Adaptation Report 2020/2021

October 2021

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Foreword

Yorkshire Water has long recognised the importance of responding to the climate emergency, publishing our first adaptation report in 2011 closely followed by our position paper on climate change in 2012, our climate change strategy in 2013 and our second adaptation report in 2015.

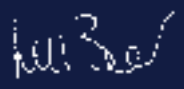
The public awareness of climate change has accelerated enormously over this time, with every local authority in our region declaring a climate emergency and many organisations, including Yorkshire Water, committing to significantly reduce carbon emissions. But even if we meet global ambitions to meet Net Zero, we will still inevitably have to adapt to climate change because of the emissions already released and the changes that are already happening to sea levels, rainfall patterns and temperatures.

This report shows how we are factoring these changes into our decision making, models and long-term planning, to ensure that we can continue to deliver essential public services into the next century. It sets out the investment that we have made in protecting future water supplies and the natural habitats on which we rely, and how we manage the risk of drought, flooding, and coastal erosion. It also describes our experience of managing through some of the extreme weather events which have hit our region in the last five years including the Boxing Day floods in 2015 and the drought in 2018.

Even though we are well used to managing through these types of extreme events, and we practice and prepare for all sorts of eventualities, no one could have predicted how COVID-19 would change all our worlds in the last two years. More people than ever before appreciated the importance of access to the natural environment and with the UK hosting COP26 this year, there is a great deal of attention on, and a growing demand for, a cleaner, greener, more resilient society and economy.

We want to be at the heart of creating this future and this report sets out how we will ensure good quality drinking water and sanitation services are maintained in the face of a changing climate, how the precious habitats, landscapes, rivers and coasts that are under our stewardship will be protected and how we will collaborate and bring people and organisations together to deliver landscape scale, city wide solutions to the challenges we face.

We look forward to sharing our experience, knowledge and plans with you and working together to achieve a more resilient, climate adapted future.



Liz Barber,
Chief Executive Officer

Contents

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The report is structured as follows:

1. Introduction

About this report

Welcome to Yorkshire Water's third Adaptation Report. This document is our formal response to the Secretary of State's invitation to provide an update on our previous Adaptation Report which we published in 2015. These reports form part of the UK's climate risk assessment and policy cycle under the Climate Change Act, 2008, and will be used to inform national climate risk understanding and policy development. Reports are invited from all water and sewerage companies along with other providers of essential infrastructure and other bodies with functions of a public nature.

We have followed Defra guidance and reported against the following seven risks from the national Climate Change Risk Assessment, along with along with two additional risks we felt were especially relevant to a water company, and which we reported against in our previous report. Our report contains information about the following risks:

- Risks to public water supplies from drought and low river flows (In9)
- Risks of sewer flooding due to heavy rainfall (In4)
- Risks to infrastructure services from river, surface water and groundwater flooding (In2)
- Risks to infrastructure services from coastal flooding and erosion (In3)
- Risks to subterranean and surface infrastructure from subsidence (In8 combined with In5)
- Risks to bridges and pipelines from high river flows and bank erosion (In5 combined with In8)
- Risks of cascading failures from interdependent infrastructure networks (In1).

Additional risks

- Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems including soils and biodiversity (Ne1)
- Risks to public health from poor water quality (PB13).

In preparing our report we have provided the following information in line with the guidance provided to reporting organisations by Defra:

- the climate evidence or data informing our risk understanding
- the extent to which we are managing the risk (we understand this to mean the level of resilience or levels of service we provide and how we do this on a day to day basis)
- the actions we have taken since our last report, and those we plan to take over the next five years to address the risk
- the shortfalls or barriers to further action, and the uncertainties and interdependencies that we are aware of through our work to date; and
- details of how we measure and report on our performance against these risks.

Our report begins with risks to our two statutory, licensed services of providing drinking water (drought) and draining an area (rainfall causing sewer flooding). We then discuss risks to water quality from changing climate, and risks to our infrastructure and services from flooding, coastal erosion and ground movement. We have included a chapter on how we are managing the risks to the natural environment as we are very reliant on high quality habitats such as peat lands and rivers to provide our core product – good quality water. Our emergency planning and response capabilities are included in both Chapter 4 and Chapter 8.

We trust this report will give the reader confidence that consideration of climate change is well embedded in both our long-term planning and our day to day operations, and demonstrates the progress we have made and the wide range of actions we have taken in the last five years and those we plan to take in the next five years.

2. Risks to public water supply from droughts and low river flows

Risks to public water supply from droughts and low river flows

We supply drinking water to nearly five million domestic customers and around 135,000 commercial customers across the Yorkshire region. Raw water is sourced from rain-fed reservoirs in the west of the region, river abstractions in the centre and groundwater sources in the east. It is then treated at one of our 48 water treatment works before entering the clean water distribution network and being piped to customers.

Because water is an essential public health service, the Water Resources Act 1991 (amended by the Water Act 2014) places a statutory requirement on water companies to produce long-term plans to ensure demand can be met, now and 25 years into the future. These Water Resource Management Plans (WRMPs) are produced in line with guidance issued by the Environment Agency and follow a conservative, risk-based approach, with more detailed planning required for areas at higher risk of supply deficits. The plans consider the impact of climate change on future rainfall, how much the population is expected to grow, and projected changes to industrial and domestic demand. Statutory drought plans accompany the WRMP and set out the actions we would take in the event of a drought. Plans have been produced every five years on a rolling basis since the 1990s and are open to consultation with customers and key stakeholders before being published on water company websites.

The mix of water resources and our Grid means Yorkshire Water has one of the most resilient water supply systems in the UK. Our most recent WRMP, published in 2020, found our water supply services are resilient to 1 in 500 drought. Over the next five years we are managing our drought risk by reducing leakage and encouraging customers to use water wisely, however in the longer term, supply side options may need to be developed.

We note that reducing customer demand is one of the single most cost effective adaptation actions as highlighted by the Committee for Climate Change and welcome the recent announcements by the Government to introduce domestic per capita consumption targets and water efficiency labels on dishwashers and washing machines. We would encourage the Government to be bold and go further with water efficiency standards for new homes and developments as well as products such as showers.

This section also highlights the work we are doing with our neighbouring water companies through the National Framework for Water Resources. This new framework means all water companies are exploring how cross boundary planning can improve drought resilience across the whole of England, to reach a target of 1 in 500 year drought resilience by the 2030s. It is likely that significant further investment will be required to meet this target nationally and the Environment Agency, Drinking Water Inspectorate and Ofwat have formed the Regulators Alliance for Progressing Infrastructure Development (RAPID) to design an appropriate regulatory framework to achieve this.

Informing our risk understanding – improvements since our last report

Water resource management plans

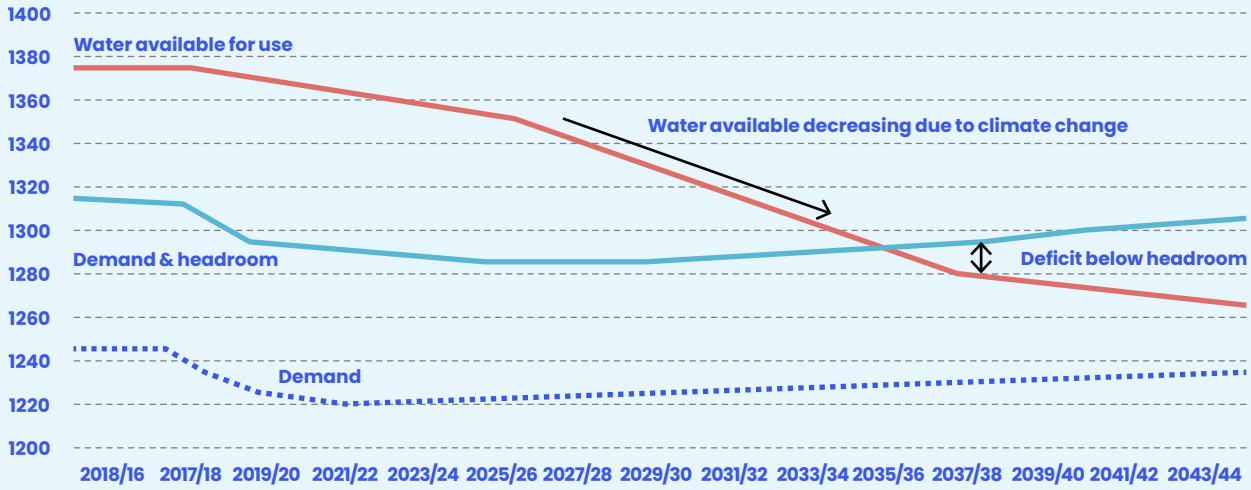
Since our previous adaptation report we have produced a new WRMP and accompanying Drought Plan which we published in 2020. The WRMP19 covers the period from 2020 to 2045. We have also extrapolated data to give us an idea as to what our water resources situation could be in 40 years' time although the further into the future we project, the greater the uncertainty.

Climate data from UKCP18 was not available when we were carrying out the modelling for our latest plan (WRMP19), so we used a smart sample of 20 of the 10,000 climate model runs available from UKCP09 to assess the likely impact of climate change on future water availability. UKCP18 data is being used to inform our next plan, which will be published in draft in August 2022, following publication of the draft Water Resources North Regional Plan in January 2022. The 20 climate model runs used for WRMP19 cover a temperature rise of between 1.6 and 5.3°C by the 2080s. In the baseline scenario (if we took no mitigating action) WRMP19 predicts a deficit of 100Ml/day by 2045 due to the impacts of climate change. This is a change from our previous plan (WRMP14) which predicted a much earlier deficit due to climate change, by 2018/2019.

This change in when we predict climate change will cause a deficit is because of some changes to the methodology:

- In WRMP14 we used UKCP09 medium emissions forecasts to the 2030s. However, the Environment Agency guidance on which forecasts we should use has changed so for WRMP19 we used forecasts to the 2080s.
- As in WRMP14, we used 20 selected climate change model scenarios (out of 10,000 that are included in the UKCP09 dataset). For WRMP14 we analysed the data and selected 10 low probability dry runs and another 10 from across the whole range of projections. We modelled these 20 scenarios and used the median. For WRMP19 we carried out an intermediate vulnerability assessment, and based on this, selected 20 runs from across the whole range of scenarios, using statistical sampling stratification to get a representative sample. We additionally looked at three dry scenarios.
- In WRMP14 we used the Environment Agency scaling equations. In WRMP19, we did not use the new Environment Agency scaling equations but instead followed guidance and used an alternative interpolation, similar to that used in 2014, but with a less steep initial gradient. We did this because using the Environment Agency scaling gave a loss of about 70Ml/day in year 1 of AMP7 (in 2020), which we did not believe to be a likely scenario in Yorkshire. We agreed this approach with the Environment Agency.

Figure 1. Baseline supply demand forecast, 2015-2045.



Although we showed a reduced impact of climate change in WRMP19 compared to WRMP14, it remains the biggest single influence on our long-term future water resources prospects. The impacts of climate change would result in being below our target headroom by the 2030s if we did nothing, so we need to either increase supply or reduce demand. WRMPs generally consider demand reduction options before supply side options, so our preferred way of closing this gap is to first reduce leakage.

Our draft WRMP contained a very stretching target of 40% reduction in leakage by 2025. However, despite customer support, this target was not supported by our economic regulator and our PR19 Final Determination instead directed us to reduce leakage by 15% by 2025. This lower leakage target is still sufficient to protect our supply demand balance through the planning period. Along with other companies, we have committed to a longer term target to reduce leakage by 50% by 2050 compared to a baseline of 2017/2018. We will also continue our water efficiency campaigns with customers to encourage them to use water wisely to conserve resources.

Levels of service

WRMP19 sets out how we plan to meet the supply demand balance to continue meeting the levels of service (and therefore resilience) that we have agreed with our customers. We calculate levels of service using historic weather patterns and previous worst case scenarios to meet forecast demand.

Our current levels of service for water supply are:

- **Introduction of temporary use bans:** no more than 1 in 25 years on average
- **Drought permits/orders implementation:** no more than 1 in 80 years on average
- **Rota cuts/standpipes:** 1 in >500* years[1]

Our Level of Service has improved since 2001 through leakage reduction, grid extension and additional abstraction licences. Yorkshire has experienced droughts in 1995/1996, 2003, 2011/2012 and 2018. However, we have not had to restrict water use since 1996 due to the high level of resilience in our Grid system, the mix of different raw water sources and the fact that we plan for worse droughts than in our historical record. Over 99% of our customers are now connected to the Grid. The 1% who are not are in the East Surface Water Supply Zone which has a considerable surplus even in drought situations (including that experienced in 2018). All of which means our customers enjoy one of the highest levels of resilience to drought in the UK[2].

The National Framework for Water Resources, published by the Environment Agency in March 2020, requires all companies to plan to meet a 1 in 500 level of service for restrictions such as rota cuts and standpipes. Although we believe that we already exceed this, we will review this position in our next WRMP and as a part of our work through the Water Resources North regional group, to ensure that we maintain our high levels of resilience to drought.

[1] This is an estimate of an exceptionally rare event. The frequency is an average over a long period of time, and therefore does not preclude a more frequent occurrence if there is a particular run of very dry years.
[2] **water.org.uk/publication/water-resources-long-term-planning/**

Drought Plan

We have a statutory requirement to produce Drought Plans every five years which we develop in consultation with our regulators and other stakeholders. These plans are reviewed on an annual basis and after any drought events. Because every drought is different in terms of location, extent, severity and impact on the supply system, plans need to be flexible to account for a range of possible scenarios. The plan therefore gives an agreed framework of actions to allow a drought to be best managed dependent on conditions. These actions have been costed and assessed for environmental impact and, in line with the approach taken in WRMPs, the Drought Plan implements demand side measures before supply side ones.

Demand side measures include water efficiency campaigns to encourage customers to use water wisely (including hosepipe bans, officially known as Temporary Use Bans or TUBs), increasing our leakage find and fix resource, and moving water around the Grid. If a drought persisted, we may then need to look at supply side options such as reducing compensation flows, increasing abstraction, re-commissioning unused sources, or inter-company transfers. Our Drought Plan contains 58 supply side options, that are designed to conserve reservoir supplies or provide additional river or groundwater supplies. Further detail about all these options can be found in our Drought Plan, the latest version of which is available on our website.

To assess if we are entering a drought situation where there could be a risk of public water supply restrictions, we use long, medium, and short-term planning models and data including rainfall, reservoir stocks, demand, weather forecasts and asset availability.

We use a model called WRAP to plan water production on a weekly basis and another model called WRAPsim for our medium and long-term planning. During dry spells, we use WRAPsim to forecast forward from current reservoir stocks and assess when stocks could fall below drought control lines if the dry spell were to continue, and demand remained the same. If the model predicts that stocks will fall below the drought control line within six weeks then we will prepare for a TUB.

Water companies must have implemented a TUB before they can apply for a drought order from the Environment Agency or Defra, which is required to implement any of the longer-term, supply side options in the Drought Plan. Our latest Drought Plan also describes our approach to 'agile communications' with our customers, encouraging them to reduce their water use during periods of dry weather and drought; if effective, this approach could help us to avoid the need for compulsory measures such as TUBs.

We monitor our water resources year round regardless of the weather and produce a weekly Water Situation Report which we share with the Environment Agency, and which we also publish on the Data Mill North website[3] and as an animated summary on our own website[4]. These reports show water stocks compared to various control or trigger lines. If stocks cross the regional drought trigger line, we will open formal liaison with the Environment Agency and start to monitor the water situation more closely. The trigger is set so that it is crossed well before any area is in potential drought and its purpose is to provide an early indication of problems that may develop later. Once the trigger has been crossed, we implement our drought plan procedures and work with the Environment Agency to manage the situation as it develops, including de-escalating as water stocks recover.

Our current Drought Plan includes the lessons learnt from our previous experiences of drought, including that in 2018, which is described below.

[3] **datamillnorth.org/dataset/watsit**
[4] **yorkshirewater.com/open-data/watsit-report/**

Our experience of drought since our last report

The Yorkshire region experienced exceptionally low rainfall and high demand in 2018, which led to the implementation of the Yorkshire Water Drought Plan. This was the most severe dry year experienced in our region since the drought in 1995/1996. The Environment Agency classified the Yorkshire region as "in drought" from November 2018 until February 2019 when the status was changed to "prolonged dry weather", and then changed again to "recovering from drought" in March 2019[5].

A comparison of 2018's rain with other periods in our historical record shows:

- Regionally, the 3-month period from May to July was the driest for that period in our 75-year record.
- The 2-month periods of May and June, and July and August, were both the second driest in 75 years.
- The 4-month period from May to August had only 49% of the Long Term Average (LTA) rainfall, with a return period of greater than 1 in 100 years.

The chart below shows Yorkshire's rainfall in 2018, by month, as percentages of the Long Term Average (LTA). The early part of the year was wetter than average. However, the period from May to August was exceptionally dry. The July figure is closer to average, but this is skewed by rain at the end of the month; most of July was significantly below average.

At the start of summer 2018, our initial focus was on making the best use of our resources and ensuring we could treat water fast enough to keep up with very high customer demand during a period of hot weather.

During June and July demand increased by 200Ml/day, enough to supply a city the size of Leeds. In response we stepped up our water saving messaging, putting out locally targeted social media posts reminding people to use water wisely. We optimised our use of water resources and continued to release water from our compensation reservoirs to maintain sufficient flows for fish and other wildlife in rivers.

As the dry weather continued, our modelling showed that we could require additional raw water supplies if autumn was also dry and/or if there was another prolonged spell of cold (which would have increased the rate of leakage and therefore the volume of water required for supply). In light of the risk, we applied for two drought permits which would have allowed us to increase winter abstraction from the River Wharfe and River Derwent. These would have protected public water supplies in case the winter of 2018/2019 stayed dry and our reservoirs didn't fill up as much as usual. In the end, it rained – a lot. Our reservoirs were 84% full again by December 2018 and we did not need to implement the permits. The permits have, however, been added as options in our 2019 Drought Plan and the associated strategic environmental assessment has been carried out should we require these in the future.

Yorkshire regional rainfall

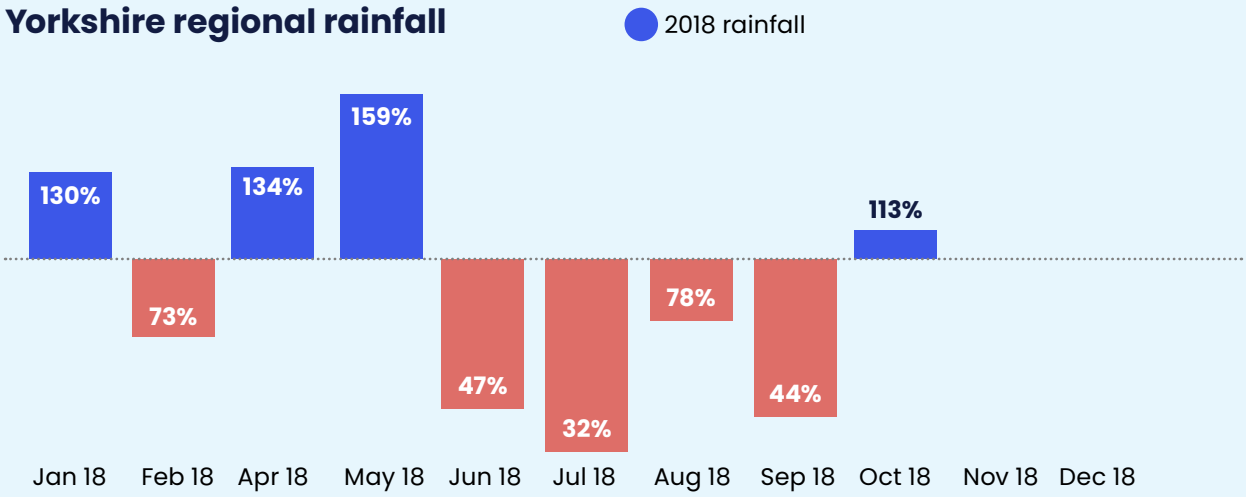
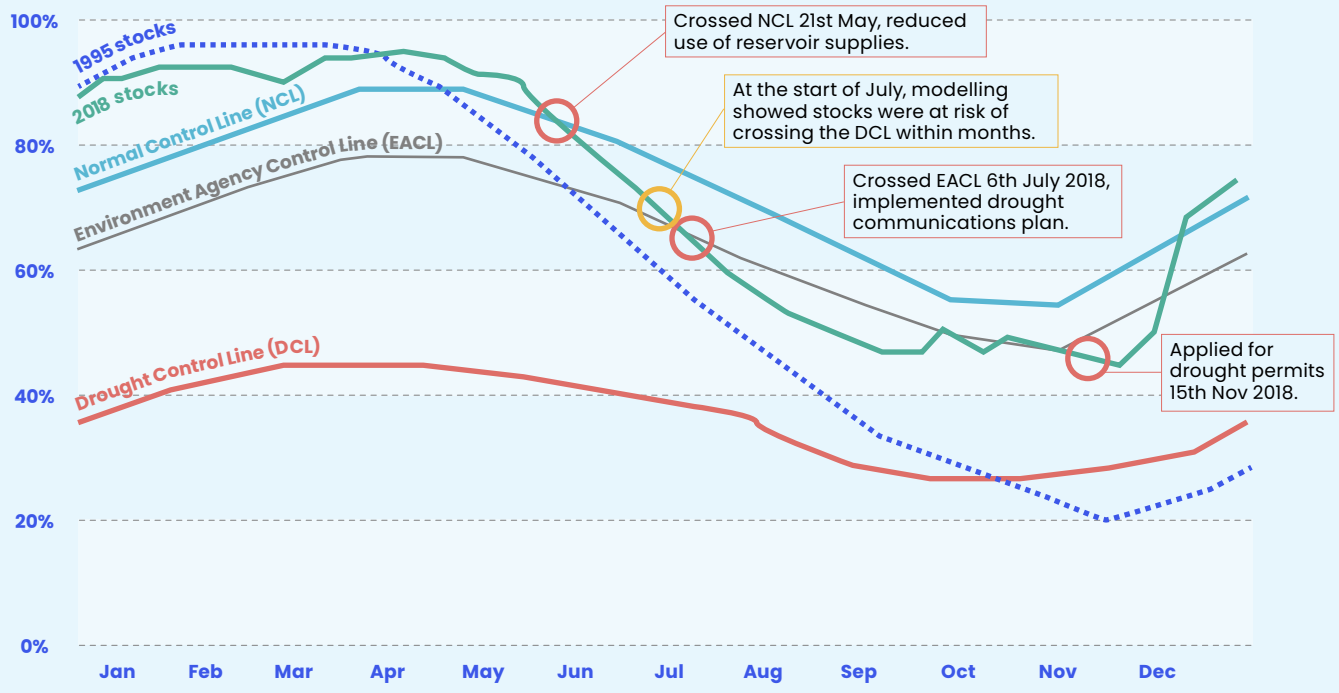


Figure 2. Regional rainfall as a percentage of long-term average rainfall Jan 2018 to Dec 2018.

[5] Yorkshire Water_Drought 2018 Lessons Identified FINAL.doc

Figure 3. Overview of 2018 drought triggers and actions.



Lessons learnt

Together with the Environment Agency, we reviewed our experience of the 2018 drought and produced a lessons learnt report. The report identified 20 actions which we are progressing along with the Environment Agency and have been included (where relevant) in our latest Drought Plan which was published in draft for consultation in June 2021. Actions include a range of different activities such as reviewing our triggers for action, updating reservoir control lines, clarifying procedures and responsibilities, adding two new drought plan options, and removing two unfeasible ones, reviewing compensation releases, and creating "application ready" templates for drought permits.

In response to the drought during 2018, we also carried out capital works installing new pumps at two raw water pumping stations and carried out some valve trials at a treated water pumping station to improve our ability to move raw and treated water across the region during drought events.

Actions 2015–2020

In our previous report we said we would carry out the following actions:

We said we would work with customers to reduce water demand by 1.5Ml/day each year from domestic customers and 0.5Ml/day from business customers, investing around £2 million in water efficiency.

We achieved the domestic savings, reducing water demand by a total of 7.1Ml/day across the five years. Services for business customers are now provided by a separate company from Yorkshire Water following the introduction of retail competition so we no longer have access to that data.

We have also met our water efficiency targets for 2015-2020, reducing domestic per capita consumption from 138.3 l/day to 135.0 l/day. This was achieved through a mixture of water efficiency campaigns, giving away water saving packs with shower timers and tap inserts, and in home water audits.

Metric	Unit	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	Total
Water saving support	Ml/day	1.55	1.78	2.01	1.46	0.88	0.97	7.1

Actions 2020–2025

Our current WRMP19 covers the period from 2020 to 2045. The immediate focus of our plan over the next five years is to reduce leakage by 15% by 2025. Our proposed investment to meet our leakage targets is £40 million per year with an additional spend of £28 million over the next five years on network resilience.

Our planned investment over the next five years for water infrastructure is approximately £260 million. This is the entire capital expenditure associated with water networks, including mains renewal, water quality investment, strategic investment to improve resilience and the replacement of fixtures and fittings.

Our previous Drought Plan was published in 2020. Our next Drought Plan was issued for consultation in June 2021. The reason for updating the plan so soon after the last one is to ensure that we comply with a new common submission date set by the Environment Agency that requires publication of draft drought plans in 2021.

Our next WRMP will be published for consultation in draft form in 2023 and will sit within a new regional tier of water resource planning driven by the National Framework for Water Resource Planning. We are part of Water Resources North which brings together Yorkshire Water, Northumbrian Water and Hartlepool Water. We are currently developing the datasets which we need to input into our models, including how we can update these with the latest climate change data from UKCP18.

We expect that WRMP24 will maintain our existing high levels of service for drought resilience (1 in 500) and supply interruptions, although some investment may be required to maintain this, which would require the support of customers.

