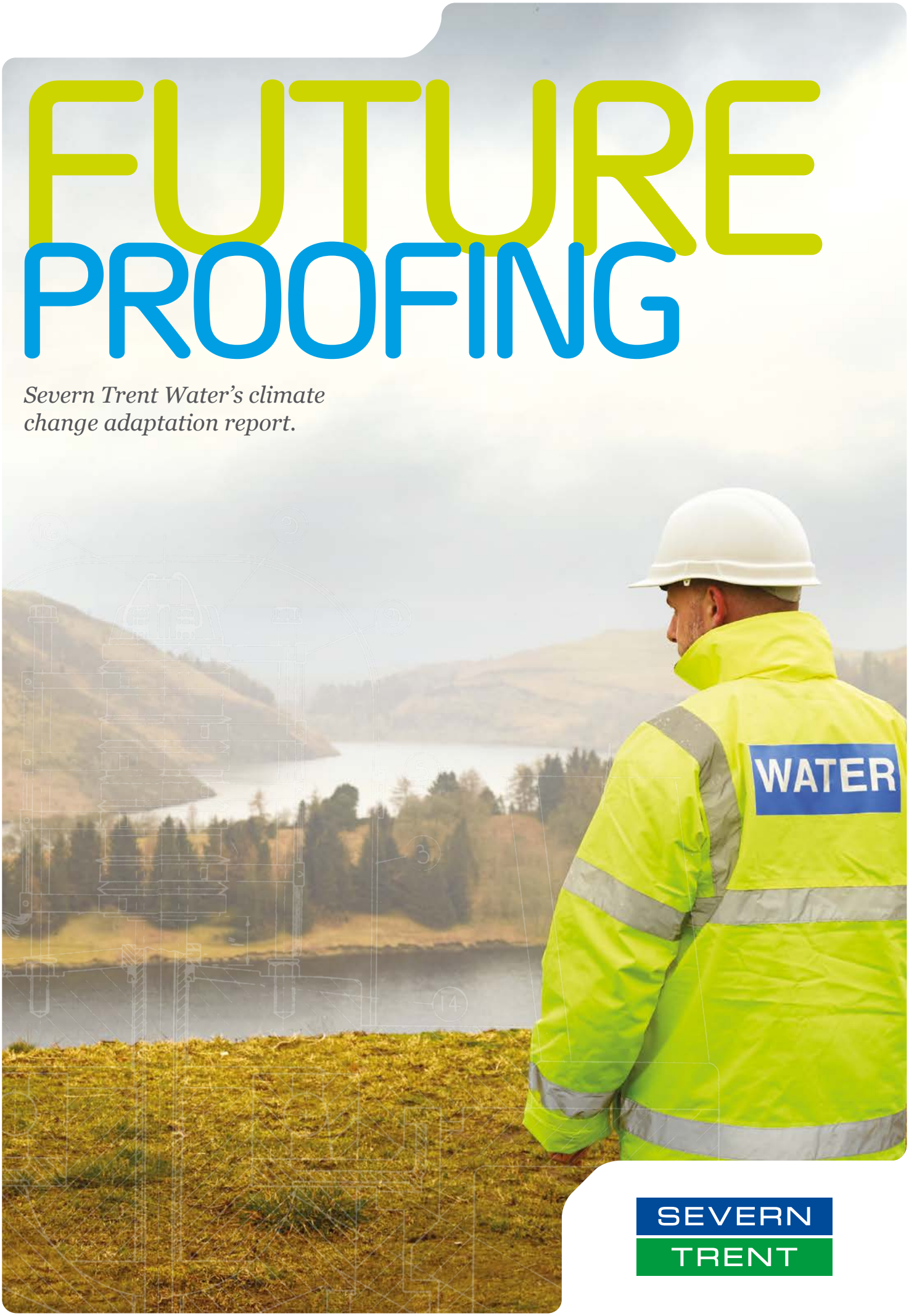
FUTURE PROOFING

Severn Trent Water's climate change adaptation report.



SEVERN TRENT

Contents

Introduction

Climate change adaptation is about coping with future changes to our weather. The focus of this report is how Severn Trent is doing this. The water sector is arguably the most vulnerable sector to the impacts of climate change; this is because almost all the activities involved in serving our customers are sensitive to the weather.

In this, our second formal Climate Change Adaptation report, we describe the actions we have undertaken over the last five years to adapt to climate change, present our review of the climate change risks across all aspects of our service and set out our plan to make further progress in building climate resilience.

Our customers trust that we will supply them with an uninterrupted supply of clean water now and in the future. They also have confidence that we will remove their waste water and return it to the environment in a sustainable way. The work we did to compile this report has helped us better understand and plan for challenges that lie ahead and adapt the way we run our business to be able to cope with more extreme and unpredictable weather patterns.

There has been much change in water regulation over the five years since our first Climate Change Adaptation report. It has probably been the most significant period of change seen in the water industry since privatisation. Many of these changes align with the proposals we set out in our 2010 publication Changing Course*, where we set out sensible steps to move the water sector into a better position to respond to the challenges presented by climate change.

There are two key changes in particular - the introduction of Outcome Delivery Incentives (ODIs) and the move from separate regulation mechanisms covering operating expenditure and capital investment to one covering total expenditure (totex). These changes bring into sharper focus the need for Severn Trent to continue to successfully identify and address future risks before they impact on the services we provide. We explain the impact of these changes later in document, but the key point is that our ability to successfully identify and adapt to climate change is now intrinsically linked to our financial performance. Climate change adaptation is now further embedded into the way we do things.

Mitigating through reducing our emissions

We are also working hard to reduce our greenhouse gas emissions that contribute towards global climate change. We have ambitious targets to increase the amount of renewable energy we generate to the equivalent of 50% of our electricity needs, which will have a significant impact on our emissions. Although this is not the main focus of this report, we recognise that adapting to and mitigating climate change are both important.

In this report we explain:

- **How weather affects us and expected climate change in our region.**
- **Progress we have made on adaptation since our 2010 report.**
- **Our latest view of the threats and opportunities climate change poses.**
- **Adaptation actions we are taking to ensure we meet our company outcomes 2015-2020.**
- **Potential barriers to adaptation.**
- **How we've engaged with stakeholders and customers.**

***severntrent.com/future/policy-regulation/changing-course**

Severn Trent Water's Climate

Our main operating region covers an area of 21,600 square kilometres, from mid-Wales to Rutland, and from the Humber down to the Bristol Channel. We provide services to around 8 million people, with the UK's second largest city, Birmingham, in the centre.

The climate in our region is transitional; cooler towards the north and drier towards the east. As our region is not on the coast, we do not face risks from coastal erosion, rising sea levels or tidal inundation. However, without the moderating effects of the sea, the temperature range across our region is more pronounced than in other parts of the UK. Temperature extremes in both winter and summer are a characteristic of the Midlands climate.

Most of our rainfall comes from the west across the Atlantic and so the central part of our region lies in the 'rain shadow' of the Welsh mountains. We rely on the rainfall in the more mountainous, western and northern areas of our region to feed the major rivers and aqueducts to supply the drier, more populous areas.

Prolonged rainfall can lead to flooding, especially in winter and early spring when the ground is saturated. The Severn valley is particularly vulnerable, because it drains extensive upland areas in mid-Wales. Places like Gloucester and Tewkesbury in the South of our region are particularly prone.

We use weather records from a range of locations in our region for monitoring and planning. In some cases these records stretch back over a century. This information allows us to observe how the local climate is changing and compare information on weather with asset and service performance.

The climate in our region is now on average around 0.8°C warmer than in the early 20th century. Over the past decade average temperatures and rainfall have remained fairly stable. However, we have seen a high frequency of extreme record events over the same period. These events are discussed in more detail later in the report.

About us

One of the largest of the 10 regulated water and sewerage companies in England and Wales. We provide high quality services to more than 3.3 million households and businesses in the Midlands and mid-Wales.

Turnover

£1,581.2m (2014: £1,544.8m)

*Profit**

£539.0m (2014: £518.6m)

*Before interest, tax and exceptional items.

Households and businesses serviced

3.3m

Litres of drinking water supplied each day

1.8bn

Litres of waste water collected per day

1.4bn

Employees

5,181 (at 31 March 2015)

Where we operate

Our region stretches across the heart of the UK, from the Bristol Channel to the Humber, and from mid-Wales to the East Midlands.

This diagram shows what we do and some key facts about our network.

Severn Trent Water and Climate Change

In order to assess the risks posed by climate change in our region, we rely on the UK Climate Projections developed and released in 2009 (UKCP09).

The projections indicate that we should expect changes in both the intensity and frequency of weather events we currently experience. This is important because it helps us to understand the potential impacts and plan effectively for the future.

We make proportionate use of the projection information from UKCP09. For most of our business, the headline messages from the climate projections are enough to inform our adaptation actions. In these cases it is the direction of travel of the climate signal that is necessary to guide decisions. In other cases where a more precise quantification of the change is required, such as in water resource management planning, a more sophisticated and resource-intensive use of the projections is applied.

A full outline of the climate change projections for our region can be seen in Appendix 2 of our first climate change adaptation report. One of the shortcomings of UKCP09, is that it cannot give an indication of changes to drought frequency or heavy rainfall events, both of which are important areas of climate risk for us. These gaps are being addressed with ongoing research, for example the CONVEX project focuses on projecting changes to frequency and intensity of rainfall events and MaRUIS focuses on improving scenarios for drought planning.

Climate Change: expected changes in our region

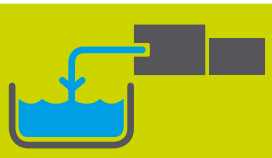
- *Increased summer mean temperature.*
- *Increased winter mean temperature.*
- *Decreasing mean summer precipitation.*
- *Increased mean winter precipitation.*
- *Heavy rainfall in winter is projected to become more frequent.*
- *Periods of drought are projected to become more common.*

Everything we do is impacted by the weather

"Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of societies." [UN]

As a water company, every stage of what we do is affected by the weather in some way. This means that in order to continue to improve our service and grow as a business, we need to understand and adapt to changing weather conditions. At the heart of dealing with future weather is an understanding of how the weather today affects our operations.

