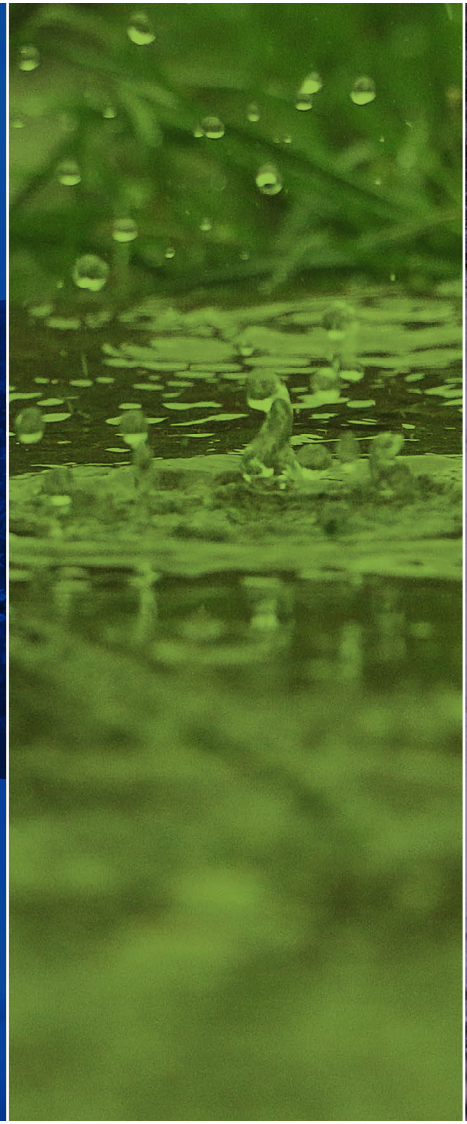
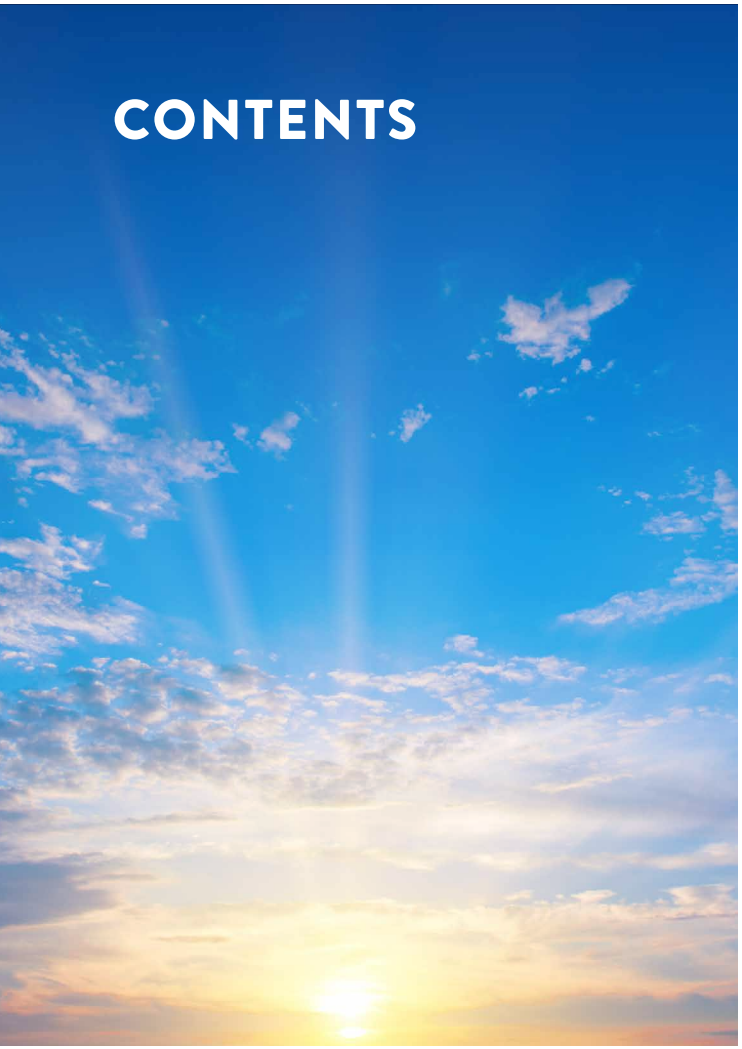
SCOTTISH WATER CLIMATE CHANGE ADAPTATION PLAN 2024



Scottish Water
Trusted to serve Scotland



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CEO INTRODUCTION: ALEX PLANT

Over the past decade we have been responding to the climate challenge, assessing the risks this presents us, and building resilience to climate change into our business and investment plans for key priorities such as flood alleviation and water resources.

But the climate threat is accelerating – we are seeing more extreme events globally and locally. This means we must go further and faster in adapting the assets that serve Scotland to ensure they remain reliable, resilient and sustainable for customers now and in the years ahead. This includes working with others to ensure the services we rely on – power, transport, telecommunications and supply chains – are also resilient.

The UK Climate Change Committee guidance suggests we plan for 2 degrees and prepare for 4 degrees of warming this century. This is why we have extended our risk assessment to inform this Climate Change Adaptation Plan. Our plan sets out the risks that we must address, the impacts that they have on our services and how we are going to respond.

Climate change is the biggest risk to society's future. As a global community we must significantly reduce the greenhouse gas emissions which drive global warming. We are playing our part, transforming our services to deliver net zero emissions by 2040. This is outlined in our **zero emissions routemap**.

The world has already warmed by more than 1 degree over the past century. As a result, we can expect drier and warmer summers, wetter winters and an increasing number of storms that will impact our water and waste water services.

The dry spell in Scotland in 2023 saw significant increases in water use which put pressure on our water treatment plants, networks and employees as they worked hard to maintain service. We are also regularly seeing significant rainfall events which cause customer flooding and the risk of environmental pollution, and severe storms which can cause severe damage to our assets and those of our infrastructure partners.

These events align with our understanding of how climate change will impact us, and our latest climate change risk assessment is showing that in the coming decades the scale of the negative impacts of such events on the services we provide to customers is going to increase significantly – unless we adapt.

> **"We must go further and faster in adapting the assets that serve Scotland."**

Our assets were simply not designed to cope with the more extreme weather conditions we now face on a regular basis. They are also ageing and will deteriorate more quickly with climate change. This makes our objectives to improve drinking water quality, ensure a secure water supply and improve our environmental performance even more challenging. We need to address these issues and build climate change adaptation into our forward plans if we are to ensure that we deliver a reliable, resilient and sustainable future service for our customers and for society as a whole.

Transition of this scale of course comes at a cost. Adapting the assets that serve Scotland to be resilient to more challenging climate futures creates the need for new investment of £2-5 billion over the next 25 years, which underlines the importance of maintaining a stable funding and investment trajectory over the short and medium term. Only in this way can we provide a viable platform for the significant adaptation investment that is projected to be required in the longer term, and ensure that we are spreading the burden fairly between current and future generations.

Climate change adaptation is not something we can choose to do; it is something we must do. This plan sets out the steps that Scottish Water will take by itself, but also, critically, what we must do in partnership with others, including our customers, if we are to effectively and efficiently ensure the reliability, resilience and sustainability of our public water and waste water services for customers now and in the years ahead.

Alex Plant,
Chief Executive

> **“Climate change adaptation is not something we can choose to do; it is something we must do.”**

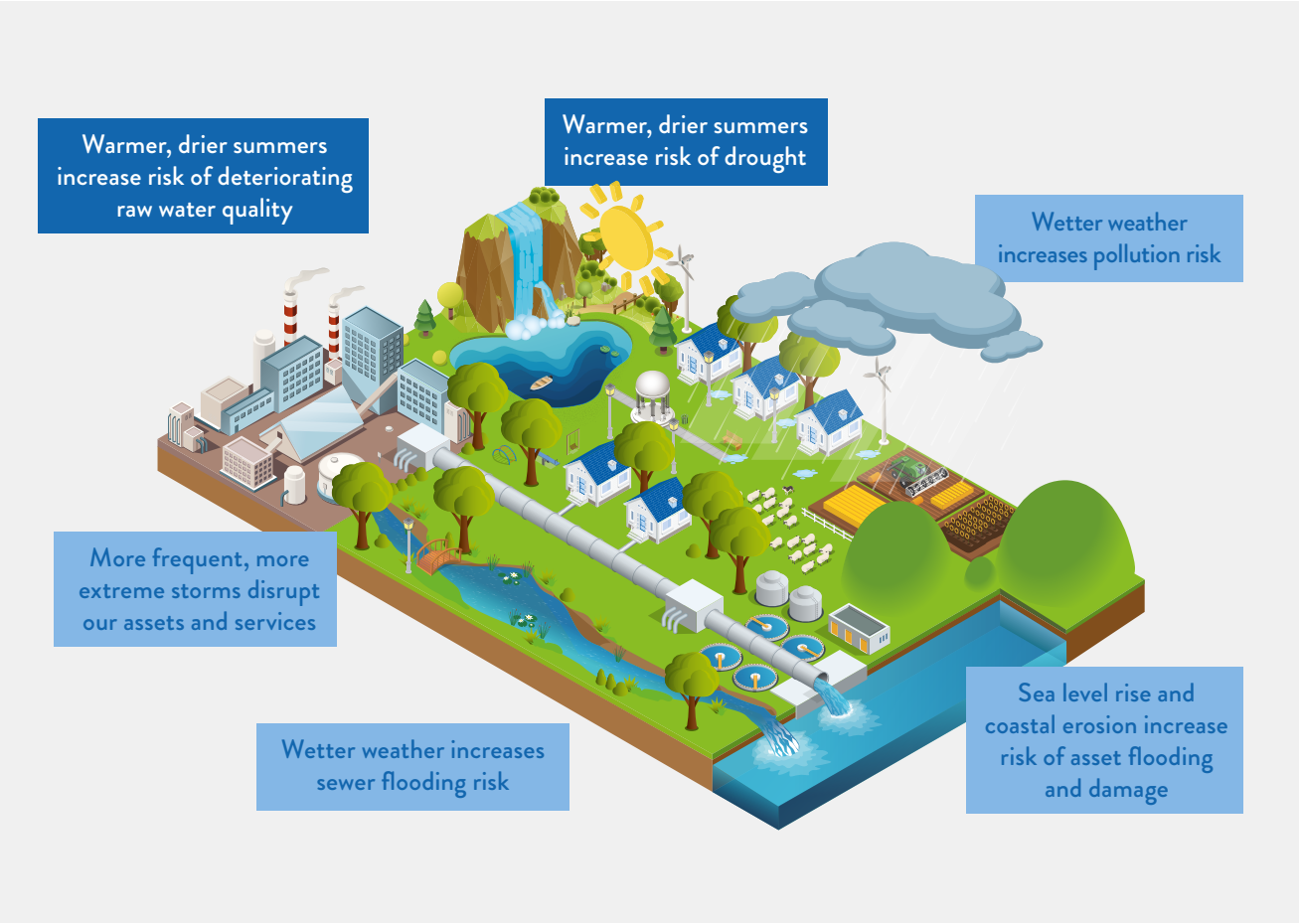
IMPACT ON SERVICES

HOW THE CLIMATE IMPACTS OUR SERVICES

As a water business we rely on the climate and the natural environment for the resources we need to provide our services. Rain is captured in our reservoirs, treated and distributed to customers across Scotland, and we collect society's waste waters for treatment and safe return to the environment.

Changes to our climate means that warmer, drier summers and extreme rainfall events will become more frequent here in Scotland if the global community does not make progress in reducing emissions. Without change, we will have to address the challenges of at times having **too little water** and other times **too much water.**

The lifespan of our assets is measured in decades – and in some cases centuries. This means we must understand how the climate might change up to the end of the century, and plan for it now so that our assets can be resilient in the future. This is even more important for the environment, landscapes and water bodies on which we depend for our water and waste water services.



EVIDENCE BASE
HOW IS SCOTLAND'S CLIMATE CHANGING?

Progress in Climate Science

Scottish Water undertook its first climate risk assessment as it prepared for the 2010-2015 investment period[1]. Using the "medium emissions pathway" we then looked at the impact of climate change across our services and assets. This information was used to set out investment approaches to improve rainfall, water quality and river flow monitoring and to integrate these projections into our water resource modelling.