Barriers and interdependencies

We note that the Committee on Climate Change's research shows that water efficiency is the single most cost effective adaptation action, with a cost benefit ratio of more than 1:10. However, encouraging society to properly value and conserve water is difficult on our often wet and rainy island and the payback period for water efficiency investment is far longer than it is for energy efficiency. Most customers drastically underestimate how much water they use with more than half of people in a recent survey saying they used less than 40 litres a day, when actual water use is more like 140 litres per person per day[6]. Alongside water company campaigns to encourage customers to save water, we suggest the following changes could be introduced in the new Environment Bill, or through changes to existing regulations, to improve drought resilience:

- The Environment Agency to allow water companies to consider compulsory water metering in all areas, including those not currently classed as water stressed.
- Defra to implement their recently announced intention to introduce mandatory water efficiency labelling and minimum standards for white goods such as dishwashers and washing machines, like the energy efficiency A-E rating. Independent analysis has shown this to be the most cost effective intervention and could save 6.3 litres per person per day over the next ten years[7].
- Department for Communities and Local Government (DCLG) to implement national statutory building standards for water efficiency rather than leaving this to individual local authorities. We have worked with Leeds City Council to introduce a water efficiency standard for new build homes of 110 litres/day (compared to the national standard of 125 litres/day).
- Government to fund a citizen's assembly to raise awareness of current and future climate risk and inform the policy options to manage these (similar to the citizens assembly held for Net Zero)[8].

An interesting interdependency that we have in our region is around the use of reservoirs for mitigating flood risk in the Calder Valley. These reservoirs usually fill up over the winter and the water is put into supply over the rest of the year. However, we were asked by the Environment Agency to examine if the reservoirs could be held 10% lower over the winter to see if this would provide some degree of flood protection to the downstream town of Hebden Bridge. We have been able to carry out a trial to assess this in 2017/2018 and 2019/2020 and 2020/2021. However, in 2018 the reservoir levels were already much lower than 10% due to the drought that was experienced that year. Using reservoirs in this way can provide a degree of flood risk benefit, however this needs to be balanced against the risk of drought and water supply shortages. Please see **page 60** for more information about this trial.

Many other businesses and organisations are dependent on a secure, sustainable water supply. The work that we are leading through the Water Resources North programme includes consideration of future water needs in sectors beyond just public water supply. We are liaising with other groups such as representatives from energy, agriculture and other industries to try and understand what their future water resource requirements may be. These other sectors are often global in nature (for example food supply) and their future plans are often inherently linked to climate change, which could impact on the range and type of crops grown in Yorkshire, as well as Government policy for example relating to the energy sector. This means that forecasts of future water need in other sectors are highly uncertain. However, we do know that we are likely to see the emergence of new sectors that will require water – for example, process and/or cooling water for hydrogen creation, or to support innovations such as carbon capture and storage. Where it is possible to do so, we will take account of these needs in the Water Resources North Regional Plan.

6. water.org.uk/news-item/vast-majority-of-brits-have-no-idea-how-much-water-they-use-each-day/
7. waterwise.org.uk/wp-content/uploads/2019/02/Water-Labelling-Summary-Report-Final.pdf
8. parliament.uk/get-involved/committees/climate-assembly-uk/

Measuring and reporting

The water industry in England has 14 common performance commitments which are measured and reported using an industry-wide, regulator-approved methodology. In addition, we also have Yorkshire Water specific performance commitments. We publish our performance on a quarterly basis on our own website, and on an annual basis on the Discover Water website, which shows comparative performance against other water companies.

Industry-wide Performance Commitments

Percentage of customers at risk of severe water restrictions in a 1 in 200 year drought – this is assessed and reported once every five years as part of our WRMP. Yorkshire Water has zero percentage of customers currently at risk during a 1 in 200 year drought as our WRMP19 shows we are resilient to a 1 in 500 year drought.

Water supply interruptions of more than three hours – this measures the average supply time lost per customer, across all our customers, for interruptions that lasted three hours or more. Our target is to reduce this from seven to five minutes by 2025.

Per capita consumption (PCC) – this is the average amount of water used by each person per day, however the way this is reported is a percentage reduction from the 2019/2020 baseline. Our target is to reduce PCC by 8.9% by 2025. This will equate to reducing PCC from 135l/day to 123l/day by 2025.

Leakage – the target for all English water companies is to reduce leakage by 15% by 2025 compared to a 2019/2020 baseline.

Yorkshire Water bespoke Performance Commitments

Significant water supply events – this is the number of water supply interruptions that last 12 hours or longer. This includes supply interruptions that are planned, a third party and applies to all domestic properties including those that are vacant. Our target for 2025 is no more than 12 such events.

3. Risk of sewer flooding in a storm

Risk of sewer flooding in a storm

Sewer flooding is one of the worst things that can happen to our customers and we try extremely hard to prevent it from happening. We deal with around 1,800 internal sewer flooding incidents per year and the vast majority of these (more than 95%) are caused by blockages or collapses. We clear 25,000 blockages (mainly wet wipes mixed with fat) every year from our network. We have a programme of both proactive and reactive work to tackle these issues, and details of this can be found in our business plan. In this report we focus on the impact of heavy rainfall events on our network and how we assess and manage this growing risk as the climate changes.

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 also a Risk Management Authority (RMA) under the Flood and Water Management Act, 2010 and have a duty to co-operate with other RMAs such as the Environment Agency and Lead Local Flood Authorities in the management of all sources of flood risk.

We collect a billion litres of wastewater a day, as a mixture of domestic sewage, trade flows, rainfall, snow melt, highways, and land drainage. This is conveyed to one of our 607 wastewater treatment plants through a network of 52,000 kilometres (km) of pipes and 1,800 pumping stations. The sewer network varies in age, size, condition and material, from Roman sewers beneath York, to the Victorian redbrick tunnels serving Bradford and the modern plastic pipes chosen for new housing developments. The average age of the sewer network in Yorkshire is around 80 years old and we invest £30-40 million a year on maintenance and improvements.

Managing the risk of sewer flooding is complex. The sewer network is not like the sealed, pressurised, pumped, drinking water distribution network. There is an automatic right to connect to the sewer network regardless of its local capacity, and the sewer network is often abused by people flushing wipes, fats, oils and greases down the drain. It is largely unpressurised, and in Yorkshire, gravity rather than pumps drive most of the flows in our sewers. Rain easily enters the sewer network through drains from roofs and roads and the network has historically been designed to cope with day to day rainfall events up to a 1 in 30 year event. During periods of heavy rainfall and in storms, storm overflows on the network allow excess rainfall to discharge to rivers to prevent it from backing up and flooding people's homes. This approach to sewer network design has served us well in the past, allowing us to balance the risks of flooding people's homes with discharging storm flows to the environment. However, a combination of 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 so that it can continue to function effectively in the face of these challenges.

We can do this by reducing or stopping non sewage flows entering our network, and by slowing down storm flows using more natural techniques such as Sustainable Drainage Systems (SuDS) like ponds and swales rather than concrete storage tanks. We can't do this on our own though and managing the increasing risk of sewer flooding requires changes to funding arrangements, legislation, planning policy, and the collaborative development of long-term plans and solutions with third parties such as the Highways Agency and local authorities. We also need to work with our customers to educate them about sewer abuse so the existing capacity of the drainage network is maintained and not blocked.

We highlighted the need for these changes in our previous report and are pleased that there has been significant progress with the introduction in 2019 of a water industry framework for long-term Drainage and Wastewater Management Plans, and in 2020, clarity over the definition, design and ownership responsibilities for SuDS with the publication of the Codes for Adoption. A new "fine to flush" standard has been introduced for wet wipes which is very welcome. We have also evolved our own approach by delivering more schemes in partnership with local authorities and increasing our internal expertise in SuDS design. We are actively engaged in the public debate around storm overflows and sewer escapes and have the first designated inland bathing water in our region on the River Wharfe. Our position paper on the Inland Waters Bill can be found at **yorkshirewater.com/about-us/public-affairs/policy-positions/**

Informing our risk understanding – improvements since our last report

As the climate changes, there are projected to be longer, heavier rainfall events in winter and more intense summer storms. Both have the potential to overwhelm our network and increase the risk of sewer flooding.

Our previous adaptation report described how we assess the current and future risk to our sewer network using asset deterioration models, drainage area models, climate change uplifts, weather data, telemetry, and analytical tools. Updates and improvements on these activities are provided below. In addition, since our previous report there are the welcome developments mentioned above which start to place drainage planning on the same long-term basis as water resource management planning.

Drainage and Wastewater Management Plans

Companies have always assessed their risks and undertaken forward planning for their drainage networks. However, there was no agreed industry-wide methodology for doing this and there was also no consistency over whether or how climate change impacts were included in these plans.

In 2018, Water UK in collaboration with Defra, Ofwat, the Environment Agency, the Consumer Council for Water, the devolved administrations, and other key stakeholders, developed a new framework to plan for the future of drainage, wastewater, and environmental water quality.

These plans are called Drainage and Wastewater Management Plans (DWMPs) and follow a step by step framework with five main stages of activity:

1. **Strategic Context** – assess the risks over the next 25 years and determine what planning assumptions will be used.
2. **Risk based screening** – determine which catchments are most at risk today and take these catchments forward to the next stage.
3. **Baseline Risk and Vulnerability Assessment** – quantify current and future drainage risks and their causes on the prioritised list of catchments.
4. **Options development and appraisal** – develop a range of solutions, focusing on integrated solutions that provide multiple benefits and which include partnership working where appropriate.
5. **Programme appraisal** – prioritise and combine solutions into a programme for delivery.

These plans are developed in consultation with other Risk Management Authorities to ensure that DWMPs align with local authority surface water flood plans, River Basin Management Plans and the Flood and Coastal Erosion Risk Management Strategy for England.

As of September 2021, water companies are at the fourth stage of this process, which is the development and appraisal of intervention options. The draft plans will then be released for consultation in 2022, after which they will be finalised and the actions contained within them implemented from 2025 onwards, subject to regulatory funding approval.

It should be noted that although a framework has been developed, it will still be some time before all companies are planning on the same basis. This is because some companies have detailed models of their whole network (foul, combined and surface water), other companies have models of their foul and combined network only, and others have no models at all. We have models for just over half of our drainage area zones, which account for 77% of Yorkshire's population. Companies are also starting from different places and have quite different risks depending on geography and historic investment decisions. For example, some areas of the country experience very high groundwater levels which can infiltrate sewer networks and cause flooding whereas other places do not. It should also be noted that this approach requires a significant amount of modelling work to be carried out and the resource implications for a large region such as ours with more than 300 drainage area zones are significant.

How is climate change included?

As part of the Stage 3 BRAVA, companies agreed to assess the risk of sewer flooding occurring in a 1 in 50 year event, in 2020 and in 2050 and to share this information with stakeholders. For the 2050 assessment, companies which have models are expected to include an uplift for the impact of future climate change on rainfall along with uplifts for population growth and urban creep. At Yorkshire Water we already had climate change uplifts for the 2030s and 2080s based on both the medium and high emissions scenarios from UKCP09 (as described in our previous report). In 2018, we updated these to include a 2050s uplift for use in our BRAVA assessments, again based on UKCP09 as we needed to begin our assessments and the appropriate data from UKCP18 was not yet available.

Across the 335 wastewater treatment works catchments assessed during BRAVA, a 47% increase in the number of modelled residential properties at risk of internal sewer flooding is predicted to occur between 2020 and 2050. This is driven by the impact of future climate change on rainfall along with population growth and urban creep. Proportionately, this is a 1% increase from 4% to 5% of the total number of modelled residential properties within these catchments. It should be noted that the models used to generate these predictions range in detail and complexity and therefore varying confidence is held in the outputs that they produce.

There is ongoing collaborative research between the academic community and the water sector to understand how the very detailed 2.2 km convection permitting rainfall data from UKCP18 can be used in drainage modelling. This project is called Future Drainage and is funded by the National Environment Research Council (NERC, NE/S017348/1)[9]. The outputs from this research will inform updates to water industry modelling tools such as Red-Up (which is used in sewer modelling) and Environment Agency guidance on the level of climate change allowance to be used in flood risk assessments. Future Drainage is expected to complete in late 2021 and the Red-Up update in 2022. The Red-Up update is being led by UKWIR, the UK water industry collaborative research body.

[9] **ukclimateresilience.org/projects/future-drainage-ensemble-climate-change-rainfall-estimates-for-sustainable-drainage/**

Informing our operational response – improvements since our last report

In our previous report we described how we use a combination of rainfall radar data, weather forecasts, real time information from our telemetered assets, and customer contact data in our Regional Control Centre to target our operational activity. This ensures we can respond quickly and avoid or mitigate the risk of sewer flooding, for example by sending field teams out to clear sewers or check on pumps.

Since our previous report, we have continued to make use of Hydromaster (a rainfall data analysis and visualisation tool), investing in new system improvements and enabling more integration of our own telemetry data. We use the tool to determine rainfall thresholds for specific areas, customers and/or assets. An alarm is issued when rainfall is predicted to exceed the threshold and we can then send out field teams or alert site operators and adjust our activity accordingly.

We also continue to make use of the Met Office 1 km rainfall radar data for post event analysis. We have replaced our bespoke version of the Flood Estimation Handbook with FEHv13 at the request of our regulator Ofwat. This tool automatically generates return periods following all sewer flooding incidents allowing us to understand in detail specific rainfall events at any location across the region.

CSO Analytics, which we described in our last report, has had significant development in partnership with the University of Sheffield and Siemens and is now called our Pollution Predictor. This tool, based on the neural network machine learning we had built, uses Artificial Intelligence to understand how the network and our assets respond to rainfall. The new predictor tool found nine out of ten potential issues, almost three times more successful than the previous version of the tool, and it has halved the number of false positive alerts. The tool allows us to monitor the characteristics and performance of the sewer network in real time and predicts problems like a network blockage before they happen, enabling our engineers to inspect and resolve issues speedily.

Alongside the above tools and data, our Regional Control Centre has real time visibility of the number, nature, and location of customer contacts. This enables us to see if we are getting a lot of calls from a particular location, which might suggest a problem. Using our text message alert system, Blaster, we can then automatically send text messages to groups of customers in specific areas to let them know we are aware of an issue and are tackling it.

Actions 2015–2020

In our previous report we said we would carry out the following actions:

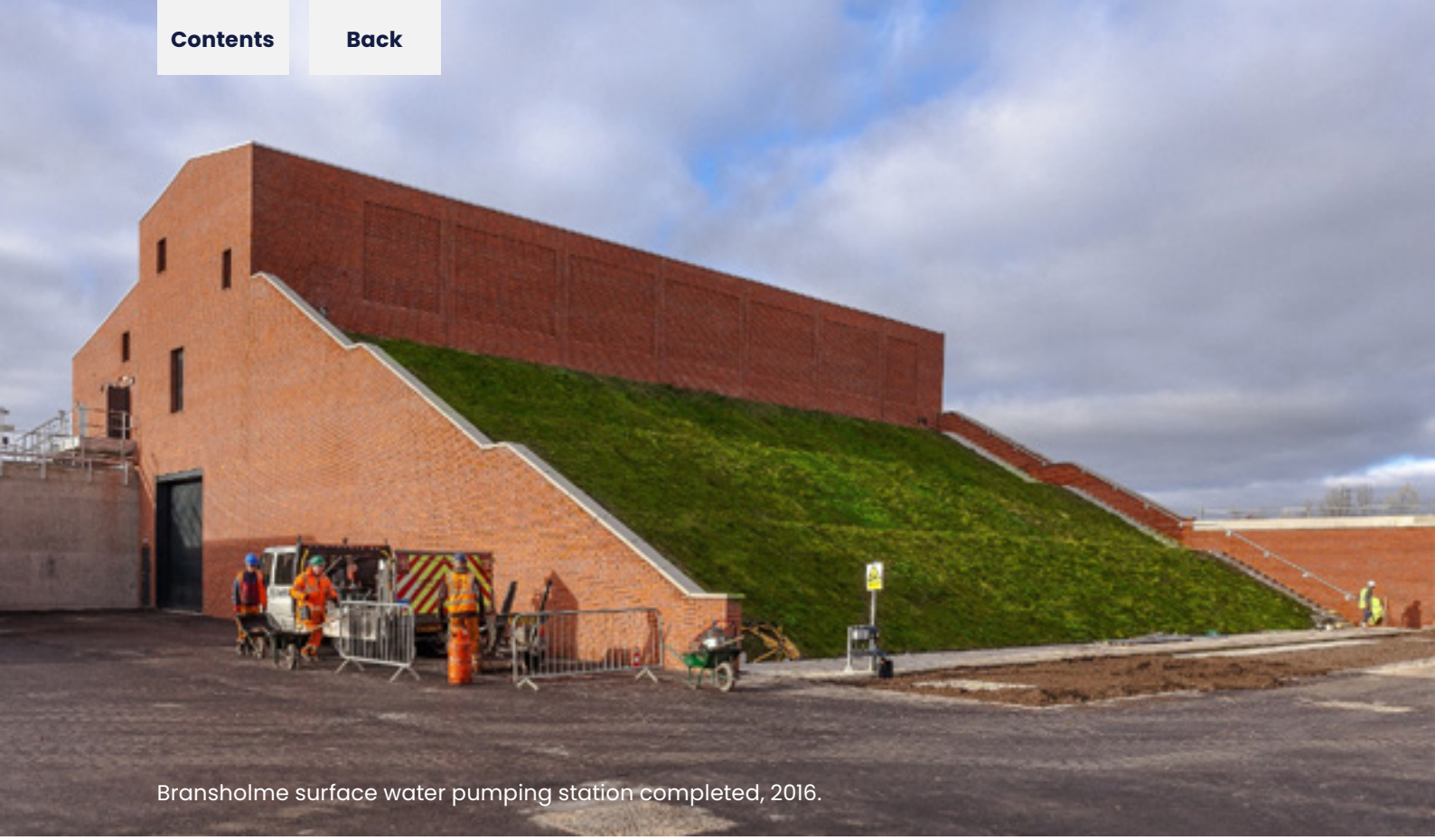
Between 2015 and 2020 we said we would invest £218 million to replace or refurbish sewers and pumps, a further £83 million to tackle sewer flooding caused by overloaded sewers and £0.6 million on upgrading and improving event duration monitoring at our CSOs. Our actual spend was £257 million on sewer and pump replacement or refurbishment, £112 million on sewer flooding and £4.17 million on event duration monitoring.

We said we would invest £25 million continuing to develop our Drainage Area Plan (DAP) models. Our actual investment was £22 million and we now have drainage area models covering 77% of the population of Yorkshire. The requirement to produce BRAVAs for DWMPs meant that we allocated our model maintenance budget differently and have undertaken model maintenance on the whole of our existing model stock.

We said we would publish our Storm Water Management Strategy and allocate £1.5 million between 2015 and 2020 to carry out feasibility studies and assess different techniques for managing storm water, such as SuDS.

We have developed our Storm Water Management Strategy and carried out a number of studies. We have delivered six schemes in partnership with local authorities to better manage surface water flood risk. Our contribution to these schemes was £700,000 with other parties contributing just over £1 million in match funding. These schemes included:

- installation of two small SuDS in partnership with Hull Council
- property level protection to address residual surface water flood risk to seven properties in Leeds following completion of the Leeds Flood Alleviation Scheme Phase One
- installation of permanent pump coupling underneath the railway at Malton to enable storm pumping in heavy rainfall which prevents rail, road, and property flooding in partnership with North Yorkshire Council and Network Rail; and
- small scale schemes with York and Rotherham Councils to remodel street furniture and our networks to direct surface water flows into nearby becks and away from properties.



Bransholme surface water pumping station completed, 2016.

We have invested a further £170,000 co-delivering "Hulltimate" with our new Living with Water partners, a major outdoor event raising awareness of flooding risk in Hull and the East Riding of Yorkshire.

We said we would refurbish our surface water pumping station at Bransholme in Hull, which we completed in December 2016 and which cost £16 million. The facility features six giant Archimedes screw pumps which during heavy rainfall will help reduce the risk of flooding by moving surface water from the sewers into the site's storage lagoon. The new and improved pumping station has around four times greater capacity and can transfer the equivalent of an Olympic swimming pool's worth of storm water into the lagoon in less than two minutes. Once stored in the lagoon, water is then slowly released into the River Hull.

Since the project began in 2014, Yorkshire Water and Black and Veatch have worked closely with the local community and used their feedback to help shape plans for the site, including softening the appearance of the new building with a living, green roof planted with sedum and wildflowers. The living roof not only improves the appearance of the building, but also provides space for wildlife and helps to reduce noise from the pumping station.

Bransholme surface water pumping station under construction, 2016.

Additional actions 2015–2020

Rainwater harvesting action research

In 2019 we worked with environmental social science experts at Sheffield University to use action research and community development to better understand how and why we can better engage with customers on rainwater harvesting and flood resilience. The Mobilising Citizens for Adaptation: Building local flood resilience through cooperative rainwater harvesting (MOCA[10]) project worked with the residents and community groups in two different areas near Hull – one more affluent and one less so – but both in locations which contribute to downstream flooding problems. We talked with households and community groups to explore whether, where and how rainwater could be stored in their neighbourhood to help prevent flooding downstream. In asking 'whether' and 'where' we considered whether there is space to put tanks or build ponds near their community buildings, in their open spaces or in their homes.

In asking 'how' we explored what sort of ponds or tanks, of what appearance, to whose cost, and under whose control. This project led to the installation of several rain water harvesting containers on local organisations' buildings, two schools and around 30 domestic homes. More importantly it has laid strong foundations for further community engagement and given us and the project partners (East Riding Council, Hull City Council, and the Environment Agency) practical ways forward. As a direct result of the MOCA project and associated findings, the project team has also secured £759,103 NERC (NE/T01394X/1) funding for a follow up project called MAGIC (Mobilising Adaptation, Governance and Infrastructure through Co-Production[11]). This will provide a further two years' additional research and development of the works already undertaken.

Customer engagement activity around flood risk at Bilton Community Summer Fayre, 2019. Credit Adva Photography.

Soak it up

During 2018/2019 we ran another community outreach campaign in schools which had been affected by flooding in the past. The Soak it Up! Project partnered with the Yorkshire Wildlife Trust to go into 12 schools and work with the children to raise awareness of flooding and how everyone can help soak up water with green solutions. Students were encouraged to design solutions for their own school which were then funded and installed by volunteer staff members from Yorkshire Water. In total the project generated:

- 706 volunteer hours
- 3,008 new trees planted
- 6,092 hours of education
- 596m^3 of new garden created
- 459m^3 new wildlife habitat created
- 1,479 new plants planted.

[10] ukclimateresilience.org/projects/moca-mobilising-citizens-for-adaptation-building-local-flood-resilience-through-cooperative-rainwater-harvesting/

[11] ukclimateresilience.org/projects/magic-mobilising-adaptation-governance-of-infrastructure-through-co-production/

Actions 2020–2025

Between 2020 and 2025 we will invest £238 million in repairing or refurbishing our sewer network and £76 million in directly reducing the number of sewer flooding incidents (all causes). This last figure includes £23 million investment in our flagship partnership Living with Water which is described in more detail in Chapter 4.

We will invest £106 million over the next five years in a proactive programme to prevent pollution and flooding from our sewer network. We will visit 280,000 properties which are at risk from internal or external sewer flooding and proactively check the condition of their sewers, clear blockages and repair any defects. This will include installing 40,000 monitors to improve our visibility of the sewer network. We will also proactively inspect and clean high risk sewers within 100m of a watercourse to reduce the risk of pollution.

We will invest £8.9 million in our modelling capabilities building 24 new Drainage Area Plan models and maintaining a further 24. These will include an uplift for climate change.

We also plan to invest £27 million in the Frequently Operating Overflows (FOO) programme which assesses the impact of our storm overflows on river water quality,and which will include an assessment of the future impact of climate change driven rainfall. For more information about how we manage the impact of our activities on river water quality please see **Chapter 8**.

We will publish our first DWMP in 2022. This will identify the schemes we will seek to fund through our next business planning period from 2025 to 2030 and beyond in order to manage the risk of sewer flooding. These plans are being developed in consultation with our stakeholders and will help identify partnership solutions including SuDS. Our DWMPs will include an assessment of climate change impacts.

Building on our Working with Others Performance Commitment (introduced in 2015), we will continue to identify opportunities to work in partnership with Lead Local Flood Authorities to manage surface water flood risk. We have created another new Performance Commitment for 2020 onwards which is to remove at least four hectares (ha) of surface water from our network each year, preferably using SuDS. This will help Yorkshire Water deliver more of these types of schemes, building up our knowledge, costs, and experience to enable more of these types of solutions in the future. We have also created an internal Yorkshire Water SuDS Design Guide to inform the design of adoptable SuDS assets which will be used by our solution engineers, capital delivery partners and developer services teams. Our Design Guide is aligned with the industry best practice guidance issued by CIRIA and the Codes for Adoption, issued by Ofwat.

The publication of the Codes for Adoption in March 2020 has clarified the definition, design, and ownership responsibilities for SuDS for developers. A SuDS can be one or several different types of interventions including permeable paving, bioretention systems (e.g. rain gardens), ponds, dry basins, swales, filter drains, or infiltration trenches. Some of these can be legally classified as sewers and can therefore be "adopted" by a water company and maintained as part of our sewer and drainage network. Some, such as permeable paving, cannot.

Now that this legal clarity has been reached, there is much greater opportunity for water companies to install these types of solutions (either on their own or in partnership), and more importantly, to adopt them when they are built as part of new development such as a new housing estate. We are working with several developers on their SuDS proposals and expect to adopt several basins and ponds once these developments are completed. The Codes sets the expectation that below ground features should be designed to accommodate a 1 in 30 flow (as is the standard in existing sewer design) with surface features such as ponds and swales generally designed to take a 1 in 100 year flow plus an allowance for climate change as set out in local authority or National Planning Policy Guidance.

We will invest £23 million in our Living with Water partnership with the Environment Agency, City of Hull Council and East Riding Council to reduce the risk of flooding from all sources in Hull and Haltemprice. This programme will deliver various partnership schemes including SuDS over the next five years.

One of the early achievements of the partnership is the creation of a legally binding sustainable drainage policy for all new developments in the area. The policy requires developers of brownfield sites to reduce run off by 50% using rain gardens, swales and other sustainable drainage features, and greenfield sites must not discharge any new surface water to the drainage network at all.

We will continue to engage with and educate customers about their role in looking after our drains and sewers. For example, we will run targeted campaigns to alert customers to the impacts of disposing of fats, oils, grease, and wet wipes inappropriately. We welcome the recent change in wet wipe labelling (the fine to flush standard and logo) so that it is clear these should not be flushed as these can block the sewers and make them less able to cope with heavy rainfall events. We note, however, that many products still have misleading or confusing labelling.

