Cost Range		
Scenario 1	£1.0 billion	£3.0 billion
Scenario 2	£1.1 billion	£3.2 billion
Scenario 3	£0.8 billion	£2.5 billion
Scenario 4	£0.9 billion	£2.7 billion
Level 2 Dearne 25-Year BVP Cost Range		
Scenario 1	£1.0 billion	£3.0 billion
Scenario 2	£0.1 billion	£0.3 billion
Scenario 3	£0.8 billion	£2.5 billion
Scenario 4	£0.9 billion	£2.6 billion
Level 2 Derwent & Rye 25-Year BVP Cost Range		
Scenario 1	£0.4 billion	£1.3 billion
Scenario 2	£0.4 billion	£1.0 billion
Scenario 3	£0.4 billion	£1.2 billion
Scenario 4	£0.4 billion	£1.2 billion
Level 2 Esk & Coastal 25-Year BVP Cost Range		
Scenario 1	£0.4 billion	£1.1 billion
Scenario 2	£0.4 billion	£1.2 billion
Scenario 3	£0.3 billion	£1.0 billion
Scenario 4	£0.3 billion	£1.0 billion
Level 2 Holderness Coast (Gypsey Race) 25-Year BVP Cost Range		
Scenario 1	£0.4 billion	£1.1 billion
Scenario 2	£0.4 billion	£1.2 billion
Scenario 3	£0.3 billion	£0.9 billion
Scenario 4	£0.3 billion	£0.9 billion
Level 2 Hull 25-Year BVP Cost Range		
Scenario 1	£2.7 billion	£8.0 billion
Scenario 2	£2.7 billion	£8.0 billion
Scenario 3	£1.2 billion	£3.7 billion
Scenario 4	£1.2 billion	£3.7 billion

Level 2 Leeds 25-Year BVP Cost Range		
Scenario 1	£2.7 billion	£8.1 billion
Scenario 2	£2.8 billion	£8.3 billion
Scenario 3	£2.6 billion	£7.8 billion
Scenario 4	£2.7 billion	£8.1 billion
Level 2 Lower Aire 25-Year BVP Cost Range		
Scenario 1	£0.7 billion	£2.0 billion
Scenario 2	£0.7 billion	£2.2 billion
Scenario 3	£0.5 billion	£1.5 billion
Scenario 4	£0.5 billion	£1.5 billion
Level 2 Lower Dales 25-Year BVP Cost Range		
Scenario 1	£0.9 billion	£2.8 billion
Scenario 2	£1.0 billion	£2.9 billion
Scenario 3	£0.7 billion	£2.2 billion
Scenario 4	£0.8 billion	£2.3 billion
Level 2 Lower Don 25-Year BVP Cost Range		
Scenario 1	£1.4 billion	£4.3 billion
Scenario 2	£1.4 billion	£4.3 billion
Scenario 3	£1.1 billion	£3.3 billion
Scenario 4	£1.1 billion	£3.4 billion
Level 2 Lower Ouse -Year BVP Cost Range		
Scenario 1	£0.1 billion	£0.4 billion
Scenario 2	£0.1 billion	£0.4 billion
Scenario 3	£0.1 billion	£0.3 billion
Scenario 4	£0.1 billion	£0.3 billion
Level 2 Rother & Doe Lea 25-Year BVP Cost Range		
Scenario 1	£0.8 billion	£2.5 billion
Scenario 2	£0.9 billion	£2.6 billion
Scenario 3	£0.7 billion	£2.1 billion
Scenario 4	£0.7 billion	£2.1 billion
Level 2 Sheffield 25-Year BVP Cost Range		
Scenario 1	£1.3 billion	£3.9 billion
Scenario 2	£1.4 billion	£4.3 billion
Scenario 3	£1.3 billion	£3.8 billion
Scenario 4	£1.4 billion	£4.1 billion
Level 2 Upper Aire 25-Year BVP Cost Range		
Scenario 1	£3.3 billion	£4.9 billion
Scenario 2	£1.9 billion	£5.6 billion
Scenario 3	£1.4 billion	£4.1 billion
Scenario 4	£1.6 billion	£4.8 billion

Level 2 Upper Dales 25-Year BVP Cost Range		
Scenario 1	£0.5 billion	£1.5 billion
Scenario 2	£0.5 billion	£1.5 billion
Scenario 3	£0.5 billion	£1.4 billion
Scenario 4	£0.5 billion	£1.4 billion
Level 2 York 25-Year BVP Cost Range		
Scenario 1	£0.6 billion	£1.9 billion
Scenario 2	£0.6 billion	£1.9 billion
Scenario 3	£0.5 billion	£1.5 billion
Scenario 4	£0.5 billion	£1.5 billion

Our least cost plan is show below in Table 75 for our Level 2 SPAs.