Everything we do is impacted by the weather

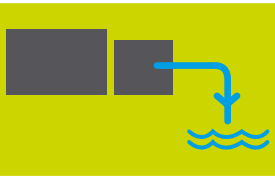


Temperature and rainfall impact the quantity and quality of water available to abstract.

The performance of our assets such as pipes are threatened by extreme weather.

The demand for our product rises significantly on hot days.

Hydraulic capacity of our sewers is impacted by both extended dry periods and extreme rainfall events.



Temperature and rainfall impact the condition of the environment to return final effluent.

Recent weather events

Over the last five years we have experienced a number of extreme weather events in our region including drought, floods, heatwaves and storms. Nationally, we have also seen record breaking average conditions with:

- **2012 the wettest year on record**
- **winter 2013/14 the wettest on record**
- **2014 the warmest year on record.**

Although individual events cannot be said to be caused by climate change, we know that they are more likely to occur in the future. In this section we highlight how extreme weather can have an impact on our services. We analyse all significant service failures and their causes in order to learn lessons to minimise the future impact on the services our customers receive. In general, factors like sewer misuse, aged assets failing or third-party damage are more common causes of service failure than the weather. For example our analysis shows that in the last 5 years extreme weather has directly influenced less than 2% of our water supply interruptions.

It is important that we understand how extreme weather affects our services. If we can improve the way we cope with current severe weather then we will be much better placed in the future when more extreme and unpredictable weather will occur.

Timeline of weather impacting service 2010-2015

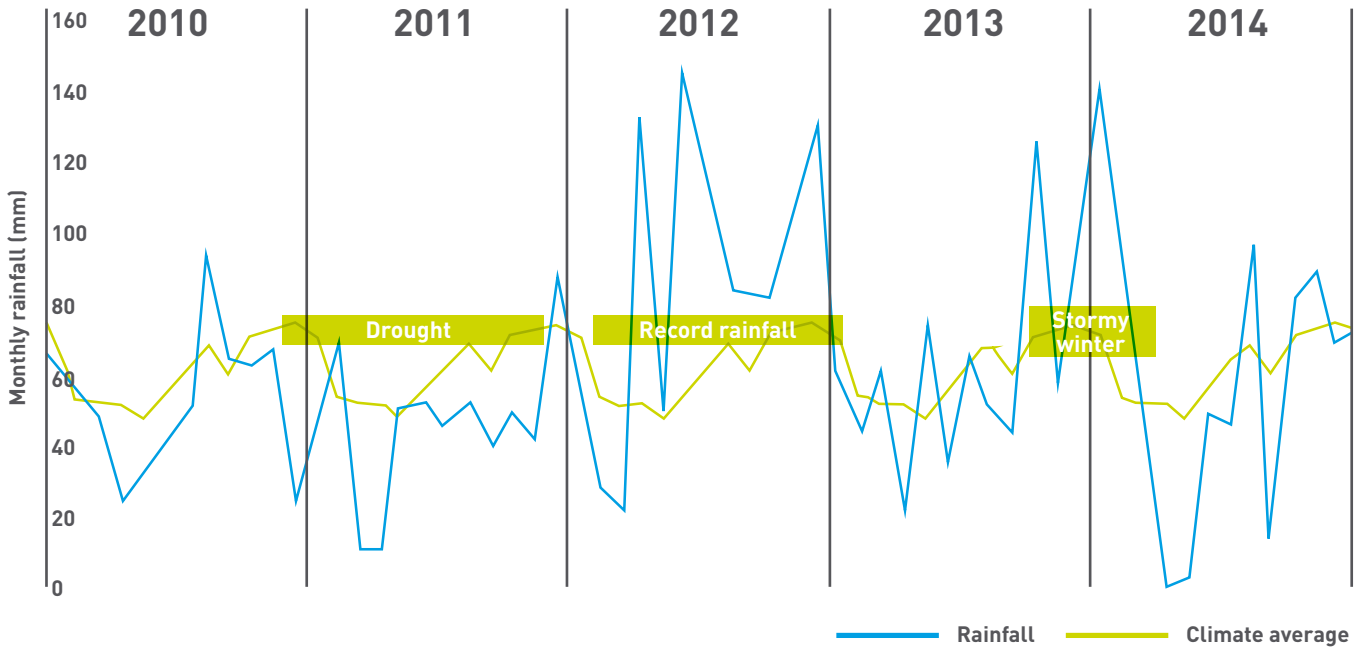


Figure 1 - The rainfall records for the Midlands over the last five years show the exceptionally dry periods we experienced in 2010 and 2011 and the extremely wet months experienced in 2012, 2013 and 2014.

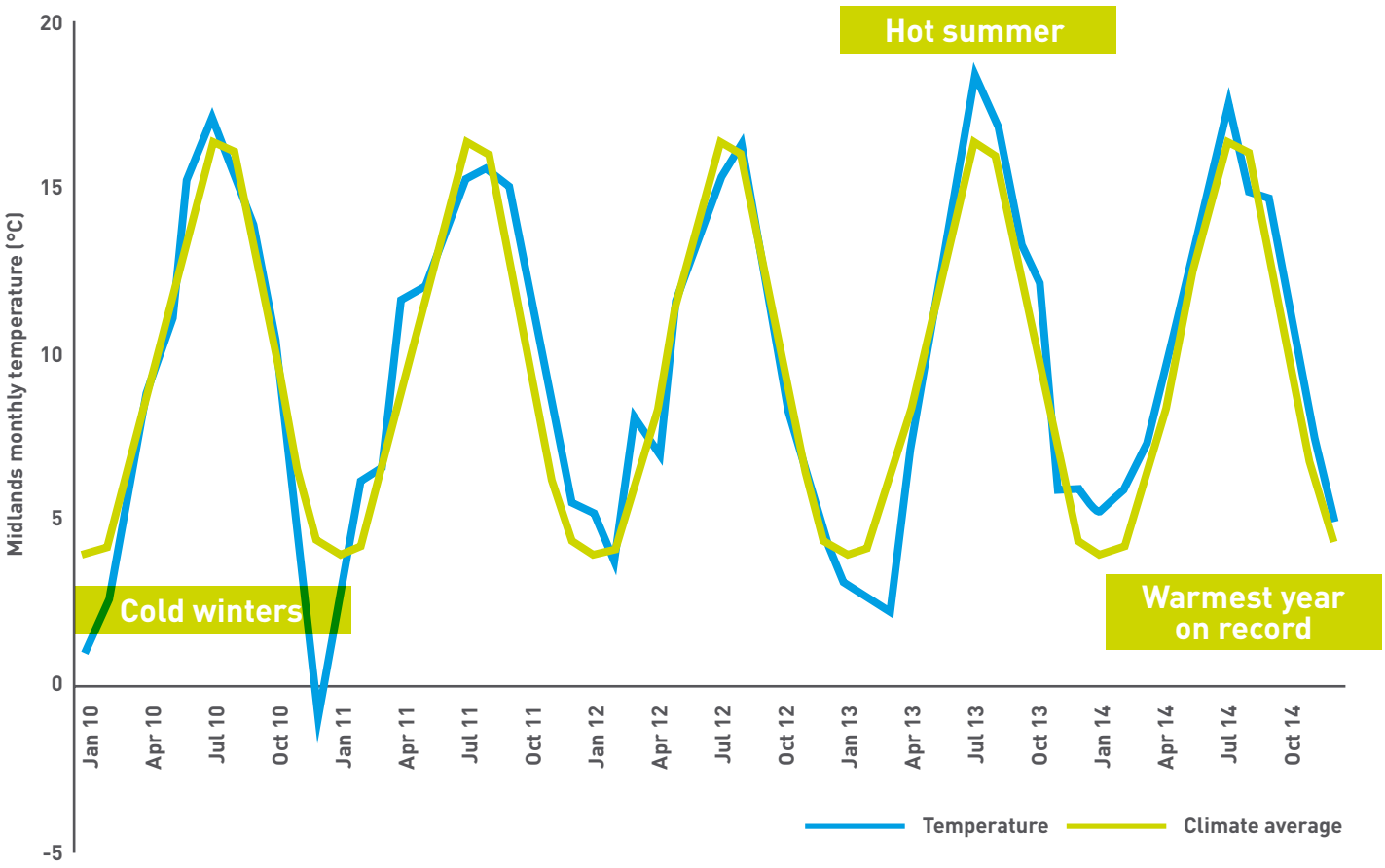


Figure 2 - The temperature records for the Midlands over the last five years show the extreme cold winter we experienced in 2010/11 and the hotter than average period during the summer of 2013.

When	Weather event	How it affected us	Key learning points
Winter 2009-10	Over the winter the UK saw a spell of very low temperatures and snowfall across the country. A similar cold weather event was experienced in December 2010.	This resulted in more severe ground penetration of frost and greater pipe stress, leading to more bursts. Reported leakage increased by 80Mld between Dec 2009 and Jan 2010. Mains bursts peaked at 1760 in Jan 2010 – a 70% increase on the previous month.	Our winter contingency plan ensured that sufficient additional resources were in place to deal with the effects of the prolonged freezing temperatures and to recover under-performance earlier in the year. In addition we significantly increased our leak detection and repair activity to address the resulting increase in leakage. As a result, the leakage for the year was below our target commitment.
Winter 2009-10 to Spring 2012	An extended period of lower than average rainfall over two years led to a drought being declared in the Midlands.	Risks to our balance of supply and demand rose and we began to implement procedures to move water and reduce demand in certain affected areas. Other abstractors and rivers in our region began to experience water shortages.	In contrast to other areas of England, supply restrictions were not necessary due to the actions we took. Our procedures were tested including how temporary overland connections can function as an effective response to supply risks in key areas (see the case study on "Water transfers").
Summer 2012	The UK experienced record rainfall levels, even higher than those experienced in 2007.	Heavy runoff made a significant difference to the water reaching our water treatment works. Our treatment regimes had to change to deal with this. The event also proved the effectiveness of our water treatment works flood defences completed since 2007.	This event emphasised the benefits of seeking to influence catchment runoff at source to reduce water quality risks and secure the resources required for water treatment.
January 2013	Heavy rainfall over December 2012 saturated land and prompted a landslip in the Llandinam area.	The landslip caused a major pipe burst resulting in 1300 customers being out of supply for a period of over 6 hours.	This event highlighted the importance of landslides as a risk to supply and prompted us to improve response processes.
July 2013	Summer 2013 was a significantly hot and dry spell with temperatures 2°C above the average.	Demand spikes in many of our regions led to demand at 120% of the average.	This event showed the short-term impacts (as well as longer-term effects) that spikes in demand during hot weather periods can cause in some of our supply zones. This has led to an improvement of our hot weather action plans.
February 2014	High wind speeds over parts of the UK caused a major power outage in the west of our region. The peak mean wind speed recorded in the area during the first storm ranks as the joint highest on record for that location.	Power supplies were lost to a number of works in the west of our region and there was disruption to our telecommunications providers, which caused a loss of telemetry. As a result water supply was lost to 6,119 customers. Falling trees hampered the delivery of bottled water and uprooted trees caused a pipe burst which was then difficult to access and repair due to storm damage and flooding.	This event was a good opportunity to test our contingency plans. For example, different departments ordered generators which means we ended up with more backup than we needed. We learnt some helpful lessons about what to do when our energy supplies fail and have streamlined our processes.