We would like to encourage more customers to install water butts and prevent rainwater from entering our network, and will continue with our activity in this area, including the MAGIC study described on page 26.

Barriers and interdependencies

Preventing surface water from entering our network is one of the best ways we can adapt it to cope with future climate change. This can be achieved through a portfolio of options:

- removing non-foul flows from historic connections which we are not funded to transfer or treat e.g. highways drainage, local authority surface water drains, land drainage and watercourses
- slowing down and holding back the flow of surface water entering the network, preferably using SuDS such as ponds and rain gardens rather than concrete storage tanks if possible
- preventing new surface water entering the combined sewer network by ensuring new development is not adding additional surface water flows
- maintaining, and where possible, upgrading our network with larger pipes and pumps to cope with existing flows and the impact of population growth, urban creep, and climate change (see actions page 27); and
- helping our customers understand the role they play in keeping our sewer network functioning as it should by preventing sewer abuse (see actions page 27).

We observe that there is no mechanism in our regulatory regime for the first option to be funded which means we are left with a significant legacy of flows which have historically been connected to our network. Since the introduction of the new Codes for Adoption in 2020, there has been progress on the second two options.

Planning policy now recognises that surface water from new developments be managed in line with the new Codes and should only discharge to a combined sewer as the last choice in the connection hierarchy. Planning policy in England encourages, but does not mandate the use of SuDS (unlike in Wales and Scotland). If these SUDS meet the definitions set out in the Codes, they can be categorised as sewers and adopted by water companies who will take on their future operation and maintenance. As Page 27 describes we are currently working with a handful of housing developers to agree the design and potential adoption of a range of SuDS.

Although planning policy requires separate systems on new housing developments of ten homes or more, this does not address the issues caused by the existing housing stock and urban creep. When front gardens are paved over, or conservatories and extensions added (known as urban creep), this can increase the flow of rain to our sewers instead of it being absorbed by gardens. Working in partnership with our local authorities and other stakeholders on our shared surface water flooding risks will help tackle some of these issues, and the development of DWMPs will greatly assist in this process. We are pleased that the Environment Agency rules around partnership funding for flood schemes have been updated and now better reflect surface water flood risk meaning that partnership projects to tackle existing surface water flood risk are more likely to be funded and delivered.

The affordability challenge we highlighted in our previous report remains. We maintain that it is not possible to upgrade our network to cope with the additional demands of population growth, development, and climate change without significant additional funding.

We also recognise that there has been a shift in the public expectations around the acceptability of storm flows from our network into rivers. COVID-19 has meant that more people than ever before have been enjoying their local rivers and there has been a huge surge of interest in wild swimming. We have the first designated inland bathing water in the UK in our region which presents several interesting challenges and opportunities. Our paper on the Inland Waters Bill sets out **our position** on this topic but in summary we are broadly supportive of the measures in the Bill, however we are keen to understand more from the public on what they want to see from rivers in the future. If the driver is a desire for bathing water quality in rivers, then the challenge is a public health one, and this leads to a focus on certain types of interventions such as tertiary treatment. If, on the other hand the concern is around the impact on biodiversity and the environment, then the focus of the interventions could be very different.

Not all storm overflows have a significant environmental impact and there will be a significant carbon cost to implementing tertiary treatment at all wastewater treatment works. So, there is the potential that some measures could do more environmental harm than good. We suggest a prioritised approach can be established and that the effective deployment of Drainage and Wastewater Management Plans would provide a transparent and consistent tool to do this. It's also important to be clear about how the ambitious measures in the Bill would be funded and the timescales involved. Regulators will need to recognise the significant investment required to carry out this work when carrying out future price reviews. The need to invest in long-term resilience was the reason Yorkshire Water did not accept its final determination from the 2019 Price Review and asked for a redetermination by the Competition and Markets Authority.

Measuring and reporting

The following metrics are reported on our website quarterly and on the Discover Water website annually (which also shows comparative performance against other water companies). The first four are common across the water sector with the fifth and sixth being Yorkshire Water specific metrics designed to encourage more partnership working, removal of surface water and installation of SuDS.

Industry-wide Performance Commitments

Number of internal sewer flooding incidents – (flooding inside the home, all causes including blockages, collapses, third parties and hydraulic overloading) including those caused during extreme rainfall events reported per 10,000 sewer connections per year – our target is to reduce this from 1.68 to 1.34 per 10,000 connections by 2025.

The percentage of the region's population at risk from internal hydraulic flooding from a 1 in 50 year storm, based on modelled predictions – our models show that 5.6% of our population is at risk during an extreme rainfall event. This modelling is carried out once every five years to inform our DWMPs (to be published in 2023). DWMPs will set out the solutions to managing this risk which will be submitted to our regulator as part of our next business plan in 2025.

Number of pollution incidents (severity category 1-3) per 10,000 km of sewer per calendar year – our ambition is to have zero pollution incidents, however constant investment is required to achieve this. Our target is to reduce the number of incidents per 10,000 km of sewer to 19.5 per year by 2025.

Number of sewer collapses – per 1,000 kilometres of all sewers causing an impact on service to customers or the environment – our target is to reduce this from 18.26 to 15.39 by 2025.

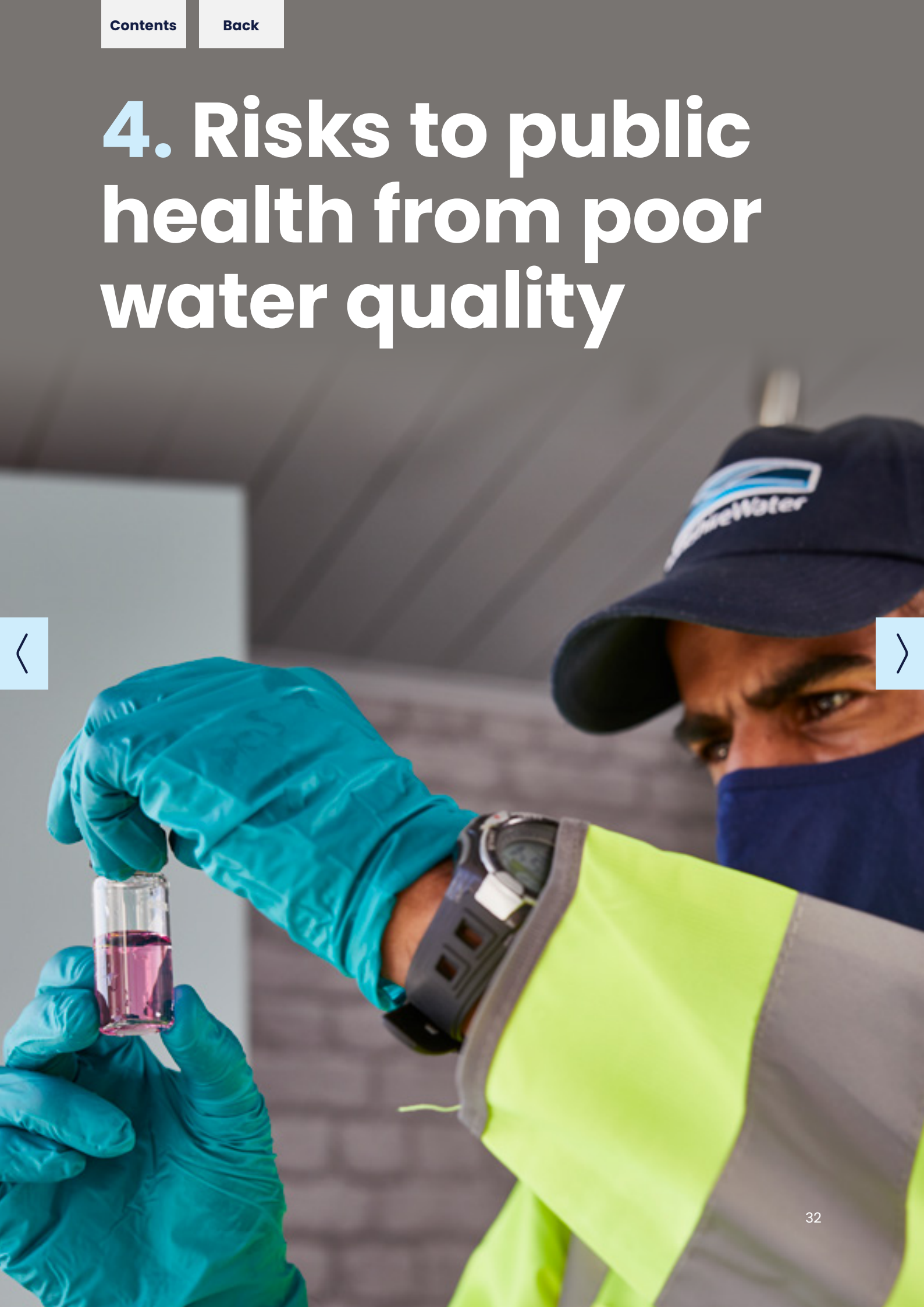
Yorkshire Water bespoke Performance Commitments

Number of external sewer flooding incidents (flooding outside e.g. to a park or garden or street, all causes) including incidents caused by severe weather – our target is to reduce this from 7,188 incidents per year to 5,175 incidents per year by 2025.

Surface water removed – this is the surface water run-off from impermeable areas that is removed or attenuated from our sewer network using blue-green infrastructure solutions or surface water disconnection over the 2020 to 2025 period, reported in hectares. Our target is to remove four ha by 2025.

Working with Others – the number of solutions delivered in partnership with third parties. Our target is to deliver at least 45 partnerships by 2025 across the business, several of which will be focused on sewer or surface water flooding, rainwater harvesting amongst other activities such as biodiversity enhancements and river restoration.

4. Risks to public health from poor water quality



Risks to public health from poor water quality

The risks to public health from poor drinking water quality are very low thanks to very strict drinking water standards and a robust regulatory regime protecting this most essential public service. Compliance with drinking water safety standards is extremely high with 99.96% of all samples tested meeting the required standard across England and Wales[12] over the last five years.

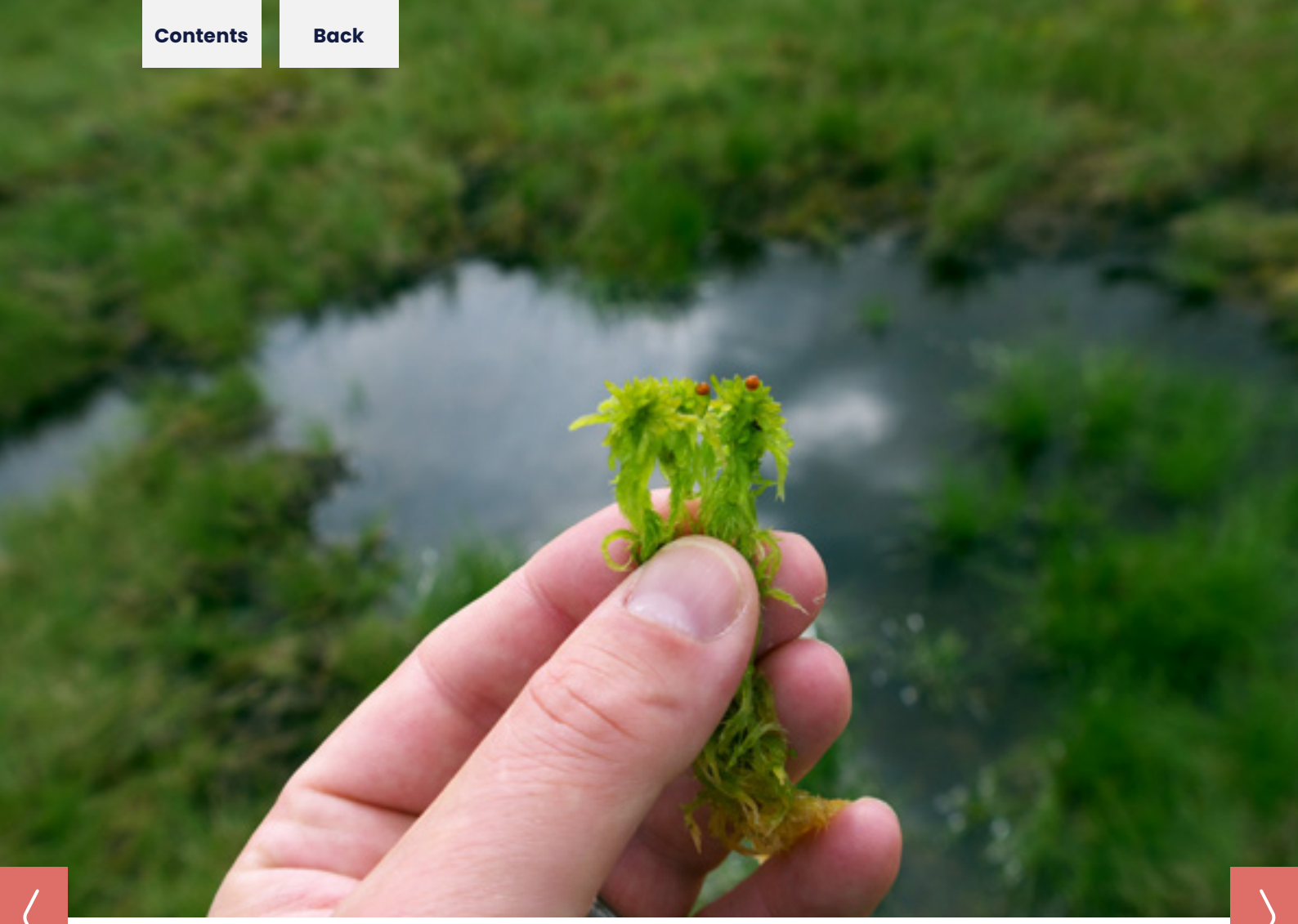
The standards are set to protect public health and to ensure water quality is acceptable to consumers and include strict limits on micro-organisms, chemicals such as nitrate and pesticides, metals such as lead and copper, and the way water looks and how it tastes. All water companies must comply with the requirements of the Water Supply (Water Quality) Regulations 2016 and follow statutory risk assessment and mitigation procedures which are described below. This includes consideration of long-term risks such as the impacts of climate change.

The impact of climate change on water quality can be separated into two areas – the impacts of climate change on raw water quality, which is the quality of untreated water taken from the environment, and the risks to treated drinking water as it travels through the distribution network to customers taps.

Some of the ways in which climate change could affect water quality include:

- gradual warming, changing rainfall patterns and extreme events cause changes to the habitats and environments from which we draw our raw water, which can lead to a decline in its quality, for example floods washing soil and fertilisers from farmers' fields into rivers which must then be removed;
- increased frequency and severity of drying and wetting cycles of peatlands, resulting in release of carbon as CO_2, or natural organic matter which requires more intensive treatment processes;
- declining raw water quality means water treatment plants must work harder and use more energy and more chemicals such as coagulants to meet drinking water standards;
- extreme weather could damage pipes and pumps e.g. scour during flood events or soil heave in long dry spells leading to interruptions to supply (see **Chapter 6**);
- increased ground temperatures raise the temperature of water in the distribution network which could affect the taste and odour of water; and
- power cuts from extreme weather could affect the ability to pump drinking water around and disrupt supplies (see **Chapter 8**).

12. discoverwater.co.uk/quality



How much, and what type, of treatment water requires before it meets drinking water safety standards depends on the environment from which it is drawn and how that environment is managed. For example, in Yorkshire, groundwater tends to be of good quality and requires little treatment, whereas river water naturally contains high levels of bacteria and can contain pollutants from farms and wastewater discharges. As a result, river water requires multi stage treatment processes to remove contaminants. Reservoir water is generally soft and of good quality. However, in our region, reservoir water can be impacted by high levels of dissolved organic matter (DOC, also known as 'colour') from the peat and blanket bog habitats from which water drains into our reservoirs.

Climate change will affect these different sources differently. Raw water quality is also dependent on a wide range of other factors such as what land is used for, how land is managed and what, if any, crops, or livestock are grown, which are themselves influenced by policy and subsidy regimes and by global markets.

For example, subsidy regimes have encouraged some farmers to shift from summer to winter arable production. This can result in greater amounts of soil and pesticides washing into rivers during heavy winter storms, which must then be removed at our treatment works. The uplands of Yorkshire, from which we source around 40% of our raw water, were artificially drained after the second World War and have since been affected by acid rain, grazing, and burning. We have observed growing levels of DOC entering our reservoirs and treatment works, which can be tricky to remove. Climate change impacts will layer over these existing drivers and pressures.

This chapter sets out how we manage the risks to both raw and treated water, and the measures we are taking to protect and enhance the quality of the natural environment we draw our water from, to ensure lasting sustainability of drinking water supplies.

Informing our risk – improvements since our last report

We take regular samples at all stages in the water cycle including at reservoirs and at the inlet to treatment works. These samples are sent to independent laboratories for analysis and the results are shared with the Drinking Water Inspectorate.

This analytical data is used to inform our Drinking Water Safety Plans which we put in place to mitigate the risks to water quality as supplied to customers. The Drinking Water Safety Plans includes risks to untreated, raw water as well as risks to treated drinking water.

We have improved our raw water risk assessments since our last report and now assess a greater number of risks at a more granular level. We piloted the improved process for assessing risk at our reservoirs during 2019/2020 and are now applying this process to our groundwater and river catchments. The risk assessments combine the sample data we already collect with data from rain gauges, minimum and maximum temperature, and soil moisture deficit. When combined with intelligence from our raw water field teams, and our catchment land and property teams, this gives us a much more detailed understanding of what is happening in a catchment. We also now assess a greater number of risks more frequently.

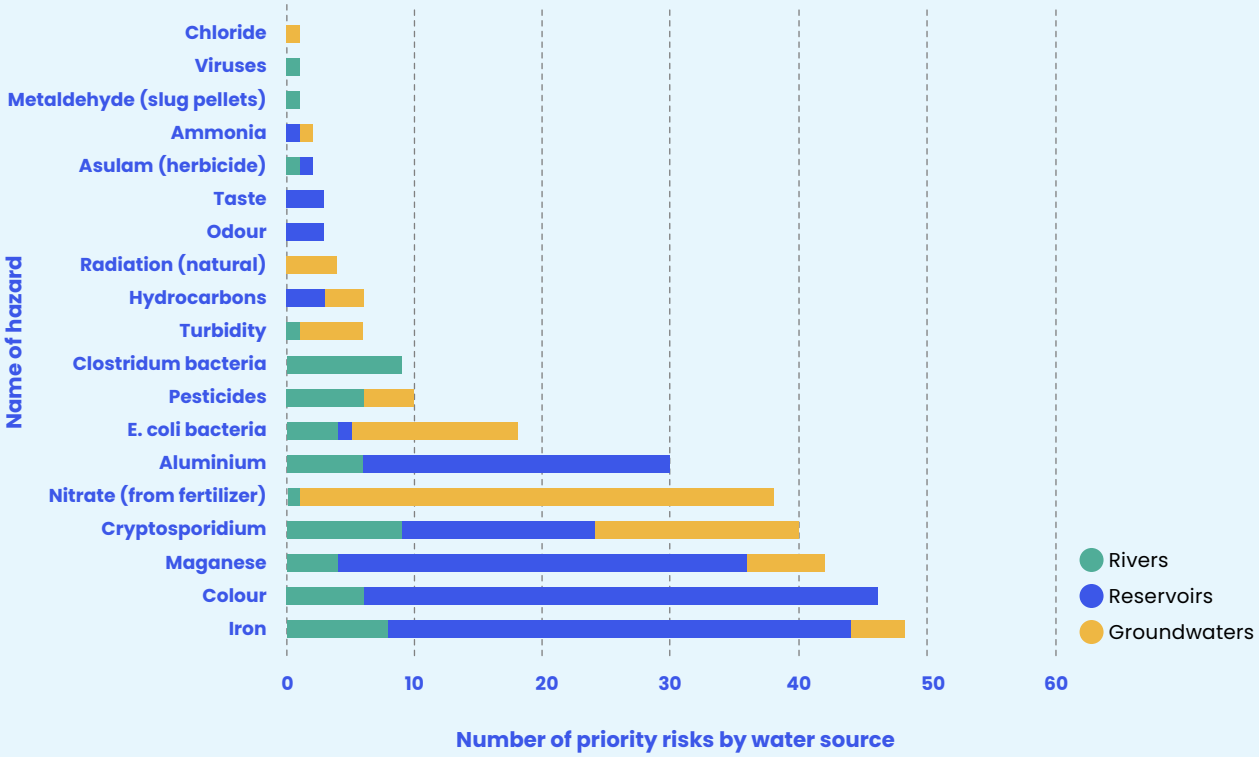
For example, discolouration risk is now split into the risk of iron or manganese discolouration whereas before these were combined, and borehole risks are now reviewed every two years instead of every five. Risks are reviewed on a monthly basis and a plan to mitigate the risk is agreed with the Drinking Water Inspectorate. These plans include investment at our water treatment works and water supply systems and working in the catchment with farmers and land owners where appropriate.

Our priority risks

Our priority risks are shown in the chart below. Iron, manganese, and aluminium occur naturally in water and are a result of the underlaying geology, which can also result in very low levels of natural radiation. Colour is dissolved organic carbon (DOC) from peat soils whereas turbidity is a general term for suspended solids including particles of soil. Many of the other substances come from farming.

Whilst all these risks can be removed by various treatment processes, this can be chemical and energy intensive and it is better to prevent these substances getting into raw water in the first place. This can be done through catchment management which includes a wide variety of different interventions: restoring peat habitats; working with farmers to facilitate and encourage use of cover crops to reduce nutrient, pesticide and sediment loss; planting of buffer strips to stop soil washing into rivers; improving soil health by supporting low cultivation methods; providing drinking toughs for cattle to reduce water quality problems associated with poaching of riverbanks; etc. We use both treatment and catchment management approaches to manage our drinking water safety and our activity in this area is described more on page 39.

Figure 4. Priority risks to untreated water sources by water source and hazard.



Understanding our risk – improvements since our last report – colour

Our previous report contained a section on the importance of healthy peat habitats for the provision of much of Yorkshire's water. We have continued to expand our knowledge and understanding of how best to protect and restore these upland habitats, which make up 22,000 ha of our land holding, mainly around our reservoirs in the Pennines.

Studies have shown that between 1988 and 2003 there has been, on average, a doubling of DOC concentrations in the upland waters of the UK (Evans et al., 2006), an effect that has also been seen across northern Europe. There are generally considered to be three main drivers for this change in DOC – recovery from acid rain, climate change and land management practices.

In 2016 we commissioned a team at the University of Leeds to review the available academic literature to determine what proportion each of these factors contributes to levels of DOC in order to inform what action we take to manage this risk[13].

The study found that recovery from acid rain was the main driver of the observed historical increase in colour. The report highlighted previous work which found that the 0.66°C increase in central England temperature since 1990 has driven around 10-20% of the increase in colour.

[13] Chapman, P.J. & Palmer, S.M. (2016) A review of the factors controlling trends in water colour/dissolved organic carbon. Report to Yorkshire Water Services, Project S3918, University of Leeds, Leeds.

A lack of long-term data made determining the contribution of land management practices to colour levels difficult to assess, however the report drew the following conclusions regarding land management:

- Grazing has no impact on DOC, despite leading to a change in vegetation composition.
- While afforestation leads to an increase in DOC in soil solutions from the organic horizon, no consistent impact is observed in surface waters at the catchment scale. In addition, DOC trends have been found to be similar for adjacent forested and moorland catchments.
- Small differences in DOC concentrations occur between drained and blocked peatlands at the local scale (soil solution, drain), but more evidence is needed at larger spatial and longer temporal scales.
- The balance of evidence suggests that heather burning has a negative effect on water colour and DOC release to stream waters, but longer-term records are needed.

Following on from this piece of work we commissioned water@leeds[14] to investigate the relative importance of rainfall, temperature and sulphur deposition (acid rain) in controlling the increase in water colour at seven of out treatment works over the period 1988-2015. Using linear regression modelling, they found that 88-97% of the long-term trend in water colour was controlled by sulphur deposition and summer rainfall. They then used two different models to predict future water colour levels at our Keighley water treatment works using realistic scenarios of future sulphur emissions, temperature and precipitation.

The first model was a predictive statistical model based on multiple linear regression modelling and the second is a process model called INCA-C which is based on current understanding of soil processes such as DOC production, hydrology, and chemistry. Both models (statistical and processes) used data from our Keighley water treatment works and showed that the biggest increase in DOC/water colour was observed in the 1990s, as a result of declining SO_4 deposition which led to an increase in soil pH and a decline in ionic strength leading to an increase in DOC solubility within the peaty soils. Both models suggest that DOC/water colour (annual and monthly mean concentrations) will be similar in 2030 as they have been in the period 2010 to 2015, and that in the future climate change, in particular wet summers, will have a bigger impact in controlling DOC/water colour.

Using realistic scenarios of future SO_2 emissions and summer rainfall, the statistical model predicted for Keighley Moor that mean annual water colour is likely to stabilise in the period to 2030, with predictions for the wettest summer rainfall scenarios (50-year and 100-year events) delivering annual mean colour that is similar to that observed for the wettest year on record (2012, mean = 172 Hazen). Results from INCA-C, using two different rainfall datasets, predicted that mean monthly DOC concentrations will be very similar in the 2030s as they have been in the period 2010 to 2015 and between 20 and 24% higher by the 2080s. Thus, both modelling approaches suggest that the most rapid increases in DOC/water colour have been observed. Other studies have also concluded that as the most rapid decline in SO_4 deposition has already been observed, SO_4 will not be driving water colour much further upwards (e.g. Erlandsson et al., 2008), therefore changes in climate will become the dominate control on water colour as we move towards the 2080s. The statistical model has suggested that wet summers will lead to higher DOC/water colour and INCA-C shows the impact of increasing temperature on DOC production and thus increase in DOC/water colour in the 2080s.

As the statistical model has used annual data and INCA-C presented monthly results, neither model was able to investigate the impact of drought or intense rainfall events on water colour. Both are predicted to increase with climate change. Droughts will release stored sulphur from the peat, which will increase soil water SO_4 and H^+ ion concentrations and therefore lead to a decline in water colour, as observed in the 1995 drought. As the top meter of peat can contain as much as 10,000 kg S ha^{-1} (Miller et al., 1996), mobilisation and loss of sulphur (that has accumulated from atmospheric deposition) from the peat during droughts is likely to be a slow process. Thus, droughts are likely to lead to a suppression of DOC/water colour for the foreseeable future. However, this will be followed by an increase in DOC/water colour once the drought has passed. Intense rainfall events, especially in the summer, are likely to lead to an increase in DOC/water colour as the humic acids are washed out of the soil, as observed in 2012.