Table 75: Level 2 Least Cost Plan – All Scenarios +/-50%

Level 2 Calder 25-Year Lowest Cost Plan Range		
Scenario 1	£2.1 billion	£6.6 billion
Scenario 2	£2.4 billion	£7.2 billion
Scenario 3	£1.0 billion	£3.1 billion
Scenario 4	£1.3 billion	£3.8 billion
Level 2 Colne & Holme Valley 25-Year Lowest Cost Plan Range		
Scenario 1	£0.8 billion	£2.5 billion
Scenario 2	£0.9 billion	£2.8 billion
Scenario 3	£0.5 billion	£1.5 billion
Scenario 4	£0.7 billion	£2.0 billion
Level 2 Dearne 25-Year Lowest Cost Plan Range		
Scenario 1	£0.6 billion	£1.9 billion
Scenario 2	£0.6 billion	£1.9 billion
Scenario 3	£0.3 billion	£0.8 billion
Scenario 4	£0.3 billion	£0.9 billion
Level 2 Derwent & Rye 25-Year Lowest Cost Plan Range		
Scenario 1	£0.4 billion	£1.1 billion
Scenario 2	£0.4 billion	£1.1 billion
Scenario 3	£0.3 billion	£0.9 billion
Scenario 4	£0.3 billion	£0.9 billion
Level 2 Esk & Coastal 25-Year Lowest Cost Plan Range		
Scenario 1	£0.3 billion	£0.8 billion
Scenario 2	£0.3 billion	£0.9 billion
Scenario 3	£0.1 billion	£0.3 billion
Scenario 4	£0.1 billion	£0.4 billion

Level 2 Holderness Coast (Gypsey Race) 25-Year Lowest Cost Plan Range		
Scenario 1	£0.3 billion	£0.9 billion
Scenario 2	£0.3 billion	£0.9 billion
Scenario 3	£0.1 billion	£0.3 billion
Scenario 4	£0.1 billion	£0.3 billion
Level 2 Hull 25-Year Lowest Cost Plan Range		
Scenario 1	£2.5 billion	£7.5 billion
Scenario 2	£2.5 billion	£7.5 billion
Scenario 3	£0.7 billion	£2.0 billion
Scenario 4	£0.7 billion	£2.0 billion
Level 2 Leeds 25-Year Lowest Cost Plan Range		
Scenario 1	£1.0 billion	£3.0 billion
Scenario 2	£1.2 billion	£3.5 billion
Scenario 3	£0.6 billion	£1.8 billion
Scenario 4	£0.8 billion	£2.3 billion
Level 2 Lower Aire 25-Year Lowest Cost Plan Range		
Scenario 1	£0.6 billion	£1.8 billion
Scenario 2	£0.6 billion	£1.8 billion
Scenario 3	£0.4 billion	£1.2 billion
Scenario 4	£0.4 billion	£1.3 billion
Level 2 Lower Dales 25-Year Lowest Cost Plan Range		
Scenario 1	£0.8 billion	£2.5 billion
Scenario 2	£0.9 billion	£2.6 billion
Scenario 3	£0.4 billion	£1.3 billion
Scenario 4	£0.4 billion	£1.3 billion
Level 2 Lower Don 25-Year Lowest Cost Plan Range		
Scenario 1	£1.0 billion	£3.0 billion
Scenario 2	£1.0 billion	£3.0 billion
Scenario 3	£0.3 billion	£0.9 billion
Scenario 4	£0.3 billion	£1.0 billion
Level 2 Lower Ouse -Year Lowest Cost Plan Range		
Scenario 1	£0.08 billion	£0.2 billion
Scenario 2	£0.08 billion	£0.2 billion
Scenario 3	£0.04 billion	£0.1 billion
Scenario 4	£0.04 billion	£0.1 billion
Level 2 Rother & Doe Lea 25-Year Lowest Cost Plan Range		
Scenario 1	£0.5 billion	£1.7 billion
Scenario 2	£0.6 billion	£1.7 billion
Scenario 3	£0.2 billion	£0.6 billion
Scenario 4	£0.2 billion	£0.7 billion

Level 2 Sheffield 25-Year Lowest Cost Plan Range		
Scenario 1	£0.6 billion	£1.8 billion
Scenario 2	£0.7 billion	£2.2 billion
Scenario 3	£0.3 billion	£0.9 billion
Scenario 4	£0.5 billion	£1.4 billion
Level 2 Upper Aire 25-Year Lowest Cost Plan Range		
Scenario 1	£1.4 billion	£1.3 billion
Scenario 2	£1.7 billion	£5.0 billion
Scenario 3	£0.6 billion	£1.7 billion
Scenario 4	£1.1 billion	£3.3 billion
Level 2 Upper Dales 25-Year Lowest Cost Plan Range		
Scenario 1	£0.5 billion	£1.3 billion
Scenario 2	£0.5 billion	£1.4 billion
Scenario 3	£0.3 billion	£1.0 billion
Scenario 4	£0.3 billion	£1.0 billion
Level 2 York 25-Year Lowest Cost Plan Range		
Scenario 1	£0.6 billion	£1.7 billion
Scenario 2	£0.5 billion	£1.7 billion
Scenario 3	£0.3 billion	£0.9 billion
Scenario 4	£0.3 billion	£0.9 billion

10.1 Next steps

In the short-term, we will be working on our final plan, which is due for publication in March 2023, by continuing to develop our plan and incorporating feedback from the consultation process that will run until the 23 September 2022. We will be working closely with Defra and the EA to ensure that our final DWMP accurately reflects the evolving requirements for storm overflows. We would welcome your comments on our draft DWMP24 and you can access the consultation via our website link

https://www.yorkshirewater.com/about-us/drainage-and-wastewater-management-plan/

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.

Alongside these changes to our DWMP we will be developing our business plan for 2025-2030. 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. We will seek to incorporate before final and within the next cycle of the DWMP the recommendations from the Strategic Environmental Assessment that has been undertaken and can be seen through the links to the SEA in Section 11. Within this document Section 7.1.1 highlights the key recommendations.

In the medium-and long-term we will commence work on the next cycle of DWMP development, which will start in April 2023. This will make use of newly available datasets, including climate change projections and we will incorporate learning and feedback from the completion of our first DWMP.