Learning from across the globe

Climate change is a global problem and the weather conditions we expect to face in the UK in future can already be observed in other parts of the world. Severn Trent plc is a global water company, so we know that water and wastewater services can be provided in different climates with some simple adaptations.

Severn Trent plc can be broadly divided into two sets of operations. The largest part is the appointed water and sewerage company operating in the UK. This report deals with the climate change risks and adaptation measures in that part of our business. The second part of our business is collectively known as 'Severn Trent Services', and covers a variety of functions, operating around the world, as described below.

Regulated - Severn Trent Water

Wholesale water and waste operations

Retail services

One of the largest of the 10 regulated water and sewerage companies in England and Wales. We provide high quality services to more than 3.3 million households and businesses in the Midlands and mid-Wales.

Non-regulated - Severn Trent Water

UK Operating Services

US Operating Services

Renewable Energy

UK Operating Services (incl. Italy and Ireland)
UK Operating Services provides contract services to municipal and industrial clients and the UK Ministry of Defence (MOD) for design, build and operation of water and waste treatment facilities and networks. Retail services are also provided to UK businesses.

US Operating Services
US Operating Services provides contract services to community, municipal and industrial clients for the operation and maintenance of water and waste water treatment facilities and networks.

Our operational responsibilities and business strategy in the Severn Trent Services part of our business are different to those in the regulated UK business. Severn Trent Services tends to have a more narrow range of responsibilities defined by the specific needs of our customers. Generally, we tend to operate assets and do not bear overall responsibility for long-term management of assets or water resources. This means we take a different approach to climate change risks. This report does not cover the risks to those parts of our business.

However, there is a great deal we can learn about weather impacts and resilience from our experiences abroad. We operate assets in more extreme climates than those projected for the UK over the next century. This means that we can draw on experiences of coping with major extreme weather events, of the type which we expect to occur more frequently in the UK in the future. This gives us confidence that we have skills and technology available to adapt to climate change and has already provided helpful learning points to improve our operations in the UK. Some examples are described here.

Hurricanes and storms

In 2012, hurricane Sandy, known as 'Superstorm Sandy', caused a significant amount of destruction across the eastern USA. There was a high level of property damage and human suffering, and power supplies were affected in over 17 states. Severn Trent Services operate several treatment works in the North East of the USA, which were affected by the storm and lost power for several days. Despite this, water supplies were not interrupted. The response was based on clear and simple local emergency plans and having backup generators readily available. Maintaining service after the storm had hit required drawing on manpower and fuel from a region much wider than we typically consider feasible in the UK. Some important learning points for our operations included the need to flexibly move manpower around our whole region and the importance of staff wellbeing during incidents, such as consideration and provision for the families of those involved in supporting the aftermath of major weather events.

Drought

In the US, responsibility for water resources planning and management is executed at the federal level – or through multi-state collaboration. This is different to our operations in the UK, where we hold a much greater level of responsibility over the management of water resources in our region. However, experiences of severe drought in areas of the US are helpful in informing our approach to adaptation. Dry and hot weather has been experienced for protracted periods in Oklahoma, Southern California, Texas and Arizona, where we have operations. Water restriction programmes and rapid development of new sources of water are more common than in the UK and could be instructive if we faced extreme drought scenarios.

Other climate risks

Operating globally gives us an insight into weather risks which are less likely in the UK, but which could occur in the future due to climate change, particularly conditions projected under the most extreme scenarios. An example of this is the risk of forest fires, which we know from our Severn Trent Services operations in the US can cause significant problems for water utilities due to siltation and water quality issues following rainfall and runoff from land. The risk of forest fires in the UK remains low, but they have occurred in parts of England and are expected to increase with climate change. This is an example of a risk we need to continue to track and seek to learn best practice from across the world.

Adaptation best practice from across the globe

We will continue to share ideas with Severn Trent Services and look more broadly at solutions to water problems being deployed around the world. Very recent experiences in 2015 in California, for example, show us various measures which can be trialled and deployed at relatively short notice to control water use in circumstances of prolonged drought. Other innovative solutions will emerge in areas experiencing similarly extreme climate pressures and we need to be aware of new technologies. Taking a global view means that our journey to adapt to climate change in the UK need not be into completely uncharted territory.

Adaptation progress since 2010

Over the last 5 years we have improved our resilience to climate change by investing in our assets and improving our processes. Full details of our performance and investment can be seen in our annual report for 2015.

This section describes the actions we have taken since 2010 to improve our resilience to weather and adapt to climate change. Many of these actions were described in our first adaptation report - we have delivered some additional actions which are also described here.

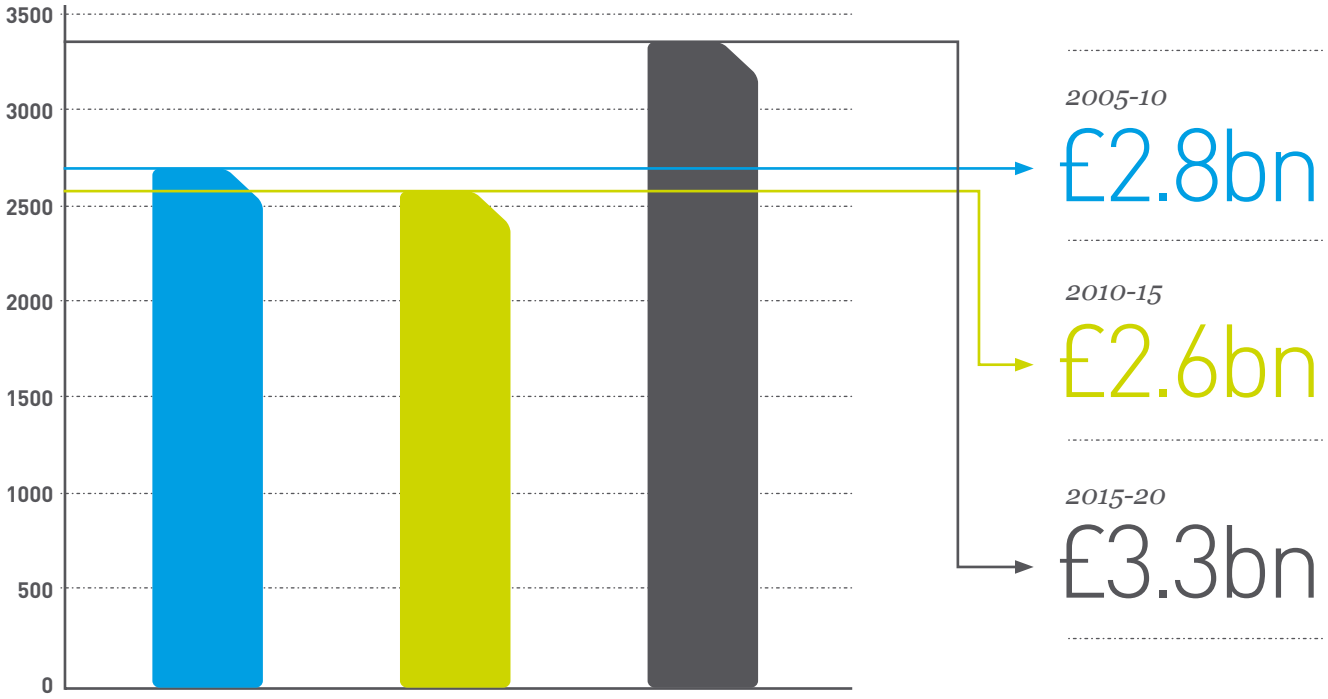
These actions were not driven by the threat of climate change alone. All have multiple benefits and enable us to cope better with the weather of today, at the same time as reducing the risks associated with the weather of the future.

We said...

We'd invest £2.2bn (£2.6bn in 2014/15 prices) to maintain and improve our services, reducing risks to customers.

We have...

Invested £2.6bn to deliver our plans and the improvements customers asked for.



Highlights of actions over the last five years

Leakage has reduced by around 10% since 2009/10 and we now fixing 38% of leaks within 24 hours.	We are one of the most resource efficient companies, at 229 litres of water per person per day - down from 242 in 2009/10.	We have protected 741 properties from internal sewer flooding and 360 areas from external flooding.
77% of our customers now have a resilient water supply (i.e. they benefit from a second source of supply).	We have increased the resilience and security of water supply to over 5.4m customers	In 2014, we achieved our best ever performance on wastewater treatment works compliance – at 99.3%.
We have reduced the average number of minutes that our customers are without supply from 16 minutes in 2013/14, down to 10 minutes in 2014/15.	We have reduced properties at risk of low pressure down to 230 in 2014/15, from 424 in 2009/10.	We have maintained 99.96% compliance with drinking water quality standards.