Scientific understanding on the impact of climate change is constantly improving as evidence becomes available and climate change models are adopted. To inform this plan Scottish Water has further updated and extended its climate change risk assessment to consider both the latest projections of climate change and to look out to the 2080s. We will need to repeat this risk assessment every few years to reflect the changing climate and improvements in climate science and projections.

This will help us to understand and identify short, medium and long-term risks and responses, and enable adaptation choices to be made.

Today, our approach is to plan for 2 degrees warming in the medium-term to 2050 but prepare for 4 degrees of warming by the 2080s. This is in line with the UK Climate Change Committee's recommendations[2]. We will keep this approach under review should the evidence change. For this plan, we have chosen the 'high emissions scenario' within the UK Climate Impact Programme 2018 projections (Relative Concentration Pathway 6 (RCP6)) to represent the 2 degree world and RCP8.5 to represent the 4 degree world.

[1] Project Record: UK Climate Projections 2009 (UKCP09) (ceda.ac.uk)
[2] Climate Change Committee Insights Briefing 6: Undertaking a Climate Risk Assessment, 2021

EVIDENCE BASE
WHAT IS THE RISK ASSESSMENT TELLING US?

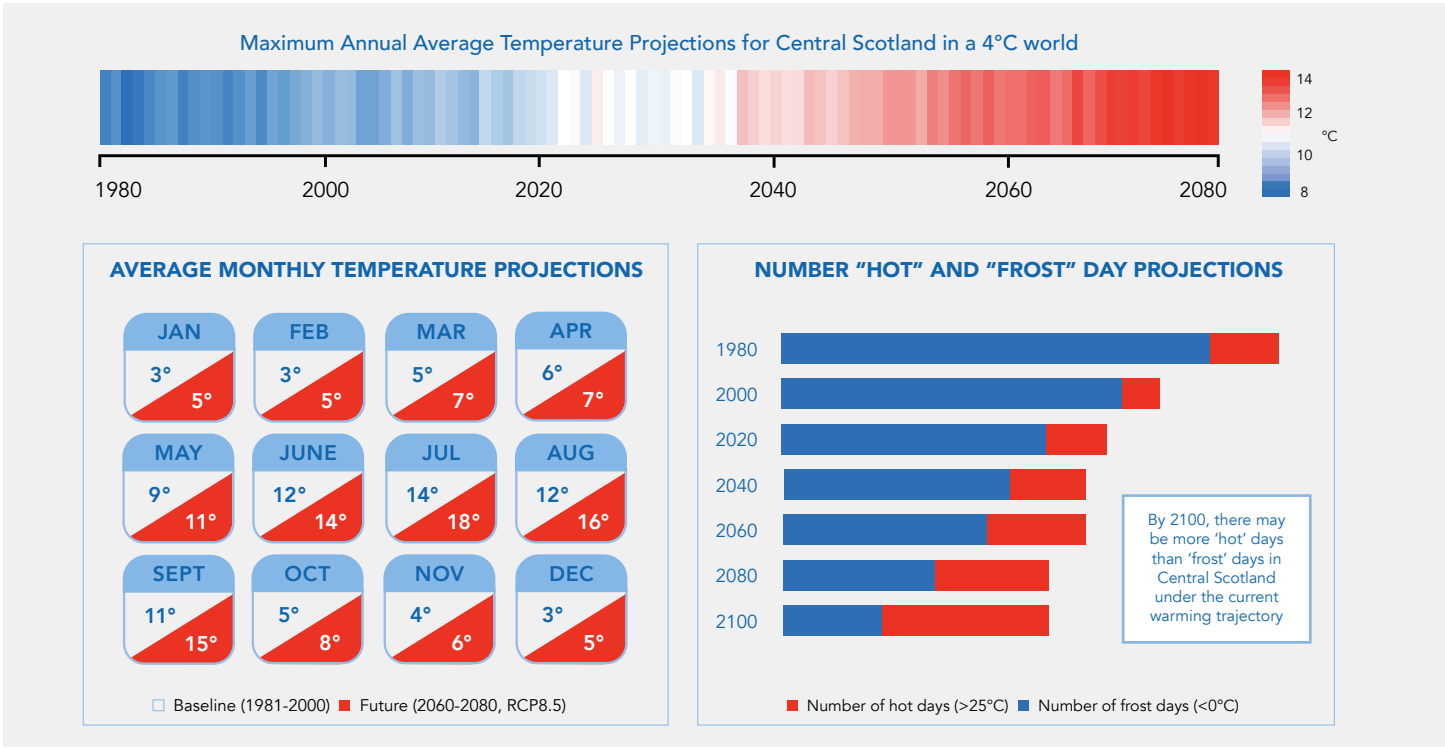
Temperature

Scotland's temperatures have been getting warmer and will continue to do so, with the upper end of the forecast range showing a significant rise under the 4 degree pathway.

We are forecast to see increases in temperature throughout the year, with winters forecast to be around 2-3 degrees warmer and average peak summer temperatures up to 4 degrees warmer.

In addition to changes in average conditions the number of "hot days" (>25 degrees C) will increase significantly in the summer months. At the same time there will be fewer cold days in winter and a significant reduction in "frost" days (when the temperature is at or below 0 degrees C). There may be less snowfall which will have an impact on water resource availability.

During 2100 the number of days considered "hot" could exceed the number of "frost" days each year.



Rainfall

Scotland's winters will be wetter, with both more rainy days and intense rainfall events. Summers will be drier; however, summer storms will be more intense leading to a high risk of flooding. There will be a greater risk of storms throughout the year which will impact our services: UK climate projections indicate there may be an increase in the intensity of rainfall events in winter, with a smaller increase in summer.

Lower summer rainfall means there will be a greater chance of drought, which will impact reservoir levels which can impact on customer service.

This graphic shows the impact that climate change is already having on the summer storage level at one of our major reservoirs. Storage levels in late summer have fallen in recent years compared with the average storage levels between 2010 and 2017.

AVERAGE MONTHLY PRECIPITATION PROJECTIONS

PROJECTED DECREASE IN SUMMER RAINFALL
23% DECREASE IN JULY AND AUGUST

PROJECTED INCREASE IN WINTER RAINFALL
23% IN NOVEMBER
14% IN DECEMBER

GLENDEVON RESERVOIR STORAGE

Storage levels in late summer have fallen in recent years compared with the average storage levels between 2010 and 2017.

Sea Level

Sea levels will rise, impacting our coastal assets across the country.

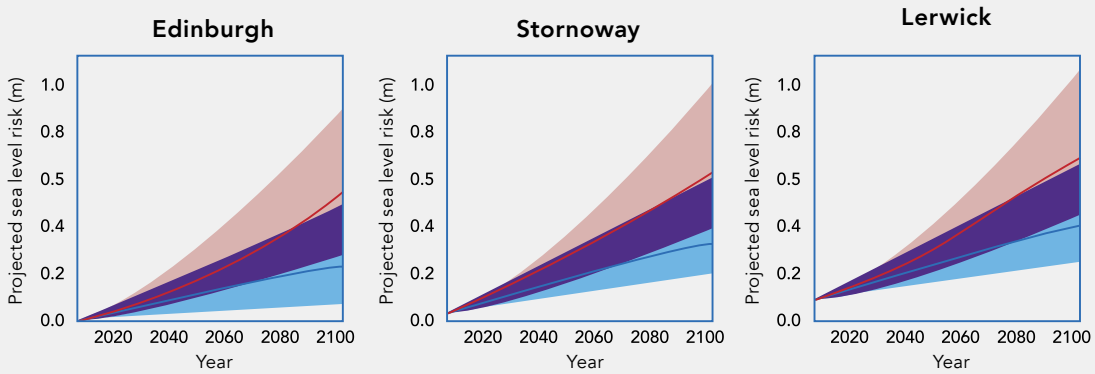
The image below, derived from Scotland's Dynamic Coast project shows the potential impact from sea level rise and coastal erosion at Kirkcaldy waste water treatment works by 2100[3].

Coastal erosion risk projected for Kirkcaldy waste water works by 2100 (without adaptation)

[3] Dynamic Coast - Webmaps

Sea level rise and coastal erosion

Range of sea level rise projections for Scotland to 2100



Sea level is predicted to increase by 0.4m by 2100, but could be as much as 1m depending on how much the climate changes. The increase will vary across the country and put our coastal assets and services at risk.

For more information visit: **Adaptation Scotland climate projections**

CLIMATE CHANGE RISKS

Scottish Water has a mature risk management process in place that is applied across the business. This identifies risks and the mitigating actions that need to be carried out to manage them. These are reviewed within the business and by the Scottish Water Board. Risks are ranked by likelihood and consequence, with each being scored on a scale of 1 to 5, giving a maximum risk score of 500.

Climate change adaptation is a category that has been built into the risk management process.

Through the climate change risk assessment, we identified and assessed 122 risks to explore and through a series of workshops these were consolidated to 27 key risks.

We have identified the following key climate change risks that we need to address:

- Warmer, drier summers that can lead to drought and deteriorating raw water quality
- Wetter winters that cause flooding
- Variable rainfall patterns that impact environmental performance
- More frequent storms that disrupt our assets and services
- Sea level rise and coastal erosion that floods or damages our assets.

The Risk Assessment Appendix sets out the 27 key risks addressed in this plan.

From the climate change risk assessment, we now have updated information on these risks out to 2050 and 2080. There is greater certainty of the impacts of these risks to 2050 and in this document we will refer to the information we have on risks to 2050 and use them as the basis for our long-term investment planning, in line with the UK Climate Change Committee's recommendations of plan for 2 degrees but prepare for 4 degrees.

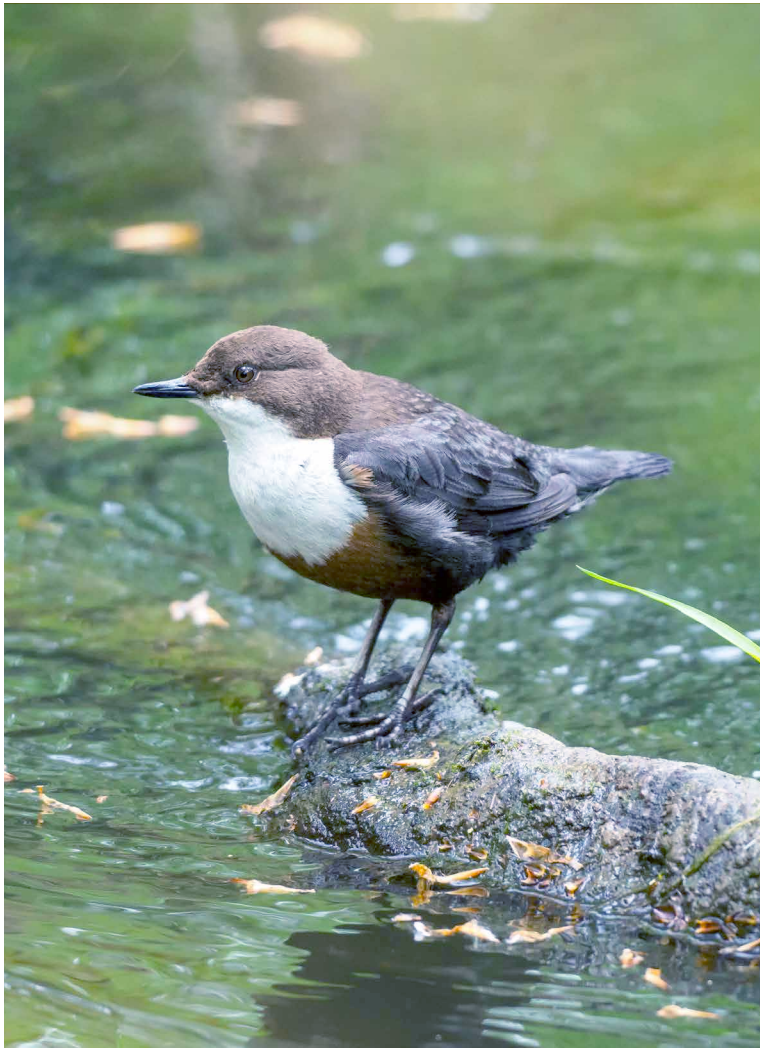
Scottish Water needs to consider these risks in terms of:

- **Our Environment** – the availability and quality of the water on which we depend, the landscapes in which we have assets and the flows of storm water in the natural and built environments
- **Our Assets** – their performance and reliability under both long-term changes and in more extreme conditions
- **Our Customers and Communities** – the future water demand we will have to meet and how we will need to work with customers, communities and stakeholders to support sustainable water use
- **Our People** – who operate at the frontline of climate change. We must ensure they are equipped with the skills and capabilities to address the impacts of climate change on their roles, and be able to carry out their roles safely
- **Our Suppliers and Interdependencies** – we rely on a global supply chain and need to understand what the impacts of climate change globally will have on materials availability.