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 adapt our DWMP based on the outcomes of investigation, continued monitoring of scheme impacts, emerging risks and increase our certainty about the impacts of climate change and population growth by monitoring against current projections. We will also monitor new and emerging technologies to see where these offer opportunities to provide best value.

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.

11. Strategic Environmental Assessment

We have undertaken a Strategic Environmental Assessment (SEA) on our Level 1 plan. This can be seen by clicking on the link below:

https://www.yorkshirewater.com/strategic-environmental-assessment

12. Assurance

YW appointed Atkins as the 3rd line assurance provider for the development of the draft 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.

The Public Value Committee which is a YW Board sub-committee has received an overview of the DWMP development and will continue to provide oversight and strategic steer as we move towards the publication of our final DWMP24.

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.

YW 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 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 below photographs show the work in progress to install the pumps and also showing the extent of flooding in Malton and Norton.

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.

Images below show typical flooding in the area.

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 on the river Don. 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 between partners YW, Don Catchment Rivers Trust (delivery), Canal and River Trust (weir owner and part-funder), EA (part-funder), Heritage Lottery Fund (part-funder).

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, and the public are 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 image 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.

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 (and shown in images 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 preventing surface water flooding.

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.

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.

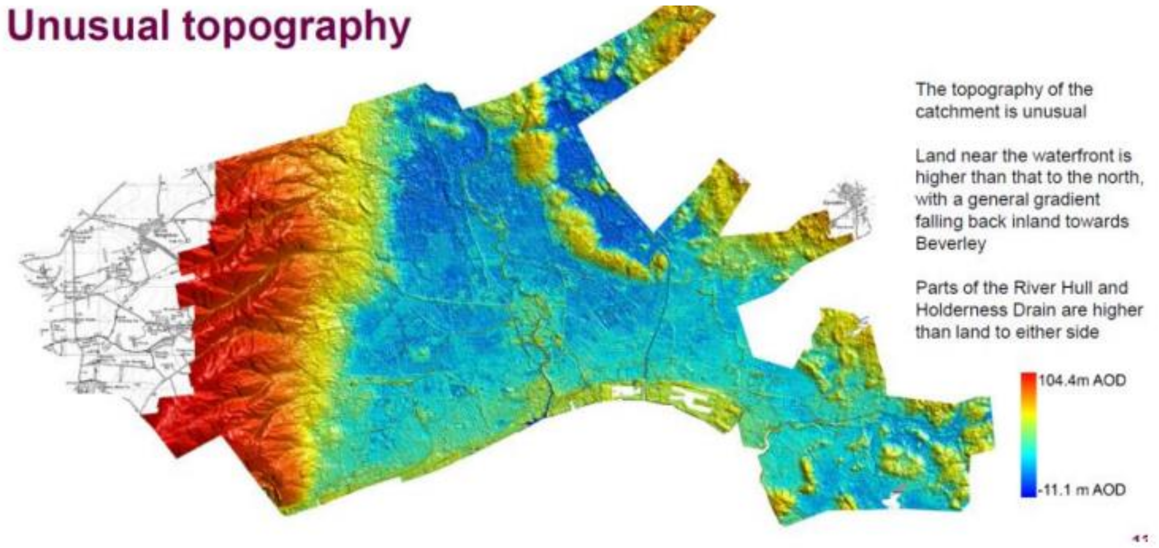
1.2.1 Geographical Context

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 52 below:

Figure 52: Map showing height of land in Hull and Haltemprice



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

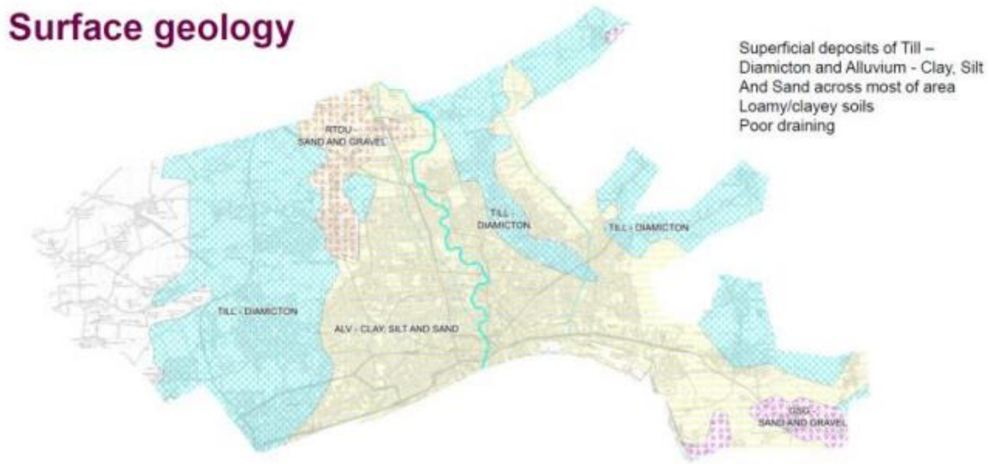
A high proportion of surface water flows (88%) from the Hull catchment enter the combined sewer network. In Hull, unlike most drainage systems, there are minimal relief points on the drainage network.

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 53. Archaeological significance, unexploded ordnances and a history of contaminated land are also known to drive higher costs of development in the Hull catchment.

Figure 53: Surface geology showing extent of clay soils (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.