We said...	*We have...*
We would improve the resilience of our water supply and reduce the number of customers experiencing interruptions.	*Improved the resilience of our water supply for over 5.4 million people.*

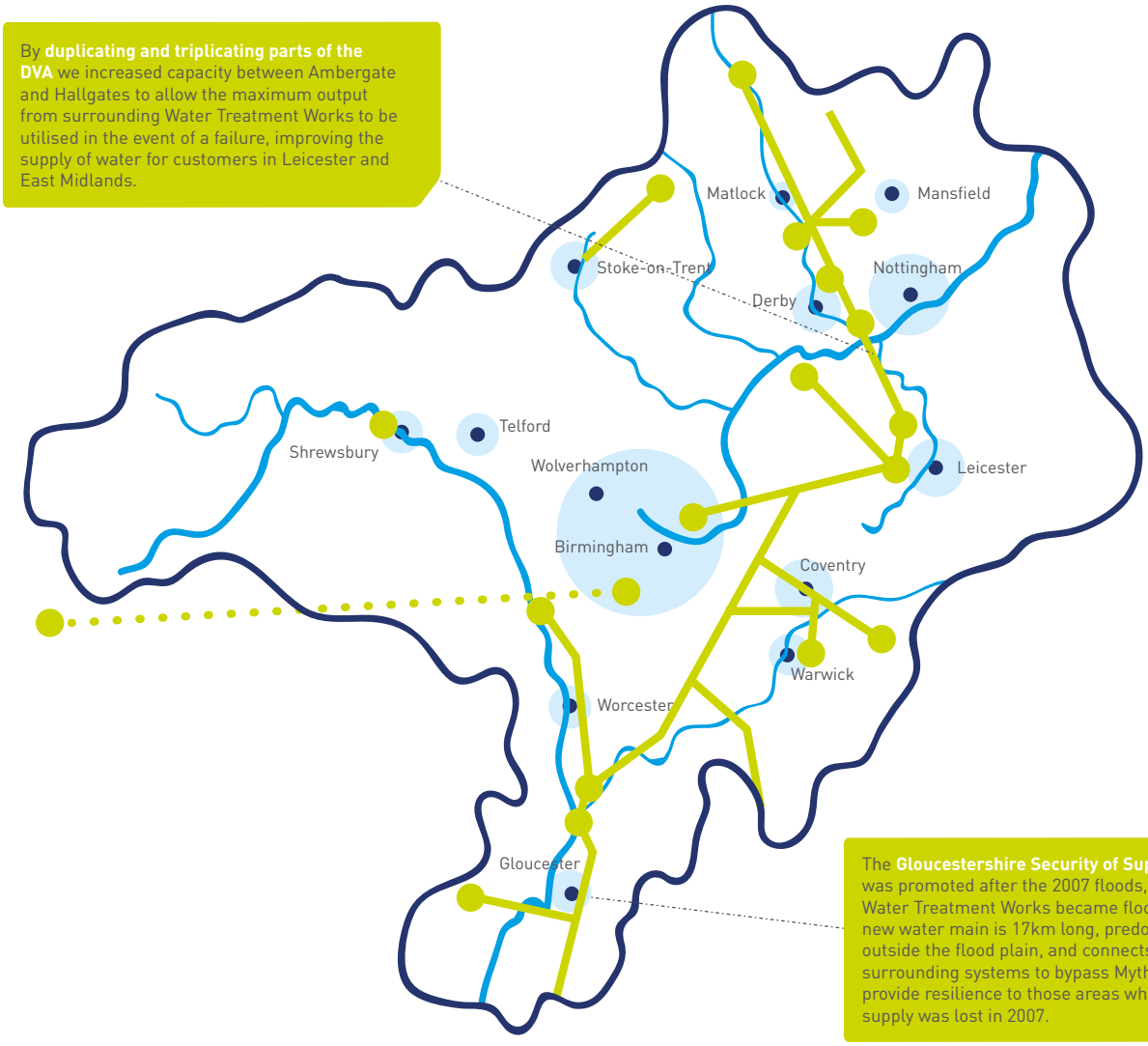
We have invested £132m over the last five years to build our resilience to a number of hazards, further protecting the water supply to our customers. Our balanced programme focussed on flooding, power failure, increasing the flexibility of our network and addressing single points of failure.

- **We have invested in flood defences at seven vulnerable sites, applying the company standard of protection from a 1:200 year return period flood event. This return period was chosen to incorporate headroom due to climate change impacts.**
- **We have made improvements to our strategic grid and wider network to enable more movement of water across our region (see case study). This adds redundancy to our network and allows alternative sources of water to be used in the event of an emergency; for example, the loss of critical boreholes or key single points of failure.**
- **We have invested in power supply resilience through a combination of new generator connection points, allowing mobile generators to be brought on line quickly, and additional fixed generators at critical sites. More information on power resilience is set out later in this section.**

Our programme is aligned with the Cabinet Office's resilience framework which sets out four components of resilience that should be considered: "resistance", "reliability", "redundancy" and "response and recovery". Our resilience programme is directly concerned with the "resistance" and "redundancy" components of resilience; our capital maintenance work (not discussed in this document) contributes to the "reliability" component and our "response and recover" work is discussed further below.

Case Study: Strategic grid improvements

We have invested in our strategic grid to improve our ability to move water from the areas of higher rainfall in the west and north of our region to the areas of higher demand. The flexibility of being able to move water will help us to meet the extra demand predicted with climate change and minimise the potential impacts of drought, improving our overall resilience of supply. A more flexible strategic grid also helps us minimise supply interruptions by providing alternative sources of water in the event of a major failure at our water treatment works or trunk mains.



Case Study: Water transfers - the Draycote "big blue pipe"

We have taken dozens of individual measures to avoid any usage restrictions for our customers. These range from small changes to large network alterations. For example, the record low rainfall during 2011 and 2012 meant that Draycote reservoir, which supplies water to customers in Rugby, was at lower than normal levels. So, we installed a temporary pipe to take water out of the river Leam to refill it. Thanks to this solution we were able to pump up to 12.5 million litres a day to safeguard supply for our customers. We have subsequently turned this into a permanent solution.

We said...

We would save water by helping our water customers to be more water efficient.

We have...

Run an engagement and water efficiency programme which has delivered an estimated saving of over 20 Megalitres per day during 2010-2015.

Our main engagement focus has been on domestic customers and we have been offering a range of services and products (many of them free) to encourage them to change the way they think and to use less water. For example, our award winning "Plug in" programme involved working with social housing providers and the Environment Agency to offer social housing customers advice on saving water and energy and installing water saving devices at home. We estimate we have reduced water use by 20 Megalitres per day since 2010, exceeding our own water efficiency target.

Our schools education programme reaches more than 45,000 children each year, educating future and current customers on water efficiency and what can be safely disposed down the sewer. The team also do outreach visits to community groups, and offer site tours at our education centres in Derby and Hayden. Our combined programme of visits, tours and workshops has engaged 347,941 people since 2010.

We said...

We would reduce sewer flooding by improving and managing our sewer network.

We have...

Protected 741 properties from internal sewer flooding and 360 areas from external flooding.

Over the past five years we have completed major strategic improvements to our sewer system to reduce sewer flooding. Our largest schemes in Leamington Spa and Gloucester now protect over 100 properties from the risk of internal sewer flooding during periods of high rainfall.

Our understanding of the sewage network has improved markedly since 2010. We have now developed sewage management plans with live hydraulic and operational data, covering over 53% of our population in the highest risk areas of our region. They are used to inform capital programmes and investigations and give us better visibility of our assets and their relationship with the weather than ever before. We aim to increase this to 100% population coverage by 2020.

We design our sewage systems so they are resilient to withstand a 1 in 40 year flood event, above the industry standard of 1 in 30 years. We estimate that precipitation intensities would need to increase by 7% to erode this difference. Based on UKCP09 data we estimate that our sewer system is likely to remain resilient against peak winter precipitation until the 2030s. However, beyond that a step change in surface water management is needed over the next decade in order to protect service levels in the long term.

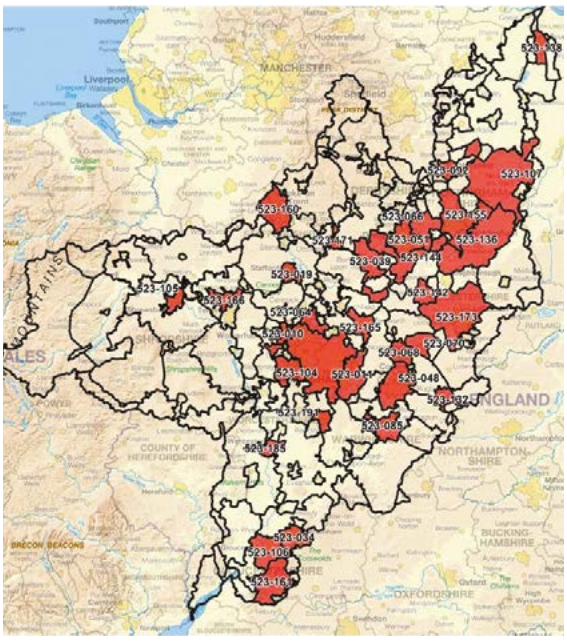


Figure 3 - The sewer catchments in red are our highest-risk areas and each of these now has a live Sewer Management Plan developed since 2010. Over the next five years we aim to have live plans in place for all catchments.

Figure 4 - In 2014 we built a comprehensive digital model with Birmingham City Council to understand the causes of the flooding which occurs in the Lodge Hill area of Birmingham during heavy rainfall events. Working together to understand the various causes of flooding and evaluate the solutions makes it more likely we can identify and address the root causes of flooding.

We have increased our focus on developing solutions which manage surface water flows into the sewerage system rather than traditional containment designs (e.g. larger sewers/tanks to attenuate excess flow). This approach has provided the opportunity to work with other flood risk management bodies to manage overland surface water flood risk by addressing the multiple sources of flood risk.

Since 2010, we've completed 7 investment projects to prevent sewer flooding in partnership with other agencies. The lessons and successes from these projects are now being applied to help shape future projects.

We said...

We would improve and protect our sewage treatment works and pumping stations to reduce the risks to river water quality.

We have...

Improved our overall treatment standards to reduce the number of pollution incidents and invested £6m specifically to protect rivers from the effects of our works flooding.