In addition to the projects described above, which have specifically looked at the impacts of climate change, we have also commissioned or partnered in another ten research projects related to catchment management since 2015. These include the Twenty65 Landsat project which explored the potential to use instrumentation on board Landsat 8 satellite to measure DOC in upland reservoirs with Imperial College, a review of peatland hydrology indicators with University of Leeds, and an investigation into the effects of burning on the North Yorkshire Moors using aerial images.

[14] Chapman, P.J. Palmer, S.M., Blundell A., Irvine, B., Futter, M.N. and Ledesma J. L.J. (2017) Factors controlling trends in water colour: Role of regional drivers. Report to Yorkshire Water Services, Project S3918, University of Leeds, Leeds.

Understanding our risk – improvements since our last report – emerging risks

Since our previous report we have observed an increased risk of temporary declines in river water quality due to flooding events. The widespread flooding of fields and roads can wash significant amounts of sediment, hydrocarbons, and other substances into rivers. These contaminants can be present in such high levels that it can overwhelm the ability of our treatment works to remove them. In these cases, we would switch off the intake to a works and allow the contaminated water to pass downstream. This can present operational issues and challenges in meeting regional water demand if a particularly large intake were to be affected. In 2018, we had to switch off the intake to a large water pumping station as a pulse of dirty water passed down the River Ouse following intense rainfall and flooding in Swaledale. This meant we lost around 3% of our average daily demand for several days. We currently manage this risk by sending staff out to take river water quality samples whenever particularly heavy rain and flooding is forecast, and we can then switch off the intake if necessary. We are also exploring locations where we could install automatic samplers, however, we are reliant on the goodwill of riparian land owners to allow us access to a suitable, safe place on the riverbank to take a sample from.

Our previous report in 2015 did not discuss the potential impact of wildfires on raw water quality. Fires in the catchments from which we draw our raw water can negatively affect the quality of water, potentially contaminating it with ash, soot and possibly also fire fighting chemicals. We have previously had to take reservoirs off supply due to fires in the catchment in order to protect water quality. Fires also destroy the peatbog habitats from which we draw much of our raw water, meaning that negative impacts can persist for years after a fire, and can undo years of previous restoration work. Fires on peatbog habitats also release significant amounts of carbon when they burn.

Fires are a growing risk as the climate warms and as more people explore the countryside, because despite the name, wildfires are almost entirely caused by humans[15] and very rarely by lightning or other natural causes. Smouldering barbeques or pieces of broken glass can ignite grass, and fires are also set deliberately by arsonists. Even those set by gamekeepers to burn heather for grouse moor management can occasionally get out of hand. Hot, dry weather, which is predicted to become more common as the climate changes, obviously exacerbates this risk.

We have a proactive approach to managing wildfire risk and are members of several Fire Operations Groups which bring together land owners, the Fire and Rescue Service, National Park Authorities, and others as appropriate. These groups hold contact lists, equipment, and expertise to co-ordinate responses to wildfires and limit the damage they do.

Our work to restore and re-wet peatland habitats also helps mitigate our risk of wildfires. The EU funded MoorLife project bought together Yorkshire Water, Severn Trent and United Utilities to restore 8,500 ha of priority blanket bog habitat that had been damaged by two decades of heavy nitrogen and sulphide deposition and fires, to the extent that the peat forming sphagnum moss could no longer grow. Moorland restoration specialists Moors for the Future have planted more than 1,200 ha of native species to restore this precious habitat and make it more resilient to future wildfires and the other impacts of climate change.

We are also engaged in national policy debate and influencing to reduce and phase out rotational burning except in very prescribed circumstances such as in hard to reach areas for invasive species control or similar conservation objectives. In 2018, we announced that we would include a presumption against burning as a land management technique in any new leases on our land. Tenants will only be allowed to burn in exceptional circumstances where they can demonstrate that intervention is needed but alternative measures aren't safe to deliver. They will also need the appropriate approvals from Government regulators. In addition to this, in 2020, we also asked our tenants to cease burning to avoid putting pressure on emergency services during the COVID-19 pandemic as a result of wildfires and potential air quality issues.

Finally, we have started to examine the risk climate change poses to the frequency of agal related events in raw water reservoirs. Algal blooms can result in unwanted taste and odour contacts from customers and could be a growing risk as the climate warms. We have started to work collaboratively with other water companies and universities to quantify this risk by using eDNA techniques and advanced genomics. The aim is to understand the full community of organisms within a reservoir along with the environmental and climatic triggers that can lead to algal blooms. Part of this research is being funded from the OFWAT Innovation fund.

[15] GLAVES, D.J., CROWLE, A.J.W., BRUEMMER, C. & LENAGHAN, S.A. 2020. The causes and prevention of wildfire on heathlands and peatlands in England. Natural England Evidence Review NEER014. Peterborough: Natural England.

Managing our risks

We carry out an enormous range of activity to manage our raw and treated water quality risks, as often the action required is very specific to the particular risk and its location. We refurbish or upgrade our reservoirs, water treatment works, and distribution assets as required, and we also work to protect raw water quality by restoring peat habitats and working with farmers and other land owners.

We have more than a decade of experience in peatland restoration techniques which have been informed by the body of research and monitoring described above (and in Actions 2015 to 2020 below) and this will be an ongoing activity across our 22,000 ha of land for the foreseeable future. We also work in partnership to influence how land we don't own is managed, and collaborate with our neighbouring water companies, National Park Authorities, catchment partnerships, the Forestry Commission, local authorities and many more to achieve landscape scale habitat enhancement and protection.

The sections below detail some of the investment we have made and what we plan to do in the next five years and beyond.

Actions 2015–2020

In our previous report we said we would carry out the following actions:

We said we would invest £2 million to enhance and protect upland habitats, £0.45 million on education campaigns, and appoint two catchment officers, a Geographical Information Systems Specialist, and a hydrogeologist.

Our actual spend on catchment restoration was £7 million which included two landscape scale projects to restore almost 10,000 ha of peatland habitats in partnership with our neighbouring water companies and the Environment Agency. These projects were both supported by European Union funding. MoorLIFE 2020 focused on the southern part of our region and partnered with United Utilities and Severn Trent with delivery by Moors for the Future. Pennine PeatLIFE focused on the northern part of our region and partnered with United Utilities and Northumbrian Water with delivery by the Yorkshire Peat Partnership. The additional staff were also hired.

We said we would carry out three projects to map where there are high concentrations of nitrate in groundwater, identify their source, and identify what action can be taken to reduce nitrate pollution.

We have completed these investigations which found that agriculture contributes between 60-90% of nitrates in these groundwater sources, with the rest coming from sewer misconnections or leaks, septic tanks and use of fertilizers in parks, gardens, and golf courses. The investigations developed a ranked list of interventions to prevent nitrate leaching with the most effective being the use of cover crops[16]. These solutions are now being implemented through our Sustainable Landscapes partnership. See **page 41**.

[16]. The next two most effective interventions were precision agriculture (only applying farm chemicals where tests show they are needed instead of across whole farms) and covering slurry stores.

We said we would invest £15 million at our upland water treatment works to improve their stability and reliability. We have invested this amount and more at our works at Rivelin and Langsett in South Yorkshire. We carried out a Six Capitals valuation on the scheme at Rivelin to quantify the wider environmental benefits of two different options for the scheme which you can read about here **yorkshirewater.com/about-us/capitals/**.

We said we would continue to monitor the effectiveness of our catchment interventions, sharing learning with others through forums such as the Catchment Sensitive Farming groups.

We have carried out extensive monitoring of our upland catchment interventions to determine their impact on raw water quality and inform our future work. The monitoring was carried out by a team from water@leeds, a world leading interdisciplinary research centre at the University of Leeds. The interventions included blocking up drainage channels, revegetating bare peat with sphagnum plug plants and cutting back heather. Some of these interventions were shown to have a positive effect in reducing levels of DOC:

- Vegetation cover was shown to have a strong correlation with levels of DOC with lower levels from areas vegetated by cotton grass and sphagnum than heather;
- Replanting sphagnum in low to medium densities was found to be more effective in reducing DOC than high density planting (possibly due to the increased disturbance of the soil);
- Gully blocking which causes ponding to the level of the peat surface was more effective than blocking which did not; and
- Techniques that focus on hydrological restoration such as pool creation and the use of bunding to re-wet as large an area as possible were more effective than other measures[17].

The findings are informing the types of interventions we carry out in our next business planning period (2020 to 2025) and have been shared with Catchment Sensitive Farming groups.

In addition, we have launched two major sustainable farming programmes and set up a strategic partnership with the National Trust. See **page 41**.

Our catchment interventions have restored 11,806 ha of habitat between 2015 and 2020.

[17] Blundell, A., Holden, J., Moody, C., Grayson, R., Greenwood, J., Gilpin, M. and Chapman, P.J. (2020) S3676 Catchment management evaluation monitoring programme: end of AMP6 report. Report to Yorkshire Water, May 2020, University of Leeds, Leeds.

Additional actions

Our sustainable farming initiatives – Beyond Nature and Sustainable Futures

We have 22,000 ha of upland farmland that we let to tenants who mainly farm sheep. Our tenancy agreements have always required farmers to protect raw water quality and prohibited the use of certain farm chemicals. However, we wanted to go further than this, so in 2016 we launched Beyond Nature, our flagship programme for encouraging a more holistic and sustainable approach to farming.

Beyond Nature is focused on a wider range of benefits than just raw water quality and seeks to maximise ecosystem services whilst still running a profitable business. The nine themes of Beyond Nature are shown in the graphic below.

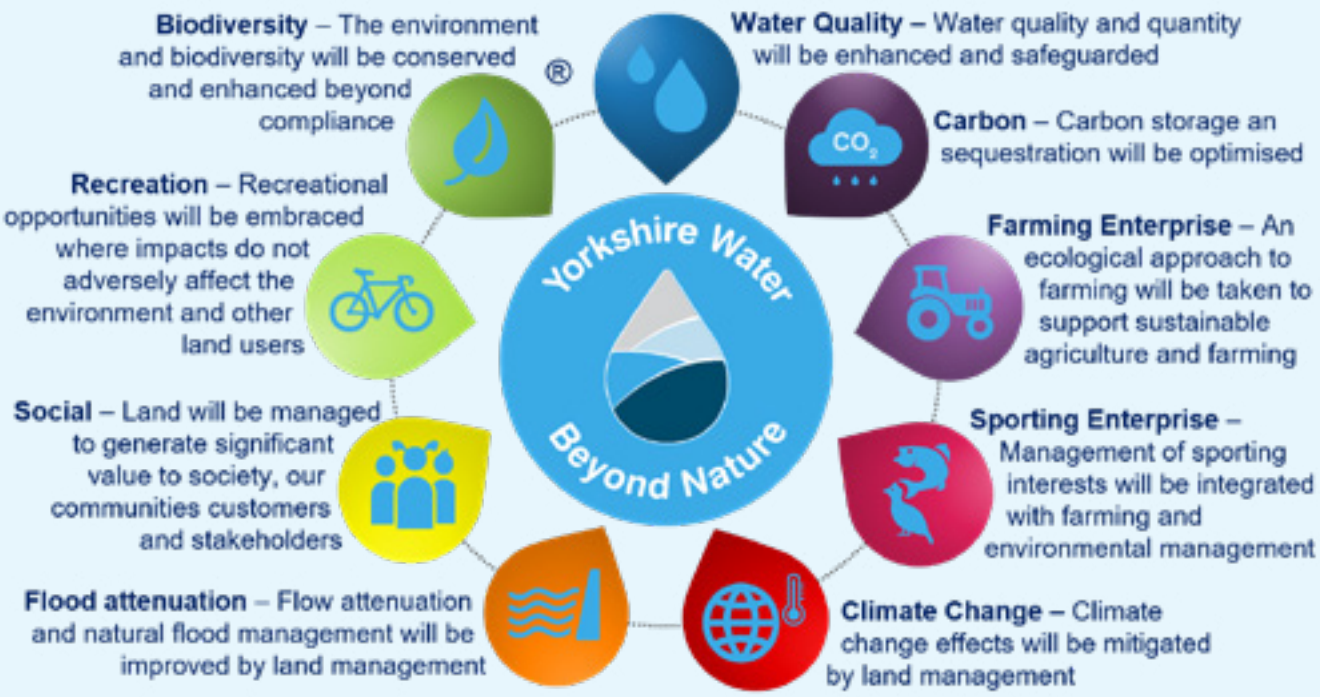


Figure 5. Beyond Nature themes.

The first tenancy we advertised had more than 100 applicants, and we now have nine farms under this flagship programme which together cover 5,000 ha. Our most recent development is our Next Generation Farming project where we provide a young farmer with a five year tenancy at Scow Hall Farm to get them started in their careers. We provide training, mentoring and capital support to improve farm buildings, create or enhance habitats, plant trees, fencing etc. For more information about Beyond Nature including details of each of the farms signed up, please see **yorkshirewater.com/environment/beyond-nature/**. Our ambition is to eventually move all our tenancies to the Beyond Nature approach.

Our Beyond Nature programme is focused on the land we own where we can have a direct influence over the tenant. We also wanted to create a programme that addresses raw water quality on land which we don't own and where we have much less influence over how it is managed. We especially wanted to encourage farmers to manage their land better, reducing the amount of soil (and associated farm chemicals) being washed into the regions' rivers.

One of the best ways to reduce soil erosion is to increase the organic matter content of soil. This makes it less erodible, more resilient to both floods and droughts, and stores carbon. Building soil organic matter and using cover crops[18] also means the soil and crops can absorb more carbon than is emitted, creating the potential to produce carbon neutral/negative crops.

In 2018, we launched the unique Sustainable Futures initiative, a partnership between some of the regions' largest agricultural producers, food and drink companies including Heineken, Birds Eye and Wold Top Brewery, and a range of other expert partners. This partnership is focused on practical advice to farmers, demonstrating that healthy soils, rich in organic matter, can deliver more sustainable and resilient food production, provide carbon and flood mitigation, water quality and biodiversity benefits, whilst also being more profitable for the farmers involved. The project has piloted in three areas and now involves more than 50 farms covering an area of 17,000 ha.

Sustainable Landscapes Site visit to Elvington Water Treatment Works. More than 11,000 tonnes of top soil are washed into the works every year and, after removal at the works, has to be landfilled. Showing farmers what happens to their soil really brings home the need to keep it on their fields and stop it eroding from their land!

Soil sample from a field sown with cover crops using minimum tillage techniques.

Soil sample from traditionally ploughed field left bare over winter.

[18] Cover crops include planting things like rye, mustard or clover which are grown on land that would have been bare after harvest or in some cases in-between main crops – both protect , aerate and feed the soil.

Actions 2020–2025

Our planned investment in maintaining our clean water asset base such as aqueducts, catchwaters, boreholes, water treatment works, water towers, pumping stations and the distribution network is around £220 million over the next five years. This will help ensure the ongoing quality of our raw and treated water.

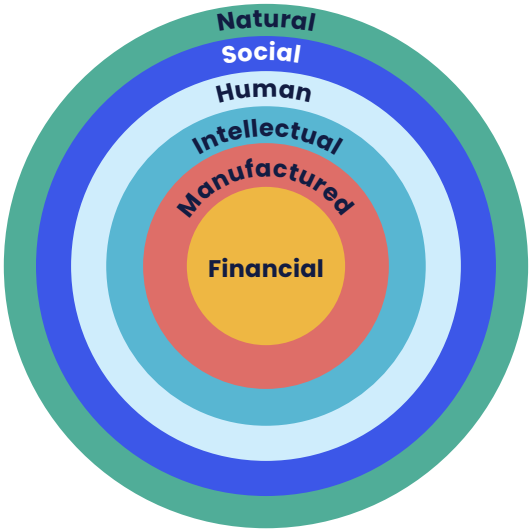
We will also invest around £76 million in managing our raw water quality risks through investment at our treatment works for example in upgrading existing works or replacing assets as they age, as well as a further £12 million in catchment restoration. We plan to expand and build on the successes of our Beyond Nature and Sustainable Futures initiatives.

We will carry out another 13 investigations at our groundwater sites building on those we carried out in the previous five years. Seven of these will look at nitrate, four will look at pesticides and four will assess what the environmental impact would be if, at some point in the future, we took our full licensed volume. The nitrate and pesticide investigations will be a similar vein to those carried out previously in that they will assess the sources, pathways, and mitigation solutions. The investigations cover sources in the Doncaster, Selby, Wolds, and Hull wellfields.

We will further develop our land carbon model which allows us to assess the carbon impact of different land management practices and assess how much carbon our land is storing. We are collaborating with the rest of the water sector to create an industry-wide standard for measuring land carbon stocks and flows. This will help inform our approach to maintaining excellent raw water quality and help spread best practice across the sector.

In 2020, we launched our new Land Strategy which sets out 10 strategic ambitions for our land and which aligns with our Six Capital Valuation Framework (See Chapter 6), the UN Sustainable Development Goals, the UK's 25 year Environment Plan and the Manifesto for the North (see graphic below). The strategy details the initiatives we will use to deliver our ambitions including tree planting, land based technologies, recreation, urban landscapes and place making.

"Delivering exceptional land for Yorkshire, forever."



Through land we will...

1. Deliver exceptional water
2. Be more resilient
3. Address the climate emergency
4. Enable plants & wildlife to thrive
5. Unleash the power of partnerships
6. Be healthier, safer & happier
7. Increase skills & jobs
8. Increase and share our knowledge
9. Create better places
10. Increase prosperity

Figure 6. Our ambitions for our land strategy.

Figure 7. Objectives for our land strategy.

Land strategy Objective	Yorkshire Water Performance Commitment	Relationship with Yorkshire land network objectives[1]/Manifesto for the North[2]
1. Deliver the best water	Drinking water quality	
	Bathing water quality	
	Length of river improved	
2. Be more resilient	Surface water management	Lead the UK in climate change adaptation & resilience[1]
3. Address the climate emergency	Operational carbon	A carbon positive Yorkshire by 2030[1], Clean growth[2]
	Capital carbon and carbon arising from owned land	A carbon positive Yorkshire by 2030[1], Clean growth[2]
	Renewable energy generation	A carbon positive Yorkshire by 2030[1], Clean growth[2]
4. Enable plants & wildlife to thrive	Land conserved & enhanced	Reversing biodiversity decline by 2030 and targeting biodiversity gain[1]
	Integrated catchment management	Reversing biodiversity decline by 2030 and targeting biodiversity gain[1]
	Length of river improved	Reversing biodiversity decline by 2030 and targeting biodiversity gain[1]
	Biosecurity implementation	Reverse Yorkshire biodiversity decline by 2030[1]
5. Unleash the power of partnerships	Working with others	
6. Be healthier, safer & happier	C-MeX	Link land to the 5 ways of wellbeing[1]
7. Increase skills & jobs		Education, skills and work[2]
8. Increase & share our knowledge	Education	Action through partnerships[1], innovation[2]
9. Create better places	Surface water management	Housing[2]
10. Increase prosperity	Affordability of bills	Trade and investment[2]

Through the consultation and engagement work we did in developing our Land Strategy, we realised there was a need for a forum that brought together various stakeholders engaged with land. On the 4th Dec 2019, we held the inaugural meeting of the Yorkshire Land Network (YLN) which brought together:

- direct landowners of more than 93,000 ha of Yorkshire,
- Country Land and Business Association representing a further 405,000 ha,
- collective representation of more than a third of Yorkshire's land,
- the top five of the UK's landowners,
- the owners of more than 8% of the UK's land area, that's over 1.9 million ha of land.

Through the YLN we have engaged more than 40 organisations regarding the collective ambition for Yorkshire land and we will continue to engage and explore partnership opportunities with those who share our values and ambition to deliver against the objectives set out in our Land Strategy.

The first project that the YLN is collaborating on is establishing a steering group to help determine and drive forwards the priorities of the organisation. The steering group contains environmental groups, statutory authorities, and representatives of private landowners. Steering group members (as of 13/08/2020) include Yorkshire Water, The National Trust, The Forestry Commission, The National Farmers Union, The Bolton Abbey Estate, The Country Land and Business Association, Leeds Diocese, The Woodland Trust, the Yorkshire Wildlife Trust, The Crown Estate, Keyland Developments and the Royal Society for the Protection of Birds. The YLN is a relatively new organisation and its first project – looking at a carbon market – is underway. The YLN intends to create a wider range of workstreams, with discussions already having taken place regarding economic recovery and skills, the challenges and opportunities surrounding increased use of recreation spots, and the potential to look at planning law to improve natural capital outputs **yorkshirewater.com/business/our-land-and-property/**

Barriers and interdependencies

The most effective way to ensure drinking water quality is to protect the quality of our raw water sources. Where we own the land around these sources, we have put in place tenancy arrangements which fulfil this requirement. On land we don't own, we are influencing farmers through our catchment partnerships and through our strategic partnerships with other land owners such as the National Trust and the Yorkshire Land Network and the supply chain.

We see a major opportunity to enhance the protection of raw water quality through the new Environment Bill and the replacement of Higher Level Stewardship (HLS) Schemes with the Environment Land Management Scheme which comes into force in 2024. This scheme could focus more on protecting raw water quality (which is not currently included in HLS), remove constraints to working at a landscape/catchment scale and provide a consistent, long-term framework of support for better environmental outcomes from the agricultural sector. Ultimately this will lead to better value for customers and a more sustainable, resilient, and reliable water supply. This will, however, require innovative and flexible opportunities for water companies to support or fund actions and partnerships with land users to protect and enhance catchments and the raw water sources they feed.

We also observe regulatory barriers around the presence of lead piping in customer properties. The presence of lead piping can cause water quality failures at the customers' tap, and our region has some large areas of homes with a lot of lead piping. Our regulatory regime prohibits us from replacing the lead piping on the customer side, and it could be considered unfair to ask other customers to subsidise this cost. However, if the customer is unable or unwilling to do this work, then it is impossible for Yorkshire Water to fully meet its water quality standards at this property. A working group has been formed by the UK water quality regulators, health experts, Ofwat and Water UK to develop strategies to resolve this issue.

Barriers to water quality also existed with regards to metaldehyde, a chemical used in slug pellets, which is virtually impossible to remove from raw water. There is currently only one water treatment works in the UK which has been specifically designed to remove metaldehyde and it uses an extremely energy and carbon intensive process. Metaldehyde has only recently been banned from use, with Autumn 2021 being the last season for legal application of this product outdoors. It is not clear however how long previous applications of this the chemical will persist in the environment and it is still permitted for use in indoor horticulture. The polluter pays principle should apply in this instance and water customers should not have to pay for expensive and carbon intensive water treatment to remove this chemical from their supplies.

Monitoring and reporting

The following metrics are reported on our website quarterly and on the Discover Water website annually (which also shows comparative performance against other water companies). The first one is common across the water sector in England, with the others being Yorkshire Water bespoke commitments.

Industry-wide Performance Commitments

Compliance Risk Index (CRI) – this is a complex metric, newly implemented for AMP7, which is defined and set by the Drinking Water Inspectorate. The lower the score on this measure, the better. The regulatory target for this metric is zero, on the basis that no level of water quality failure is acceptable. However, none of the larger water and sewage companies have ever achieved this target level and although we expect to maintain our CRI as low as possible, we do not anticipate meeting the zero target. This is partly because compliance with drinking water standards can be affected by the fixtures and fittings in customers' homes – something we have no control over, and also by the seasonal activities of land managers and farmers such as how moorlands are managed, slurry spreading, and pesticide use.

Yorkshire Water bespoke Performance Commitments

Drinking water quality contacts – this is the number of times that customers contact us due to the taste, odour, or appearance of their drinking water, reported per 100,000 people. Our target is to reduce the number of customer contacts from 11.4 contacts per 100,000 people per year, to 8.1 contacts per 100,000 people per year by 2025. This can be affected by weather because during dry spells we move water around the region more to balance supplies and demand, which can mean that customers receive different water from what they are used to (eg switch from soft reservoir water to harder river water) which can result in more customers contacting us. This metric can also be affected by the taps and pipes in a customers' home.

Integrated Catchment Management (ICM) – this performance commitment measures the percentage of our catchments where the 'Natural Capital Operator' approach has been implemented. For each catchment, an independently reviewed Natural Capital Operator management plan will be developed, consulted upon, and agreed with stakeholders including Natural England, the Environment Agency, the relevant Catchment Based Approach (CaBA) partnership, Local Nature Partnership, the Yorkshire Water Biodiversity Advisory Panel; and external regional stakeholders, such as Wildlife and Rivers Trusts. Our target is to achieve this approach on three priority catchments by 2025.

We also have metrics around the quality of the natural environment from which we draw much of our raw water, such as the length of river, or the area of land we have improved or restored. These are described more in **Chapter 7**.

5. Risks to infrastructure from river, surface, and ground water flooding

Risks to infrastructure from river, surface, and ground water flooding

The Yorkshire region has and will continue to experience flooding from all sources including rivers, rainfall, and groundwater and Yorkshire Water assets are, by necessity, often located next to rivers (or the sea). This chapter describes how Yorkshire Water assesses and manages the risk of widespread flood inundation affecting multiple above ground assets simultaneously.

This includes how we manage the risk of reservoir flooding and a case study on a trial we are carrying out in Calderdale to use our reservoirs differently to try to reduce flooding risk. We also include details of our natural flood risk management activities here. **Chapter 2** contains details of how we manage the risk of sewer flooding in a storm.

Yorkshire has extensive fluvial (river) flood risk with steep sided, flashy catchments such as Calderdale in the west of the region, and wider, flatter, lowland catchments in the centre of the region around the Vale of York. Parts of Yorkshire, particularly around the Humber and the city of Hull, depend on man-made drainage systems and pumping is required to manage surface water. Our region is not especially vulnerable to groundwater flooding apart from a few small areas to the east. We also have an extensive coastline to the east including the low-lying Humber estuary which can be vulnerable to storm surges. Our coastal flooding and erosion risks are described in **Chapter 4**.