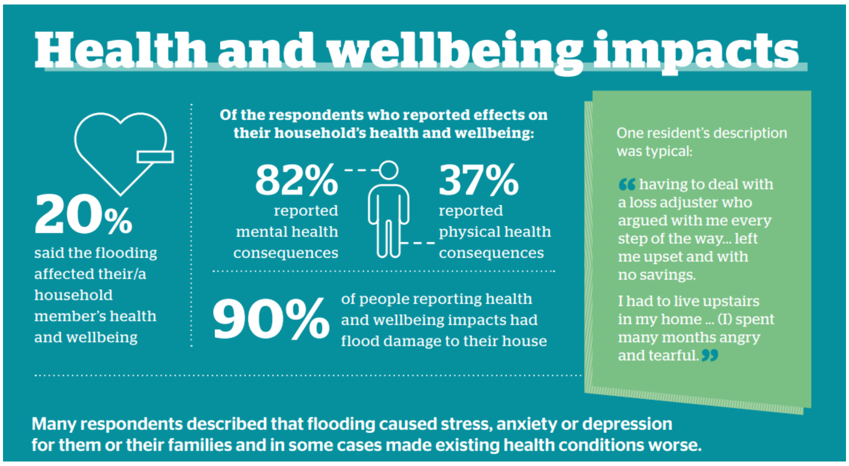
Historic legislation and policy have separated the responsibilities for managing surface water between RMAs, each with differing funding, regulation and drivers. Surface water is defined by where the rain falls: local authorities are responsible for managing overland flows; water companies for water 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 here:



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 **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 which is available for local youth groups.

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. 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 Arup 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)

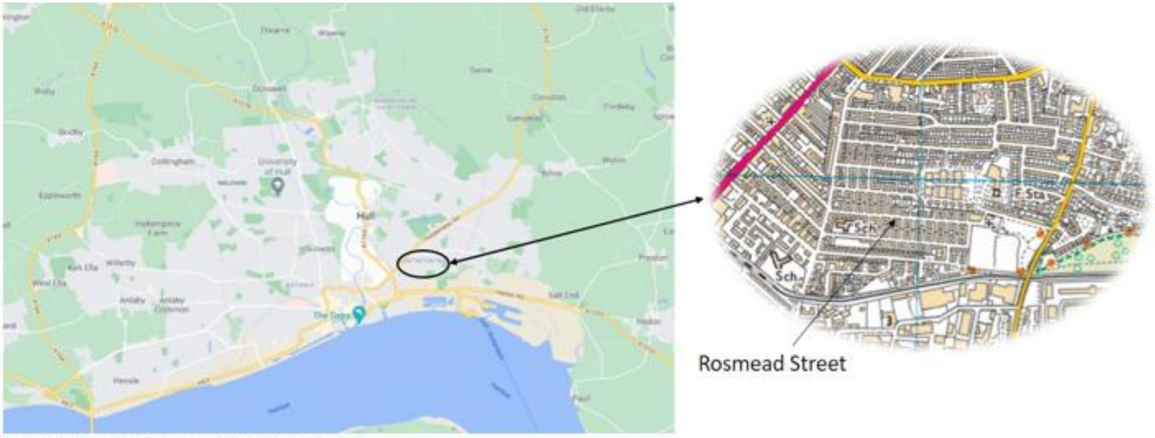
LWW is co-investing during 2020-25 to deliver flood resilience to over 800 properties. YW was allocated £23m to invest in schemes in the LWW area and the partnership is working hard to access match funding and ensure value for money by co-delivering alongside other major local investments.

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 54 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.