Pollution incidents are caused by unplanned discharges of water or sewage into the environment and can vary in severity from a minor impact to an event creating significant environmental damage. We have invested significantly in assets, people and processes to reduce the risks of pollution over the last five years. As a result, in 2014 we achieved the highest performance rating from the Environment Agency for environmental performance. This has been achieved despite the significant high and low rainfall periods we experienced in 2012 and 2013, both of which affected the discharge and quality of receiving water.

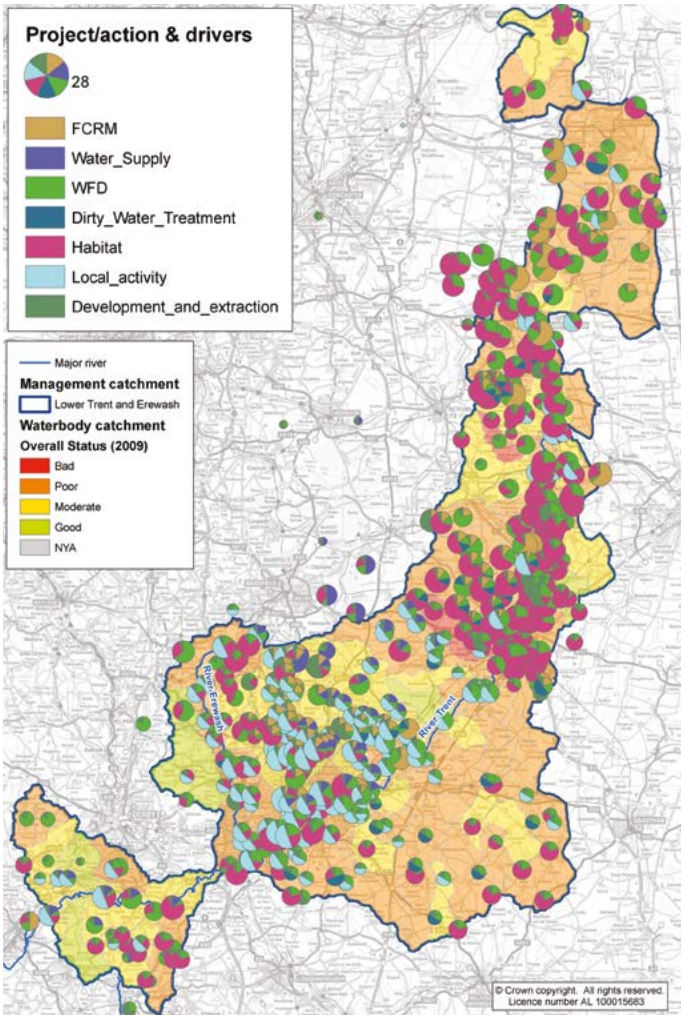
Over the last five years we have invested £6m to protect customers and rivers by strengthening, relocating or modifying the key sewage pumping stations and sewage treatment works which were identified as being at risk of flooding. We have also fitted standby generators at one of our major sewage treatment works, which was identified as being at risk of power outage due to fluvial flooding.

We said...

We would promote sustainable catchment management

We have...

Developed our understanding of the catchments in our area and started nitrate and pesticide control trials to reduce water quality risks from runoff.



Catchment management means working with others to deal with water quality risks at their source, rather than at the treatment works. Since 2010 we successfully delivered one of the largest programmes of catchment management investigations in the sector at a cost of £1.8m. Our work was primarily aimed at improving our understanding of our catchments so we could target schemes on the ground.

We started with desk-based catchment characterisations and modelling of the impact of different catchment schemes. We then carried out extensive stakeholder engagement to develop relationships with farmers, advisors, pesticide manufacturers, regulators, and other conservation groups. With these groups, we have developed risk mapping, cost benefit assessment and high resolution water quality monitoring tools to target activities.

This work over the last five years has allowed us to develop robust future plans that deliver benefits to both water quality and the wider environment. We are targeting the areas with the highest water quality risks, which are those which represent the largest threat to water supply as changes in the severity and frequency of heavy rainfall events occur due to climate change.

Figure 5 - Over the last five years our understanding of our catchments has improved. This example shows the water quality status and projects underway in the Lower Trent and Erewash catchment

We said...

We would ensure continuity of services and manage the effect of climate change on our support services.

We have...

Improved our approach to extreme weather events, increased power resilience, reduced health and safety risks and improved our workplaces.

Sam Harris – Resilience specialist

"Our Being Prepared programme will help ensure we are prepared to deal with the potential impacts of climate change and severe weather, including floods, drought and power interruptions, so we can continue to operate our core functions and maintain the critical services our customers rely upon."

A key feature of an organisation which is well-adapted to climate change is one which is able to cope with disruptive events such as those caused by severe weather. We have a framework called "Being Prepared" that covers business continuity, emergency planning and incident management (including civil contingencies) and is designed to systematically improve our operational resilience. The framework is reviewed on an annual basis and tests our plans and systems to ensure they are fit for purpose. We learn lessons from disruptive events which occur and implement improvements in order to continually improve and increase our resilience.

Opening of Severn Trent's Coleshill food waste to energy plant - March 2015

We have continued with our strategy to increase our power resilience. We have done this through increasing our back up supplies (using standby or mobile generators) and by generating our own renewable energy. Our investment in back up supplies is discussed above and this is supplemented by site-specific operational procedures for a loss of power supply. We also require our suppliers to evidence that they have a robust severe weather action plan in place and their own contingency suppliers to ensure they are able to meet our service level expectations.

We generate our own renewable energy from a diverse range of technologies. This approach reduces costs and carbon emissions and improves our resilience. In 2014-15 we generated 250 GWh of renewable energy, which is the equivalent of 28% of our electricity consumption. We plan to continue to grow this generation to 50% by 2020.

Case Study:
'Being Prepared' for all weathers

Our "Being Prepared" framework ensures we are able to respond and recover quickly and effectively to a range of events, and improve from those we experience. The framework covers business continuity, contingency planning and incident management.

Business continuity concerns how Severn Trent Water's essential services continue to operate in the event of a serious incident. It focuses on workplace recovery, IT service continuity, supply chain resilience and coping with staff absence.

Over 90% of our supply chain is based in the UK, globally a low risk country. All of our critical suppliers are certified on the Utilities Vendor Database, an external body measuring health & safety standards; quality standards; financial performance; social responsibility; sustainability and insurance and liability.

We have a set of contingency plans to support our response to both short term and long-term disruptive events. These range from plans for incidents at specific sites to consequence based plans, e.g. mass absence plans that cover the entire company. The examples most relevant to climate change risks include wet weather action plans, drought plans and flood emergency response plans.

We have an ongoing accredited training programme to develop incident management competency for people who operate at operational, tactical or strategic levels. This follows the national framework for emergency response. This will develop consistency across our business and helps us to work effectively with external organisations that are trained on the same principles and standards.

Our three levels of response are:

- **Gold - Strategic response**
- **Silver - Tactical response**
- **Bronze - Operational response**

As a Category 2 responder under the Civil Contingencies Act we work with the Local Resilience Forums within our region to share information, develop area-based plans and engage in training exercises. These help to develop relationships and coordinate our activities as part of any multi-agency response. Where required, we liaise closely with the Environment Agency and other key external stakeholders to share and develop our flood response plans.

We take proactive action to minimise the impact of adverse weather on our staff both in and out of work, by making weather warnings available and via behavioural campaigns. Targeted communications are prepared and issued twice a year, to help better inform our staff of the actions they need to take to limit the consequences of adverse weather and prepare for winter and summer working challenges.

These comms are then translated into detailed arrangements in the field which mitigate the risks for example promoting the use of orange PPE in summer on water treatment works to deter mosquitoes. We also provide self help guides on our webpage, for example on what to do during a power outage.

We provide our staff with a safe and comfortable working environment, using efficient heating and cooling systems. During the past five years we have completed the refurbishment of a number of regional sites as part of our £65m workplace improvement programme designed to create more efficient, resilient and comfortable workspaces. Notable sites included a new call centre at Pride Park, Derby, and an office building at Shelton in Shrewsbury.

Our new headquarters, Severn Trent Centre, finished construction in September 2010 and achieved a BREEM "excellent" rating. It includes rainwater harvesting and an energy efficient building management system designed to be comfortable in all weathers. We have a continued plan of investment in AMP6 to maintain and further improve the resilience of our other sites.

Case Study:
Making a positive difference in the community

Our primary duty is to provide water and waste water services to our customers. However, we aim to play a positive role in the communities we serve and during the last five years we have gone beyond our duty of care to help those communities during incidents of adverse weather. Examples include:

Pumping to prevent flooding at Hylton Road, Worcester

"We know that Upton upon Severn and Hylton Road in Worcester are likely to flood when the river levels get high and we know it causes a lot of disruption when this happens. To help avoid any issues we have put out our pumps, ready to cope with the extra water we might see. We know that when the river does get high, the local pub has problems with the cellar flooding, and putting out these pumps now to be ready for the river levels rising should help protect that property"

Paul Acton, Wholesale Operations, Worcester

After the floods in our region in 2007, we donated a hovercraft to the Gloustershire fire and rescue service using our community recovery fund. Following improvements in the fire services' own water rescue equipment, the hovercraft has now been passed onto the Severn Area Rescue Association who can make extra use of the hovercraft's unique advantages, specifically in large expanses of coastal mud flats.

Severn Trent Services donated 11 portable electrolytic water disinfection systems to humanitarian agencies working in Haiti 2014 to assist in the effort to provide safe drinking water to the residents of that country. The combined units, which convert saltwater and energy into liquid sodium hypochlorite — a chlorine equivalent — are capable of disinfecting up to 13 million gallons of drinking water per day. The donation was part of a grassroots campaign to enable ordinary citizens to treat their drinking water at the point of consumption.