Climate change can be felt through changes in annual average conditions – seasons being generally drier or wetter – this can increase stress on our assets and water resources leading to a risk of service deterioration over time.

It will also impact the frequency and severity of extreme weather events – storms, droughts and floods will be more intense and can directly lead to increased risk of service disruption.

To ensure that we can continue to deliver a reliable, resilient and sustainable service to customers we need to adapt to address these impacts.



OUR COMMITMENT

We are committed to addressing the climate change challenge – we will do this by mitigating and by achieving net zero emissions and adapting to deliver a reliable, resilient and sustainable service for Scotland.

To adapt our services to climate change, we will:

- Understand the climate change risks we will need to focus on
- Assess the impact on our assets, services and people
- Identify when and how we need to deliver adaptation to climate change
- Work with our customers to help them understand the changes they can make that will help us to cope with increasing risks from climate change
- Invest to deliver efficient, effective adaptation through our long-term strategic planning
- Work in partnership to deliver adaptation.

We have updated our climate change risk assessment to consider the latest projections for climate change looking ahead to the 2080s. We will repeat this exercise every few years to reflect the changing environment. This will help understand short, medium and long-term risks and responses, and enable strategic adaptation choices to be identified.

We will consider our service risks in two ways. Firstly the strategic, long-term adaptations we might make from water sources to customers' taps – our water systems and from customer's sinks to the sea – our waste water systems. Secondly, we will also look at the specific risks for any individual asset or project we are developing.

We must understand the impact of these risks on all our assets and services to ensure we can deliver a reliable, resilient and sustainable service in future. We will explore the impacts of these risks on all our 229 water and 1,838 waste water systems, looking from our upland catchments all the way to our waste water discharges. This will be a key element of our System Planning process[4].

[4] System planning is a dynamic process which sets out how Scottish Water will operate, maintain and develop their water and waste water system over time taking account of ageing assets, impact of a changing climate, service level expectations and changes in demand for water or waste water disposal.

We will understand the timeline for when we will need to adapt each system and the potential costs of adaptation so we can forecast future investment.

We are planning to deliver adaptation to climate change to allow us to continue to deliver the same level of service to future customers as we do today. We will be exploring with our stakeholders through our Strategic Review process different service levels we might deliver in future.

To deliver adaptation to climate change Scottish Water must work with others to secure the most effective and efficient outcomes:

- We must work in partnership with landowners, farmers, industry and other organisations to support healthy, resilient natural landscapes to safeguard precious water resources
- We must work with customers and communities to change our relationship with water – both how we value and manage water – to reduce the water we take from the environment as there will be less water available
- We must work with local authorities, roads authorities and developers to reshape our urban landscape to deal with extreme rainfall and develop blue-green infrastructure. This will make our cities more resilient places in a climate changed world.

Our Adaptation Plan sets out how we will understand the risks that climate change has to our services and build the capacity of our services to deal with climate change, and to engage and work in partnership with others to deliver effective and efficient climate change adaptation. It does not address the investment required to deliver climate change adaptation – this will be addressed through our strategic planning process with stakeholders.

DROUGHT

03. Drought – Too little water 15

DROUGHT
TOO LITTLE WATER

In Scotland, we rely on a good quality, plentiful water supply. Our water resources have historically been managed on the basis that Scotland enjoys frequent rainfall, particularly in winter, that can regularly recharge our lochs and reservoirs and swell rivers.

Climate projections show there will be changes to rainfall patterns, with extended periods with less or no rain in future. Coupled with higher temperatures and the greater demands we see in warmer weather, the water resources on which we rely will be under greater pressure than they are today.

Lack of rain will increase drying of the land. This can lead to more ground movements resulting in increased burst pipes and greater risk of leakage in our network.

At the same time there may be new demands on Scotland's water – from changes in land use and from exciting new industries such as hydrogen production.

Unless we take steps to adapt and work with others to responsibly manage Scotland's water resources, and focus development where supplies are plentiful, protect vulnerable sources we may face more situations where our ability to supply customers will be affected.

WHERE ARE WE TODAY?

On average Scottish Water abstracts, treats and supplies 1,800 million litres (Ml) of water per day, of which up to 1,000Ml is for domestic customers. On a hot summer day we see demand go over 2,000 million litres per day and our water systems struggle to meet this increase in demand. Domestic consumption per person is among the highest in the UK: for instance, the English average is 146 litres per day, while the typical customer in Scotland uses around 180 litres per day.

We abstract from over 420 water sources with a mix of reservoirs, lochs, rivers, boreholes and springs. Most people in Scotland get their water from reservoirs which store water during wet weather. Some of these are large such as Loch Katrine that supplies Glasgow, but others are smaller which are more susceptible to changes in rainfall patterns.

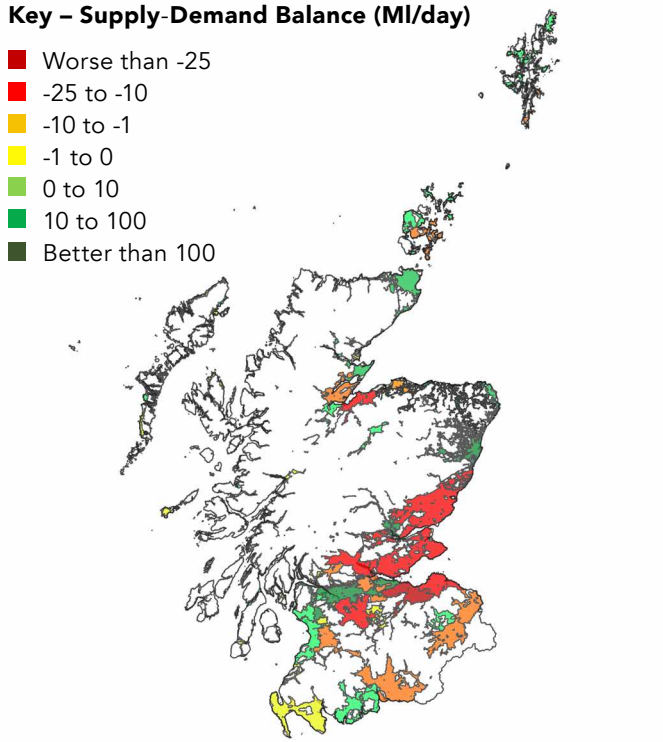
Cities like Aberdeen and Perth get their water from rivers like the Dee and Tay. Relatively few people get their water from boreholes.

> **We use over 420 sources with a mix of reservoirs, lochs, rivers, boreholes and springs.**

We have assessed the impact of climate change on Scotland's water resources. This forms part of our Water Resource Plans. In 2050 Scotland will be in a worse position than today for water resource, and as a result we will have to take action to maintain service levels.

The availability of water supplies is measured as the balance between the available water for supply and the demand from customers: the "Supply-Demand Balance". Today, nationally we have a deficit of 60Ml/day in drought conditions. This means we already have to take drought plan actions across our network to maintain supplies, by reducing compensation flows, abstracting from additional sources, changing network configuration or using tankers to augment supplies. By 2050 if we don't deliver adaptation this will increase to around 240Ml/day nationally during extended periods of low rainfall.

We forecast up to 100Ml/day deficit in Supply-Demand Balance in Edinburgh, Lothians, Dundee and Fife, whilst some areas in the North and West are projected to increase the amount of water available.



A 2050 future without adaptation. Outcomes:

- A national deficit of 240 Ml/d, compared to 60 Ml/d today during drought conditions
- Of this, increase 100 Ml/day, will be key population centres (Edinburgh, Lothian, Dundee, and Fife) – c. 1.6 million customers by 2050.

For populations under 10,000 people, we can often deploy operational responses to ensure that water is available for customers. That is not practical for larger populations – which is why we must adapt our assets and manage demand on our system. Addressing leakage and consumption levels will help us address some of the forecast 240Ml/day deficit.

We also expect that ground movements as the ground dries out in extended warm periods are forecast to cause an additional 5,000 bursts across our water network by 2050. As well as impacting water resource availability, the larger of these forecast additional bursts will lead to over 2,000 unplanned interruption events to customers' supply by 2050.

The risk assessment allows us to identify the impact on each of our 229 water systems[5] and what we will need to do to adapt them. This will range from working with customers to reduce consumption, addressing leakage, investing in infrastructure such as increasing connectivity, increasing the capacity of existing reservoirs, accessing new sources and replacing old pipework. We will also be reviewing our drought resilience plans using recorded historic drought events and future climate projections that will increase this risk. This will help us to maintain services to customers as the risk of droughts increases as a result of climate change.

Beyond 2050, if the world continues on a 4 degree warming pathway then more action will be needed. We will update our modelling assessments every few years, building in new evidence to ensure we take a long-term strategic approach to adaptation to the 2080s.

Improving Resilience

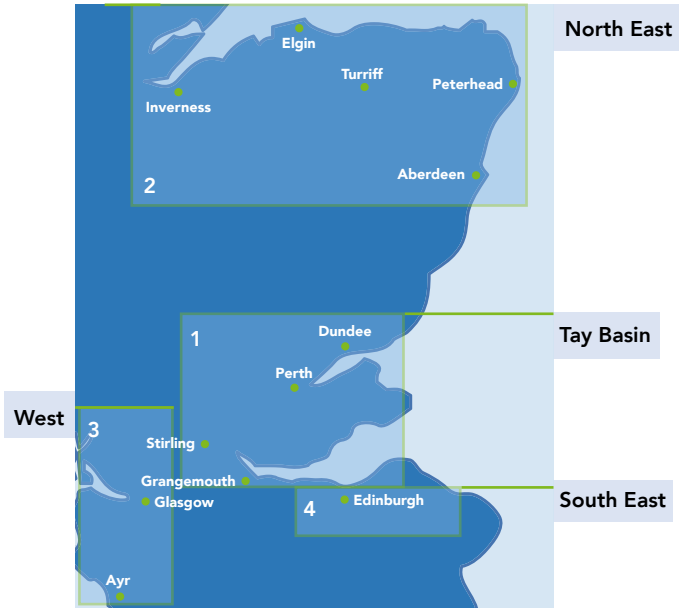
Unlike electricity, there is not a national grid for water distribution. Currently around 30% of customers can be supplied from more than one water source. Improving the connectivity of our systems will increase flexibility to move water around and improve resilience in times of drought, helping to address the 240Ml/day deficit. and we are developing plans to increase connectivity between regions to address this problem. Whilst addressing consumption has a part to play, to address the 100Ml/day challenge in the Edinburgh, Fife and Dundee areas would need consumption to reduce from 180l to 115l per person per day, a sustained 36% reduction.

We have already delivered investment to improve connectivity in Ayrshire and Edinburgh and further such resilience schemes will be considered as part of adaptation and service resilience planning.

[5] We have 229 water systems and over 420 water abstraction points. Some systems are linked to a single abstraction point eg a large reservoir, others are linked to multiple.

> **"Beyond 2050, if the world continues on a 4 degree warming pathway then more action will be needed."**

Areas of the country where we are developing plans to improve resilience of water supply



WHAT HAVE WE DONE SO FAR?

We have reduced leakage by 58% over the last 15 years, and we recalculate and set new leakage goals each year to support effective management of water resources.

We have improved our operational responses to drought events.

We have invested in system connectivity, providing increased resilience to over 100,000 properties.

We have run multiple campaigns with customers to press home the message that water is always worth saving.

We have trialled smart meters with our non-domestic customers to help them manage their consumption.

We have updated our water resource plans and drought plans to reflect climate change projections.

We have installed a further 52 rainfall gauges across key catchments to better monitor and understand water resources.

CASE STUDIES

Click on the case studies below to read more:

WATER IS ALWAYS WORTH SAVING

RESILIENCE

GLASGOW/AYRSHIRE RESILIENCE SCHEME

Reducing Leakage

Having abstracted water from the environment it is critical we do not waste it. Scottish Water operates one of the largest and most distributed water networks in the UK with over 49,000km of pipelines across the country, much of which has been in place for decades.