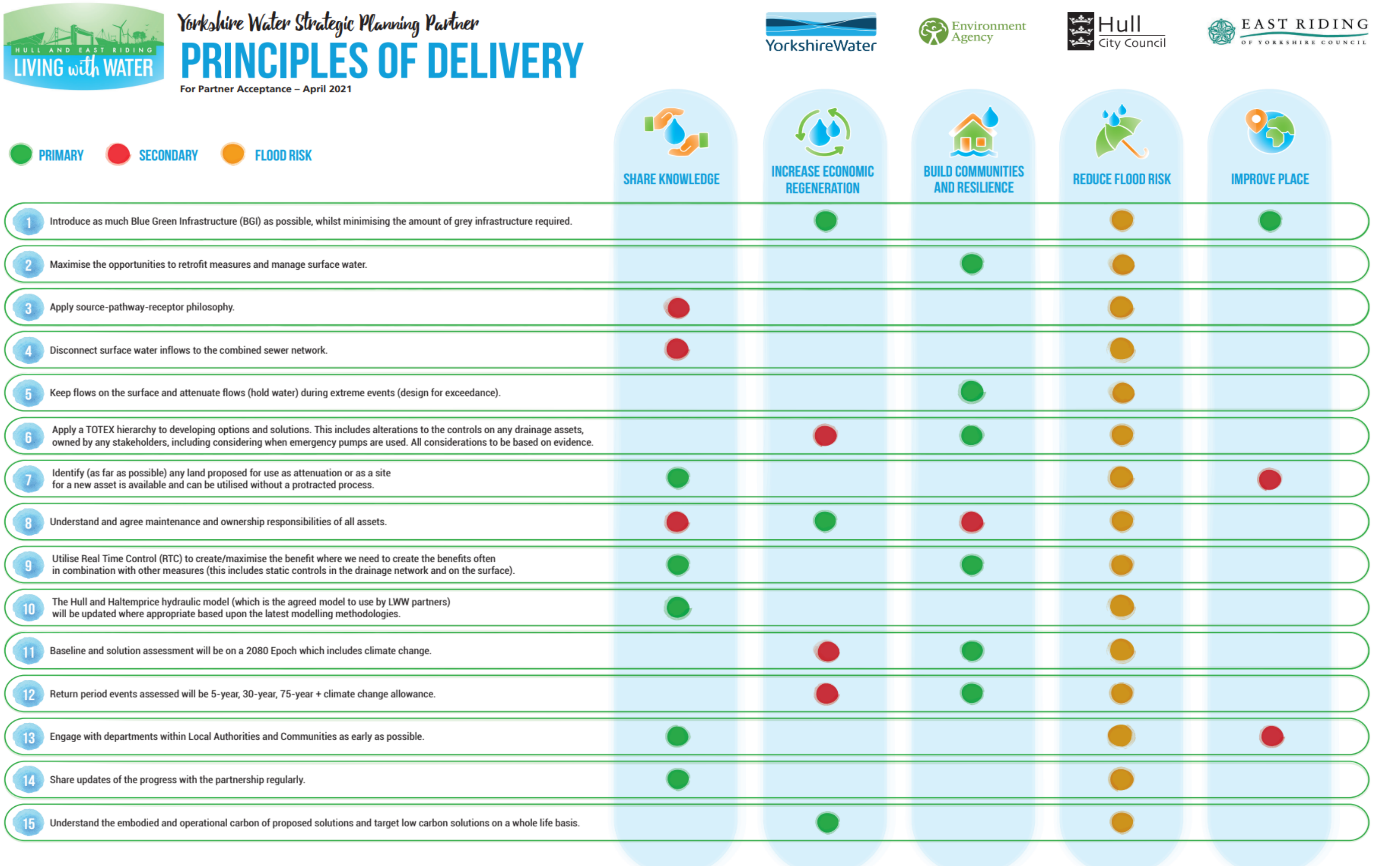
Figure 54: Location of Rosmead Street



Ssource of images: Google Maps and Microsoft Bing data 2021

LWW collectively created and signed up to 'principals for delivery' during 2020-25 (see Figure 55) 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 55 – LWW Principals of Delivery (Source Stantec)



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.		🟢		🟠	

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. This is by addressing the significant flood risk and ultimately reducing storm overflow spills to river through surface water disconnection. 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 Table 76 below.

Table 76: Living with Water Pillars

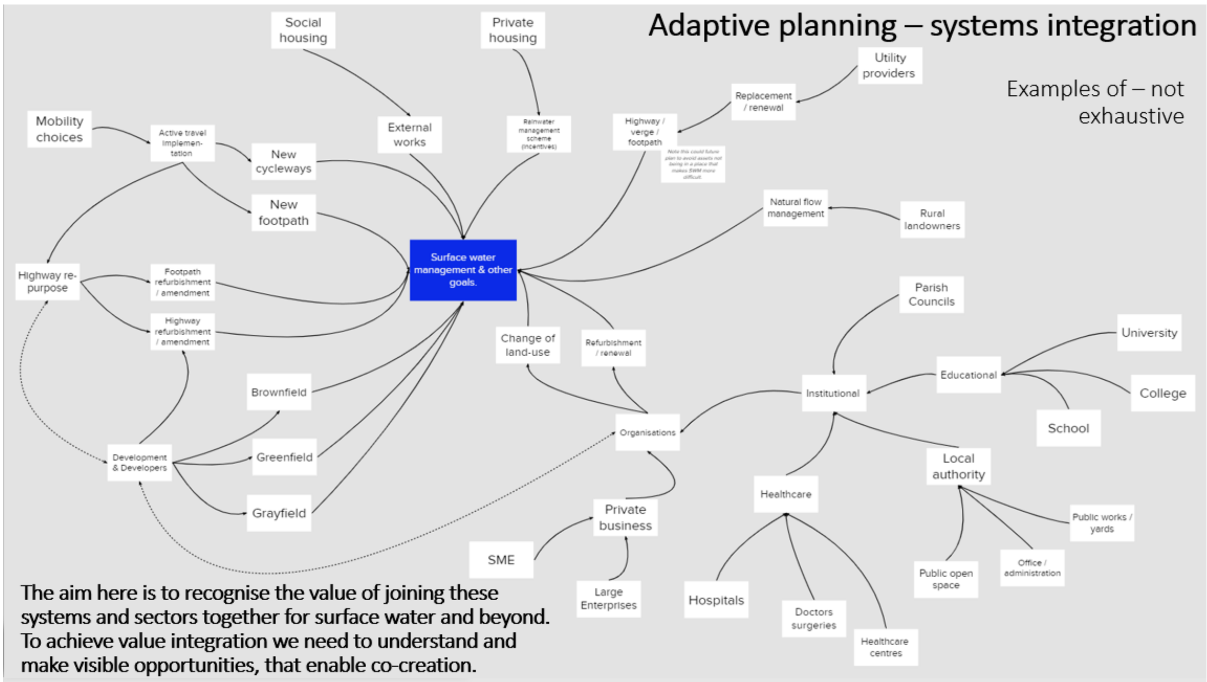
Aligned Programmes and Objectives	Good Placemaking
Healthy Places for our citizens	Managed Change
Biodiversity Net Gain	Knowledge and Skills
Housing	Smart and Connected
Mobility	Culturally Aligned

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 adaptive 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.