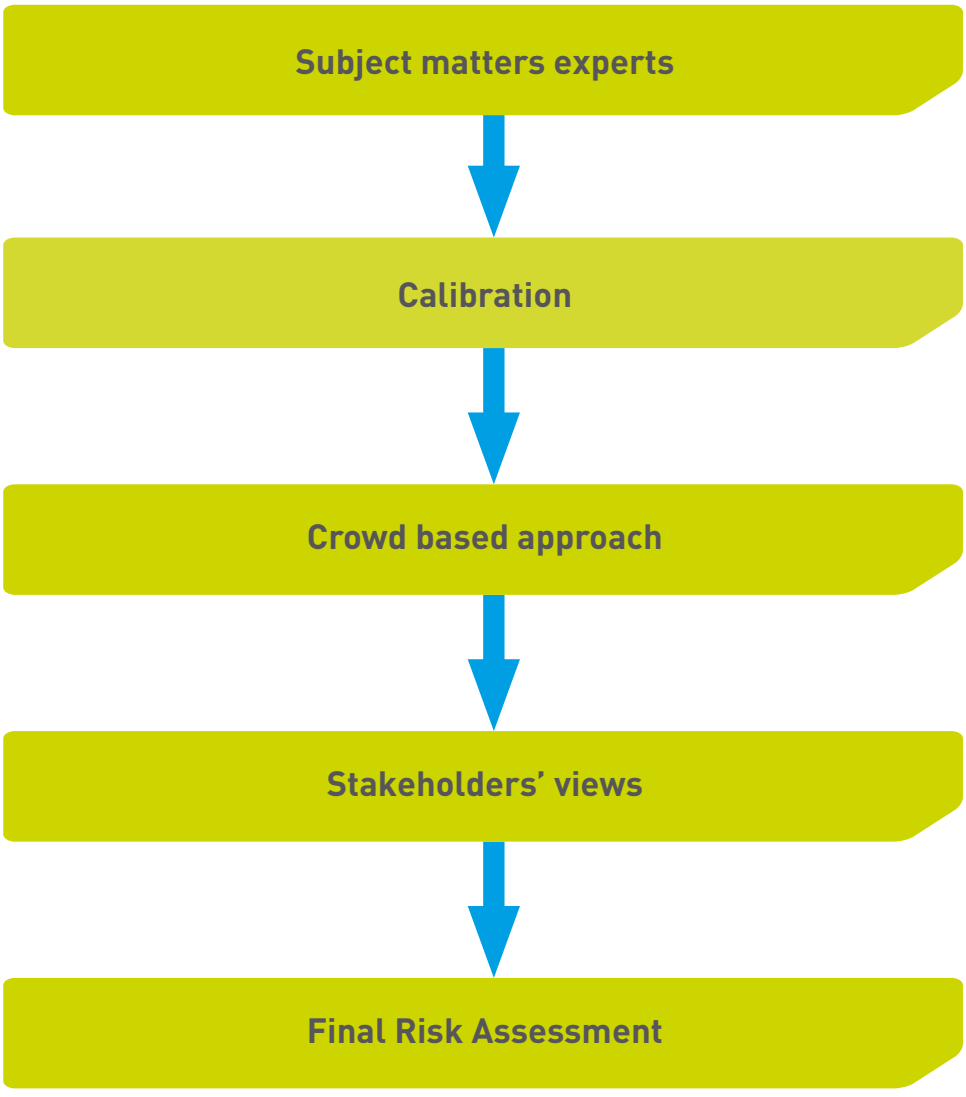
Our Climate Change Risks

Our climate change risk assessment is central to our work on adaptation. Our 2010 risk assessment was wide-ranging and thorough but given our progress in building resilience over the last five years and our improved knowledge and experience, we felt it was the right time to undertake a full review. We used this as an opportunity both to re-evaluate our climate change risks and to raise awareness within our business.

Risk Assessment Process

We completed a five step process to re-evaluate our risks.

In order to ensure consistency and enable us to evaluate changes in risk over the last five years, our starting point was the set of risks we identified in 2010. We then applied the same scoring system with the addition of some new steps in the process. We included these extra steps in order to improve the scoring and calibration of risks and drive direct benefits from the review process itself.



We discuss each of these steps in turn below

More information about the 2010 risk assessment and the scoring methodology we applied can be found in our 2010 adaptation report. **stwater.co.uk/environment/adapting-to-climate-change**

Subject Matter Experts

For every risk we initially flagged in 2010, we identified a group of subject matter experts to review and rescore them. Each subject matter expert was responsible for scoring the risk, using the same methodology as we applied in the 2010 assessment. The methodology gives a risk score out of 50 based on likelihood, proximity, scale of impact and severity of impact. A higher score represents a greater risk.

Each subject matter expert took into account the actions we have taken, changes in our processes, experience during the past five years and improvements in our understanding. A central risk assessment project management team provided base data, support and advice and delivered briefing sessions to ensure consistency. Assessors were also asked to raise any new risks which they thought had previously been missed. The outputs from each assessor were shared with the wider group of assessors for peer review.

Calibration

The central project team then reviewed the updated assessments for all risks against their 2010 equivalent and against each other, alongside the most recent company-wide corporate risk register. An iterative process took place to challenge the scores provided from subject matter experts and seek evidence behind any significant changes. In order to align the risks to our company objectives and make it simpler to communicate both internally and externally, the climate change risks were then aggregated by impact, rather than by the meteorological output variables given in the UKCP09 projections (as we did in 2010). This resulted in a more concise presentation of the risks, making them easier to understand, track and manage.

Crowd based approach

We created an online survey for our internal staff to complete, giving their opinion on our priority risks.
This survey was designed to do two things in a quick and low-cost way:

- Sense-check our findings
- Raise awareness of the most important risks climate change poses to our company, and the importance of adaptation.

One of the major findings was that we needed to clarify our explanation of the risks in order for them to be understandable for all our key audiences. We intend to use this survey approach again periodically during the next few years.

Stakeholder Engagement

In February 2015 we held a stakeholder engagement workshop on our adaptation report. At the event we asked stakeholders for their views on our risks and our prioritisation, providing us with further calibration and review of our scores. We also discussed adaptation actions and opportunities for working together. Several risks had their scores either raised or moderated as a result of these internal and external engagement exercises. Overall, our engagement exercises gave us confidence that our risk prioritisation was reflective of the challenges we face.

You can find out more about our engagement processes on page 59.

Final risk assessment

Our final risk assessment gives us an up-to-date view of the incremental risks which climate change poses to our business, based on the best information we have available to us. A key finding is that most of the climate change risks we identified are existing risks facing our business; however, in the future they are more likely to occur and in many cases the impact is greater. This reinforces our attention on the adaptation options which address current and future risks together.

We took a proportional approach to carrying out our risk assessment. This means we gathered information to a reasonable level that was sufficient to inform priority areas for subsequent action. It is important to note that this level of detail is not necessarily to the standard that would be required to support individual investment business cases. Further work will be done to evidence specific business cases when necessary.

We also chose not to commission an external assessment of our risks because we believe it is important that we retain the knowledge and skills within our company. We believe this is a more sustainable approach to building our institutional capacity to adapt. We did subject our report to external peer review. This is discussed further below.

Climate change risks and company objectives

In total, 36 climate change risks have been identified across our business. We have aligned our priority risks with our company objectives, which reflect what is most important to our customers.

Our objectives and plans for the future are based on three years of consultation and discussion with our customers in England and Wales and discussion with our regulator as part of our five-yearly price review. Our plan for the next five years delivers value for money, is fair and balanced and does the right thing for the long-term. It delivers improvements to our services at the same time as reducing our customers' bills and managing the long-term risks such as climate change.

More detail on our objectives and our plan can be found here:

admin.stwater.co.uk/upload/pdf/Business-Plan-our-commitments.pdf

Our company objectives are:

- *We will provide water that is good to drink*
- *We will ensure water is always there when you need it*
- *We will have the lowest possible charges*
- *We will safely take your wastewater away*
- *We will protect our local environment*
- *We will protect the wider environment*
- *We will make a positive difference in the community*
- *We will provide you with an excellent customer service*
- *We will help you if you struggle*
- *We will finance our business sustainability*

Five of our objectives are the most at risk from climate change over the next few decades so we have grouped our priority risks into these objectives.

Risks are split into two subcategories:

- Direct risks are those which affect the achievement of our own objectives by impacting on a process we control.
- Indirect risks are those which affect our objectives, but by impacting a process we do not directly control (although we can influence).

Priority direct risks

We have identified 14 priority risks (scoring over 20 out of a total of 50) that climate change poses to our business.

Climate Driver	Risk	Description	Score
Hotter & drier summers	**Failure to meet customer demand**	Increased pressure on our water resources means more risk to service and higher cost to meet customers' needs.	**40**
Wetter winters & increased storminess	**Exceeding the sewer capacity**	Runoff exceeding capacity of sewer system and storage, causing surface flooding which affects customers and can cause river pollution.	**35**
Hotter & drier summers	**Abstraction restrictions**	Reduced reservoir and river levels results in restrictions on the amount we can abstract from resources, increasing our costs as we use alternative sources and additional resources which can threaten customers' supply.	**32**
Wetter winters, drier summers & increased storminess	**Decrease in raw water quality**	When it rains after long, dry periods, runoff from fields increases the amount of pesticides (including metaldehyde), pollutant concentrations, and sources of discolouration in water sources. Increased water treatment costs, and threatens compliance with water quality regulations.	**29**
Wetter winters & increased storminess	**Poorer customer experience**	Increased resources required to react to high call volumes more frequently, increasing risk of negative impact on customer experience and more customer complaints.	**29**
Wetter winters, drier summers & increased storminess	**Increase in land movement**	Aqueducts/pipes swept away affecting customers supply and costing money to fix.	**27**
Hotter & drier summers	**Lower river levels**	Lower river levels drop below environmental limits. Compensation from boreholes and raw water reservoirs is required to protect the river, reducing water available for customers and need to seek more expensive sources.	**26**
Increase in temperatures	**Increased bacterilogical growth**	Increased bacterilogical growth, requires increased use of chlorine or organics removal at treatment works, increasing costs of water treatment or water quality deteriorates.	**26**
Hotter summers & increased storminess	**Blockages causing flooding**	Lower average carry flows result in greater sewer deposits, causing blockages, and following intense rainfall events cause local sewer flooding and /or overflows causing environmental damage.	**25**
Increase in temperatures	**Tighter discharge consents**	Lower water quality in the environment, requires us to compensate and increase the treatment of our effluent to a higher standard with associated costs.	**25**
Wetter winters & increased storminess	**Flooding of water works**	Flooding of our water treatment assets impacting our serviceability; threatens ability to supply customers demand. Damage to our equipment.	**25**
Increase in temperatures	**Reduced water levels**	Increased evapotranspiration reduces recharge from current levels. Causing lower river, groundwater and reservoir levels. The amount we can abstract from resources is reduced, which increases our costs as we use alternative sources and additional resources and can threaten customers' supply.	**23**
Hotter & drier summers	**Low pressure water supply**	Higher domestic demand on water. More customers experience low pressure incidents.	**22**
Wetter winters & increased storminess	**Flooding to waste works**	Inundation of sewage treatment works can cause failure of treatment processes which can cause pollution and increase costs.	**20**

Priority indirect risks

There are a few climate change risks which we don't have direct control over that could potentially affect our business on a large scale. Our classification of indirect risks is not intended to suggest they are entirely out of our control. We know that we can take action to reduce the indirect risks; for example, we can improve our resilience to these risks by engaging with and influencing the external organisations which manage these risks directly.