Over the past 15 years we have more than halved leakage from our networks to the point where it would cost us more to fix leaks than it saves in lost water. But this is not the point. The main driver in the coming years will be to protect the security of water resources and minimise what we need to take from the environment.

If we did nothing leakage would rise as pipes age, the ground moves and connections fail. Despite this we still lose 454 Ml/day from our systems.

Each year we assess the performance of the networks, the supply-demand balance risks and target where we need to do more. We are using digital and analytical techniques to identify leaks more quickly – one of our challenges is locating leaks in rural networks – and once targeted to reduce the time it takes to repair. Improved pressure management control in our networks is helping to reduce leaks and bursts.

We are also targeting leakage between our network and the customer tap the supply pipes in properties. Recent research is indicating that up to a third of all leakage may be between our pipes and customers properties. Identifying these leaks is more difficult, but we will invest to repair the customer's pipes where it is the right thing to do to protect resources.

Climate change will make managing leakage more difficult. We will need to target more leakage control in areas where the water resources may be more at risk from climate change.

WHAT WE PLAN TO DO

Climate change will present major challenges to Scotland's water resources and their ability to sustain the environmental, ecological and amenity value of our landscapes – as well as to meet society's demands for water for consumption, agriculture and industry.

To adapt to the risk of increased drought conditions presented by climate change and to maintain current service to customers and to address the projected 240Ml/day deficit:

We will work with other water users to plan water resources at catchment scale

We will reduce demand by reducing leakage and consumption

We will improve operational and asset capability to respond to more frequent drought events

We will increase the resilience of water supplies by developing further plans to reduce the number of customers fed from a single water source

Adapting to climate change is an ongoing activity across the century. This table illustrates the key actions we plan to take out to 2050 to deliver adaptation.

Engage Scottish Government, SEPA and key stakeholders to support the development and implementation of National and Regional Water Resource Planning	1.	To develop the methodology for National and Regional Water Resource Planning.	2024-2030
	2.	To produce the drinking water inputs needed for National and Regional Water Resource Planning.	2024-2030
Continue to monitor and reduce leakage from the Scottish Water network	1.	Prioritise network management and leakage reduction to support water resource and environmental resilience (raw and treated water).	Ongoing
	2.	Work with customers to reduce leakage in their pipes.	Ongoing
Engage customers to reduce demand over time	1.	Engage customers in understanding the value of water to change behaviours on water consumption.	Ongoing
	2.	Pilot smart domestic water meters to build intelligence on water use.	2024-2028
	3.	Continue to work with Building Standards and Planning Authorities to ensure homes and developments are as water efficient as possible.	Ongoing
Improve our drought response activity	1.	Ongoing review of our operational resilience plans for drought ensuring that we build in learning from events.	Ongoing
	2.	Build drought response into our water system plans.	2024-2030
Improve resilience of water supplies	1.	Complete delivery of Edinburgh and Ayrshire resilience schemes.	2024-2027
	2.	Develop and deliver prioritised resilience schemes agreed with stakeholders.	From 2027

WATER QUALITY

DETERIORATING **WATER QUALITY**

Climate change will lead to an increased risk of drought but also of increasingly intense rainfall events throughout the year. Both these extremes will impact the quality of our water resources making it harder to treat and supply to customers.

> **"The warmer temperatures in summer can also increase blooms of algae in some of the reservoirs and lochs we use to supply water."**

Scotland's upland water resources are deteriorating in terms of the amount of organic matter they contain. Perversely this is a consequence of the shift to cleaner fuels since the 1990s as a response to managing acid rain – acidic conditions tended to keep these materials bound in the soil. As more natural conditions are restored this has seen a release of organic matter. The increased variability of rainfall and increased extremes of both low and high rainfall in a climate changed future will further increase the release of organic material into the water.

Low rainfall in rivers and lochs in summer, along with higher summer temperatures, leads to low oxygen levels that also alter the chemistry of water bodies. This releases natural occurring chemicals such as manganese from sediments. The warmer temperatures in summer can also increase blooms of algae in some of the reservoirs and lochs we use to supply water, and of bacterial growth within the systems. These make it harder to treat the water to the required quality standards and the algae can also impact the taste and odour of the water we supply, although it remains suitable to drink.

Intense and prolonged rainfall presents different challenges. Increased runoff from land increases sediments in the water and can also increase the bacterial load by flushing animal waste from farmland. Most of our catchments have lots of peat and heavy rain can flush out high levels of organic matter, increasing turbidity and colour and making it very difficult to treat.

Climate change will make these rainfall conditions more likely. Not all our water treatment works were designed to cope with such a range of raw water conditions. We have already invested at some treatment works to manage this, but climate change will mean that we will need to adapt more of our water treatment works to address this problem.

WHERE ARE WE TODAY?

Water is supplied from 229 water treatment works across the country that are designed to cope with the range of raw water quality that we currently see. Over the past 20 years Scottish Water has invested extensively in improving water quality, both in terms of the quality of water sources and in the effectiveness of treatment.

Water Quality Risk Management

We manage water quality and supply risks through our water supply risk management system. This is informed by water treatment works capability assessments and many other data streams. These assessments have been undertaken at most of our treatment works. Together with information on water resources, water quality and water networks this helps us understand and manage risk in each water supply area across Scotland. Working with the Drinking Water Quality Regulator (DWQR), we have developed our Water Risk Assessment Platform tool to help us understand and manage risks across our water systems – a key part of how we are building our water system plans. Our approach is going through the certification process for *BS EN 15975-2 Security of drinking water supply, Guidelines for risk and crisis management*.

We are assessing climate change adaptation risks alongside all other risks to water quality, so that when we plan interventions, we ensure all risks are addressed efficiently.

Water resource quality

We have assessed the impact of climate change on water resource quality. Some sources are more vulnerable than others to different impacts and our assessment has identified the following key risks:

- **Small river sources**
  These can respond quickly to weather events and are particularly vulnerable to greater flushing of material into the water with bacteriological risks increasing
- **Upland sources**
  Much of Scotland's upland areas drain from organic rich peaty catchments. These can be vulnerable to increased organic loading presenting treatment challenges
- **Reservoirs or lochs vulnerable to low water levels**
  Low water levels in some water bodies can lead to exposed sediments and issues with water chemistry or algal blooms presenting treatment risks.

Some areas access water from deep aquifers such as parts of Fife. At present these are reasonably resilient, but it will be important for us to continue to monitor them and research the potential risks to water quality.

The interaction between the environment, climate change and water quality are complex, and we need to increase the monitoring of a range of environmental and water quality parameters to help us understand where, when and how we might need to invest to secure quality.

Our assessment indicates that by 2050 we can expect to see further deterioration in raw water quality at times of the year across most water resource zones.

> **"The interaction between the environment, climate change and water quality are complex."**

Algae

We are already seeing the impacts of climate change on the levels of algae in our reservoirs. Warmer summers are leading to increased temperatures in reservoirs which means that the naturally occurring microalgae in the water grow more rapidly. This can be made worse by lower flows, which leads to less flushing of the system and an accumulation of nutrients that further stimulates algal blooms. Our water treatment works were not originally designed to treat for higher levels of algae and this is resulting in taste and odour issues at some treatment works.

At present there are few lochs or reservoirs in Scotland that experience extended periods (at least one month) of temperatures above 17 degrees C, above which algal blooms are much more likely. By 2050 it is estimated that most water bodies will experience this for at least one month in the year[6]. Our assessment indicates that over 200 of our water sources will be at higher risk of algal blooms by 2050.

Manganese

The lower water levels in our reservoirs in summer is also raising issues with manganese. Manganese is a naturally occurring mineral essential in trace amounts, and is found in the sediments of some water bodies. Lower water and oxygen levels plus warmer temperatures can alter the water chemistry leading to the release of manganese from sediments, raising the levels within the water we need to abstract. Like algae, our water treatment works were not originally designed to treat manganese and higher levels of manganese results in discoloured water being supplied.

Our assessment indicates that around 200 of our water sources are at risk of greater manganese levels by 2050.

[6] CREW - Assessing climate change impacts on the water quality of Scottish standing waters_1+link3_0.pdf

Dissolved organic matter

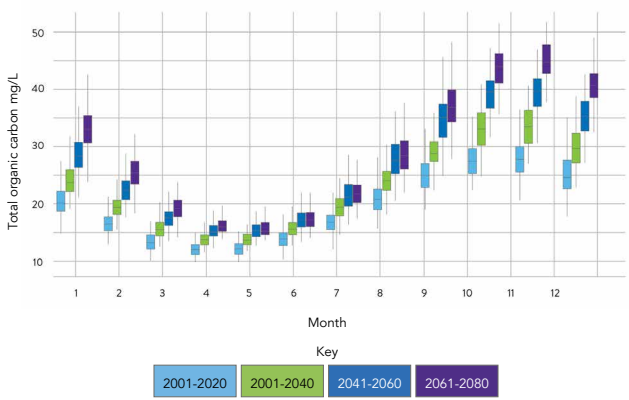
Drying out and erosion of peaty soils can release naturally occurring organic matter into water when it rains, which gives many of Scotland's upland water its characteristic colour. The impact on raw water quality from organic matter is forecast to be highest in winter when more intense rainfall following drier summers is predicted. Our ability to manage the raw water quality and to treat water to the required water quality standards throughout the year is a key focus for adaptation.

The assessment shows that the majority of our water sources are at increased risk of being impacted by the release of more natural organic matter into our water sources.

A 2050 future without adaptation. Outcomes:

- Of 420 sources we currently use the majority will have a risk of deteriorating raw water quality
- Upland reservoirs become increasingly vulnerable to organics, temperature, algae and manganese
- Small west coast sources are particularly vulnerable to organic matter load increasing
- River sources will be more vulnerable to flash storm events and runoff (bacteria, turbidity and organics)

Forecast of Increased Organic Levels in Upland Sources[7]



We will continue to monitor water quality to better understand the rate of deterioration in water bodies in the coming decades, and when and how we might need to act.

[7] Redrawn from UK centre for ecology and hydrology FREE DOM-BCCR project (FREEDOM_BCCR_Climate_Effects_ Modelling_05.pdf (ceh.ac.uk))

Water Asset Capability

Each water treatment works is designed to treat its source water. The risk from climate change depends on both the type of source water and the type of treatment.

We have assessed the climate change vulnerability of both the different treatment processes and the water sources they use to help us understand the risks to future service.

A 2050 future without adaptation.
Current water asset capabilities assessment indicate:

- 14 water treatment works have high vulnerability to climate change
- 71 water treatment works have medium vulnerability to climate change
- 92 water treatment works have low vulnerability to climate change

Our analysis indicates that with their current capabilities, there are 14 water treatment works serving 30,000 customers that have that have high vulnerability to climate change and will need to adapt by 2050. A further 71 water treatment works covering 4.6 million customers have a medium vulnerability. This is partly managed in larger conurbations by the ability to supply from more than one water treatment works. We will maintain our sites and adapt to climate change to ensure they can continue to deliver great water quality for customers.

WHAT HAVE WE DONE SO FAR?

Refurbished or upgraded the majority of our water treatment works, networks and pumping stations over the last 20 years, to improve service performance and resilience.

Created a catchment management programme that has worked with landowners and farmers to reduce the risk of runoff impacting water sources. This has seen extensive investment in measures such as buffer strips along watercourses and farm management plans to improve riparian habitats and reduce erosion risk.

Worked with NatureScot and Peatland Action to restore damaged peatland to reduce runoff risk to water quality. By re-profiling land, re-vegetating bare ground and raising water levels we improve water-holding capacity of the land, reduce erosion risk and support biodiversity and carbon capture - making a more resilient landscape.

Undertaken asset treatment capability studies to identify current performance and capability of treatment works to deliver the required water quality standards.

Developed our Water Risk Assessment Platform (WRAP) to bring together asset capability, water resources, water quality and customer information to inform actions to protect drinking water quality and direct our response to water quality incidents.

Increased monitoring of rainfall and the quality of source waters to better understand water quality throughout the year, the risks from rainfall and land runoff, and to enable us to identify longer term environmental trends in raw water quality.

CASE STUDIES

Click on the case studies below to read more:

UNDERSTANDING THE RAW WATER QUALITY IMPACT OF CLIMATE CHANGE

IMPROVING CATCHMENT RESILIENCE

Improving Treatment and Catchment – Black Esk

Black Esk Water Treatment Works is located near the town of Lockerbie in Dumfriesshire and along with Winterhope Water Treatment Works supplies up to 21.5Ml/d of water to 40,000 customers in Lockerbie, Annan, Dumfries and the surrounding area.