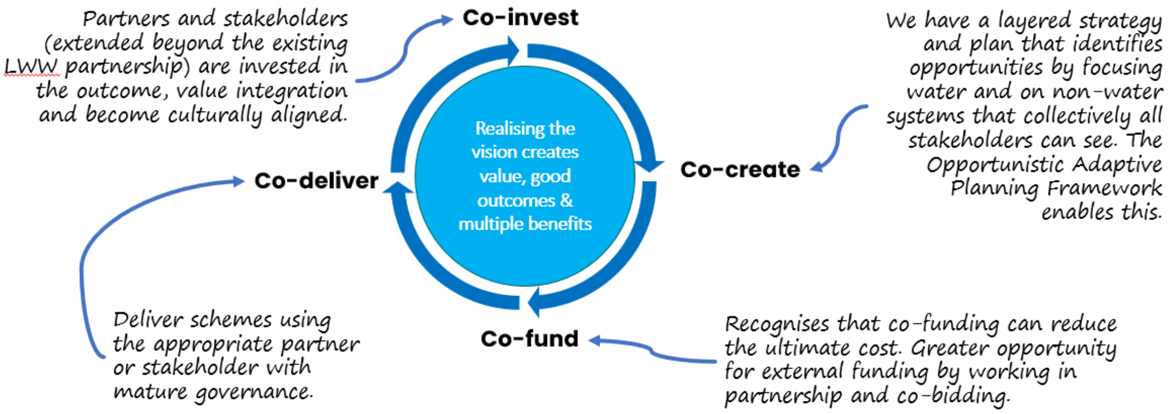
Figure 56, Figure 57 and Figure 58 provide an overview of the scale and benefits that an adaptive planning framework provides.

Figure 56: Systems Integration



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 57: Co-creation and delivery



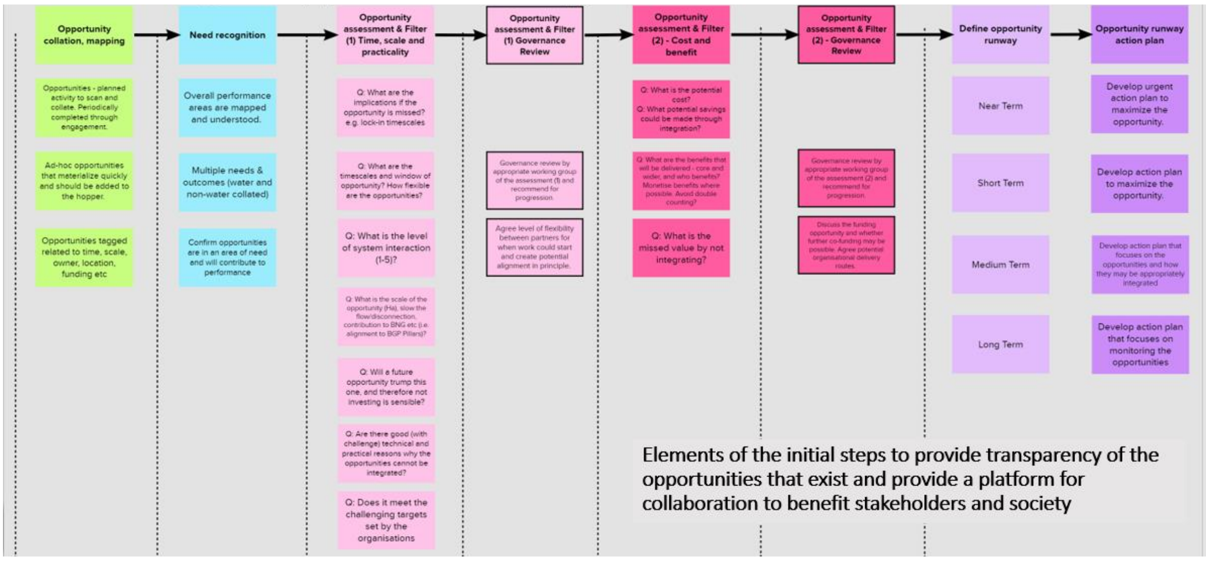
Partners and stakeholders (extended beyond the existing LWW partnership) are invested in the outcome, value integration and become culturally aligned.

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.

Deliver schemes using the appropriate partner or stakeholder with mature governance.

Recognises that co-funding can reduce the ultimate cost. Greater opportunity for external funding by working in partnership and co-bidding.

Figure 58: Governance



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.