We operate a substantial asset base, much of which is in the flood plain due to the need to either abstract drinking water from rivers or discharge treated final effluent to rivers or the sea. We have experienced several flooding events since our last report, with significant events on Boxing Day 2015 across the west of the region, and more recently around Doncaster in 2019 and again in Calderdale in 2020. These events have tested our operational response and resulted in damages to our assets but fortunately no customers have experienced a loss of drinking water supply due to flooding.

Informing our risk understanding

We rely on the national flood maps produced by the Environment Agency and Lead Local Flood Authorities as well as our own knowledge and experience to inform our understanding of our flooding risk. The maps produced by the Environment Agency show various flood extents based on different levels of probability of that flood occurring each year. The maps are based on both historic and modelled flood extents but do not include the impact of climate change.

Our previous adaptation report described Phases One and Two of our flood risk assessment where we have used the available flood maps to determine which of our above ground assets are at risk, and then carried out more detailed flood risk assessments for 176 our most critical assets. The detailed risk assessments involved undertaking topographical surveys and obtaining flood model data from the Environment Agency to determine the level at which critical equipment such as electrical panels would be affected. Just under half of the flood models obtained from the Environment Agency included a consideration of the impact of climate change, so this data has been included in our analysis where it was available.

Since our previous report we completed Phase Three of our flood risk assessment. We have updated and consolidated our flood risk assessment information into a central repository which now includes pluvial risk as well as fluvial risk, incorporates an additional, more extreme fluvial flood risk extent (1 in 1000), includes details of previous flood history and any resilience measures that have been installed, and links to site specific flood risk assessments where these exist. This dataset is widely used across the business for diverse purposes such as highlighting where a potential scheme may be at risk when a new solution is being designed, understanding our insurance exposure, and informing our operational response. An extract from the tool is shown below. We plan to update this tool later in 2021.

Common name	[redacted]
Major Catchment	DON
Distance from FZ2	27
Distance from FZ3	37
Distance from SW 30yr	6
Distance from SW 100yr	1
Distance from SW 1000yr	0
Flood Score	4.625
Combined Criticailty	A – Very high
Criticailty Score	5
Risk Score	23.125
Minimum Resilience Level	<200 year
Flood History	True
Year of Flood	2007, 2019
Flood Resilience Level	Area around bottom settlement tanks flooded and damage to decant pump house (now repaired and new dry well sump pump installed)
VAP/Contingency Measures	True
2012 Resilience Survey Report	[redacted]

Figure 8. Extract from flood risk information tool.

Numbers of assets within Flood Zones

The table below shows our headline flood risk in terms of number of assets located in either a fluvial, pluvial, or coastal flood zone according to the Environment Agency flood maps (note these do not include groundwater flood risk and in some areas the risk from river and coastal flooded is combined). These numbers should, however, be used with caution as while these assets may sit within the modelled flood extents, the presence of flood defences, local topography or other factors means that they may not be as vulnerable to flooding as may be expected. This can be seen by the third column in the table which shows how many assets have experienced flooding. This is not to say we should be complacent; we recognise that our flood risk exposure will increase due to climate change and the standard of protection offered by existing defences will decline.

Table 1. Numbers of assets at risk from flooding from rivers, rain, or sea.

Asset type	Assets located within Flood Zone Three (high probability river or coastal flooding)	Assets which have flooded in the past
Raw or clean water pump station	40	4
Water Treatment Works	0	0
Sewage Pumping Station	555	86
Wastewater Treatment Works	137	50
Total no. assets	**2003**	**140**
Asset type	**Assets located within Flood Zone Two (medium probability river or coastal flooding)**	**Assets which have flooded in the past**
Raw or clean water pump station	57	7
Water Treatment Works	7	1
Sewage Pumping Station	776	106
Wastewater Treatment Works	192	66
Total no. assets	**1032**	**180**
Asset type	**Assets located with 1 in 30 surface water flood zone**	**Assets which have flooded in the past**
Raw or clean water pump station	13	1
Water Treatment Works	1	0
Sewage Pumping Station	85	13
Wastewater Treatment Works	30	10
Total no. assets	**894**	**24**
Asset type	**Assets located with 1 in 100 surface water flood zone**	**Assets which have flooded in the past**
Raw or clean water pump station	17	1
Water Treatment Works	3	0
Sewage Pumping Station	198	27
Wastewater Treatment Works	52	16
Total no. assets	**1488**	**44**

The vast majority of our fluvial (river) flood risk is on our wastewater treatment assets, which by necessity are located next to rivers and can be very difficult to fully flood proof. We have invested at many of our largest wastewater treatment works to improve flood resilience where possible by raising electrical panels and protecting key equipment, but it is likely that some of these assets will flood repeatedly so the best we can do is to reduce the costs of recovery. It is important to note that there tends to be little customer impact from wastewater sites flooding although there can be aesthetic and environmental impacts if screens and storm tanks are overwhelmed. A number of our sewage pumping stations are at risk from pluvial (surface water) flooding, and we have protected these assets where possible (See how we manage our risk and actions sections on page 53).

Groundwater flood risk

We do not currently have much risk from groundwater flooding in our region due to our underlaying geology. The areas with greatest risk are in the east around Hull and East Riding of Yorkshire, mostly in the northern Wolds, and also in Selby and east of Doncaster. We have experienced minor flooding in 2007, 2012 and 2019 at a few of our borehole sites in these areas due to flows from artesian springs. When the water table is high, water can flow out of the adit shafts and the adjacent ground and flood the surrounding fields. These sites are remotely operated and can continue to pump water even when flooded. The pumping helps prevent flooding during most years and helps to move the water away and reduces the extent and duration of flooding that occurs during periods when the water table is very high.

Cottingham adit flooding, 2019.

How we manage flood risk

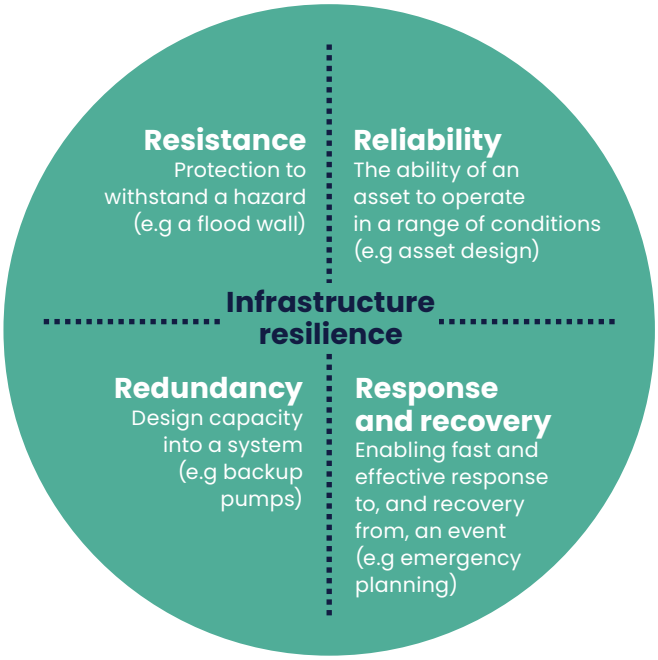


Figure 9. The cabinet office model for infrastructure resilience.

We use the Cabinet Office four box model for infrastructure resilience to manage our flooding risks, as this model recognises that it is not always practicable or cost effective to build flood walls around a large site, and indeed this may actually increase flood risk for others downstream. This approach was described in our previous adaptation report and is well recognised and used by other infrastructure providers.

In practice this means that our most critical clean water sites that are at risk from flooding have resistance measures such as our own or Environment Agency flood defences. For example, our water treatment works in York and Hull are protected by Environment Agency flood embankments. To the best of our knowledge, we have only ever had flooding at one of our clean water treatment sites which was in 2007 and was caused by the onsite drainage system backing up due to high river levels and partially flooding some areas of the site through cable ducting runs. The site has not flooded since.

We also have a high degree of redundancy in our clean water production and distribution networks due to the Grid which allows us to move clean water around the region. Following the 2015 floods, we have also invested in demountable defences for our clean water supply systems at risk from an extreme flood event (1 in 1,000) should they be required.

For our largest and most at-risk wastewater treatment sites we have progressively increased their reliability and ability to be recovered quickly by reconfiguring site layouts, raising electrical panels, and installing submersible pumps.

For existing sites, where it is cost effective and practicable, we will install flood resilience measures as part of site upgrades, repairs, or refurbishment. For example, by thinking carefully about site design and layout when installing new phosphorous dosing equipment at 15 of our existing wastewater treatment works, we have been able to place new equipment on higher parts of sites thereby avoiding adding any additional flood risk, and in several cases, also saving on costs. For any new sites a detailed flood risk assessment is generally required for planning permission purposes and so flood resilience is fully embedded as part of the design process. For sites that have flooded (such as those in 2015 or 2019/2020) we will improve resilience where possible during the repair work, for instance raising electrical equipment.

To provide assurance that we are adequately considering flood risk, our end to end business funding approval process requires a flood risk assessment and resilience options to be presented prior to detailed design sign off and funding approval. Our flood risk assessment guidance is for critical sites or equipment to be resilient to a 1 in 200 flood plus an allowance for climate change. This is the standard suggested by the Pitt Review, the Cabinet Office, and the National Infrastructure Commission.

Informing our operational response to flooding – improvements since our last report

As a Category Two responder under the Civil Contingencies Act and a Risk Management Authority under the Flood and Water Management Act, 2010, we have a statutory role to play in managing flooding incidents. Our operational response to flooding is led by a wide range of data, forecasts and alerts and is governed by our Company Incident Management Plan. These were described in our previous adaptation report. Since then we have:

- spent £3.6 million on our emergency response capabilities including purchase of new customer welfare vehicles, a new incident management vehicle, a new strategic store, and 1,120m of demountable defences;
- updated our Company Incident Management Plan;
- updated our Severe Weather Plan;
- reviewed our weather triggers and thresholds as used by the Control Room to escalate risks;
- carried out Exercise TanksaLot where we practiced our temporary water supply procedures for in the event of a widespread water supply outage. Defra and Local Resilience Forum members were invited to observe the exercise;
- carried out a mock incident response situation hosted by iCASP[19] and attended by regional partners to examine how improved surface water flood forecasts could improve operational response and
- successfully managed two severe flood events (2015 and 2019/2020) without customers losing drinking water supply.

[19] iCASP is a six year interdisciplinary knowledge exchange partnership hosted by the University of Leeds **icasp.org.uk**

Managing our reservoir flooding risk

The Reservoir Safety Act 1975 and the Flood and Water Management Act 2010 provide the legal framework that ensures the safety of reservoirs, including a requirement for regular inspection by independent civil engineers, and preparation of reservoir flood plans.

Reservoir spillways are designed using a standard industry methodology and make use of guidance set out in the Flood Estimation Handbook[20]. They are model tested to accommodate a maximum probable flood with an additional safety margin of 10%, which includes a climate change factor. We own and operate 134 reservoirs, 104 of which are classed as Category A or B reservoirs under the Reservoir Safety Act 1975, which are reservoirs that would pose a risk to life if they failed. All our reservoirs are inspected three times a week by qualified reservoir engineers and we carry our regular exercises and training to prepare for worst case scenarios. See page 57 for details of how we supported the Toddbrook reservoir incident and page 60 for details of how we are trialling the use of reservoirs in the Calder Valley to reduce downstream flood risk.

[20] The Flood Estimation Handbook and related software offer guidance on rainfall and river flood frequency estimation in the UK. Flood frequency estimates are required for the planning and assessment of flood defences, and the design of other structures such as bridges, culverts, and reservoir spillways. **ceh.ac.uk/feh2/fehintro.html**

Our experience of flooding since our last report

The Boxing Day 2015 Floods

The winter of 2015 was the wettest on record in Yorkshire at the time with rain falling almost constantly throughout November and December, saturating catchments, and causing record-breaking river flows. In some locations the total rainfall during December was 300% more than the long-term average for the month, with a significant proportion of that falling during a single storm on Boxing Day[21]. Not surprisingly this huge volume of rain led to significant and severe flooding across several catchments, notably the Calder, Aire, Wharfe, Nidd and Foss, which are largely across the centre and west of the region.

The most severely affected areas were the Calder Valley, Leeds, York, and Bradford with:

- more than 4,000 homes and 2,000 businesses flooded
- almost 100 Yorkshire Water assets, of which 34 required significant investment to repair or rebuild,
- a critical phone and internet exchange in York which led to the loss of all emergency services contact for a four hour period,
- 13 substations in Leeds causing power cuts to around 400 homes,
- 19 substations in Calderdale which led to power cuts to 7,000 homes, and
- numerous sections of rail and road including critical bridges such as the one in Tadcaster which carried gas, electricity, and water mains and which took more than a year to repair.

The economic damage is estimated at £0.5 billion across the Leeds City Region with £100 million of this being damage to infrastructure[22].

Our staff played an important role in helping to manage and respond to the incident, working closely with the emergency services, the Environment Agency, local authorities, and the Army. We called in more than 1,000 extra staff to cope with the incident and its immediate aftermath. We also called on our water industry mutual aid arrangements when it became clear we didn't have enough tankers, pumps, or staff to cope with the volumes of flood waters that needed to be pumped out. Colleagues from Wessex Water, Welsh Water and Northumbrian Water arrived the day after Boxing Day to support our recovery efforts with tankers, jetters and centrifuge machines.

The immediate impact on Yorkshire Water was the operational loss of 48 wastewater treatment works and 40 sewage pumping stations. Clean water treatment was unaffected, and no customers lost drinking water supply although we were extremely fortunate that a scheme to provide flood resilience to a critical clean water pumping station north of York had just completed, protecting drinking water supplies to more than 500,000 customers.

Recovery costs, post event reviews, lessons learnt

Recovery of our flooded sites took many months, with 34 assets requiring substantial investment to repair and, in some cases, completely rebuild. Our insurance claim for this event was £56 million. However, this only covers the property damage and does not include the indirect costs such as increased electricity use (and carbon footprint) from pumping huge volumes of flood water, additional staff costs for overtime, provision of 24/7 welfare facilities, hiring equipment such as sewage de-waterers, centrifuges and generators for months, the cost of jetting out and de-silting many kilometres of sewer, or the cost of cleaning up customer homes.

[21] Hydrology of the December 2015 Flood in Yorkshire, Environment Agency, 2016
[22] Leeds City Region Review of the 2015 Floods

Following floods of this magnitude, Lead Local Flood Authorities (LLFAs) are required to carry out a post event review called a Section 19 report under the Flood and Water Management Act, 2010. Yorkshire Water contributed to each of the LLFA's reviews as well as a region-wide de-briefing session held by the Local Resilience Fora. We also helped to verify the flood extents produced by the Environment Agency after the flooding to help ensure their accuracy.

We also carried out our own internal post event review. Our review was carried out by an independent consultancy specialising in crisis management. The review made 27 recommendations covering improvements to our Company Incident Management Procedures, changes to stand-by rotas, improvements in asset data collection, media training, development of severe weather thresholds, improvements in the use of weather forecasting/ flood alerts and raising awareness of our mutual aid arrangements. These recommendations have largely been accepted and implemented by the company and have stood us in good stead for the floods in 2019/2020.

Following the 2015 Boxing Day Floods, we participated in the National Flood Resilience Review[23] led by Sir Oliver Letwin. This review asked infrastructure operators to assess their flood risk for assets serving more than 25,000 people using a plausible but extreme rainfall scenario generated by the Met Office. The return period for the rainfall is estimated at 1 in 1,000 so represents a very extreme weather event. The expectation was that the review would lead to infrastructure operators investing in either temporary or permanent flood defences to clean water sites that served more than 25,000 people to reduce the risk of flooding causing interruptions to customer drinking water supplies.

Our submission for this review found that we have 18 water treatment assets at risk during a very extreme rainfall event (seven water treatment works, eight boreholes and three raw water pumping stations/river intakes). At four of these sites, however, flood waters would not breach the site perimeter and at five of these sites there is no practical flood defence solution (e.g. they are a river intake). The networked nature of our drinking water supply system also means that, in extremis, we could sacrifice some of these sites in the event of a flood, and still be able to supply water from elsewhere, for example by increasing production at other sites and transferring water around the region.

In response to the review, we have taken the following actions (note that some of these were already planned):

- procurement of 520m of rough terrain demountable flood defences and 600m of hard standing demountable flood defences
- creation of a new central strategic emergency plan storage facility housing high capacity pumps, welfare vehicles and demountable defences
- creation of localised demountable defence storage at three key sites
- updated Vulnerable Asset Plans (operational contingency plans) for strategically important sites
- updated Bronze, Silver and Gold Incident Management Training for all senior staff across the business
- procurement of Environment Agency targeted flood warning service
- procurement of weather stations to fill gaps in regional coverage
- total programme cost £400,000, delivered by December 2016.

South Yorkshire Floods 2019/2020

The spring and summer of 2019 was extremely wet across much of the UK, with flooding events occurring in Wales, West and North Yorkshire, London and elsewhere. In August, heavy rainfall led to the evacuation of Whaley Bridge residents, downstream of Toddbrook Reservoir. This is a Canal and Rivers Trust owned reservoir which due to heavy rainfall was at risk of collapse. We supported the request to help in the relief operation by sending one of our high capacity pumps and four of our reservoir engineers to assist. Fortunately, disaster was averted in this case.

By November 2019, the Don catchment had recorded its wettest five-month period since 1891 with repeated storms tracking over the same location, and some places receiving over a month's rainfall in 18 hours. The Environment Agency issued six severe flood warnings on the River Don indicating a risk to life. We implemented our Company Incident Management Plan and mobilised resources in advance of the rain. We evacuated staff from our three of our wastewater treatment works in the area and were also supporting the Environment Agency in their pumping efforts elsewhere in the region, at Hull. We also worked hard to ensure that we were able to identify and support our vulnerable customers through this incident.

[23] **assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf**

The most severely impacted area were the villages of Fishlake and Bentley where 1,600 homes were flooded. An Army helicopter had to be brought in by the Environment Agency to drop aggregate on a flood bank that was in danger of collapsing. Flooding affected 41 of our wastewater treatment works, along with numerous sewage pumping stations, however the flood waters were not as deep as in 2015 and a few days later 32 of those sites were back in operation, with more substantial repairs needed at nine sites. Despite being flooded, our pumping station at Green Royds in the village of Fishlake continued to operate throughout the event. Clean water treatment was not affected, and no customers lost drinking water supply during this incident, although many customers' homes and gardens were flooded.

In February 2020, the arrival of Storm Ciara and Storm Dennis meant Yorkshire received over three times the long-term average rainfall for the month, leading to repeated flooding this time mainly in North and West Yorkshire. In response to the incoming weather and flood alerts, we once again implemented our Company Incident Management Plan. This time, 56 of our wastewater treatment works and pumping stations were affected, some of which were also flooded in the November 2019 event. Again, we were able to recover most of these relatively quickly although some required more substantial repairs and have been added to the flood recovery programme from the November 2019 floods. We also saw a significant impact on raw water quality from the February rain and storm events at our river fed clean water treatment works. We had to stop abstracting raw water from the Rivers Ouse and Derwent as levels of sediment in the raw water were too high to treat. Despite these challenges we were able to maintain drinking water supplies to customers.

Recovery costs, post event reviews, lessons learnt

The flood recovery programme for both the November 2019 and February 2020 events together covers 27 sites and is in delivery now with most work expected to complete by Summer 2021. The insurance claim has not yet been settled but is expected to be in the order of £8.5 million. In advance of the insurance claim, we have taken the decision to improve resilience at 25 of these sites at a cost of around £2.6 million e.g. by raising electrical panels and kiosks on concrete plinths. At many sites, the resilience improvements we had made following the 2015 floods have stood us in good stead and prevented as much damage. The flood depths were, in most cases, also lower than the 2015 event.

We have not carried out an internal post event review as the COVID-19 pandemic hit shortly after these floods and the business has necessarily focused its attention on managing this situation. We have however contributed as usual to the statutory Section 19 reports produced by Lead Local Flood Authorities following significant flooding events.


Raised electrical control panels at Blackburn Meadows Wastewater Treatment Works after the 2019 floods.


Staveley Wastewater Treatment Works during the 2019 floods.


Raised sewage pumping station kiosk at Westhorpe SPS after the 2019 floods.


Staveley Wastewater Treatment Works raised kiosk after the 2019 floods.

Actions 2015–2025

In our previous report we said we would carry out the following actions:

We said, "Our aspiration is to improve the resilience of all critical assets to at least a 1 in 200 year level of protection (0.5 per cent annual probability), with allowances for climate change and engineering freeboard where practical." This standard is now embedded in our end to end business work flow process and our most critical at-risk assets have had resilience improvements such as raising electrical panels.

We said we would include capital flood resilience enhancements within other projects. We have improved flood resilience at 15 sites where we were doing other work anyway, at 34 sites which were flooded during the 2015 event and at another 23 out of the 27 sites that were flooded during the 2019/2020 event. The remaining five sites which were flooded in the 2019/2020 event will have their recovery work completed by the end of 2021.

We said we would develop operational flood contingency plans for all at risk sites. We produced 164 Vulnerable Asset Plans (VAP) for our most critical and flood prone sites. These are currently undergoing a review and refresh to ensure they take into account recent experience of flood events and any capital works. We expect our VAP update programme of work to complete in the next 18 months and have put measures in place to ensure they remain up to date.

We said we would play an active role in our local and regional flood partnerships – we have taken part in 89 exercises with Local Resilience Forums and relevant stakeholders since our previous report, and worked to manage two severe flood events 2015 and 2019/2020. The exercises include all sorts of different activities including practicing for widespread flooding, loss of power, loss of IT, combinations of multiple events, explosions at chemical sites, oil spills in the North Sea, flu pandemic, civil unrest and the impacts of Brexit.

We said we would work to identify opportunities to work together to mitigate flood risk from our drainage network – we have delivered eight partnership schemes with local authorities that have reduced the risk of flooding by removing or attenuating surface water from our network.

We said we would invest £3.6 million to improve our emergency response, including purchase of high capacity pumps, demountable flood defences, all-terrain vehicles, and training exercises, which we have done.

We said we would implement phase three of the flood risk assessment, which is described above.

We said we would invest £60 million between 2015 and 2020 to maintain reservoir structural integrity and enhance their spillways. Our actual spend was £55 million.

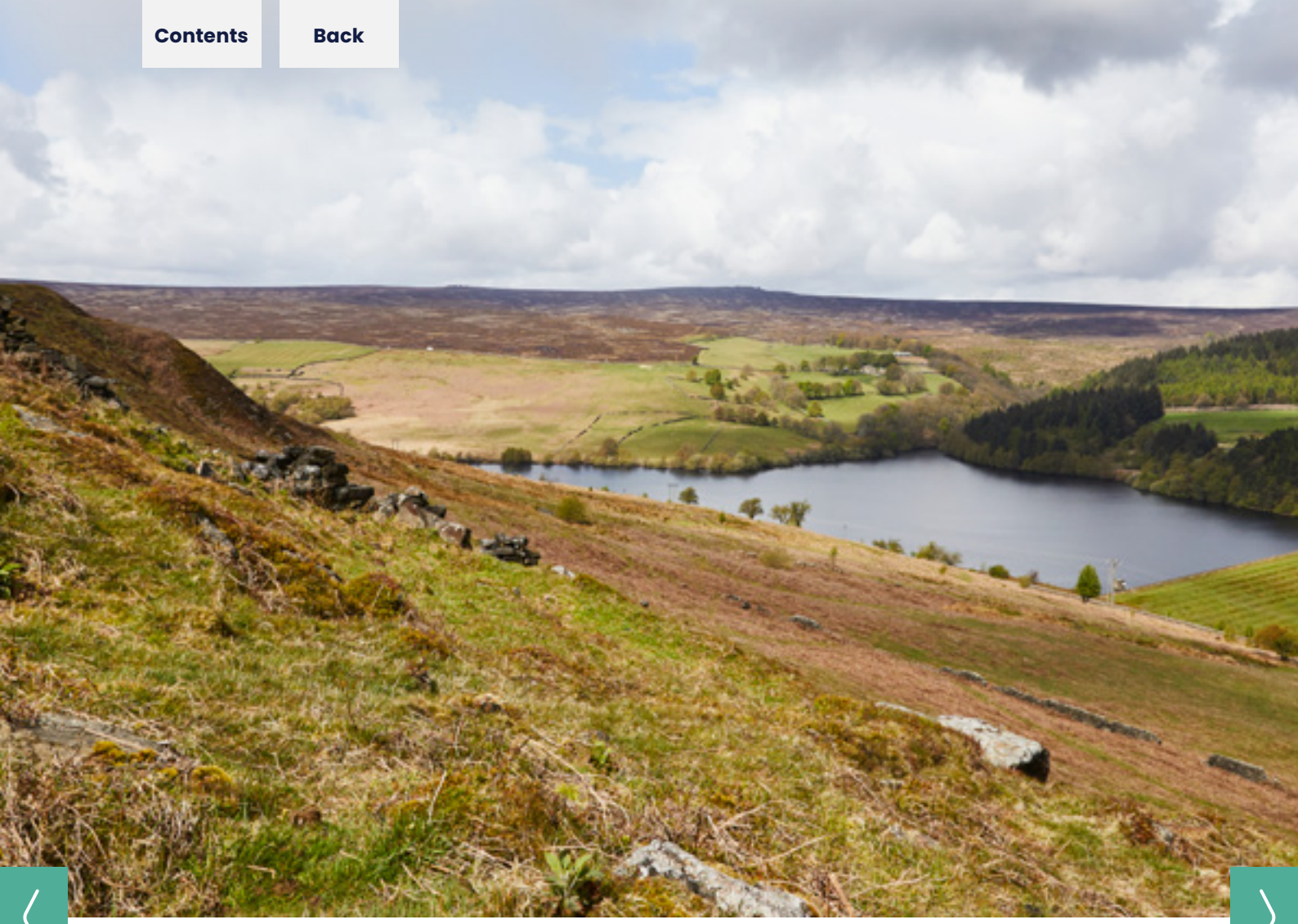
Additional actions 2015–2020

Managing reservoirs for flood risk reduction

In 2017, we collaborated with the Environment Agency to carry out a high-level screening assessment to understand which reservoirs across the whole of Yorkshire might be able to provide some flood risk benefit if they were operated differently. This assessment identified that the reservoirs above Hebden Bridge in Calderdale could potentially reduce the peak flows downstream.