Water is supplied from Black Esk impounding reservoir, fed by the Black Esk river and sits within a catchment comprising commercial forestry and open moorland with significant amounts of peat. The system has benefits from improvements since it was created in 1987, with treatment upgrades and an increase in the reservoir height to improve the resilience of the water source.

The key challenge in recent years has been water quality, with high organic matter in the source water presenting risks in meeting discoloration and water quality standards, soluble manganese and microbiological issues. To address these issues a combination of measures is being deployed to reduce risks in the raw water and to enhance the capabilities of the water treatment works.

Catchment measures will see peatland restoration and woodland improvement work that will improve the resilience of the catchment and manage the risk of further erosion and loss of organic matter into the water body.

Scottish Water owns some land around the catchment with Forestry and Land Scotland (FLS) the main third party landowner. Land and habitat surveys have been completed, and FLS engaged in work that will see:

- Peatland restoration
- Rewetting of peatland soils by blocking grips and ditches
- Creating woody debris dams to capture sediments in the direct tributaries into the reservoirs
- Reducing sheet, rill and gully erosion
- Retaining more water in catchment and slowing flows into reservoir via wetlands.

Enhanced treatment is the principal means by which we will manage risks. New ion-exchange treatment stages, along with improved filters and microbiological treatment systems are being developed to address the range of quality risks.

The improvement work is in the final stages of development to enable us to progress to site. The improvements to treatment will ensure we meet customer and regulatory expectations on water quality in the coming years, whilst the catchment work will manage the risks of further deterioration in environmental water quality and make the catchment more resilient to climate change.

WHAT WE PLAN TO DO

Climate change will present major challenges to Scottish Water's water treatment works ability to deliver high quality drinking water for customers.

To adapt to the risks presented by climate change and to maintain current service to customers:

We will improve water quality monitoring and intelligence

We will make our water catchments more resilient to climate change

We will adapt our water treatment works to ensure they continue to deliver high quality drinking water for customers

Adapting to climate change is an ongoing activity across the century. This table illustrates the key actions we plan to take out to 2050 to deliver adaptation.

Engage Scottish Government, regulators and other sectors in Scotland to identify and prioritise the collection, storage and access to national climate related environmental data	1.	Develop improved raw water data set that supports increasingly effective and efficient analysis of water and land impacts to understand the impacts of climate change.	from 2024
Conclude studies of the condition of all Scottish Water peatland and set out improvement programme	1.	Complete restoration of all poor condition peatland on Scottish Water land.	2024-2027
Work with landowners and farmers to understand and address water quality risks in catchments	1.	Restore peat on third party land where it is impacting raw water quality.	2024-2030
	2.	Deploy catchment management good practices with landowners and farmers to reduce water quality risks.	from 2024
Deliver climate change adaptation at water treatment works to maintain drinking water quality for customers, addressing the impacts of algae, manganese and dissolved organic carbon	1.	Complete deliver of SR21 water quality programme.	2024-2027
	2.	Develop and deliver prioritised water quality projects agreed with stakeholders.	from 2027
Progress development of our Water Risk Assessment Platform	1.	Deliver certification to BS EN 15975-2 Security of drinking water supply, Guidelines for risk and crisis management.	2024

CUSTOMER FLOODING AND ENVIRONMENTAL POLLUTION

CUSTOMER FLOODING AND ENVIRONMENTAL POLLUTION
TOO MUCH WATER

The safe collection and treatment of society's waste waters is one of the core duties for Scottish Water. At times our sewer capacity can become overwhelmed. This can be either through extreme rainfall exceeding the capacity of the sewer, or blockages from inappropriate items such as fats, wet wipes and sanitary materials.

When this happens there is a risk that waste water will back up and surcharge from sewers and in the most serious cases cause flooding in and around customer properties. There can also be an impact from the operation of combined sewer outfalls (CSOs) into watercourses. These remain a vital part of our infrastructure to manage excess flows.

Climate change will see an increase in the number of extreme rainfall events. This will mean there is a higher risk of flooding or environmental pollution.

Where we can, we will act directly to address the flooding. However, addressing flood risk often cannot be done in isolation by a single organisation. The type of rainfall events that can lead to sewer flooding are likely to have caused wider flooding problems as local areas become inundated with surface water.

There are many occasions where sewer flooding can be addressed directly by Scottish Water through improvements to our system, but the wider management of excess rainfall requires partnership working between Scottish Water, local authorities, roads authorities and SEPA to develop integrated approaches.

The responsibilities of these public bodies to address flood risk are set out in Scotland's Flood Risk Management Act 2009[8].

[8] The Flood Risk Management (Scotland) Act 2009: Guidance on duties of a local authority to assess bodies of water and to carry out clearance and repair works (www.gov.scot)

WHERE ARE WE TODAY?

Climate change will impact the performance of sewers – increased rainfall intensity can overload our systems, whilst unusually low flow can reduce flushing and lead to the accumulation of material which causes blockages in heavy rain. The incorrect disposal of items like wet wipes, fats, oils and grease makes this worse.

Much of Scotland's sewer network capturing foul drainage from properties is combined with surface water drainage systems – together termed a combined sewer, which captures the rainfall runoff from buildings and hardstanding such as car parks and roads.

Combined sewers were historically designed to manage the typical rainfall and runoff from the catchments they served. Heavy rainfall or faster runoff can exceed the capacity of the system. To prevent water and sewage backing up and potentially flooding customers, "pressure releases" were created in the form of CSOs.

These were designed and licensed to spill diluted sewage to watercourses to prevent flooding during heavy rainfall.

Further urbanisation since the combined sewers were laid has increased the area of land connected to these sewers and when it rains the rain quickly enters the sewer system. Coupled with increased rainfall and intensity of storm events through climate change this has increased the risk of flooding and of CSOs operating.

This risk was identified and addressed by the introduction of new regulations for drainage in 2003. As a result, combined systems are no longer permitted in new developments. Instead, all new developments have what is known as a two pipe system: the sewers only convey foul sewage and separate surface water sewers are used for rain. The rain is then managed on the surface in wetlands and basins. These are examples of what are termed blue-green infrastructure. These are dry normally but fill up when it rains and then slowly release the rain into the nearest watercourse. As a result, sewer flooding risk is reduced and downstream CSOs operate less frequently. These types of blue-green infrastructure are the norm in new housing and business developments.

Removing rainwater from combined sewer systems is core to Scottish Water's stormwater management strategy[9] to reduce climate change related flooding and environmental pollution risk.

> **"Heavy rainfall or faster runoff can exceed the capacity of the system."**

[9] Stormwater strategy

Our stormwater strategy can be simply summarised as “no more in, what’s in out”. This means that we aim to accept no more surface water into our network from new developments. We also want to remove the rainwater that is currently connected to the combined sewer system. To do this we need to work in partnership with local authorities, SEPA, developers and communities. This is not a simple task – combined sewer systems form about around a third of Scotland’s sewer network – and changing them will take many decades. We are already progressing work in this area.

We have worked with all 32 local authorities to develop a comprehensive library of hydraulic models that replicate the sewers and watercourses in urban catchments. We can run these models with today’s rainfall data and with forecast future rainfall patterns to help understand flood and pollution risk now and in a climate changed future. From this we can work with local authorities to develop Surface Water Management Plans which outline how flooding and pollution risk will be managed in the future.

These plans set out how surface water can be retained and managed on the surface in an urban area. In Glasgow, Edinburgh, Aberdeen and Dundee projects have been delivered by Scottish Water and local authorities that are reducing flooding and pollution risk through surface water management. Each project uses a variety of techniques but all incorporate nature as part of the solution. As well as managing future flood risk, these projects deliver multiple benefits in the form of new green space for a community as well as improve biodiversity.

> **“We need to work in partnership with local authorities, SEPA, developers and communities.”**

Customer Flood Risk

Our understanding of the risk of sewer or surface water flooding of properties across Scotland is based on a combination of hydraulic model data and records of validated flooding events.

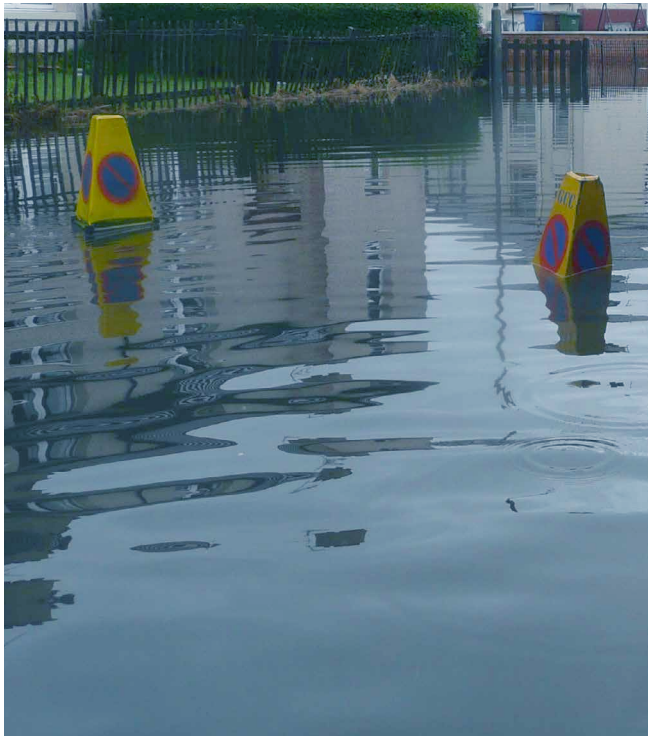
Sewers are designed to convey the typical rainfall that might be expected to occur with a 3% chance of a flooding event in any year.

Today over 2,300 properties are identified as being at risk of sewer flooding across Scotland. Climate change rainfall projections indicate that without adaptation there could be c.4,800 properties at risk of flooding; a 60% increase by 2050.

By 2080, projections suggest there will be a further significant increase in flood risk from climate change.

A 2050 future without adaptation. Outcomes:

- c.60% increase in the amount of customer properties at risk of sewer flooding.
- 20% increase in CSO discharges.



Environmental Risk

Scottish Water has around 3,700 CSOs across our sewer network, with further overflows at treatment works to protect the processes. Of the 3,700, 785 are currently classed as unsatisfactory because of the way they operate. The vast majority of them (700) require upgrading to prevent sewage litter, whilst the remainder surcharge too early or in a very few cases can have a water quality impact.

To reduce spills from CSOs we either need to remove the amount of rainfall that drains to sewer or invest in additional storage capacity within the sewer system. Scottish Water and SEPA have developed an Improving Urban Waters Routemap that outlines how we address current issues with CSO discharges, with a plan to invest £500 million over 6 years to address 108 priority discharges and install monitors on 1,000 discharge points.

Without further interventions, climate change is projected to increase the volume discharged by around 20% by 2050, with fewer, larger discharges as a consequence of increased storm intensity. We are developing a more detailed understanding of which CSOs will require adaptation and will include information on this in the next revision of our adaptation plan.

By 2080, projections suggest there will be a further significant increase in discharges to the environment as a result of climate change.

WHAT HAVE WE DONE SO FAR?

Provided support for customers impacted by internal flooding – from the time of a flooding incident until the problem is resolved.

Installed 1,000 monitors in the sewer network to give us near real time intelligence on sewer performance to address flood and pollution risk.

Enhanced our understanding of sewer networks through the creation of network models that cover 95% of the population we serve.

The work of the Metropolitan Glasgow Strategic Drainage Partnership saw over £1.5 billion invested in major flooding and environmental projects in Glasgow, including the creation of the Shieldhall Tunnel – a 4.2km transfer tunnel big enough to drive a bus through that provided an additional 90,000 cubic metres of additional flood storage, alleviating risk and improving water quality across the catchment.

Developed innovative partnerships to manage collective action with stakeholders in Glasgow (the Metropolitan Glasgow Strategic Drainage Partnership), Edinburgh (the Edinburgh and Lothians Strategic Drainage Partnership) and built close working relationships to address flooding challenges in both Aberdeen and Dundee.

Over the past 15 years we have invested over £2 billion in improving the capacity and performance of the networks, addressing internal flooding for customers and improving over 450 CSOs.

Piloted blue-green infrastructure in Glasgow, Edinburgh, Aberdeen and Dundee to reduce flood risk and pollution.