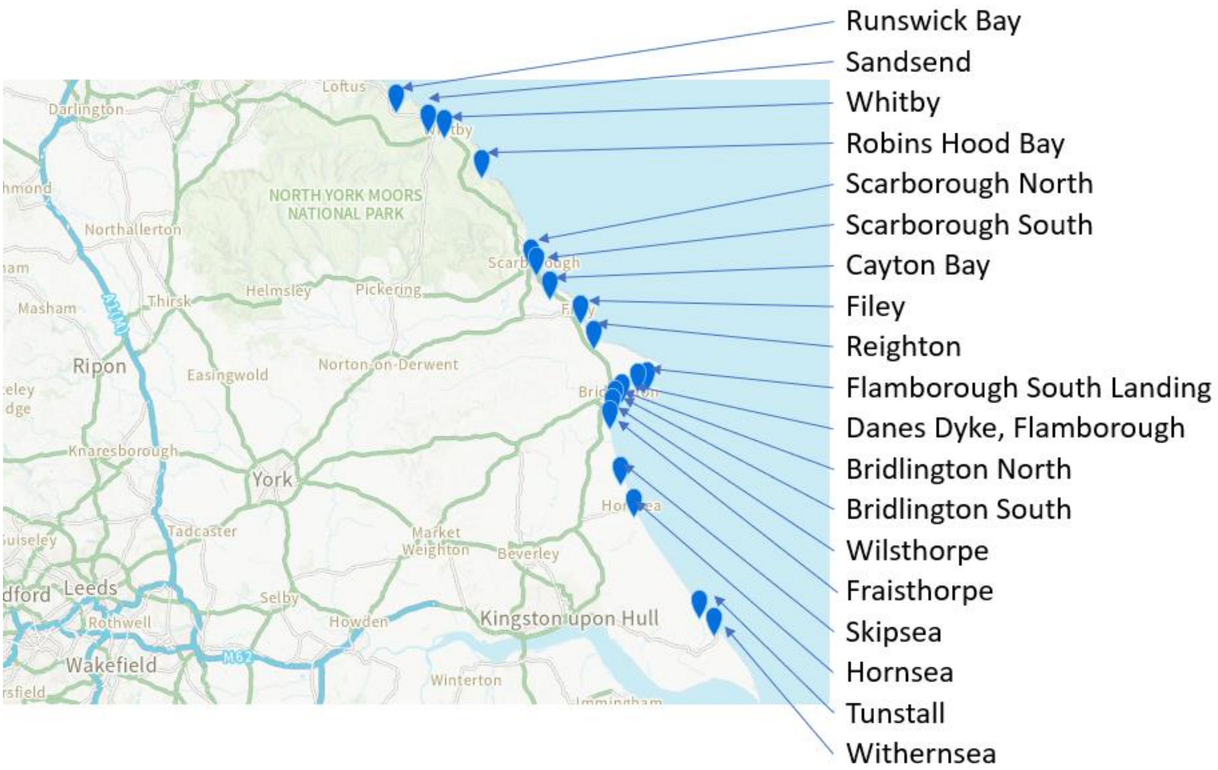
As we begin to move away from the approach of creating capacity in combined sewers by providing storage, to a more adaptive approach of source control and surface water separation, a wide reaching cultural and economic shift is needed. This shift will need to embrace an adaptive programme to ensure integrated 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 59. 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 59: 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

DO YOUR BIT FOR The Beach

Working in partnership to improve Yorkshire’s beaches

Environment Agency

EAST RIDING OF YORKSHIRE COUNCIL

YorkshireWater

www.YorkshireWater.co.uk

The Yorkshire Wildlife Trust and the University of Hull are also involved in working on specific projects with the partnership.

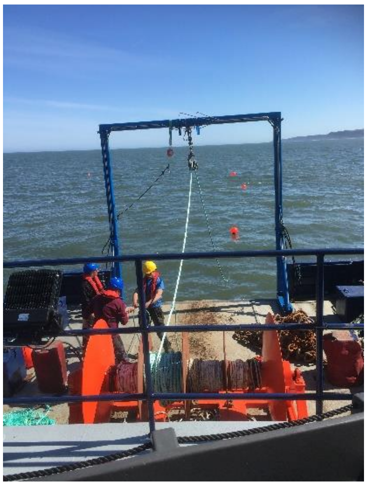
The partnership is overseen by a Partnership Board. This comprises of Executive and Senior Management support from each organisation. A Technical Action Group reports to the Board and carries out day to day activities and projects which aim to achieve the vision and objectives set out by Board. A Stakeholder 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.

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. Below photographs illustrate the deployment of these trial lines and anchors.

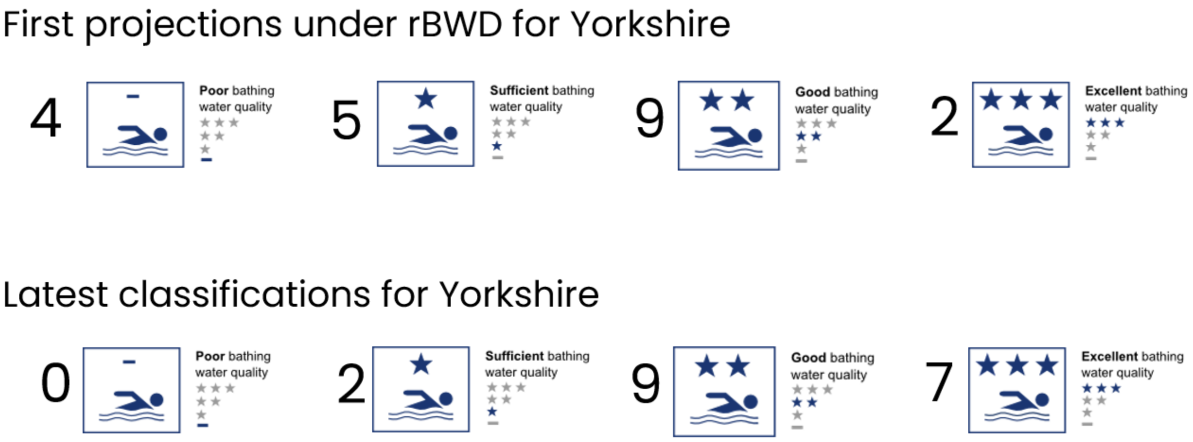


We have also worked with the partnership to dramatically improve our sampling regime at Bridlington and Scarborough.

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 60 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 60 : Bathing Water Classifications



Tunstall is 'unassessed' due to lack of safe access.