Once the Environment Agency had modelled this effect, we considered what the other implications could be. Because autumn 2017 was very wet, we were confident that there was sufficient water stored across the region for supplies into 2018. On that basis, we agreed to carry out a trial draw down of the reservoirs above Hebden Water. For winter 2017/2018, we held the reservoirs at 90% full when possible although sometimes the levels rose above this after heavy rainfall.

The trial was not repeated over winter 2018/2019, because the drought that we experienced in 2018 meant that the reservoir levels were only around 40% as we entered that winter. The reservoirs did not increase to above 90% until April 2019. Since then we have carried out two further trials, over the winter of 2019/2020 and 2020/2021. This work is being carried out in collaboration with the Environment Agency and our learning from these trials is helping to shape national policy on this issue. In parallel, we have continued to work with the Environment Agency on a more permanent scheme for these reservoirs, which would complement the proposed flood alleviation scheme (flood walls) within Hebden Bridge itself. https://eyeoncalderdale.com/household-resilience-blog-and-news/hebden-bridge-reservoirs-to-be-lowered-to-help-reduce-flood-risk



Strategic partnerships – Living with water

In 2018, we formed the Living with Water (LwW) partnership between ourselves, the Environment Agency, East Riding of Yorkshire and Hull City Council to collaborate on managing flood risk in the Hull and East Riding area. This area has a complex mix of flood risk from surface water, the sea and rivers and so requires a multi-agency approach, as well as the support of local communities and businesses. The LwW partnership is a long-term commitment to work together to improve resilience to flooding from all sources. In 2020, East Riding Council successfully completed a £7.4 million major flood storage scheme protecting 4,000 homes from surface water flooding, and Yorkshire Water have completed their upgrade to Bransholme Surface Water Pumping Station as described above.

Further investment is planned, with Yorkshire Water allocating £23 million towards the partnership over the next five years which will be matched with contributions from the other partners. Activity will be focused on the creation of a bluegreen masterplan for the city and surrounding areas. This will form the first part of a 25 year plan to improve not just flood resilience but also wider financial and community resilience. For more details please visit the LWW website here: **livingwithwater.co.uk**

Orchard Park surface water storage lagoon.

Strategic partnerships – Common Cause

In 2019, we formed a strategic partnership with the National Trust as we have similar ambitions to manage our respective land holdings for multiple benefits including flood risk attenuation. The partnership has successfully bid for, and recently completed, a £2.6 million landscape scale natural flood risk management scheme in the Calder Valley. We have planted over 100,000 native trees and installed willow fascines and leaky dams on our land at Gorpley reservoir and similar scale work has taken place on neighbouring National Trust land at Hardcastle Craggs and Marsden Moor. Over the two-year project, 350 ha of uplands have been restored (including re-wetting, invasive species management and erosion control) and 62 ha of new woodland created which will reduce flood risk to downstream communities and provide multiple benefits for local people and wildlife. We are now looking to build on our experiences at Gorpley by delivering a further, landscape-scale, project through the Yorkshire Water/ National Trust 'Common Cause' partnership.

Landscape scale natural flood risk management in the Calder Valley. Credit Geoff Lomas.

The £2.6 million West Yorkshire Combined Authority funded Calder and Wessenden NFM Project has delivered the following Natural Flood Management interventions across three sites in West Yorkshire (National Trust Marsden Moor, National Trust Hardcastle Crags and Yorkshire Water Gorpley Reservoir):

140 stone built leaky dams

120 turf dams

90 leaky willow dams

21,000 sphagnum plugs planted

1,200m² ephemeral ponds

150m peat reprofiling

New SuDS car park (Hardcastle Crags)

463 brushwood fascines

Commenced woodland creation scheme – planting **11,000 native trees**

Volunteers creating leaky dams in the Calder Valley.

Volunteers building leaky willow dams.

Actions 2020–2025

We will complete our flood recovery programme of works covering 25 sites which flooded in 2019/2020.

We are updating our flood risk assessment tool and have made a request to the Environment Agency to obtain the full detailed flood model coverage for our region. We will use this to create a database of flood levels for each of our assets. This will enhance our risk understanding and ensure we are maintaining and enhancing resilience wherever possible.

We will continue to improve flood resilience at our existing sites when carrying out repairs, refurbishments or upgrades and following any major flooding incidents, to a minimum standard of protection of 1 in 200 year plus climate change and freeboard (where practical).

We will continue to maintain our emergency planning and response capabilities, training, planning, and exercises including participation in Local Resilience Forums.

We will continue with our landscape scale catchment restoration activity and natural flood risk management (NFM) opportunity identification and implementation, in partnership where appropriate. For example, we chair the Calderdale NFM Operations Group and are actively exploring where our land can be used to store and slow the flow of water through various collaborative mapping exercises.

We will also continue to support the Yorkshire Integrated Catchment Solutions Programme which has already helped us identify best practice for monitoring NFM interventions, supported business cases for additional funding, founded an NFM community of practice and created models to show where peatland restoration can create the most flood benefit.

We will contribute £23 million to the Living with Water partnership over the next five years. This will help develop long-term plans to improve resilience to all sources of flooding in partnership with local authorities, Environment Agency and local communities and businesses.

We will continue to work in partnership with Lead Local Flood Authorities and the Environment Agency to identify and implement surface water flood schemes to resolve our shared risk. For more information on how we manage the risk of flooding from our sewer network please see **Chapter 3**.

We will carry out a further £52 million of capital improvements to our reservoir asset base over the next five years with a focus on spillways given the production of new Flood Estimation Handbook following the findings from the investigation into the Toddbrook reservoir incident. Additionally, we will continue to upgrade outlet facilities to allow emergency draw down and undertake stability works as required to ensure ongoing reservoir safety.

We will continue to manage our reservoirs above Hebden Bride to provide flood risk attenuation whenever possible, balancing the need to store water for drinking water supply with the opportunity to reduce peak flows.

Barriers and interdependencies

In our previous report we noted that various interdependencies exist regarding flood risk management, not least as responsibility is split between different agencies for different types of flooding. We identified data sharing, affordability, the need to work in partnership and the lack of common flood resilience standards as potential barriers to further progress with flood resilience. We welcome progress on some of these issues and below discuss what further policy changes would support additional flood resilience.

Since our previous report we have been working to develop better data sharing arrangements, especially around vulnerable customers. Lists of vulnerable customers are kept by water, gas, and electricity providers, as well as by local authorities to enable priority reconnection or additional support should services be interrupted. We are running a pilot with the North Yorkshire Local Resilience Forum to make it easier for different organisations to share their vulnerable client lists in a secure and straightforward way during emergencies. Lists cannot be shared ahead of time due to GDPR constraints, and because the lists are dynamic as people's circumstances and vulnerabilities change.

We also routinely share our drainage models with other Risk Management Authorities. We have developed integrated catchment models with the Environment Agency and local authorities in Hull and Goole and are building one for Hebden Bridge. Our policy is to be "open by default" for data and we are partners in Data Mill North, an open data sharing platform hosted by Leeds City Council, which regularly hosts hackathons and other events to analyse multiple datasets.

Affordability continues to be an issue in our regulated industry with four water companies referring their final business plan determinations to the Competitions and Markets Authority on the basis that our regulator had not allowed sufficient costs for long-term resilience, a finding which was upheld by the independent group overseeing the referral.

We actively seek out opportunities to work in partnership to manage our flood risk and we welcome the broader approach to managing flood risk which is now the norm – a mixture of land management, hard defences, slow the flow techniques and community resilience. We welcome the recent changes in the Environment Agency's benefit calculations for flood risk projects which make it easier to work in partnership on flood schemes.

We welcome the National Infrastructure Commission's recommendations that government should set standards for flood resilience and note that the new Flood and Coastal Erosion Risk Management strategy places an expectation that water and sewerage companies will be resilient to flooding by 2025. However, the level of resilience is not specified. Whilst we appreciate that this allows companies to set their own level of resilience based on local needs and customer willingness to pay, we feel it is more straightforward to mandate a specific level of resilience (e.g. 1 in 200) which can then be supported and funded through our regulatory business planning process.

It is also important that customers are only paying once for flood resilience. As we note in various places in this report, we are reliant on Environment Agency and local authority flood defences being maintained to at least the current standard in order to protect our assets. As the climate changes, the standard of protection offered by existing flood defences is reduced which increases the risk of overtopping and failure, and thus the risk to our assets and potentially to service. Water customers should not be paying once through national taxation for centrally funded flood defences and again through their water bill due to their declining levels of protection.

The UK has world leading climate science and should be rightly proud of the quality of climate change projections freely available. However, these projections of future rainfall need to be translated into easily useable, freely available products such as flood risk maps in order to be useful for risk assessment.

We note that the Environment Agency plan to release a new National Assessment of Flood Risk in 2024 and that these will include the impact of climate change for the first time which is very welcome.

For our customers we would like to see further improvements to the FloodRe scheme in line with the recent independent review of insurance cover[24] in the Doncaster and Fishlake areas. This will help ensure that customers are adequately insured against flooding damages, encourage uptake of property level protection, and allow people to build back better following flooding events.

[24] **assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932523/review-flood-insurance-doncaster.pdf**

Monitoring and reporting

We report our flood risk in several places, including annual returns to the Environment Agency and Section 19 reports as required by the Flood and Water Management Act. At present there is no common flood risk metric for the English water sector, although development of one is being considered for inclusion in the Environment Agency's Environmental Performance Assessment[25] for water companies in England from 2024 onwards.

Yorkshire Water bespoke Performance Commitments

We have two Yorkshire Water performance commitments which are connected to flood risk, although they do not directly measure the risk of flooding to our infrastructure. These are Working with Others (WWO) and Surface Water Removed (SWR). Both of these are bespoke performance commitments unique to Yorkshire Water.

Working with others – the number of solutions delivered in partnership with third parties. Our target is to deliver at least 45 partnerships by 2025 across the business, several of which will be focused on managing our flood risk amongst other activities such as biodiversity enhancements and river restoration. We have already delivered seven projects against this target, including a project to clear a drainage ditch to increase flood flows with Barnsley Council, and a project with Sheffield University looking at what works when engaging communities about rain water harvesting.

Surface water removed – is designed to facilitate greater use of sustainable urban drainage solutions to remove surface water from our network to reduce the risk of flooding. It is measured as the surface water run-off from impermeable areas that is removed or attenuated from our sewer network using blue-green infrastructure solutions or surface water disconnection over the 2020 to 2025 period, reported in hectares. Our target is to remove 4 ha by 2025.

We also report our activity regarding flood risk management in several places.

The Flood and Water Management Act, 2010 (FWMA) requires us to submit a Section 18 return to the Environment Agency each year which sets out what investment we have made in reducing the risk of flooding and coastal erosion, and how we have had regard to the national flood and coastal erosion risk strategy. These reports are compiled into an overview by the Environment Agency and are published here: gov.uk/government/publications/flood-and-coastal-risk-management-national-report

The FWMA also requires the Lead Local Flood Authority to publish a review under Section 19 of the Act after any "significant" flooding incidents. The definition of "significant" is locally determined but is usually any flooding that affects at least five properties. Yorkshire Water feeds into these reviews and they are published by the relevant local authority. The latest S19 reports in Yorkshire detail the impacts of Storms Ciara and Denis in February 2020 which mainly affected North Yorkshire County Council, Calderdale District Council and Doncaster Metropolitan Council. These reports are available on the relevant local authority website.

We also include a section in our annual report every year to fulfil our requirements under the Task Force on Climate related Financial Disclosures (TCFD) which will describe any major flood incidents, our response, and any subsequent investment.

[25] Environmental Performance Assessments are annual reports of water and sewerage companies performance against a basket of metrics including pollution incidents and security of water supply published by the Environment Agency.

6. Risks to infrastructure services from coastal flooding and erosion

Risks to infrastructure services from coastal flooding and erosion

The Yorkshire region has an extensive coastline, stretching around 90 miles from Staithes in North Yorkshire to Spurn Point at the tip of the Humber estuary, with coastal fishing villages and Victorian seaside resort towns like Whitby and Scarborough. Our coastline has 18 bathing beaches and multiple sites that are nationally and internationally important for their rare habitats, sea bird populations and other wildlife. It's also got a long history of erosion and more than 35 villages have been known to be lost to the sea since Roman times. The fertile Wolds of East Riding of Yorkshire are important for agricultural and the Humber estuary is home to significant industry and the UK's busiest port complex. The Humber is also the area of second highest tidal flood risk outside of London.

Yorkshire Water is a Risk Management Authority (RMA) under the Flood and Water Management Act, 2010. RMAs are those organisations who, between them, have responsibilities for managing flooding from various sources, as well as coastal erosion. Flood defences along the Yorkshire coastline are owned and operated largely by the Environment Agency, whilst coastal erosion activity is largely under local authority control.

Shoreline Management Plans (SMPs) set out the policy for managing the coastline. These are prepared by partnerships made up of the coastal local authorities, the Environment Agency, Natural England, English Heritage, the National Farmers Union, and any other relevant stakeholders.

There are four options for managing coastlines:

- **Hold the line** – maintain the current line of defences
- **Advance the line** – advance the current line of defences
- **No active intervention** – allow natural processes to take effect, any existing defences will not be maintained
- **Managed retreat** – move the line of defences inland. There is a national target for 10% of our coastal defences to be realigned by 2030.

We have two SMPs in our region – The Tyne to Flamborough Head led by Scarborough Borough Council and Flamborough Head to Gibraltar Point[26], led by East Riding Council. The policy for most of the Yorkshire coastline is to allow natural processes to continue (i.e. no active intervention) while maintaining the line of existing defences around seaside towns such as Bridlington, Hornsea and Withernsea.

[26] Shoreline Management Plan, The Tyne to Flamborough Head, The North East Coastal Authorities Group, 2007.

As well as the two SMPs which cover our coastline, there is also a separate flood risk strategy for the Humber estuary[27]. This is a long-term (150 year) plan for managing flood risk along the Humber estuary. In common with the Shoreline Management Plans, the strategy sets out areas where defences will or will not be maintained in the future and shows where defences will be breached to create managed realignment areas. The Humber Strategy is currently being reviewed and new options appraised following the storm surge in 2013. The new strategy will look at three potential strategic approaches:

- managing the tide (using a combination of improved flood defences, existing and additional flood storage),
- adapting to the tide (improve or maintain defences in some areas, and changing land use in others, to allow defences to be deliberately altered or moved back in some locations over time) and
- keeping out the tide (by constructing a tidal surge barrier, most likely in the outer estuary).

The new strategy is being co-developed by a partnership of the 12 local authorities, the Local Enterprise Partnership and the Environment Agency. Yorkshire Water will be engaging with the developing strategy as the options above are appraised over the next two years. In the event of the Environment Agency proposing any new realignment areas which affect Yorkshire Water assets, we would be consulted and have the opportunity to discuss these plans.

[27] Shoreline Management Plan, Flamborough Head to Gibraltar Point, Humber Estuary Coastal Authorities Group, 2009.

Assessing our risk of coastal flooding

Sea level rise driven by climate change will add to our risk of coastal flooding by decreasing the level of protection afforded by coastal defences owned and operated by the Environment Agency or local authorities, and from which many of our assets benefit. Climate change may also increase the frequency, and intensity of storms, and storm surges which may mean coastal defences are overtopped more regularly.

Storm surges can occur when there is a low pressure system out at sea combined with on shore winds; if this coincides with high tide, storm surges can result in significant coastal flooding. Storm surges propagate in an anti-clockwise path around the North Sea, lasting around 12-15 hours. Fortunately, this means that it is rare that the peak of a storm surge coincides with the peak of a high tide (which happen approximately every six hours). We are also fortunate that the Humber estuary is a macro-tidal estuary with a large tidal range (the difference between high and low water levels). A 50 year return period storm surge has a height of around 1.75m, whereas the Humber estuary has a large tidal range of up to 7m so unless the storm surge coincides with the high tide, the impacts are within the normal tidal range[28].

In our previous report we described how we had commissioned JBA to undertake a coastal flooding risk assessment using the Environment Agency flood maps and sea level rise data from UKCP09 and described how we have already protected several critical assets from coastal flooding. The assessment did not identify any new assets at sufficient risk to invest in specifically due to coastal flooding risk alone and thus we have not repeated the exercise.

Evidence produced by Sayers et al for the forthcoming third national Climate Change Risk Assessment found that in Yorkshire we can expect between 0.30m sea level rise if the world warms by 2°C, or 0.65-0.68m if the world warms by 4°C.

With 0.35m of sea level rise we will see a decline in the level of protection offered by sea defences:

- Between Tyne and Flamborough will decline from a 1 in 100 to 1 in 47,
- Between Flamborough and Gibraltar Point will decline from a 1 in 100 to 1 in 35.

The report also found that the Yorkshire Water's operational region has the highest future exposure to flood risk (assuming no additional action over current planned or in policy) out of all the UK's water companies due mainly to the increased risk from coastal flooding caused by sea level rise[29].

[28] Catastrophe loss modelling of storm surge flood risk in eastern England. Wood et al, Phil Trans R Soc A. 2005
[29] Sayers, P.B; Horritt, M; Penning-Rowsell, E; McKenzie, A. (2015) Climate Change Risk Assessment 2017: Projections of future flood risk in the UK. Research undertaken by Sayers and Partners on behalf of the Committee on Climate Change. Published by Committee on Climate Change, London.

Our experience of coastal flooding 2017

We have experienced two storm surges in recent years, one in 2013 which affected the Humber estuary and was described in our previous report, and another in 2017 which was predicted to affect the Esk estuary and the North Yorkshire Coast.

The 2017 storm surge was forecast well in advance and enabled us to deploy demountable defences at four of our coastal assets in the seaside town of Whitby. We located our emergency planning team in Whitby the night before the surge was predicted to make sure the right staff were in the right place. Fortunately, in this event, the surge did not happen at the same time as the high tide, so the water levels were not as extreme as predicted and there was minimal impact.

Demountable defences around our Wastewater pumping station on Whitby sea front, 2017.

Our experience of coastal flooding 2019

In December 2019, high rainfall and high tides led to the River Hull overtopping its banks and causing a 3m wide gap in the flood defences half a kilometre upstream of our water treatment works. We were alerted to the damage done to the flood defences by a local farmer which prompted us to implement our company incident management procedure, liaising with the Environment Agency to deploy both our own and Environment Agency demountable flood defence assets to protect the water treatment works.

We considered how we could evacuate our staff safely should a full breach occur and made sure we could supply Hull from the Grid in case the treatment plant was lost. The Environment Agency shored up the damaged embankment with sandbags as a temporary measure and we carried out daily inspections for the following three months until sheet piling was installed to repair 800m of the embankment.

How we manage our coastal flood risk

Our business funding approval processes requires a flood risk screening prior to detailed design so any coastal flooding risk will be assessed and mitigated if appropriate for capital schemes along the coast. We aim to protect our coastal assets from a 1 in 200 year flood, plus an uplift for climate change wherever possible and pragmatic. This in line with national planning policy and the Environment Agency guidance for climate change allowances in flood risk assessments. Our wider approach to managing flood risk is described more in **Chapter 4**

Actions 2015–2020

In our previous report we said we would carry out the following actions:

The storm surge described in our previous report in 2013 caused major damage to several coastal assets, including the council-owned sea wall protecting the village of Runswick Bay in North Yorkshire. We have worked in partnership with North Yorkshire County Council, the Environment Agency, and Runswick Bay Flood Action Group to divert our sewer which then allowed free access to the sea wall so that new rock armour could be installed. Our contribution demonstrated match funding without which the scheme is unlikely to have been funded by central government. This scheme completed in 2017 at a total cost of £2 million, with Yorkshire Water's sewer diversion costing £420,000.

Runswick Bay sea wall partnership scheme.

Actions 2020–2025

Please see **Chapter 4** for more details of our planned activity related to flooding from all sources. We don't have any specific coastal flooding schemes planned for the next five years although where we are doing work at an existing site, we will make sure that we are not adding additional risk and will install new assets above the 1 in 200 year flood plus an allowance for climate change and freeboard where possible. We will also take sea level rise into account, in line with national planning policy and Environment Agency guidance.

Flood risk in Hull and surrounding areas is complex. The city centre is below the high tide mark and relies on surface water, water courses and land drainage being pumped out of the city, with multiple agencies responsible for managing water levels. The area is also at risk from coastal flooding and storm surges, relies heavily on flood defences and a tidal barrier across the River Hull. In light of this and recognising that no single agency can solve these problems alone, we have created a flagship partnership called Living with Water (LwW). This is a long-term partnership with Hull City Council, East Riding of Yorkshire Council and the Environment Agency which will work with communities and business to improve resilience over the next 25 years. We have allocated £23 million towards LwW over the next five years to help develop a blue green masterplan, engage with communities, install property level flood protection, and other solutions in partnership with others.

Assessing and managing our risk from coastal erosion

The Yorkshire coast varies from soft glacial til found around the Humber estuary and the Holderness coast to much steeper, harder chalk cliffs further north. There has been a long history of erosion along this coastline, with around 2m of land lost every year in some locations.

Our previous report described how we commissioned Arup to assess our risk from coastal erosion. This risk assessment used a range of information sources including historic maps, observed data from local authority monitoring stations, and projections of future coastal erosion rates from the Shoreline Management Plans (SMPs) and the National Coastal and Erosion Risk Mapping (NCERM) dataset. The SMP and NCERM data include for the impacts of climate change in their projections. Our previous risk assessment identified several assets at risk which we have had to relocate, and which is described in the actions section.

In 2017, we repeated the risk assessment using the SMP and NCERM datasets to inform our business plan for the next five years. The risk assessment identified a small number of assets potentially at risk in the coming decades, including a handful of sewage pumping stations and a few sections of water or sewerage pipes. We are investigating solutions to relocate one of these assets and are proactively monitoring the others and will take steps to cap off pipes or move assets when necessary.

Actions 2020–2025

Long sea outfall arriving at Alexandra Dock, Hull, 2019. Credit Van Oord.

Our previous report identified one wastewater treatment plant, three pumping stations and a section of water main at risk from coastal erosion. Our wastewater treatment plant at Withernsea has been relocated; the new plant is nearing completion and expected to go live in September 2021. We have moved one pumping station (Flamborough Head) and are investigating solutions for relocating the other two.

We have also capped off and diverted several short sections of water main where they were at risk from erosion. Most of our coastal underground assets are on the landward side of the properties they serve so we will continue to maintain these pipes as long as the properties they serve are occupied.

When our Withernsea wastewater treatment plant was upgraded and a new long sea outfall installed in 2001, it was more than 180m from the cliff edge and had an expected lifespan of 60 years. More than 100m of land has been lost in the last 30 years and both the works and the outfall have had to be moved. This scheme has taken much longer than anticipated to come to fruition due to difficulties securing enough land in the right location, and then a lengthy negotiation with the Environment Agency regarding our choice of treatment technology. We have decided to use a proven, but new to us, low carbon, zero input, biological treatment process called Aero-Fac. The Environment Agency have agreed to a three year trial of this process to see if it can meet our discharge quality consents.

A new outfall has been tunnelled down through the cliff and out to sea to connect to a long sea outfall diffuser chamber. The new wastewater plant cost £10 million and the outfall £15 million and are expected to "go live" in the summer of 2021.

The new treatment plant, which has a lifespan of 40-60 years is located behind the 100 year erosion line and more than 10m above sea level. The impact of future climate change driven flooding and sea level rise has been taken into account using the climate change allowances for planners as available in 2015.

The 1 km pipe for the long sea outfall was towed across the North Sea from Norway, here it is arriving at Alexandra Dock in Hull before it had concrete collars attached and was then maneuvered around 70 km of coastline to its final position where it was welded together and connected to the land based section of the new outfall.

Our previous report also said that we would be relocating our sewage pumping station at Flamborough Head further inland. This scheme was completed in 2016 at a cost of £400,000 with the new pump station now located behind the 100 year erosion line. This scheme was quite complex as the pump station is in a nature reserve, and immediately adjacent to a Special Protection Area, Special Area of Conservation, Site of Special Scientific Interest, a scheduled ancient monument, and the popular tourist attraction that is Flamborough Head lighthouse. The new pump station has been moved inland and away from the tourist footpath, so it is less obtrusive, and all works were carried out during the winter to avoid affecting tourism. The pump station was served by a Northern Power Grid (NPG) substation, and prior to the scheme we approached NPG to see if we could make savings by relocating the pump station and the NPG substation at the same time.

Unfortunately, NPG did not have the funds available to move their substation at the time, however, this project has brought the erosion risk to NPG's attention who have now added it to their risk register for future funding. If NPG wish to relocate their substation in the future, the newly created Yorkshire Water pump station compound would be available to share with NPG.

As well as the above capital schemes, we have continued to play our part in regional and national exercises to test our emergency planning and business continuity capacities along the coast and Humber estuary including such as widespread power failure due to cold weather and widespread flooding.

Pre cast concrete storage pipes arriving on site at Flamborough Head Sewage Pumping Station, 2017. Credit MMB.

Actions 2020–2025

In our previous report we said we would carry out the following actions:

We will continue to monitor coastal erosion rates and to proactively relocate our at risk assets. We are currently investigating solutions for two of our sewage pumping stations. However, these coastal schemes can be expensive, sometimes requiring new land purchases and complex civil engineering, but only benefit small numbers of properties, which themselves may have a limited lifespan of just a few years before they are evacuated. This can make such schemes difficult to progress when compared to other priorities.

We will also continue to explore opportunities to work in partnership to manage our coastal risks. We will continue to play our part in local resilience forums, exercises, and simulations with our regional and national partners.

Barriers and interdependencies

We have clear interdependencies with other agencies in managing our coastal risks. Our pumps in Hull play a critical role in moving surface water from watercourses out of the city and into the sea, and we in turn depend on flood defences provided by the Environment Agency and local authorities to stop the sea from flooding Hull. Our assets also benefit from coastal protection schemes in some locations such as Runswick Bay.

The incident at our water treatment works near Hull demonstrates how reliant we are on the condition and reliability of Environment Agency defences and also illustrates the difficulties and trade-offs involved in prioritising limited investment, which is necessarily focused on schemes which protect the most people and the most properties.