CASE STUDIES

Click on the case studies below to read more:

MITIGATING FLOOD RISK

INTELLIGENT WASTE WATER NETWORKS

STOPPING SEWER ABUSE

REDUCING RIVER POLLUTION

Turning our landscape blue-green

Preventing rainwater from entering sewers and allowing it to drain naturally through well designed "blue-green" infrastructure such as ponds, wetlands, swales and rain gardens is an effective way to reduce flood risk and improve resilience to climate change. It can also offer wider benefits through creating green spaces in urban areas and improving biodiversity. Removing surface water from combined sewers is at the heart of our surface water strategy.

But it needs partnership with local communities, regulators and planning authorities to make it work.

St Mary's, Dundee

An innovative partnership project is underway in Dundee to reduce flooding in the Downfield area using nature-based solutions. Scottish Water, NatureScot and SEPA are working in collaboration with Dundee City Council and the local community to improve the way storm water is managed to reduce flood risk and increase biodiversity in the St Mary's area of Dundee.

Working with stakeholders the aim is to transform a landscape corridor and reopen a watercourse that has been culverted for 50 years to restore a natural watercourse. It will also see pathways for local connectivity, walking and cycling; areas for wildlife; and areas for active use such as play opportunities.

While flood prevention is the driver for these plans, the proposed management of water in greenspaces provides exciting opportunities to realise multiple benefits for people and nature.

As well as neighbourhood schemes, individual householders can take action. Simple measures such as having a water butt or water garden connected to a roof drain can slow down the peak flow of rain entering the combined sewer and reduce flood and pollution risk. It takes many households to take action to make an impact so we are working with some businesses and public bodies who have buildings with large roofs or large car parks that could be disconnected from the combined sewer system.

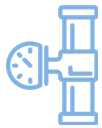
WHAT WE PLAN TO DO

Climate change will present major challenges to Scottish Water's sewer network that, unless we act, will increase the risk of customer flooding and increase pollution risk.

To adapt to the risks presented by climate change and to maintain current service to customers and the environment:

We will focus on supporting customers vulnerable to flooding whilst we develop and deliver solutions to address flood risk

We will partner with local authorities and developers to transform our urban landscapes with blue-green infrastructure, delivering our stormwater strategy of "no more in, what's in out" to reduce climate change flood risk and pollution



We will increase monitoring of the sewer network to better understand sewer performance to allow us to avoid flooding and pollution incidents

Adapting to climate change is an ongoing activity across the century. This table illustrates the key actions we plan to take out to 2050 to deliver adaptation.

Deliver a recovery service to impacted customers following sewer flooding event and while a solution is developed and delivered	1.	To continuously improve our support to customers in the event of a sewer flooding event.	Ongoing
	2.	Support customers with flood prevention equipment whilst solutions are being developed and delivered.	
Expand live monitoring of sewer network to avoid flooding and pollution events	1.	Expand sewer monitoring in key catchments prioritised with SEPA and stakeholders.	Ongoing
Work with all 32 local authorities on how to tranform urban landscapes to deliver blue-green infrastructure to reduce flood risk	1.	Complete delivery of Edinburgh and Dundee pilot blue-green projects.	2024-2028
	2.	Work with local authorities to develop blue-green infrastructure plans for urban areas.	from 2024
Deliver interventions in our networks to deliver our stormwater strategy to reduce flood risk	1.	Complete delivery of SR21 Flooding and CSO programmes.	2024-2027
	2.	Complete deliver of our Urban Waters Routemap.	2023-2030
	3.	Develop and deliver prioritised flooding and CSO projects agreed with stakeholders.	From 2027

WASTE WATER AND ENVIRONMENTAL QUALITY

WASTE WATER AND ENVIRONMENTAL QUALITY

Scottish Water collects, treats and returns to the environment around 1 billion litres of society's waste waters each day. This service is delivered through a network of over 54,000 kilometres of sewers, thousands of pumping stations and 1,838 waste water treatment works ranging from small septic tanks serving a handful of properties to our largest at Seafield in Edinburgh serving over 500,000 people.

Each waste water treatment works is designed to treat the sewage and surface water flows from the catchment it serves to the required environmental standard before it is returned to the environment. The level of treatment is determined by the waterbody – the local river, loch or sea – that the sewage is being discharged to. The standards are set by SEPA using their knowledge of the waterbody and what needs to be done to ensure that it meets water quality standards. Climate change will have two main impacts to our waste water treatment works.

Impact on treatment

Low rainfall and extended dry periods reduce the volume of surface water arriving at the treatment works making the sewage more concentrated so the treatment process will have to work harder to deliver a compliant discharge.

More intense storms and variable rainfall mean our works will have to deal with a wider range of influent flow and load conditions that will change rapidly and that can affect the biological processes that treat waste water.

Impact on the environment

Low rainfall also means that there is less water in a river or loch to dilute the treated final effluent. This can have an impact on water quality and may lead higher standards of treatment being required in the future to continue to protect the environment.

WHERE ARE WE TODAY?

Sewage is treated at 1,838 waste water treatment works across the country that were designed to cope with the mix of sewage and surface water that has been the norm in Scotland. Over the last 20+ years Scottish Water has invested extensively in improving waste water treatment quality. This has resulted in improvements to river and seawater quality – 87% of all Scotland's water bodies are classed as being at "good" status or better.

Much of Scotland's sewer network is combined with surface water drainage: the rainfall runoff from buildings and hardstanding such as car parks and roads. This means that the volume and concentration of sewage flowing in our systems for treatment can be very variable with low volume, concentrated loads during dry periods, and very dilute high volume in wet weather.

Waste water treatment works are designed for the "flow" (the hydraulic volumes of waste water they need to treat), the "load" (the organic load from domestic and business customers) and the level of treatment required to protect the environment. Whether a small septic tank or large complex biological treatment process the works needs to operate within a defined "envelope" of flow and load to perform and meet the required discharge standards.

Changes in flow can impact the treatment process - low flow conditions can lead to much stronger sewage that is more difficult to treat, as can unusually high flows of weak sewage. Both impact the biological processes at the heart of treatment.

Waste water discharge compliance with environmental standards remains high at 96% compliance and has benefited from extensive investment in assets and operating practices over the past 20 years.

> **"Low flow conditions can lead to much stronger sewage that is more difficult to treat."**

Environmental Quality Risks

Just as in the water service, we are carrying out capability assessments at our waste water treatment works to understand the risks to treatment and what we might need to do to address these risks over time. These are a key step in the development of our system plans for waste water.

Changes in the flow and load to waste water works may make it more difficult to treat sewage effectively and meet the required discharge standards. This is a particular challenge for works with what are called "numeric" licences – where they have to meet specific standards, for example ammonia.

For sites with numeric consents our assessments suggest that, based on current capabilities, forecast climate change impacts such as changes in rainfall and flow may lead to a reduced ability to meet environmental standards at approx 730 of our waste water treatment works by 2050.

> **"There is a risk that in low river flow conditions the discharges may impact water quality."**

This does not mean the sites will fail, and more work is required to fully understand the specific risks that need to be managed. We will have to explore how we develop adaptations to ensure that we can continue to deliver environmental compliance. These adaptations could see upgrades to the treatment technology or the installation of temporary treatment units to help manage low flows in extended low rainfall periods.

We will deliver compliance to current discharge standards – there is a risk that in low river flow conditions the discharges may impact water quality.

We have assessed the impact of climate change on river flows and this has identified that there may be 35 waste water treatment works at risk of tighter discharge standards being applied by 2050.

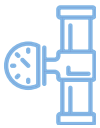
WHAT HAVE WE DONE SO FAR?

Invested over £2 billion at over 1,000 waste water treatment works during the last 20 years, to improve environmental quality.

Developed Low Flow Management Plans that can be deployed in dry conditions to ensure that waste water treatment works remain compliant.

Delivered our exemplar waste water treatment works project at our 16 largest sites which saw live monitoring of final effluent, site control improvements and condition monitoring of key equipment to manage performance under all conditions.

Undertaken waste water asset capability assessments to determine current performance and capability to deliver the required standards.



Developed our waste water system planning methodology.

Invested in modelling improvements to help us understand future rainfall impacts to drainage catchments and the consequent impact on flow at waste water works.

CASE STUDY

Low flow waste water treatment works – enhancing capability

Spring and summer 2018 was extremely dry, particularly in the North and East of Scotland where average rainfall was less than half the level we might normally expect.

We saw progressive reductions in flow to many of our treatment works that treat water from combined sewer systems. In many cases the flow arriving at the works was less than half the flow we would usually expect during dry weather.

Operational teams initiated a low flow management plan that extended to over 100 sites, but with a particular focus on around 30 sites in the North and East, particularly Perthshire and Aberdeenshire.

At Drumoak and other sites using biofilter technology we installed additional pumps and pipework to recirculate the flows around the works and to keep the biofilters wetted and maintain a compliant treatment process.

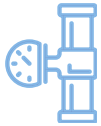
At Crieff Waste Water Treatment Works and other sites using aeration technology extensive operational management was put in place to monitor and enhance the performance of the site, with additional aeration capacity installed on a temporary basis to maintain compliance.

WHAT WE PLAN TO DO

Climate change will present major challenges to Scottish Water's waste water treatment works that could impact environmental performance and impact river water quality.

To adapt to the risks presented by climate change and to maintain current service to customers and the environment:

We will assess the capability of our waste water treatment works and networks to understand the impacts of climate change



We will adapt our waste water treatment works to deal with the impacts of climate change

Adapting to climate change is an ongoing activity across the century. This table illustrates the key actions we plan to take out to 2050 to deliver adaptation.

Assess the capability of our waste water treatment works and networks to understand the impacts of climate change	1.	Complete capability assessments of over 200 priority waste water treatment works.	2023-2027
	2.	Build outcome of capability assessments into waste water system plans, identifying the interventions needed to maintain performance and deliver adaptation to climate change.	Ongoing
Improve control and monitoring at waste water treatment works to maintain performance	1.	Develop plans to further improve control and optimisation of waste water treatment works.	Ongoing
Deliver climate change adaptation at waste water treatment works to meet environmental performance	1.	Develop and deliver prioritised waste water quality projects agreed with stakeholders.	from 2027

ASSET FLOODING AND COASTAL EROSION

ASSET FLOODING AND COASTAL EROSION

One of the most significant risks presented by climate change is the potential for our assets to become flooded, overwhelming tanks, washing away infrastructure and damaging sensitive electrical equipment.

Flooding can take several forms:

- **Surface water flooding** – the intensity of rain inundates a site and causes surface water flooding.
- **Rivers flooding** – rivers and streams can burst their banks during heavy rain leading to widespread flooding around the watercourse.
- **Coastal flooding and erosion** – storm surges can inundate coastal assets and sea level rise coupled with more intense storms will make this worse and lead to erosion of coastlines.

SEPA manages Scotland's **national flood risk maps** and they can be interrogated to understand the vulnerability of different areas to the range of flooding types.
In the same way that we can model the impact of climate change on rainfall to understand the impact it will have on sewer flooding, this can be done for surface water, river and coastal flooding.

WHERE ARE WE TODAY?

Asset flood risk is location specific, based on the topography of a site, and the proximity to watercourses and flood plains. Vulnerability also varies according to the type and layout of a site – the location of equipment and the height above flood level of sensitive items such as electrical equipment.

Scottish Water operates assets from upland water resources to the bottom of catchments. Generally, flood risk is greater at waste water assets – sewers, pumping stations and waste water treatment works that tend to sit at the lower end of catchments.

Over the last 15 years, Scottish Water has investigated flood risk at critical assets and steps were taken to protect vulnerable sites – creating embankments or barriers to flooding and ensuring that less critical sites are able to be recovered quickly with minimal impact to service.

Sometimes adaptation may be as simple as elevating the vulnerable equipment above the level of the flood plan, for example at an underground pumping station, raising the control kiosk above expected flood waters to protect the electrical equipment and maintain service.

> **“Sometimes adaptation may be as simple as elevating the vulnerable equipment above the level of the flood plan.”**

Surface Water Flood Risk

More frequent storms will lead to greater surface water flooding at our assets. Our assessment indicates that 8 water assets and 65 waste water assets are at increased risk from surface water flooding during frequent storms by 2050. Waste water assets have the greatest risk reflecting that they are generally in lower lying areas. The number of impacted assets will increase to 171 water and 463 waste water by 2080.