Climate Driver	Risk	Description	Score
Wetter winters and increased storminess	**Power failure**	Adverse weather causes damage to power infrastructure e.g. storm/ flooding/ overheating, causing risk to operational failure.	**30**
Warmer, wetter winters and drier summers including extreme rainfall events	**Supply chain risk**	Suppliers are unable to procure materials or goods required for our processes or projects. (e.g. Chemicals or building materials e.g. insufficient water for processes/ access restrictions). Increases costs to find alternative solutions / unable to find alternatives.	**28**
Storminess	**Damaged ICT/ telecoms**	Damage to ICT infrastructure and telecoms (e.g. mobile phone networks and internet), including remote control and telemetry. This reduces our visibility of how our network is performing and restricts our ability to response effectively.	**28**

A full list of all our climate change risks is shown in Appendix 3.

Impact versus severity of priority risks

In the figure below we have plotted our 14 priority risks to show how they vary in both likelihood and impact. As can be seen in the graph below there is a large spread in both impact and likelihood. The remaining risks identified have medium to low likelihood and impact; they are represented by the blue area on the graph, and are not the main focus of our adaptation action for 2015-2020. All our risks are listed in the Appendix.

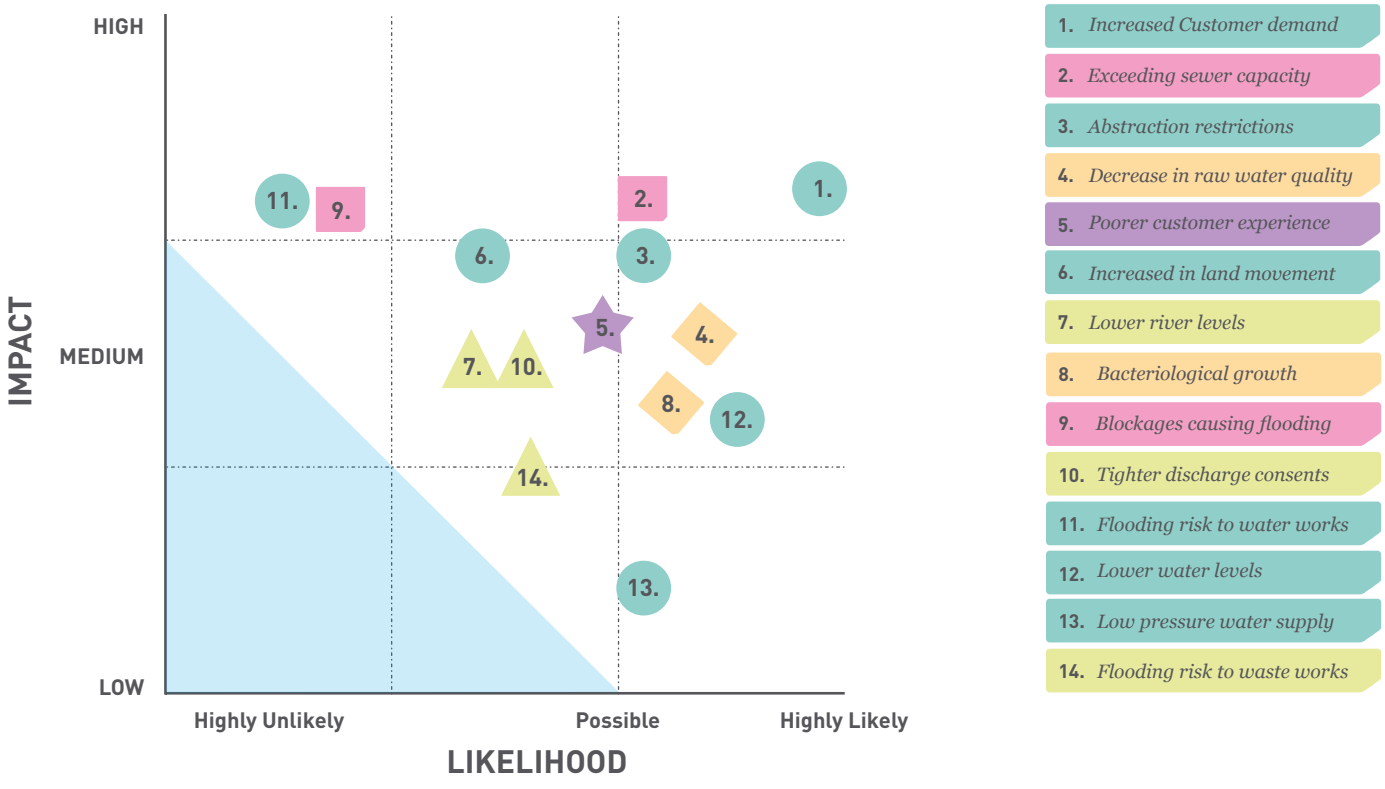


Figure 6: Our priority climate change risks

Alignment of business objectives with climate change risks and impacts

In this section we outline the climate change risks for each of our business objectives. We have grouped the risks based on the business impact. Later in this document we set out our adaptation actions for each objective.

Objective: We will ensure water always there when you need it

Impact of climate change on meeting our supply-demand balance

Risks Associated:

Failure to meet customer demand	**Abstraction restrictions**	**Reduced water levels**

Hotter drier summers are likely to put pressure on meeting our supply-demand balance by increasing domestic demand and reducing the amount of water available from the environment at the same time.

Our evidence shows us that demand for water increases with temperature. This also applies to periods of hot weather and heatwaves, which are expected to increase in frequency due to climate change. Increased domestic demand in short time scales can lead to immediate problems, including localised issues such as loss of supply and reduced pressure. Longer-term trends of increased temperature driving higher demand can cause more system-wide supply demand balance issues.

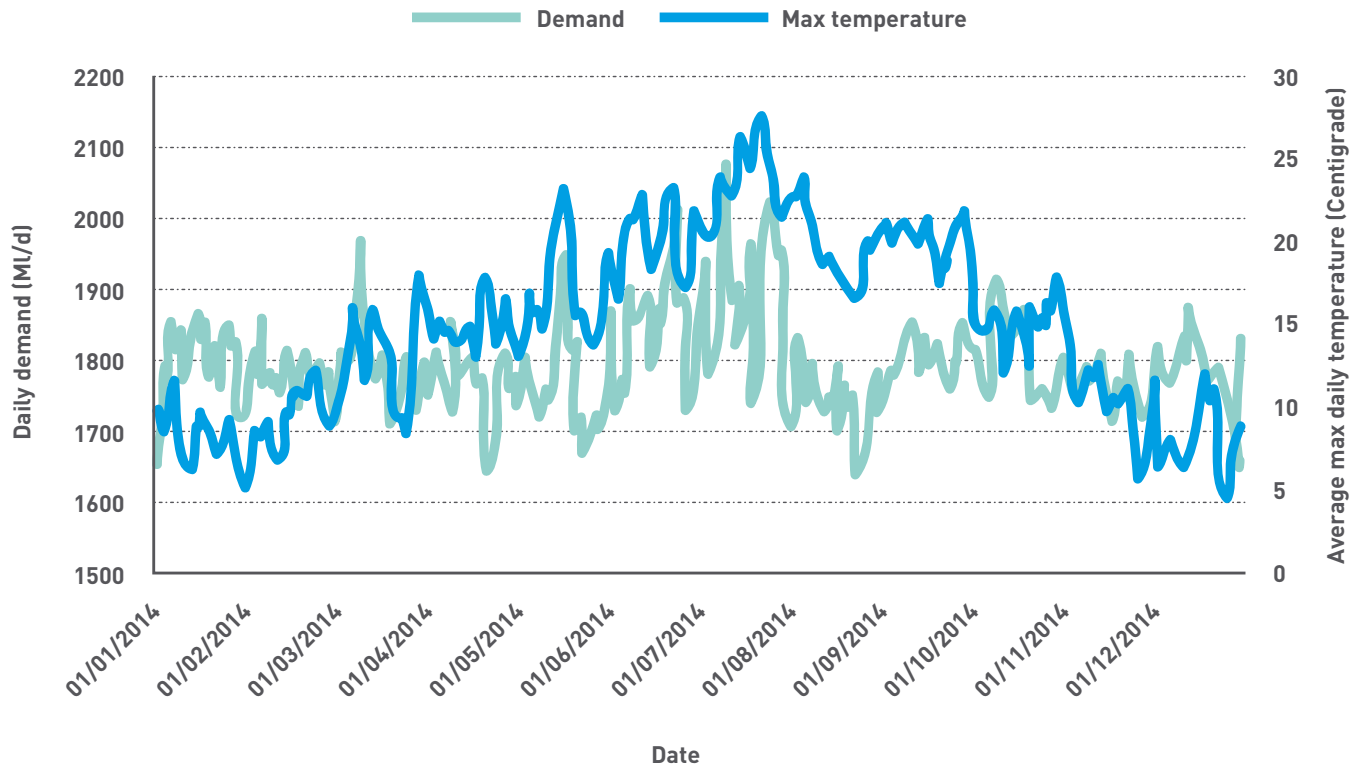


Figure 7: Timeseries of water demand and maximum temperature from 2014. The relationship between temperature and demand is particularly pronounced during the spring / summer (coinciding with the main growing season)

The amount of water available to meet this increased demand also decreases during hotter, drier summers, due to low precipitation totals and higher evaporation reducing water availability. The figure below taken from our water resource management plan, shows the predicted decrease in our Deployable Output (DO) over 25 years due to climate change and the Restoring Sustainable Abstraction programme. The need to protect our local environment in a future with more dry and hot periods will reduce the total available for public water supply even further.