The embankment near our water treatment works largely only protects farmland and our asset. A similar issue relates to our ability to proactively manage coastal erosion risks which can be very expensive to mitigate and benefit relatively few customers and potentially for only a few years. Appropriate coastal planning policies and support for roll back schemes are needed to ensure coastal communities are not left behind as the seas rise.

We are also dependent on the weather and flood forecasting services provided by the Met Office, Flood Forecasting Centre, and Environment Agency, and are a member of the Flood Forecasting Centre's User Group.

Monitoring and reporting

Any activity regarding coastal flood risk and erosion would be included in our annual return to the Environment Agency as required by the Flood and Water Management Act. As mentioned in Chapter 4, there is no common flood risk metric reporting for the English water sector, although development of one is being considered for inclusion in the Environment Agency's Environmental Performance Assessment[30] for water companies in England from 2024 onwards.

Yorkshire Water bespoke Performance Commitments

We have two Yorkshire Water performance commitments which are connected to flood risk, although they do not directly measure the risk of flooding to our infrastructure. These are Working with Others (WWO) and Surface Water Removed (SWR). Both of these are bespoke performance commitments unique to Yorkshire Water.

Working with others – the number of solutions delivered in partnership with third parties. Our target is to deliver at least 45 partnerships by 2025 across the business, several of which will be focused on managing our flood risk amongst other activities such as biodiversity enhancements and river restoration.

Surface water removed – is designed to facilitate greater use of sustainable urban drainage solutions to remove surface water from our network to reduce the risk of flooding. It is measured as the surface water run-off from impermeable areas that is removed or attenuated from our sewer network using blue-green infrastructure solutions or surface water disconnection over the 2020 to 25 period, reported in hectares. Our target is to remove 4 ha by 2025.

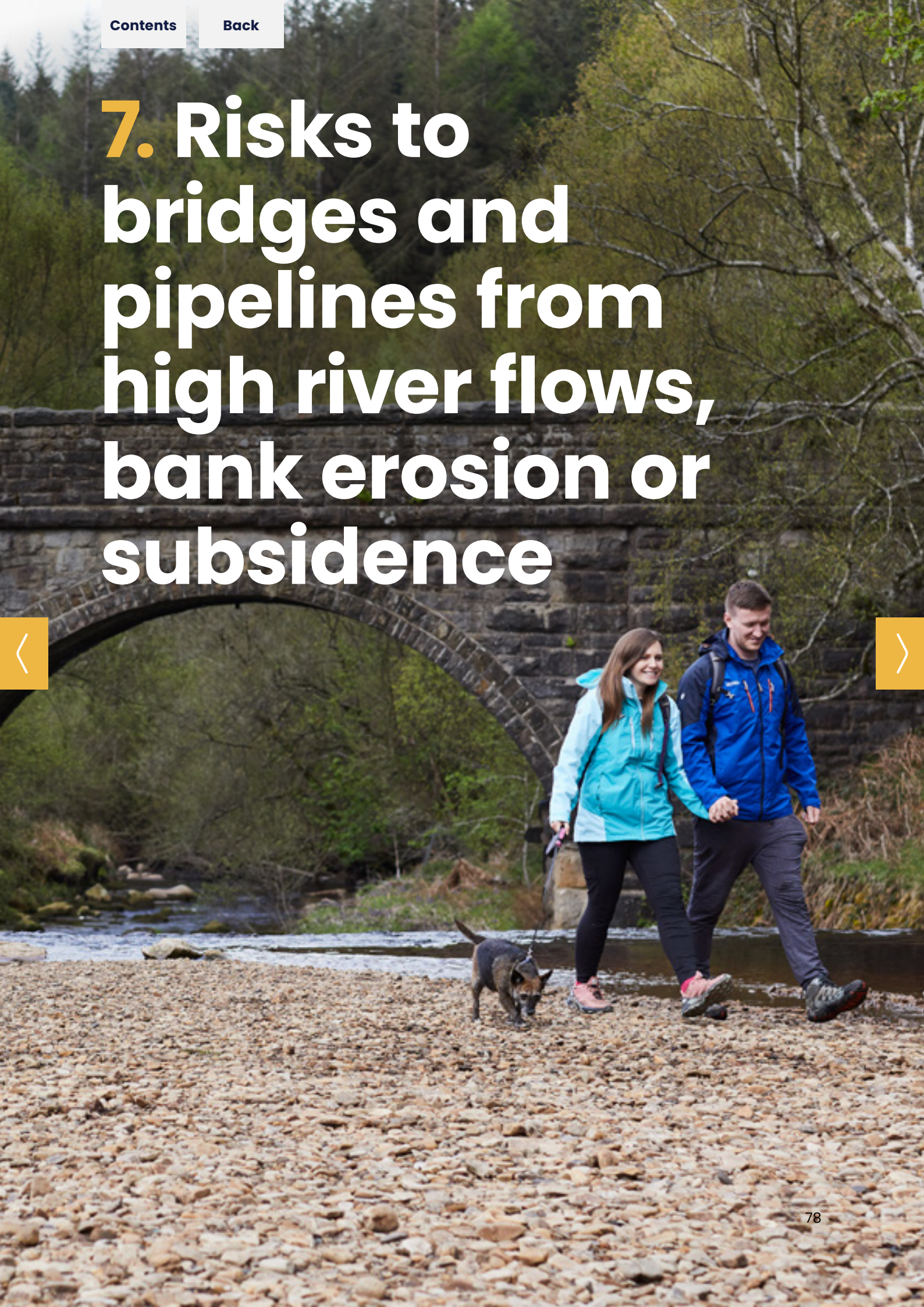
The Flood and Water Management Act, 2010 (FWMA) requires us to submit a Section 18 return to the Environment Agency each year which sets out what investment we have made in reducing the risk of flooding and coastal erosion, and how we have had regard to the national flood and coastal erosion risk strategy. These reports are complied into an overview by the Environment Agency and are published here: **gov.uk/government/publications/flood-and-coastal-risk-management-national-report**

The FWMA also requires the Lead Local Flood Authority to publish a review under Section 19 of the Act after any "significant" flooding incidents. The definition of "significant" is locally determined but is usually any flooding that affects at least five properties. Yorkshire Water feeds into these reviews and they are published by the relevant local authority. The latest S19 reports in Yorkshire detail the impacts of Storms Ciara and Denis in February 2020 which mainly affected North Yorkshire County Council, Calderdale District Council and Doncaster Metropolitan Council. These reports are available on the relevant local authority website.

We also include a section in our annual report every year to fulfil our requirements under the Task Force on Climate related Financial Disclosures (TCFD) which will describe any major flood or coastal erosion incidents, our response, and any subsequent investment.

30. Environmental Performance Assessments are annual reports of water and sewerage companies performance against a basket of metrics including pollution incidents and security of water supply published by the Environment Agency.

7. Risks to bridges and pipelines from high river flows, bank erosion or subsidence



Risks to bridges and pipelines from high river flows, bank erosion or subsidence

In our previous report, we included details of our clean water network resilience activity in our Water Resources chapter, as reducing leakage was, and continues to be, the main action to reduce the risk of drought causing public water supply deficits. Much of our wastewater network resilience activity is described in detail in Chapter 2, and in Chapter 5. However, there are also risks to our network from other climate hazards which we did not discuss at length in our previous report (largely as we had not specifically assessed them at the time) but which are described more below.

We have 32,000 km of clean water network and 53,000 km of sewer network of varying age, condition and material including plastic, cast iron, cement, and brick. Our network needs constant investment in repair and maintenance as pipes age and deteriorate, and also because they are damaged by the weight of traffic on roads, third parties accidentally cutting through pipes, tree roots, blockages, and ground movement such as freeze/thaw in cold periods and shrink/swell events in dry periods.

On average we spend around £20 million/year maintaining our clean water network, and £30-40 million maintaining our sewer network. Climate change will impact on our network by altering the pattern of ground movement with fewer cold spells but more dry, hot spells, and also by increasing the risk of scour and erosion for our pipes which cross over, under or alongside rivers as flows increase.

Informing our risk

Asset deterioration models

We assess the risk to our network using two asset deterioration models – one for clean and one for waste. These models include variables such as pipe material, age, diameter, how many customers are connected and in the case of the clean water asset deterioration model, also include soil workability, average minimum temperature and distance east. These last two variables are known to correlate with a higher risk of bursts on the clean water network. These models provide us with an indication of how many pipes will need replacing in each of our five year business planning cycles. We are currently reviewing both the clean and waste asset deterioration models to explore how climate change could be considered.

Scour risk assessment

In addition to our deterioration models, in 2017 we carried out a risk assessment specifically to examine the risk to our clean and waste network from scour and river bank erosion. This was driven by the collapse of the Tadcaster bridge in the 2015 floods, which was carrying gas and water mains. The risk assessment was based on:

- pluvial flood maps for a 1 in 30, 1 in 100 and 1 in 1,000 year surface water flood,
- four commonly available fluvial flood risk bands from the Environment Agency flood maps (high to very low),
- data about the probability of bridge failure from the Cumbrian floods in 2015, and
- potential impact on customers or the environment from a pipe failure.

The assessment provided a useful overview of our risk, however no assets were at sufficient risk to reach our cost benefit thresholds for investment in the current planning cycle when compared to the many other risks we must manage. The impacts of future climate change were not specifically assessed here as the pluvial and fluvial flood maps available from the Environment Agency do not include the impact of climate change.

Water supply system resilience dashboards

Building on the work above, we have since created resilience assessment dashboards which assess each clean water supply system's critical mains, bridges, pumps and storage reservoirs using the following variables:

- The number and type of customers affected
- The availability of network storage
- The duration of the outage
- The estimated repair times
- The ability to provide alternative means of supply
- Operational performance data
- Operational knowledge
- Past performance data
- Likely exposure to key risks i.e. flooding, power outage, plant failure.

The above analysis has been largely automated for trunk main systems using modelling and database tools to allow a rapid evaluation of the resilience of each of the elements that make up a given strategic network. The assessment of point assets such as pumping stations and service reservoirs is undertaken collaboratively through workshops, performance reviews and engineering challenge sessions.

The dashboards provide data on how many customers would be affected by a burst or pump failure, how long the operational contingency plan takes to put in place, how much storage is available in the system, details of future planned housing growth in the area, and a wealth of other data. These dashboards will help inform both our operational response and our future capital investment and will be rolled out to all our water supply systems over the next five years. The dashboards look ahead to 2030 to include planned development and population growth but there is no simple way of including climate change in these dashboards at present.

Figure 10. Screenshot of example water supply system resilience dashboard.

Soil Moisture Deficit mapping and analysis

Our previous report described how the main risk of increased leakage occurs in winter when there are freeze/thaw events which cause the ground to move and our pipes to break. In 2018 we experienced a very cold winter (The Beast from the East) followed by a dry, hot spring and summer which was officially classed as a drought (as described in **Chapter 1**). The combination of cold followed by drought had a noticeable impact on our network, increasing its failure rate and fragility, and we came very close to failing our leakage targets for the year. This event led us to undertake some analysis to examine the relationship between soil type, soil moisture deficit[31], and burst rates on our clean water network.

Clay-containing soils shrink or swell in response to moisture levels, and Yorkshire has a fair amount of clay soils, especially around Sheffield, Leeds, York and Hull. Around 60-70% of our clean water network is made from cast iron pipes which are brittle and subject to burst when soils move in either cold, wet or dry conditions. We have created risk maps for our different Distribution Management Areas (DMAs) which plot soil moisture deficit (SMD), soil type, pipe material and pipe condition. These maps give us an indication of which areas are more at risk from bursts in dry weather. We use these maps to understand our current risk and to allocate resources as appropriate e.g. if we are in very dry conditions and it's a sunny weekend is coming up we will make sure we have teams on standby in key DMAs.

The analysis we did also identified the thresholds at which we will see an increased rate of bursts. If SMD is over 90mm our risk increases to moderate, and over 110mm to high, and at 125mm which is almost fully dry soil, we will see failure rates in mains almost double compared to wet soils. In 2018 we saw peak SMD for 13 weeks which placed a huge stress on our network, at a time when customer demand was also extremely high and our reservoir stocks were worryingly close to the drought trigger line. Since conditions similar to those seen in 2018 are predicted to occur every other year by 2030, we expect our risk of summer leakage to increase as the climate changes. We are examining if and how we can quantify this impact in order to allow sufficient investment in our next business planning cycle to manage this risk.

[31] Soil Moisture Deficit (SMD) is a measure of how dry the soil is.

Managing our risk

In addition to the activity above which informs our risk, we undertake a wide range of different activities to maintain and improve the resilience of our clean water network. This includes investment, maintenance and training activity such as:

- **Smart telemetry and monitoring of our clean water network flow volumes and pressures** – acoustic loggers to inform when and where leaks are emerging, flow meters and pressure sensors to understand 15 minute minimum, maximum and average flow and pressure, and pressure transient loggers to understand how and where these are occurring[32].
- **Operational training** – clean water network staff are trained at the Yorkshire Water Network Training Centre for calm network operations to reduce the impact of pressure transients and to incorporate lessons learnt from previous network events.
- **Finding and fixing leaks** – ongoing activity to repair bursts on our clean water network. Note that our regulator Ofwat has placed a cap (and financial penalty) on the number of bursts we can fix, despite also requiring us to find and fix enough bursts to reduce leakage by 15%.
- **Renewals and relining of pipes to avoid future leaks** – replacing pipes is a longer-term solution than relining however there can be a carbon and financial benefit to relining rather than renewing pipes.
- **Operational response plans** – we draw up Winter Plans (described below) and also have a continuous supply team who can quickly model the best way to establish an alternative network configuration or use above ground temporary pipework to bypass bursts and maintain supplies.

We have also experienced an extreme cold event, the Beast from the East, in 2018 which demonstrated the resilience of our response.

The resilience of our sewer network and how we manage the risks of sewer flooding are described more in Chapter 2, including how we use weather data to inform our operational response, and the investment we have made and plan to make in renewing and repairing our wastewater network and the modelling work we carry out to understand our risk and inform our response.

[32] Pressure transients or "water hammers" are pressure waves caused by the sudden opening or closing of valves or pumps. These pressure waves stress the network and correlate with increased mains failure rates.

Actions 2015–2020

In our previous report we said we would carry out the following actions:

We said we would invest £2.4 million to reduce leakage from 297.1Ml/day to 287.1Ml/day by 2020. In order to prepare for the more stretching leakage targets which we anticipated would come into force in 2020, we invested a further £59 million over and above the £2.4 million on the following:

- 200 extra "find and fix" staff;
- installation of 35,000 acoustic loggers (a significant increase on the 4,500 we installed between 2015 and 2020);
- installation of 2,500 pressure loggers;
- procurement of satellite data across the region to detect leaks;
- £2.3 million on replacing the customer owned pipe between the stop tap and the customers property. This activity has been focused on areas with the highest rates of customer side leakage;
- Installation of new trunk main meters in Hull, York, and Leeds; and
- Data improvement projects around our CCTV archive, validation of plumbing losses, rationalising distribution management zones, improvements to our leakage calculations.

We have also updated our Winter Plan and created new Soil Moisture Deficit tracking dashboards (described above) to ensure we stay on track to meet our leakage targets. Our Winter Plan is created every year according to our current and forecast leakage performance and sets out the steps we will take (eg additional find and fix resources) at predefined thresholds (e.g. leakage at a certain level, weather forecasts) to ensure we meet our leakage target in the event of a harsh winter causing lots of bursts.

Our previous report described a multi-stage pilot we had carried out called the Longwood Trial. This informed our night use models, customer side find and fix strategy, WRMP assumptions and asset policies.

We have also delivered the first phase of the Hadfield Smart Network, building the capabilities and business case for the deployment of smart technologies across the region. This project deployed over 400 sensing assets across the water network in Sheffield including 2,000 customer water meters, which has enhanced our understanding of continuous use, night use models and per capita consumption.

We identified nine water supply system resilience schemes in our previous report costing £6.9 million which we said we would deliver by 2020. We have not been able to progress these due to funding constraints.

Actions 2020–2025

Previously leakage targets were set at the sustainable economic level of leakage (SELL) using methodologies produced by our regulators. The SELL is based on the principle that the cost of reducing leaks should be less than the cost of replacing that water from another source. In other words, it is not economically feasible to eliminate leakage entirely because the cost of finding and fixing small leaks can be excessive compared to the volume of water lost.

For example, only around 6% of leaks can be easily found, and it can cost three times as much to dig up a road than it does to fix the leak. However, for reasons including customer, Government, and regulatory expectations for greater action on leakage, targets are no longer set using the SELL and the industry has instead committed to reducing leakage by 15% by the end of 2025 and by 50% by 2050.

We will invest £28 million on clean water network enhancement over the next five years over and above our annual expenditure of around £40 million per year to meet our leakage target by 2025.

We are hoping to replace or rehabilitate between 150-200 km of clean water mains in the next five years. Due to the cap set by our regulator on the number of bursts we can fix, this work will be focused on mains with the highest burst rate (the ones that have burst five times in the last five years) and are the most cost-beneficial schemes to deliver. It will be a mixture of renewal and, where suitable, re-lining. This rate of renewal will not keep pace with the rate of asset deterioration so calming measures such as pressure management on the network will also be needed to meet burst and leakage targets. We will also repair 7,000 customer owned pipes per year by 2025.

We will progress our Water Supply System Resilience Dashboards to cover all of our water supply zones by 2025 and develop our Water Supply System Strategy to inform our activity from 2025 onwards. The Water Supply System Strategy will take a systems approach and aims to understand the key strategic challenges the network will face and deliver solutions to mitigate or enhance risks and performance.

We will install additional sensing and monitoring to improve our clean water network visibility, ensuring that 95% of our Distribution Management Areas (DMAs) have a pressure sensor at the critical point, and a pressure logger and a pressure reducing valve in every zone serving more than 150 properties.

Please see Chapter 2 for details of our previous and planned investment in our sewer network. This includes £238 million in repairing or renewing our network over the next five years and installation of 40,000 monitors to improve our network visibility.

Barriers and interdependencies

The main barrier we observe to increasing our network resilience on either the clean or the waste side is affordability. Our asset base requires constant investment to maintain current levels of service, and additional funding will be required to improve either service or resilience. This was the main thrust of our argument for not accepting our Final Business Plan Determination from our regulator Ofwat. Our case was successful however it remains to be seen if the stretching targets we have been set are achievable with the level of funding received.

We also feel that there are inconsistencies in our targets and how they have been set by our regulator. We would like to have the cap on the number of mains repairs we can carry out removed. We cannot reduce leakage without repairing pipes and to have a cap on the number of pipes we can repair is unhelpful. We would also like to be able to reline mains as a planned activity without this counting as a customer interruption to supply.

Only regions that are currently classed as water stressed by the Environment Agency are able to introduce compulsory water metering. We would like all water companies to have the option to introduce compulsory metering as this would give us much better network visibility and data about usage patterns which will help us manage our network better.

Measuring and reporting

The following metrics are reported on our website quarterly and on the Discover Water website annually (which also shows comparative performance against other water companies). Our industry wide common performance commitments that relate to network resilience include interruptions to customer's supply, leakage and asset health metrics. We also have two Yorkshire Water specific performance commitments which are described below.

Industry-wide Performance Commitments

Water supply interruptions of more than three hours – this measures the number of minutes that supply is lost per property, per year, averaged across the region. Our target is to reduce this from seven to five minutes by 2025.

Leakage – the target for all English water companies is to reduce leakage by 15% by 2025 compared to a 2019/2020 baseline.

Mains repairs – this is reported as number of repairs per 1,000 km of clean water mains. Repairs will always be needed (we carry out about 6,000 mains repairs every year) and reflect the amount of effort we expend finding and fixing leaks as we cannot manage leakage without repairing mains. The target for this metric is to reduce the number of mains repairs per 1,000 km from 186.1 to 178.4 by 2025.

Unplanned outage on clean water infrastructure – this measures the impact of unplanned shut downs of water abstraction or treatment facilities due to asset failure. The metric sums up the volume of water lost and the duration of the outage for each water treatment asset and this is then weighted and normalised using peak week production capacity for each water supply zone to arrive at a single figure for the whole company, reported as percentage of peak week production capacity lost. Our target is to reduce the impact of unplanned outages from 5% of peak week production capacity lost to 2% by 2025.

Number of sewer collapses per 1,000 kilometres of all sewers causing an impact on service to customers or the environment – our target is to reduce this from 18.26 to 15.39 by 2025.

Yorkshire Water bespoke Performance Commitments

Significant water supply events – this is the number of water supply interruptions that last 12 hours or longer. This includes supply interruptions that are planned, unplanned or caused by a third party and applies to all domestic properties including those that are vacant. Our target for 2025 is no more than 12 such events.

Customer pipes fixed – although we are not responsible for the pipes within a customers property boundary, we offer a service where we fix customers pipes for them for free the first time they burst. This metric measures the number of residential supply pipe repairs and renewals we carry out each year. Our target is to increase this from 6,882 to 8,013 per year by 2025. We are currently behind our target on this metric due to the restrictions on working in customer's homes and gardens during COVID-19 but we hope to catch up by the end of 2025.

8. Risks to natural capital

Risks to natural capital

Yorkshire is home to a beautiful and diverse range of habitats and species with two national parks, 22 Special Conservation Areas, 8 Special Protected Areas, two coastal marine conservation zones, 19 bathing beaches, 358 Sites of Special Scientific Interest, and 11 National Nature Reserves. The habitats and species found in our region are nationally and internationally important, for example we have 24% of England's peat bog habitat and the Humber Estuary is an internationally important feeding ground for migratory birds.

Chapter 3 described how we manage our land to ensure it provides the best quality raw water, as well as biodiversity, carbon storage, flood flow attenuation, a livelihood for those who live and work there and a range of other benefits. As well as managing our land for these benefits, we also have a responsibility to ensure our other operational activities such as our wastewater treatment works discharges don't negatively impact on the natural environment. We also have responsibilities under the Wildlife and Countryside Act, Water Framework Directive, Urban Wastewater Treatment Directive and various other pieces of legislation to ensure the natural environment is not just protected from harm, but actively enhanced.

This chapter describes how we model and manage our current and future impact on the environment, some of which specifically considers climate change. We also describe here the other activity we undertake to enhance the environment and improve ecological resilience such as our investment in bathing waters, biodiversity enhancement, fish pass installation, river restoration and invasive species management. We also describe how we are working to further mature and embed Six Capitals accounting into our decision making and cost benefit assessment.

Informing our risk understanding

The Environment Agency have responsibility for ensuring compliance with a range of environmental legislation that protects river and coastal water quality in England. The Environment Agency issue permits for all our clean and wastewater treatment sites which set out the conditions under which we must operate.

This includes strict limits on where, when and how much water can be abstracted from rivers (or groundwaters) and what can be returned as treated effluent, in order to protect the environment. The overarching legislation driving much of this regulatory permitting is the Water Framework Directive (WFD) which does not currently include the impacts of climate change on environmental quality. As the climate changes, it may become harder to meet WFD ambitions for river water quality (for example higher river temperatures affecting levels of oxygen in rivers).

When new regulations are enacted, or as the population grows, or assets reach the end of their life, upgrades to existing works, or new treatment works or processes, are required which may necessitate new or altered permits. To determine the effect of these changes we use a range of different models to understand our impact on the environment, which can then inform the type of treatment process or intervention required. These models are used across the industry and have been developed in collaboration with the Environment Agency. We described these models in our previous report so here we focus on any improvements and especially any specifically related to climate change.

Urban Pollution Models (UPMs) are built to investigate the cause of urban pollution from storm overflows. They focus on the impact of intermittent discharges and incorporate our sewer models, a rainfall model and a water quality model. Our water quality models are often calibrated to observed water quality data sampled from the river or stream under investigation. If the UPM shows that it is our asset causing the pollution then we will work with the Environment Agency to agree a solution. We carry out a sensitivity test to check that our proposed intervention will still be effective given future climate change driven changes in flow conditions. As well as our UPM studies which look at the impact of intermittent discharges, we also carry out investigations into the impact of our continuous discharges (from wastewater treatment works). We include several environmental studies in each business planning period to investigate problems and determine the best solution.

SIMCAT is an Environment Agency model widely used by the water sector for assessing the impact of wastewater treatment works on river water quality. We described this model in our previous report. SIMCAT is one element of wider suite of models called SAGIS which is portrayed in the diagram below. The SAGIS suite of models is used to distinguish where different chemical inputs arise from which is then used to drive investment in appropriate solutions.

Figure 11. The Source Apportionment Geographical Information System (SAGIS).

The water sector is currently engaged in a research project to incorporate climate change into SAGIS, primarily through creating a series of future river flows which incorporate changes to future rainfall derived from UKC18 (high emissions scenario). The outputs from this will need to be carefully assessed before reaching decisions about future investment as the model will not be updated with how climate change could affect diffuse pollution from farmers or flows from mine waters or highways drainage which can all have a significant impact on river water quality.

In our previous report, we discussed our Marine Impact Model which we used to assess our impact on bathing water quality. Bathing water quality is monitored by the Environment Agency during the bathing water season (1st May to 30th September).

They take up to 20 samples at each designated bathing water which are tested for faecal bacteria (E. coli and Intestinal Enterococci). At the end of each bathing water season, a classification is then issued (Excellent, Good, Sufficient or Poor) based on the previous four years data. A wide range of factors which can impact on bathing water quality, and despite significant investment in infrastructure, the bathing water quality at Bridlington South remains 'Sufficient' and at Scarborough South is 'Poor'. To better understand the causes of this, we have worked with the Centre of Research in Environment and Health (CREH) to undertake an intensive sampling regime with one sample taken every 30 minutes, 12 hours a day for 60 days across the bathing water season, resulting in more than 1600 data points.

The results were then compared against a vast number of factors to understand the best explained variance in bathing water quality. This work has fed into the Environment Agency's Pollution Risk Forecasting system which predicts via modelling when there might be short-term impacts on bathing water quality. These models are run daily and if a short-term impact is predicted, the local authority can display signage at the bathing water to warn and inform the public about the potential bathing water quality on that day. If a sign is displayed, then during the bathing water classification calculations, any samples taken on that day can be eligible for discounting from the classification calculations.

This project means that the public are better informed as to when bathing water quality is poor, and it is helping the partners understand the causes and sources of poor water quality which will then inform appropriate interventions. This model is used to assess current and real time bathing water quality rather than projecting forward so it does not include the impacts of future climate change although it will capture current rainfall patterns and how these may be changing.