River Flood Risk

The more intense rainfall and storms we will see because of climate change will increase the risk of rivers flooding our assets. 720 of our waste water assets and 279 water assets are currently at risk of flooding in frequent storm conditions. Our assessment indicates that a further 11 water assets and 194 waste water assets are at increased risk from fluvial flooding beyond 2050.

Coastal Flood Risk

Our assessment suggest that by the 2050s in Scotland we may experience significant impacts from sea level rise. Over 0.3m of sea level rise is projected for Shetland and exposed Atlantic areas, with up to 0.2m of sea level rise in the inner Firths of Clyde, Forth and Tay. These levels will increase by 2080.

Our assessment indicates that an additional 8 water assets and 235 waste water assets will be at increased risk from coastal flooding by 2080.

For water assets our primary focus is the impact on raw water intakes – increased sea levels may cause the tidal bore to extend up major rivers, raising the risk of saline intrusion into areas we abstract from the rivers Tay and Dee.

The principal concern for waste water assets is the ingress of seawater into the sewer system, particularly outfalls. This can make it difficult to discharge effluent under gravity, and saline intrusion into sewage impacts the treatment process.

> **“Principal concern for waste water assets is the ingress of seawater into the sewer system.”**

For all types of flooding, our system plans will set out what intervention is required to adapt the asset to ensure service is not impacted in the event of a flooding incident. Adaptation that is delivered to address one flood risk will generally also protect for other flood risks at the site.

Coastal Erosion

A further impact from rising sea levels is the risk of coastal erosion impacting our assets.

We have engaged with work being undertaken by Dynamic Coast, an initiative funded by the Scottish Government, NatureScot and St Andrews Links focused on understanding and improving the evidence base and awareness of coastal erosion.

This has helped us to identify erosion risks principally to our waste water assets. Dynamic Coast note that there is some £18 billion of infrastructure assets in Scotland within the coastal margins and that the majority of this is afforded protection either through natural assets (sand dunes, rocky shorelines etc) or through engineered structures (sea walls and defences).

Management of coastal flooding and coastal erosion is the responsibility of local authorities and Marine Scotland and we will work with them to understand how to progress adaptation in areas that impact our assets.

We have reviewed the Dynamic Coast output and looked at how it would impact our assets. Our assessment indicates that 215 waste water assets and 19km of sewers will be at risk from coastal erosion by 2050.

WHAT HAVE WE DONE SO FAR?

Invested to improve resilience to flooding of critical assets, elevating vulnerable equipment above the flood plain and creating embankments and flood protection as needed.

Updated our operational resilience plans to include asset flood response.

Amended our asset planning approach to include future flood risk when developing assets.

Worked with Dynamic Coast to explore the risk of coastal erosion on our assets to help us plan for engagement with local authorities on future coastal management plans.

CASE STUDIES

Click on the case studies below to read more:

FLOOD RESILIENCE RESPONSE - BALLATER WASTE WATER TREATMENT WORKS

Building resilience at pumping stations

We operate thousands of pumping stations across our water and waste water networks, the majority located underground and many operating to convey water and waste water through low lying areas, across flood plains and adjacent to watercourses.

Aviemore

One of the central waste water pumping stations at Aviemore is located in an area at risk of fluvial flooding from the River Spey – heavy rain swells the river and floods surrounding land. To make the station resilient we fitted submersible pumps in to the underground chamber and elevated the control kiosk for the pumps and level sensors above the flood level.

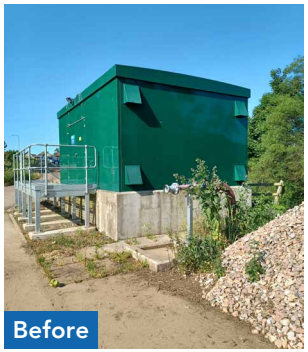
This means that the performance of the site can be quickly recovered following major flooding with no damage to sensitive equipment.

Pitscottie, Fife

A similar problem existed for the treated water supply at Pitscottie in Fife, but this is an example of where we will need to revisit the site in the future as the latest climate and flood projections suggest the site may no longer be sufficiently resilient post 2050.

Before – following historic flood events the pumping station control kiosk (green) was refurbished and elevated on a concrete plinth above the flood levels.

After – during December 2022 the area experienced significant flooding. The elevated control kiosk was protected from flooding meaning the system was able to continue operating. Flood levels were higher than previously experienced and with the latest climate projections we will need to keep this site under review and consider increasing resilience at the next major refurbishment.


Before


After

WHAT WE PLAN TO DO

Flooding of assets and coastal erosion caused by climate change will present major challenges to Scottish Water's assets that could impact their ability to provide water and waste water services.

To adapt to the risks presented by climate change and to maintain current service to customers and the environment:

We will update water and waste water operational resilience plans to ensure we can maintain service

We will embed frequent weather and flood projections in system and asset planning

We will progressively increase resilience as we repair, refurbish and replace ageing assets

Adapting to climate change is an ongoing activity across the century.
This table illustrates the key actions we plan to take out to 2050 to deliver adaptation.

Ensure our operational resilience plans are updated to reflect the changes needed to manage asset flooding and coastal erosion risk	1.	Update operational resilience plans to reflect the latest evidence from climate change risk assessment on asset flooding and coastal erosion.	2023-2027
	2.	Ensure that operational resilience plans are reviewed and updated following storm flooding events and updated climate risk intelligence.	Ongoing
Embed extreme weather and flooding into water and waste water system plans	1.	Ensure system planning process incorporates frequent weather and flooding as part of the plan development process.	2023-2027
Improve resilience as we deliver interventions at assets	1.	Develop and deliver prioritised interventions agreed with stakeholders to protect assets from flooding.	from 2027
	2.	Work with other public bodies and landowners to develop interventions that protect Scottish Water's and others' assets from flooding.	from 2027

INTERDEPENDENT RISKS

INTERDEPENDENT RISKS

We rely on external infrastructure and resources to support Scottish Water's work to deliver reliable water and waste water services.

This includes the power to run our treatment works and pumping stations, roads and transport infrastructure to access sites and transport materials and chemicals to them and telecoms to remotely monitor operation of our assets. Telecoms are key for contacting our employees in the field and importantly for our customers, especially vulnerable customers, to contact us when they have a service issue. We also rely on UK, European and global supply chain partners to supply goods and services to allow us to operate, maintain and enhance our asset base.

All of these services can be acutely disrupted by weather events – storms, floods and high winds that will be made worse by climate change – that can damage external infrastructure and make the supply and transport of materials difficult. We have developed Operational Resilience Plans for our assets and services to deal with a range of weather and other forms of disruption which allow for the disruption to the external infrastructure that we rely on.

WHERE ARE WE TODAY?

Operational resilience planning takes into account a range of factors of which the weather and climate is only one. Resilience and contingency plans reflect a range of physical and cyber threats to our services and are kept updated.

Scottish Water works closely with the Scottish Government and other agencies on national resilience planning and is a key member of regional and local resilience partnerships.

Through this Scottish Water provides support to others and can access support from emergency services, transport and energy sectors to support services to customers during incidents.

Climate change will exacerbate these risks through increased frequency of extreme weather. This is particularly focused on four areas of vulnerability: the ability to access our sites, ability to power our sites, ability to communicate with our sites, employees and customers, and the ability to access key materials from the supply chain.

> **“Scottish Water works closely with the Scottish Government and other agencies on national resilience planning.”**

Inter-dependency	Impact of extreme weather
Roads and Access 	Extreme weather events such as flooding or storms can blocked access to sites, making emergency response more difficult.
Power Outage 	Power outage caused by storms, flooding, drought or high temperatures. eg power failure resulting from cables or transmissions over-heating or damage from high winds/falling trees.
Telecoms 	Loss of ICT or telecoms service resulting from storms or temperature extremes.
Supply Chains 	Loss of access to eg chemicals, replacement parts and contracted maintenance teams resulting from inability to provide service as a result of storm or flood damage or extremes in temperature limiting production capacity.

Access

Scottish Water as a national water and waste water service provider operates all over Scotland and its islands relying on over 420 water sources across the country from remote reservoirs, lochs and burns to large rivers in the lower end of catchments.

There are 229 water treatment works, 1,838 waste water treatment works, several thousand pumping stations and thousands of kilometres of water and sewage pipes. These cover all parts of the country through diverse upland and lowland landscapes.

Generally, site access is more challenging for the most remote sites during winter: when winter storms, ice and snow can be disruptive to operational teams who need to access them. We have extensive experience of dealing with such incidents, and with a primary focus on the safety and wellbeing of our people and contractors, have been able to access and recover sites as required.

Access can also be a challenge at other times of year, as well as due to extreme weather events. Storm Arwen in late 2022 saw a lot of trees felled, particularly in Angus and parts of the East of Scotland. These blocked roads required a lot of work with other agencies to clear roads and access sites.

Power

Annually we use around 570GWh of grid electricity across almost all of the sites that we operate to provide our services. Loss of power has the potential to significantly disrupt services, but fluctuations in power during storms (brown outs) can also affect some of our sensitive instrumentation at sites.

Power companies are investing to improve the stability of the power network, but this will take time and we will need to work with them to understand how their services and supplies to our assets will become more robust in a changing climate. To manage the risk of power loss, many of our major sites with significant power demands have dual power lines. This means that local loss of one of the lines will be able to be managed. More widely we have invested extensively in standby generation across critical assets to ensure that we can continue to operate if the power grid goes down.

If a frequent storm is forecast operators will generally make ready the standby generation to ensure power is always available and, for sensitive sites, the instrumentation is not affected by an unstable supply. Each site with standby generation will have sufficient fuel to operate for a period of 72 hours.

Within that time, we need to be able to deliver fuel to keep the standby generators running if the power has not been restored. This was challenging during Storm Arwen due to the scale of treefall and we have been reviewing the number of sites with standby power generation and size of fuel storage.

We currently have a fleet of 289 standby generators at key water assets and 127 at waste water assets. We have been investigating whether we need to expand coverage of these units to address non climate change related resilience issues in the power network. This has identified that we may need to install over 130 additional units and we are developing plans as to how we might achieve this. This additional generating capacity will improve resilience to climate change related power disruptions.

> **“Loss of power has the potential to significantly disrupt services.”**

Telecoms

Many of our sites use digital telecoms for telemetry and are linked to our Intelligent Control Centre in Glasgow to manage performance and respond to incidents. Resilience in power systems will generally support onsite resilience in communications but we are reliant on digital comms providers for the restoration of services if their mobile transmitter stations are impacted by weather or power issues. Loss of telemetry from key assets will generally trigger site visits to ensure operational performance is met.

During Storm Arwen, mobile communications were down for an extended period, meaning we had challenges contacting our field staff. We resolved this by the use of our stock of satellite telephones, which can be quickly despatched to staff during incidents where normal telecoms are disrupted.

The failure of the communications network also gave our customers problems when they tried to contact us to report service issues.

Supply Chains

Scottish Water procures material and equipment from local, national and international suppliers for use in service delivery and capital investment. We have close working relations with supply chain partners to manage and secure access to critical supplies. Supply chain resilience has been a key focus in recent years with a number of drivers such as the exit from the European Union and the capacity of some sectors such electronic chips (for control and telemetry systems) informing business continuity planning.

Many of these materials come from overseas and climate change has the potential to disrupt supplies of raw materials, overseas manufacturing, or the transport of goods and materials to the UK. This may be due to local climate change impacts or through the impact of frequent storm events impacting transport infrastructure.

We therefore need to consider not only the climate risks for Scotland, but the way in which global climate change may affect parts of the world that supply key materials.

For these four areas, it is difficult to dimension the impacts of climate change by 2050 – the impact is dependant on the nature of individual storms and which part of Scotland are impacted. For supply chain impacts we need to look across the globe. Frequent storms are forecast to increase as a result of climate change, which underlines the need for us to focus in addressing these risks.

WHAT HAVE WE DONE SO FAR?

Operational resilience plans are in place for all of our critical assets, and are kept under review to ensure we learn the lesson from events.

We have invested in standby generators across our critical assets to ensure we can maintain service during storm events.

As a key part of critical national infrastructure we actively participate in national resilience planning.

We are active members of regional and local resilience partnerships, supporting other organisations (emergency services, utilities etc) and communities during events, and accessing support as needed from emergency and other services during events.

We have identified the global supply chain vulnerabilities for climate change and will take this into account in future planning and will update this intelligence over time.