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

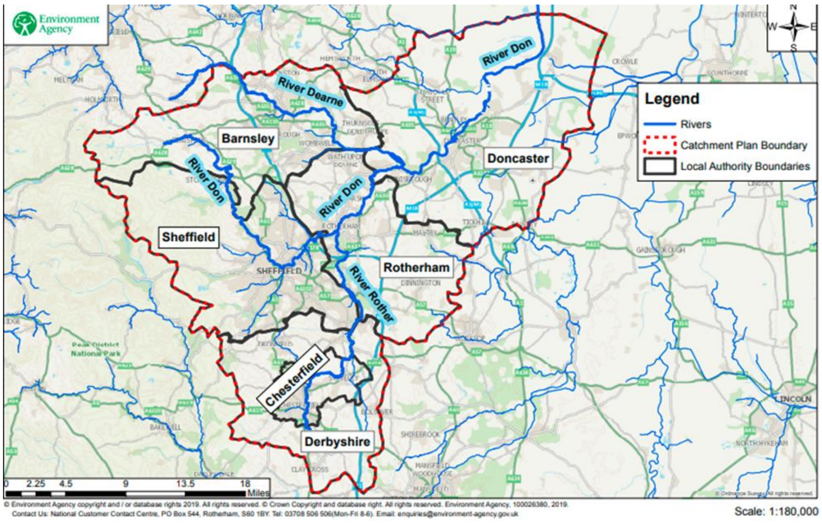
1.4.1 Background and Partnership

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.

The CBW partnership has been established to work collaboratively to meet the challenges of climate change in the South Yorkshire region, shown in Figure 61 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 61: 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

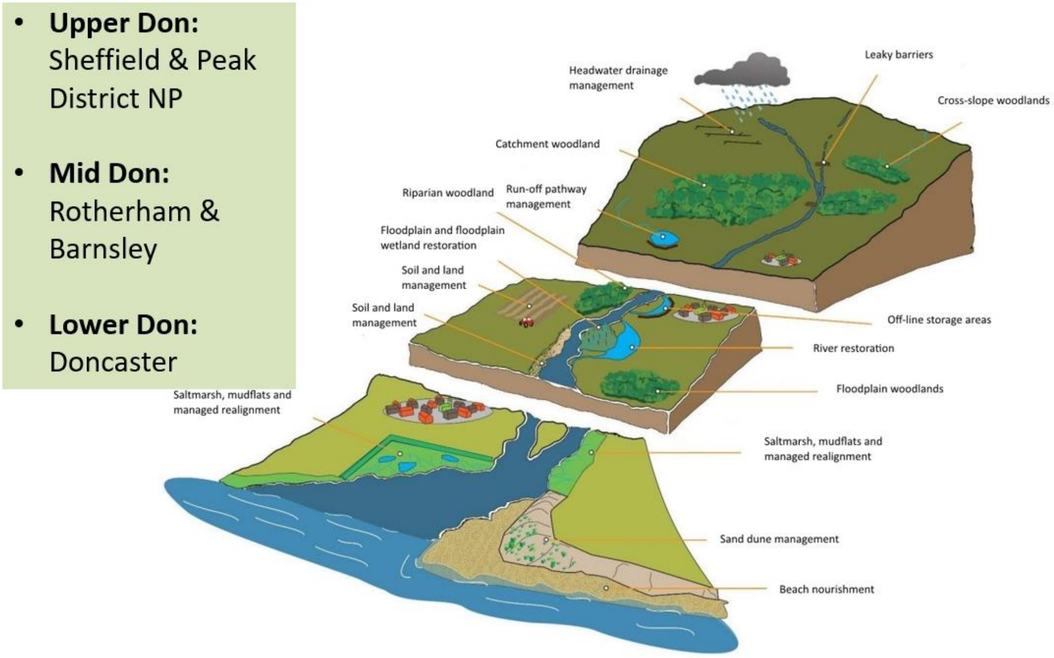
The South Yorkshire Flood Risk Investment tool will bring together flood risk data and evidence from across the region to inform future investment in flood risk management. This will ensure targeted investment to maximise flood risk benefits in the region. The tool will collate information on wider investment 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 62, 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 62: 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.

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.
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.
BAU	Business as Usual activity
BGI	Blue/Green Infrastructure - Natural and semi-natural assets which aid in surface water management whilst also providing wider environmental benefits.
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.
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.

Term	Description
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.
DAZ	Drainage Area Zone - The area drained by a network of sewers and associated assets.
DEFRA	Department for Environment, Food and Rural Affairs.
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.
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.
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).

Term	Description
ESF	External Sewer Flooding - Flooding to property curtilage or land such as gardens due to hydraulic incapacity of sewers.
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.
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 EAand Lead Local Flood Authority.
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.
Grey Infrastructure	Traditional methods of wastewater management such as concrete detention tanks.
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.

Term	Description
iCASP	Yorkshire Integrated Catchment Solutions Programme - An academic body which uses research to benefit the environment, economy, and society of Yorkshire.
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.
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.
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.
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.
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.
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.

Term	Description
NGO	Non-Governmental Organisation – a non-profit organisation, typically with social or environmental aims.
NFU	National Farmers Union - Is a member organisation/industry association for farmers in England and Wales.
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
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.
PA	Programme Appraisal
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
POT	Peak over Threshold a recognised approach to model extreme values
PR24	Price Review 2024 - The Ofwat periodic review of price limits to be in 2024 to set prices for the regulatory period 2025-2030.
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.

Term	Description
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.
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.
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.
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.
SCADA	Supervisory Control and Data Acquisition – remote visibility, control and alarm management system for assets.
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.

Term	Description
Sewerage	A system by which wastewater or surface water is transported.
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.
SOEP	Storm Overflow Evidence Project - An independent research project that considers options, costs, and benefits for reducing storm sewage discharges in England.
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.
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.

Term	Description
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.
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.

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/