We also carry out programme of surveys and habitat assessments to inform our risk understanding and mitigation responses such as invasive species surveys, surveys of our woodlands and biodiversity assessments. These are described more on page 95.

How we manage our risk

The findings from our investigations and the outputs from our water quality models are shared with the Environment Agency and together a programme of investment is agreed called the Water Industry Natural Environment Programme (WINEP). This programme of investment covers upgrades or changes to our existing treatment and/or network assets to meet new, tighter regulations or to accommodate population growth and new development. It also includes investment to manage the impact of invasive species, remove barriers to fish passage, and enhance biodiversity.

Six Capitals accounting

Our five yearly business plan must balance the many different requirements from our regulators and customers, including the statutory obligations contained within the WINEP and our WRMP, as well as the need for constant investment in maintenance and repair of our existing asset base, and building new or upgraded assets to meet the needs of a growing population. To ensure we have the best value and most beneficial overall plan, we use a suite of software tools to optimise our business plan. In the past, this was based on straightforward economic cost benefit and customer willingness to pay for specific service improvements.

However, there has long been a recognition that traditional financial cost benefit assessments and accounting practices fail to consider fully consider risks and impacts, particularly those to the natural environment and wider society. For example, traditional accounting practices find it difficult to fully value the benefits from planting trees in reducing flood risk, capturing carbon, increasing biodiversity, or providing green space for exercise and play. Our regulatory framework and the expectations of our stakeholders and customers has also matured, evolving from a requirement to deliver specific outputs such as a numerical change in specific water quality parameters to a more outcomes based approach such as an improvement in overall river ecology.

In light of this, in 2017 we began exploring how we could incorporate a wider range of benefits into our decision making using a Six Capitals Valuation Framework. This framework seeks to capture and monetise a much broader range of costs, impacts and benefits across six different domains, known as "Capitals" as illustrated below:

Figure 12. Yorkshire Water's Six Capitals Accounting Framework.

Six capitals

Financial capital
Our financial health and efficiency

Salaries
Debt
Tax contribution

Manufactured capital
Our pipes, treatment works, offices and IT

The reliability of our infrastructure
Our energy generation

Natural capital
The materials and services we rely on from the environment, especially water

Water consumption
Water quality
Carbon emissions

Human capital
Our workforce's capabilities and wellbeing

Accidents
Diversity
Education and training

Intellectual capital
Our knowledge and processes

The reliability of our operations
Innovations

Social capital
Our relationships and customers' trust in us

Customer feedback
Charitable donations
Education services

Some of these capitals can be monetised using data from academic studies, surveys, assessments of peoples' preferences and various other sources. Others are much harder to quantify, however, we are working with organisations including the Cambridge Institute for Sustainability Leadership (CISL), Accounting for Sustainability (A4S) and the Natural Capital Coalition to inform internationally developing techniques to better quantify natural and social impacts.

The Six Capitals concept is embedded into our new Decision Making Framework (DMF). The DMF is a cross-business process which integrates with many of our management systems and uses live data and cutting-edge analytical tools to improve how we manage our assets and investments, helping increase our customer service, efficiency and resilience. We've used the Six Capitals framework to quantify risk and value, to optimise investment and management decisions about our assets and operations and to help us provide the greatest net benefit to our customers and wider society.

We use our Six Capitals Framework to report our Total Impact and Valuation Assessment (TIVA) on an annual basis. Producing these reports enhances our understanding of our impact on customers and the environment, both positive and negative. The TIVA report seeks to quantify our impact, and where sensible, to put a monetary value on the impact across the six capitals: financial, manufactured, natural, human, intellectual and social. This provides a broader view of the risks to our services, and the value we create for society. It also highlights opportunities to enhance our impact and value, and the trade-offs that need to be considered when making decisions. We use this insight to shape our current approach and future strategy to ensure our services are resilient and we are maximising our potential contribution to society, the economy and the environment. **yorkshirewater.com/about-us/capitals/**

Actions 2015–2020

In our previous report we said we would carry out the following actions:

We said we would develop 13 UPMs and update our models for Holderness and the Humber. We have developed 12 UPMs (removing one in agreement with the Environment Agency). Five of these UPMs showed our assets were having an environmental impact so we are developing solutions for these which will include a sensitivity test to ensure the proposed solution will be effective under future flow conditions. We have also updated our Holderness and Humber models.

We said we would install monitoring at all outfalls that could impact on bathing waters, which we have done, as well as developing a prediction system which is the project described on page 91 with CREH to improve bathing water prediction models at Scarborough and Bridlington.

We said we would extend our innovative real time river quality monitoring project, rtRIVERi, to cover a whole catchment. We have not yet achieved this, however we continue to explore how water quality improvements can best be achieved across a catchment, perhaps through approaches such as catchment nutrient balancing.

We said we would invest £3.8 million in improving fish passage which we have done, as well as a further £10 million on 14 fish passes across the region.

Masborough fish pass, 2019.

Our previous report said we would invest £2 million in managing invasive species. Due to budget cuts, this was reduced to £500,000, however we have invested this wisely in strategic region-wide, collaborative efforts including:

- funding the Yorkshire Invasive Species Forum which has treated 126 km of river for invasive species, trained 131 volunteers in invasive species management, who delivered 1,154 hours of work, and engaged more than 200 landowners.
- sponsoring a biodiversity security knowledge transfer fellow who has delivered biosecurity training and support to many of the major environmental NGOs in the region including National Trust, Yorkshire Wildlife Trust, Yorkshire Dales National Park Authority, Aire Rivers Trust, Natural England and the Environment Agency
- supporting a trial of a biological control agent for Australian stonecrop (an aquatic invasive plant) in partnership with several other water companies and the global invasive species experts CABI[33].

[33] cabi.org/projects/finding-a-biocontrol-agent-for-crassula/

Kayak wash down facility at Thuscross reservoir to prevent the spread of invasive species.

We have also invested in a new wash down facility for kayakers at the popular Washburn Valley, in partnership with British Canoeing. The concrete pad and hose shown in the photo above is used to wash water sports equipment before and after to stop the spread of invasive species from one waterway to another.

Our previous report said we would spend £1 million on biodiversity enhancements. Due to efficiencies, the was reduced to £350,000 so to make the most of this reduced budget, various partnership projects were established which obtained match funding from external sources such as Heritage Lottery Funds. The fund has successfully delivered 14 projects which collectively have achieved:

- Conserved or enhanced 1,690 ha of habitat
- Engaged more than 944 individual volunteers
- Delivered 11,833 hours of volunteer time
- Trained 737 volunteers in otter surveys, safeguarding, herbicide licenses, biosecurity, phase 1 habitat surveys, chainsaw techniques and more.
- Secured an additional £99,100 of match funding from project partners
- Secured an additional £887,000 from external match funding (e.g HLF)
- Leveraged funding at a ratio of 3:1
- Created Six Capitals benefits valued at £2.9million (a ratio of 8:1).

Actions 2020–2025

Our WINEP programme for the next five years is £750 million. This includes £4 million on new modelling and investigations to understand our environmental impacts. We will also invest £598 million on managing our environmental impacts from our wastewater treatment works, £5 million on invasive species, £4.3 million on fish passes, £4.7 million on improving flows in Yorkshire's rivers and £6.3 million on biodiversity enhancements.

We will be undertaking an assessment of our entire landholding over the next five years to understand it's ecological value. This will involve an assessment of existing data (e.g. SSSI condition reports) and a programme of rolling surveys. This knowledge of the condition and types of habitat on our estate will assist our land management aspirations, identify areas for future conservation projects and develop and efficiently target programmes of work to safeguard priority habitats. We will also be using this next five year period to understand how Yorkshire Water can incorporate Biodiversity Net Gain (BNG) into our operations through the production and delivery of a BNG policy. This will involve piloting the Natural England Biodiversity Metric across capital schemes and incorporation of the BNG policy into company governance.

We will invest £240 million on installing Event Duration Monitoring on our outfalls.

We will invest £750,000 managing our existing woodland as well as seeking opportunities to collaborate with other land owners and managers to meet our target to plant 1 million trees by 2030. We are also involved in several projects to map opportunities for landscape scale natural flood risk management interventions (see **Chapter 4**).

Barriers and interdependencies

We strive to enhance and protect the natural capital we have in our stewardship as we are highly reliant on a healthy and resilient natural environment for our core product and operations. One of our most important interdependencies is with how land is used, the way it is managed, what chemicals are used, which crops are grown and so on, as this has a direct influence over both the quality of raw water and the quality of rivers, moorlands and other habitats. We describe some of the barriers in this area in Chapter 3.

As noted above, the Water Framework Directive standards do not currently include the impacts of climate change. These standards are set by a UK technical advisory group. The Urban Wastewater Treatment Directive also does not currently include consideration of climate change. Discussions are ongoing regarding how the Environment Bill will include climate change in setting targets.

Managing risks to the natural environment often requires a partnership approach, working across different landowners, regulatory agencies and delivery partners. We are proud of the relationships and networks we have built across our region to deliver more for nature. We have shown that more can be achieved through leveraging additional funding and delivering a wider range of benefits to our customers and the environment.

We observe that many of our important delivery partners are often local organisations with valuable expertise but limited or short-term funding, such as Rivers or Wildlife Trusts or Catchment Based Partnerships (CaBA). Securing funding to deliver schemes, although competitive, is relatively straightforward, but gaining core funding for staff is more challenging. This limits the ability of these partners to grow and become more resilient.

Recognising this issue as a risk to our partners and to our shared aspirations, we are piloting an approach where we provide direct funding to three of our Catchment Partnerships (the Aire, Don and Calder CaBa). We have created formal partnership agreement and provided the funding, and in return the catchment partners will deliver against a number of outcomes (e.g. volunteer time, community events, kilometres of river improved) with the specific outputs to be determined by the partnerships. The aims of this initiative are to increase resilience both within the catchments and the partnerships themselves. To date, five new staff have been appointed, their key focus being to deliver short/medium term plans, secure more funding and develop a longer-term vision for the catchments.

We view this closer partnership working approach as critical in continuing to improve our environment and to building greater resilience in the face of climate change. We need support from regulators in recognising that co-design and delivery can deliver greater benefits, but also carries more uncertainty and risk. More flexibility in prioritising investment, methods of delivery, longer-term funding and a greater focus on outcomes rather than outputs would be welcome. In this regard the latest WINEP guidance is encouraging.

Monitoring and reporting

All water and sewerage companies in England are regulated and monitored by the Environment Agency who produce an annual assessment of each companies environmental performance across a basket of measures. Each company is given a rating from one to four (one is worst) and includes the following metrics: pollution incidents, discharge permit compliance, percentage of pollution incidents that are self reported, delivery of Water Industry National Environment Programme (WINEP) schemes, and Security of Supply Index (a complex measure of water availability). Reports are available on the Government website.

In addition to the Environmental Performance Assessments, we also have a wide range of other metrics we use to report our impact on the natural environment which are published on our website quarterly and on the Discover Water website annually (which also shows comparative performance against other water companies). The first three metrics below are common across the water industry (and included in the EPA) with the remaining eight bespoke to Yorkshire Water.

Industry-wide Performance Commitments

Number of pollution incidents (severity category 1-3) per 10,000 km of sewer per calendar year – our ambition is to have zero pollution incidents, however constant investment is required to achieve this. Our target is to reduce the number of incidents per 10,000 km of sewer to 19.5 per year by 2025.

Treatment works compliance – the percentage of sites that comply with their discharge permits. Our target is to always strive for 100% compliance. Our performance this year is slightly below target but still within the "green" band for assessment of our overall environmental performance by the Environment Agency.

Delivery of water industry national environment programme requirements – This measure tracks the completion of required schemes in each year, as per the latest WINEP programme published by the Environment Agency.

Yorkshire Water bespoke Performance Commitments

Bathing water quality – number of designated bathing waters which exceed the European Union Bathing Water Directive requirements in the 2020-25 period, as reported by Defra. Our target is to maintain this standard at all 19 designated bathing beaches along the Yorkshire coast throughout the next five years.

Land conserved and enhanced – this is reported as the number of hectares of land we have improved, as a result of formal schemes signed off by our environmental regulators (Environment Agency/Natural England as appropriate). Our target is to conserve or enhance 15,239 km by 2025.

Length of river improved – this is the cumulative length of waterway improved as a consequence of regulatory and legislative requirements. Our target is to improve 741.6 km of river by 2025.

Integrated Catchment Management (ICM) – this performance commitment measures the percentage of our catchments where the 'Natural Capital Operator' approach has been implemented. For each catchment, an independently reviewed Natural Capital Operator management plan will be developed, consulted upon, and agreed with stakeholders including Natural England, the Environment Agency, the relevant Catchment Based Approach (CaBA) partnership, Local Nature Partnership, the Yorkshire Water Biodiversity Advisory Panel; and external regional stakeholders, such as Wildlife and Rivers Trusts. Our target is to achieve this approach on three priority catchments by 2025.

Capital carbon and carbon arising from owned land – reported as the percentage reduction in capital carbon emissions from the delivery of the company's capital investment programme and carbon emissions arising from land the company owns. Our target is to reduce our operational and land based emissions by 23% by 2025.

Biosecurity implementation – number of pathways of invasive species spread, where company biosecurity interventions have reduced the risk of that spread in the 2020-2025 period. Our target is to deliver at least twelve interventions by 2025. This is in addition to our ongoing funding of and engagement with the Yorkshire Invasive Species Forum and other invasive species activity.

Creating value from waste – this is the cumulative additional environmental, social and financial benefit, monetised (£), that the company creates from resources currently under-used or classified as waste in the 2020-25 period. Our target is to create £65million of additional value from waste by 2025.

Quality agricultural products – this is the percentage of overall biosolids sent to land that meets the Biosolids Assurance Scheme (BAS) accreditation. Biosolids are the final product from our sewage treatment process and can be recycled to land providing the material meets this accreditation. Our target is to maintain this at 100% throughout the period.

9. Risks from cascade impacts

Risks from cascade impacts

Cascade impacts generally refers to interaction of multiple hazards or events that combine to produce widespread effects across multiple systems. These events are rare but can have widespread and potentially unforeseen effects, such as the lightning strike which caused a power cut across large parts of southern England in August 2019, which then impacted on the rail network for many days afterwards.

Cascade impacts have also been seen in our region during the 2015 Boxing Day floods when a telephone exchange was flooded which resulted in the loss of emergency telephone services for several hours. The rail line from Immingham Docks was also flooded, jeopardising deliveries of biomass to Drax Power Station, which provides 7% of the UKs electricity. Had this situation endured there was a real risk to the UK's ability to generate power.

Whilst we can never foresee every eventuality, we regularly practice for the impacts of multiple hazards and cascade impacts with local, regional and national Resilience Forums, the emergency services, providers of other infrastructure such as the National Grid and Highways England, as well as organisations such as the Red Cross. We have a well developed and robust emergency planning and response capability and all water companies are category two responders under the Civil Contingencies Act, 2009 (CCA) which is the legislative framework for emergency planning in the UK. The Act defines the statutory obligations of various organisations in preparing for emergencies, including exercises and planning with other agencies. We are audited on these capabilities an annual basis by Defra and were classed as "excellent" in our most recent audit.

This chapter sets out our emergency planning responses (much of which is also covered in Chapter 4 about Flooding), our business continuity plans and how we manage the risk to our services that arise from risks to other sectors, namely our critical supply chain.

Informing and managing our risk

Emergency planning and Business Continuity

We have statutory roles in emergency planning and incident response and are active members of our four Local Resilience Forums (LRFs). These are multi-agency partnerships made of local emergency services, the NHS, local authorities, the Environment Agency and other Category One and Two responders, supported by the military and volunteer organisations. LRFs work to identify potential risks and produce emergency plans to prevent or mitigate the impacts of incidents. Since our previous report we have taken part in more than 80 different exercises with our LRFs covering hazards ranging from widespread floods to North Sea oil spills.

We have our own internal emergency planning and response capabilities and use our Company Incident Management Framework (CIMF) to manage incidents. Our CIMF takes an all hazards approach to managing risks, with prescribed thresholds for escalating between Bronze, Silver and Gold command structures. The lowest level, Bronze, will be led by a Band 3 manager, whereas Gold will comprise mainly of directors and take a strategic view, making key decisions and feeding them into the Silver and Bronze teams when we are dealing with major incidents. Our CIMF was updated in 2019 with improvements to triggers for escalating and de-escalating incidents, a supporting handbook to provide a comprehensive overview for all incident managers and a new system for tracking lessons learnt.

In addition to the above improvements we also keep strategic stockpiles of equipment such as high capacity pumps, demountable flood defences, welfare vehicles, 4x4 vehicles, tankers and water treatment chemicals and have mutual aid agreements with neighbouring water companies to share equipment, staff and other resources as necessary during emergencies.

We have a Regional Control Centre which provides a central point of co-ordination for any incident and which allows us to remotely operate our assets using real time asset performance data. More detail about this is in **Chapter 4**.

In the event of an incident we would implement our business continuity plans. We have continued to mature our approach to business continuity and have aligned ourselves to the Business Continuity Standard ISO22301 and aim to gain certification by 2023. In 2016, we installed the C2 platform which is a Business Continuity Management System which helps automate, track and manage our business continuity processes. The system allows for plan automation, creating, formatting, version controlling and managing key documents such as Business Impact Analysis (BIA) reports. It automatically updates contact lists, has a fully functional incident management notification capability, a mobile app, enables you to measure compliance, do audits and gap analysis, assess the business continuity of your supply chain, generate reports, and is aligned with all the major international best practice and standards.

Our Organisational Resilience policy can be found online here: **yorkshirewater.com/environment/resilience/**

Supply chain risk assessment and management

It is imperative that we are able to maintain drinking water supply or provide an alternative source of water for our customers so we regularly review the risk of disruption to our critical supply chains of power, water treatment chemicals and IT. All our suppliers must complete a risk assessment which includes questions about their business continuity preparations.

Solar panels on the roof of our HQ in Bradford.

Power

Our Engineering Specification requires a risk assessment for each site which examines its ability to continue operating through power outages. The risk assessment looks at the process and context in which the plant operates and considers:

- the potential impact on the customer of a power loss;
- the length of time the impact will take to become apparent; and
- the probability of the impact taking place (based on telemetry data on power failure).

Having considered these parameters, the risk assessment then goes on to determine what mitigation is appropriate to manage the impact. This could comprise of multiple secondary power supplies including:

- process storage on site
- dual power supplies from separate electricity grid supply points
- fixed standby generator
- 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.

For example, a clean water pumping station pumping directly into supply may be fitted with a standby power supply as loss of this asset would have a rapid impact on customers.

On the wastewater side, a sewage pumping station may only be fitted with remote monitoring and a mobile generator connection point as the sewer has enough storage in it to enable a mobile generator to be delivered to site and connected before customers are impacted.

Power disruptions can be classified as either long duration (power outages) or short duration (power interruptions, sometimes known as brown outs). Our power resilience strategy needs to consider both to be effective. For the former, our most critical sites have dual power supply, back up generators and priority reconnection in the event of a power outage. Brown outs, or short-term dips in voltage or frequency of supply are much more common and actually cause us issues more regularly than power cuts. Variations in the voltage and frequency of supply can cause motor starters to trip out or faults on process control systems which may require a manual reset.

We are developing action plans to improve the resilience of our internal electricity infrastructure against the effects of short-term power disturbances in line with the risk assessment process described above.

Although many of our sites have renewables (e.g. Combined Heat and Power, anaerobic digestion, wind or solar), they are often not able to operate in “island mode” which means that in the event of a power cut, we would still be reliant on our back up generators and re-connection to the grid, and in any case, the renewables on site do not generally provide sufficient energy to power the whole plant.

Chemicals

The UK water sector has mutual aid agreements in place with water treatment chemical suppliers who will maintain a certain amount of stock that is specifically allocated for the water sector. This programme ensures that strategic suppliers keep sufficient stocks of finished products and/or raw materials and any potential supply issues are identified and escalated early. In addition to these arrangements, we also regularly take part in exercises to test the impact of different hazards on our ability as a sector to maintain sufficient supplies of key chemicals. Recent exercises related to chemicals supply include UK wide preparations for Brexit and COVID-19.

IT/Comms

Yorkshire Water use SCADA (Supervisory Control and Data Acquisition) alongside associated telemetry and IT systems/telecoms to provide visibility of our assets and the ability to remotely operate our asset base from our Regional Control Centre. Security is a key focus, and we work closely with the National Cyber Security Centre (NCSC) and Centre for the Protection of National Infrastructure (CPNI) to ensure our services remain secure. We manage our holistic security risks using national standards such as the 'Security of Network and Information Systems' (NIS) and 'Protective Security Guidance' (PSG). During an incident, as a Category Two responder, Yorkshire Water would have access to satellite and emergency transportable telecoms hubs. We regularly test our back up systems and carry out frequent exercises to plan and prepare for the loss of key IT or communications systems due to any cause.

Actions 2015–2020

In our previous report we said we would carry out the following actions:

Our previous report was structured slightly differently and the section about cascade failures was included in our asset resilience chapter and did not include any actions specifically relating to cascade impacts or supply chain resilience and so no update is available. Please see Chapter 4 for details of the investment we have made in our emergency planning and response capacities.

Actions 2020–2025

We plan to invest around £120,000 per year in maintaining our business continuity capabilities.

We will continue to maintain our emergency planning and response capabilities, keeping our strategic equipment in good condition and regularly practicing deploying it.

We will continue to play an active part in local, regional and national emergency planning exercises, including our own internal planning and preparation.

Barriers and interdependencies

This report contains several examples of cascade impacts which we have successfully managed through such as heavy rains causing floods and the subsequent impacts on our own assets and operations, and on others.

Climate change means these events will become more frequent and more severe. Whilst it is good business sense for every company to have business continuity plans in place and to assess and make preparations for reasonably foreseen risks, it is not necessary or cost effective for each organisation to be fully resilient to all known shocks and stresses.

Water customers can only reasonably be expected to pay for the resilience of their water and sanitation services. They should not be expected to pay for the resilience of other sectors such as power or communications, and so there is a limit as to how much an individual water company can do to manage the risk of cascade impacts.

We therefore welcome the very recent announcement that the Cabinet Office will develop an overarching resilience strategy for the UK. No part of the system is resilient until it all is, so we need every sector and every community to step up to the resilience and climate change challenge, supported by stable, long-term policy, adequate funding and robust accountability.

We also echo and fully support the Committee on Climate Changes' calls for much more coherent policy regarding climate change, embedding adaptation and Net Zero ambitions across all government departments strategies and policies. We also fully support the National Infrastructure Commission's recommendations that Government set national resilience standards and for resilience to be properly valued in regulatory decision making.

We also note that affordability and lack of capacity are often cited by organisations as barriers to further adaptation, and we need every organisation to be resilient to avoid cascade failures. The need to invest to achieve long-term resilience was the reason four water companies, including Yorkshire Water, did not accept their final determination from the 2019 Price Review and asked for a redetermination by the Competition and Markets Authority and we maintain that additional funding will be required to manage the impacts of climate change.

Metrics and reporting

We don't have any metrics related to cascade impacts. We have both internal and external audits of our emergency planning capabilities and business planning maturity, however these are business sensitive and not available to the public. Our Organisational Resilience policy is however available on our website here: **yorkshirewater.com/environment/resilience/**

10. Closing comments

Closing comments

Adaptation to climate change is an ongoing process that must occur across all our interconnected built, societal, economic and natural systems, so there is always more to do, more to learn and more to collaborate on. We are proud of the progress we have made in the last five years. We trust this report brings confidence that climate change risks are well embedded in our long-term planning and that we are constantly working to improve our understanding and response to these risks.

We have better modelling of existing risks and more knowledge of emerging risks. We have made significant investment in a portfolio of adaptation actions from local flood defences to landscape scale habitat restoration, and we have collaborated with a wide range of partners. We have also provided detailed descriptions of how we have successfully managed services through droughts, floods, storm surges and coastal erosion.

As we note in several places throughout this report, much of our activity is directed by either the Environment Agency or the Drinking Water Inspectorate, and the prices we can charge for our services are capped by Ofwat, which means we have less discretion and flexibility than might be imagined in how we operate. Therefore, it is vital that the regulatory regime in which we operate supports and encourages adaptation at pace and at scale. We are glad to support the new requirement for long-term drainage planning, cross-regional water resource planning, and improvements to funding arrangements for shared flood risk projects.

We echo and fully support the Committee on Climate Change's calls for more coherent policy regarding climate change, embedding adaptation and Net Zero ambitions across all government department's strategies and policies. We also fully support the National Infrastructure Commission's recommendations that Government set national resilience standards and for resilience to be properly valued in regulatory decision making.

We recognise that we cannot meet the challenges of a changing climate on our own and are building on the strong foundations and relationships we have to drive more action, for example through our strategic partnerships and also by setting an example as an anchor institution for the region. We have recently announced our strategy to meet Net Zero by 2030 and our CEO Liz Barber is chair of the newly formed Yorkshire and Humber Climate Commission which is developing a region wide action plan for both climate resilience and net zero.

We also want to make sure that our customers are part of our adaptation journey. COVID-19 has changed many people's world. More people are enjoying the countryside than ever before and accessible green space has never felt so important. We need to make sure we stay abreast of changing public expectations around how our rivers and land should be managed, for example the rise in wild swimming, and the increasing role of nature based solutions such as SuDS and NFM. There is also a crucial role for customers in helping us manage the climate risks we all face.

Customers are largely unaware of their climate risks, the role they can play in helping to manage them, or the impact of their own behaviour on the long-term sustainability of water and sanitation services. In light of this, we would support the creation of a Citizens Assembly for Adaptation, much like the one held for the UK's net zero carbon aspirations, which could inform a coherent set of adaptation policies and targets.

We also note that affordability and lack of capacity are often cited by organisations as barriers to further adaptation, and we need every organisation to be resilient to avoid cascade failures. The need to invest to achieve long-term resilience was the reason four water companies, including Yorkshire Water, did not accept their final determination from the 2019 Price Review and asked for a redetermination by the Competition and Markets Authority and we maintain that additional funding will be required to manage the impacts of climate change.

We call on Government to be bold and ambitious and to act soon on the recommendations from the most recent national Climate Change Risk Assessment in developing the next National Adaptation Plan and look forward to playing our part in adapting our region and our nation to a changing climate.

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