CASE STUDIES

Click on the case studies below to read more:

STORM RESPONSE - POWER

Winter Storms – site access and maintaining water supplies

Whilst climate change generally means warmer conditions and less risk of extreme cold weather we will still be vulnerable to extreme cold snaps. There is uncertainty regarding how climate change will affect global weather patterns and in particular the Jet Stream which contributed to the UK's generally mild (and damp) winters. A weakening of the Jet Stream occurred in February 2018 leading to a lengthy spell of exceptionally cold weather across the UK – the "Beast from the East".

Significant snowfall made many water and waste water works inaccessible and our people worked closely with the emergency services and transport authorities to prioritise safe access to secure critical assets and maintain supplies for customers.

The freezing temperatures caused a lot of additional bursts in customer properties and in our network and towards the end of February this had become critical – the losses from our system were placing significant pressure on the ability to maintain supplies.

In liaison with the Scottish Government this was escalated to a red incident at the same time as the Met Office declared a red snow warning for the central belt of Scotland – the first time it has done this for this area.

We put in place our largest ever response with 50 tankers deployed 24/7 from Orkney and the North Coast down to Lanarkshire.
We worked with our first response contractors, local Police and Roads departments to clear snow and gain access to our works to ensure we could maintain water supplies, with particular priority areas from East Lothian to Aberdeen and from Ullapool to Inverclyde.

This event brought together a range of emergency and critical services to support resilience.

WHAT WE PLAN TO DO

Climate change will increase frequent storms that will not only impact Scottish Water assets but also the key external infrastructure that we rely on to deliver services.

To adapt to the risks presented by increase in climate change driven storm events and to maintain current service to customers and the environment:

We will update water and waste water operational resilience plans

We will work with Scottish Government and other partners to support Scotland's resilience response to climate change

We will reflect global climate risks in our supply chain and procurement strategies

Adapting to climate change is an ongoing activity across the century.
This table illustrates the key actions we plan to take out to 2050 to deliver adaptation.

Ensure our operational resilience plans are updated to reflect the impacts of climate change on power, transport, communications and supply chain	1.	Update operational resilience plans to reflect the latest intelligence on the impacts of climate change on key interdependencies.	2023-2027
	2.	Ensure that operational resilience plans are reviewed and updated following storm events and updated climate risk intelligence.	Ongoing
Work with Scottish Government and other partners to support Scotland's resilience response to climate change	1.	Engage with Scottish Government and other agencies improve Scotland's resilience response to major events driven by climate change.	Ongoing
Reflect global climate risks in our supply chain and procurement strategies	1.	Update our procurement strategies to incorporate climate change risk assessment of suppliers.	2024-2027

ENABLERS

ENABLERS

Scottish Water can adapt its assets to be resilient to climate change. However, we recognise that we need to work with others to deliver adaptation on a wider scale.

Water Resource Management in Catchments

All water users in a catchment need to work together to understand the impact of future rainfall patterns on water resource availability and how that water resource will be shared in a climate change future. We need to plan the landscape at catchment scale thinking where to restore peatland, where to plant trees, where to improve watercourses to make the catchment more resilient to climate change, conserving water resource, improving quality and managing flood risk. To do this, we need to work with SEPA, farmers, estates, fisheries, forestry, the hydro sector, the whisky sector and local authorities.

Flood Risk Management in Urban Catchments

Climate change will lead to increased flood risk in our urban areas. To address this, we need to look across our urban landscapes to assess how we best manage flood risk. We need to adopt blue-green infrastructure to manage the flood waters on the surface and deliver co-benefits such as placemaking and improving urban biodiversity. To do this we need to work with local authorities, developers, roads authorities and SEPA.

Engaging Customers

To help conserve water resources in a climate change future we want to reduce demand from our customers. To do this we will work with developers and building standards to make properties and appliances as water efficient as possible – making it easy for our customers to be water efficient. We will engage our customers to make them more aware of their water use and how they can reduce it to help the environment and reduce their energy costs. In parallel, we will continue our work to reduce leakage from our and our customers pipes.

Policy and Regulation

To deliver an adapted Scotland we will work with the government, the wider public sector and private sector to share best practice on adaptation, being transparent on the futures we are planning for, and to identify opportunities for effective and efficient integrated adaptation. To do this we will work with our stakeholder and government to update policies and regulation to facilitate adaptation.

Securing Investment and Growing our Supply Chain

There is a significant cost associated with adapting our assets to ensure they can keep delivering expected service in a changing climate. We are currently forecasting a range of £2-5 billion over the next 25 years. We will work to improve our intelligence of this forecast. Key here will be engaging our stakeholders on the work we need to do on adaptation, and making the public case for the funding that is needed, and prioritising the right investments to deliver it. We recognise that adaptation is one of many investment needs that Scottish Water has to progress to maintain service – the issue, however, is that whether we invest in a timely manner or not, the climate will continue to change and if we do not adapt then we will see negative impacts on service and environmental quality..

In parallel, we recognise that we need to work with our supply chain partners to grow their capacity to deliver our investments and also to grow their skills in the area of adaptation.

Updating our Adaptation Plan

Each year in our annual report we will update our customers and stakeholders with progress on our adaptation understanding and activities and how we are addressing adaptation risks on our water and waste water systems.

We will be establishing performance metrics for adaptation, and we will include these in our reports to the government as part of our reporting for the Scottish Government's Adaptation Plan for Scotland due in 2024.

We will update our Adaptation Plan when we have agreed the content of our next strategic plan and regularly thereafter to inform the updates to the Adaptation Plan for Scotland.

We will refresh our climate change risk assessment as we update our investment plans ahead of a new regulatory period.

RISK ASSESSMENT APPENDIX

RISK ASSESSMENT APPENDIX

Climate risk narrative			2050 climate risk position under a 2 degree warming world	2050 climate risk position under a 4 degree warming world
Change driven by global warming and increased greenhouse-gas emissions	Disruptions to the operating system caused by the climate driver	Resulting impacts on the operating system and downstream implications	Risk score: Likelihood x magnitude	Risk score: Likelihood x magnitude
Climate driver	**Risk**	**Impact**	**Risk score – 2050s, 2 degree**	**Risk score – 2050s, 4 degree**
Drought conditions	Lower river flows and/or reservoir levels affect the ability to abstract from source waters	Local or regional water supply deficits lead to service disruption and loss of supply to customers	**350**	**350**
More frequent/extreme rainfall	Increased frequency and magnitude of river and surface water flooding at water treatment sites	Operational impact leading to loss of supply to customers	**200**	**350**
High summer temperatures and lower rainfall	Algal blooms associated with warmer temperatures and lower flushing of source waters	Water treatment is more difficult leading to quality, taste and odour impacts to customers	**175**	**350**
More frequent/extreme rainfall	Drainage systems and sewers become overloaded with storm water and surface water flows entering the network	Increased flooding of customer properties; increased environmental impact	**175**	**350**
Increased variability in weather – drier conditions followed by extreme rainfall events	Increased land runoff, erosion and flushing of organic matter and pollutants impacts quality of source waters	Water treatment is more difficult affecting quality and supply of water to customers	**175**	**350**
Drier and hotter conditions	Low reservoir levels and warmer water leads to release of chemicals such as iron and manganese from sediments impacting the quality of source waters	Water treatment is more difficult affecting quality and supply of water to customers	**175**	**350**

Climate risk narrative			2050 climate risk position under a 2 degree warming world	2050 climate risk position under a 4 degree warming world
Change driven by global warming and increased greenhouse-gas emissions	Disruptions to the operating system caused by the climate driver	Resulting impacts on the operating system and downstream implications	Risk score: Likelihood x magnitude	Risk score: Likelihood x magnitude
Climate driver	**Risk**	**Impact**	**Risk score – 2050s, 2 degree**	**Risk score – 2050s, 4 degree**
Drought conditions	River levels fall reducing the ability of the environment to cope with waste water discharges without causing pollution during low flow events	Potential tighter standards for environmental discharges	**175**	**350**
More frequent and extreme rainfall and sea level rise	Ability to discharge waste water is compromised by high water levels in receiving waterbodies causing system back-up	Disruptions in waste water systems and site flooding	**100**	**175**
Extreme weather and storm events	Disruption of power network and power outages impacts pumping and treatment as well as communications	Operational disruptions, loss of customer service, increased emergency response	**100**	**175**
Drought conditions	Soil moisture decreases in the warmer months causing shrinking of soils and pressure on pipes leading to increase in bursts	Increased leakage, increased risk of interruptions to supply for customers	**100**	**150**
Dry conditions followed by extreme rainfall	Erosion of earth embankments causes damage to assets and any underlying infrastructure	Risk of failure of structure, increased rate of deterioration of assets, increased maintenance, repair and replacement costs	**100**	**150**
More frequent and extreme rainfall	Higher flows and water levels in reservoirs and other impounding assets leading to more frequent spills and increased pressure on assets	Damage to impounding structures and reduced asset lifetime leading to increase in maintenance costs	**50**	**150**
Lightning strikes	Incident at biogas production sites	Risk to health and safety of workforce and public	**50**	**150**

Climate risk narrative				2050 climate risk position under a 2 degree warming world	2050 climate risk position under a 4 degree warming world
Change driven by global warming and increased greenhouse-gas emissions		Disruptions to the operating system caused by the climate driver	Resulting impacts on the operating system and downstream implications	Risk score: Likelihood x magnitude	Risk score: Likelihood x magnitude
Climate driver		**Risk**	**Impact**	**Risk score – 2050s, 2 degree**	**Risk score – 2050s, 4 degree**
	More frequent and extreme rainfall	Increased frequency and magnitude of river and surface water flooding at waste water sites	Operational disruptions, loss of service to customers, risk of environmental pollution and increase in repair/replacement costs of damaged equipment and structures	**75**	**150**
	Sea level rise	Increased sea water ingress affecting the quality of source water and ability to abstract	Reduced performance of water treatment processes affecting supply of water to customers	**50**	**100**
	Sea level rise	Coastal erosion impacting the structural integrity of water and waste water assets and ability to operate	Loss of asset leading to operational disruptions, loss of service to customers and increased cost for asset relocation/protection	**35**	**100**
	Sea level rise	Increased frequency and magnitude of coastal flooding of water and waste water sites	Loss of asset leading to operational disruptions, loss of service to customers and increased cost for asset relocation/protection	**20**	**100**
	Drought conditions	More concentrated sewage reaching waste water treatment works during prolonged periods of dry weather	Reduced performance of waste water treatment and increased operational (eg chemical) costs	**35**	**50**
	High wind	Damage to structures/assets	Increased costs of repair and replacement	**35**	**35**

Climate risk narrative			2050 climate risk position under a 2 degree warming world	2050 climate risk position under a 4 degree warming world
Change driven by global warming and increased greenhouse-gas emissions	Disruptions to the operating system caused by the climate driver	Resulting impacts on the operating system and downstream implications	Risk score: Likelihood x magnitude	Risk score: Likelihood x magnitude
Climate driver	**Risk**	**Impact**	**Risk score – 2050s, 2 degree**	**Risk score – 2050s, 4 degree**
Extreme weather and storm events	Disruptions on transport network (eg fallen tree, flooding) impeding access to site for emergency repair/operations	Operational disruptions of water and waste water sites leading to loss of service to customers	**35**	**35**
More frequent and extreme rainfall	Increased river flows and velocities causing scours and bank erosion with impact on structural integrity of pipes, bridges, culverts, outfalls	Increased repair and replacement costs, environmental spills from waste water network and/or loss of treated water	**20**	**35**
Dry conditions and high temperatures	Low flows, increased deposition and higher temperatures in waste water network leads to increased septicity and corrosion risk	Increased deterioration rate and costs of maintenance of structures	**20**	**35**
High temperature	Indoor and outdoor temperature beyond acceptable working conditions	Workplace health and safety	**15**	**20**
High temperature	Increased ambient air temperatures and failure of sensitive mechanical or electrical equipment	Operational disruptions and increase in maintenance, repair and replacement costs	**15**	**20**
Higher temperature	Increased spread of invasive non native species with warmer temperatures as more favourable conditions for growth	Increased maintenance costs	**4**	**20**
More frequent/extreme rainfall	More variable demands on pumping equipment in waste water networks (ie rising mains) during storm events	Reduced equipment lifetime and increased costs of repair and replacement	**20**	**20**
Drought conditions	Reduced groundwater recharge affecting the ability to abstract from source waters	Reduced yields leading to local and/or regional water supply deficits	**20**	**20**