The combination of increased demand and decreased availability means that unless action is taken, climate change could severely impact our ability to supply customers with water whenever they need it. Our water resources management plan (WRMP) considers this risk in greater detail, and can be found here: **severntrent.com/content/ConMediaFile/1705.**

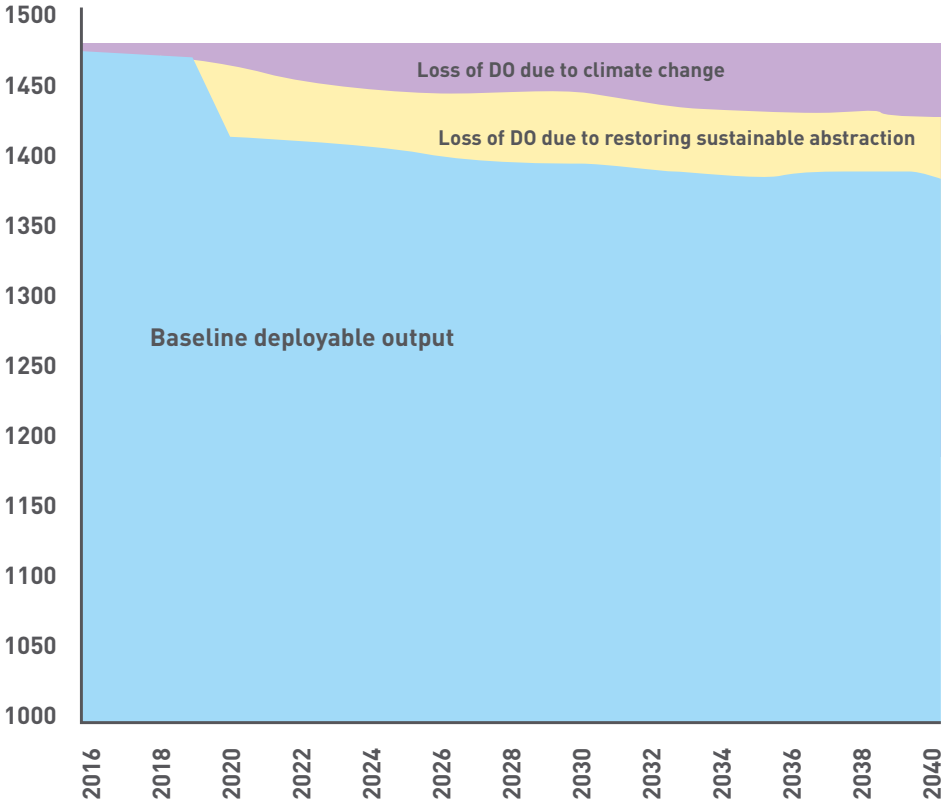


Figure 8: Projected changes to deployable output in our grid zone from our water resource management plan.

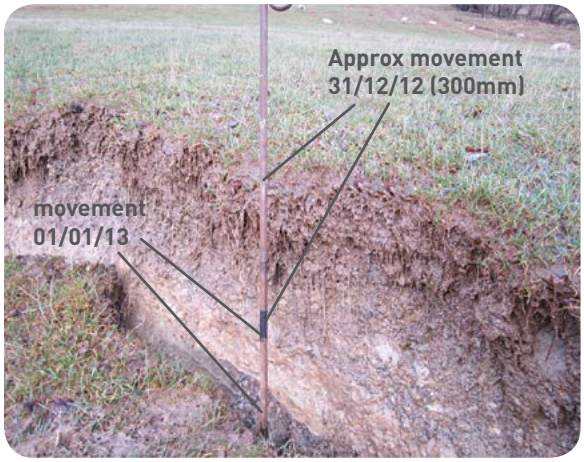
Impact of adverse weather on our assets

Risks Associated:

Increase in land movement

Flooding of water treatment works

Low pressure water supply



The weather can also affect our network and our assets and threaten our ability to transport water safely and efficiently from source to our customers. Our above ground assets, such as treatment works and pumping stations, can be affected by flood events. Our large underground network of water mains, sewers and aqueducts is exposed to landslips driven by heavy rainfall or more extreme cycles of soil wetting and drying. The areas most at risk from landslips are hilly areas or slopes, with clay soils and old cast iron pipes which don't have the flexibility to allow for any ground movement.

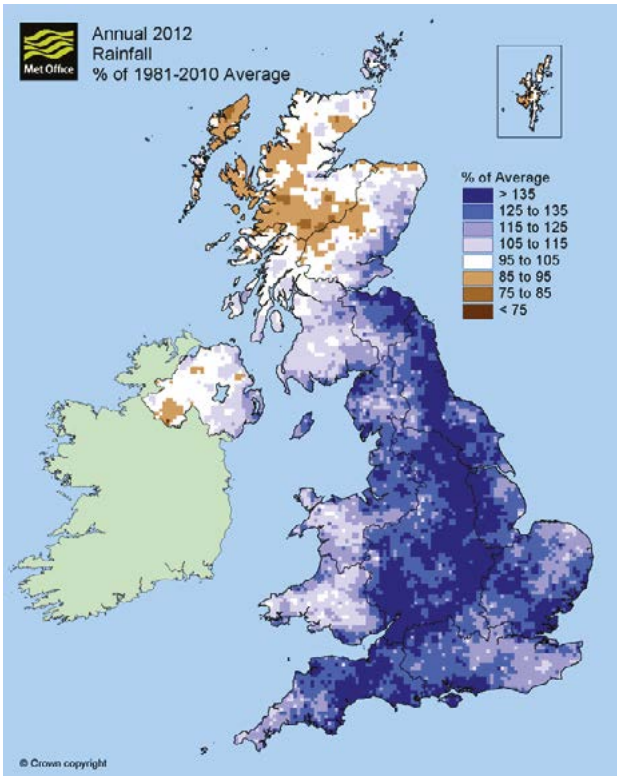
For example, Llandinam in Wales received rainfall of 150mm over a 17 day period, causing a landslide on 28th December 2012. This resulted in a burst main pipe, losing supply to over 1300 customers.

Objective: We will provide you with water that is good to drink

Impact of intense rainfall on runoff rates and water quality

Risks Associated:

Decrease in raw water quality



Warmer, wetter winters, and an increased frequency of heavy rainfall events, will increase the rate of runoff from land which carries with it pollutants, such as pesticides, into watercourses resulting in poorer water quality for abstraction. Land saturation can also reduce infiltration capacity and increase runoff from land. Runoff can be particularly high when extreme rainfall follows an extended dry period. These effects can be compounded by changes in the behaviour of land owners driven by climate change. For example, milder, wetter winters will increase the population of some pests, like slugs. This in turn could lead to wider and greater use of pesticides like metaldehyde; a pesticide used to control slugs, which is difficult to treat.

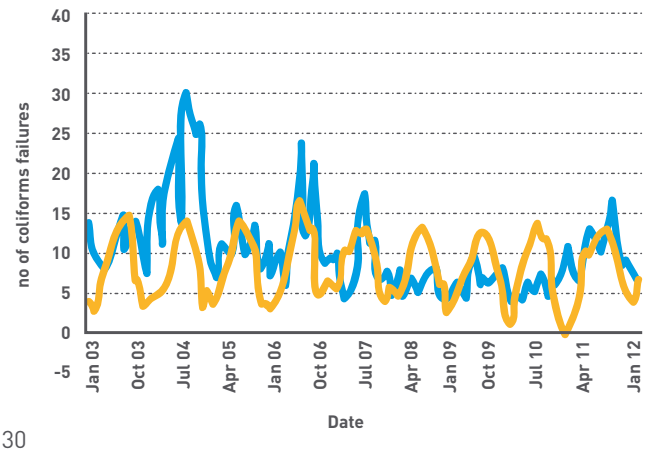
For example, 2012 was a particularly wet year (see figure) and this resulted in the very high levels of Metaldehyde in water courses in our region.

Figure 9: Rainfall in 2012 over the UK

Impact of warmer temperatures on water treatment

Risks Associated:

Increase in bacteriological growth



Warmer temperatures and hotter, drier summers create conditions where river flows are lower and mean that any pollutants entering the river are at a more concentrated level. These conditions can also encourage algal blooms and bacteriological growth. These issues present problems both where we take in water to treat and supply, and in locations where we treat wastewater and return it to the environment.

For example, figure 10 shows that peaks in coliform detections tend to occur during the warmer summer months.

Figure 10: Timeseries of coliform failures and temperatures.

Objective: We will safely take your wastewater away

Because a large proportion of the sewers in our region are designed as combined drainage and sewerage systems, rainfall can significantly affect their performance. Too much water can cause overflows and flooding but too little can result in blockages.

Climate change is likely to impact the frequency, duration and intensity of rainfall events we experience, which can significantly impact the sewers and hence our objective to safely take customers' wastewater away.

Impact of climate change on sewer performance

Risks Associated:

Exceeding the sewer capacity

Blockages causing flooding

Historically, sewer flooding has occurred more frequently during summer months and is associated with short intense and localised rainfall events. Recently in winter we have experienced prolonged periods of wet weather saturating the ground that causes increases in overland surface flows entering the sewerage system. For example, 2012 was a particularly wet winter and caused an increase in the number of sewer overflow events.

Prolonged periods of rainfall can also cause high river levels, which can prevent the use of sewer outfalls for dilute wastewater overflows. This does not usually result in any impact on the local environment, but it reduces the performance of the sewer system overall and can result in the system backing up causing overflows elsewhere which can affect customers.

Too much rainfall can cause sewer flooding, but so can too little rainfall. Prolonged periods without rainfall 'flushing' sewers will increase the build up of sediment/solids, which causes an increased risk of sewer deposits causing blockages.

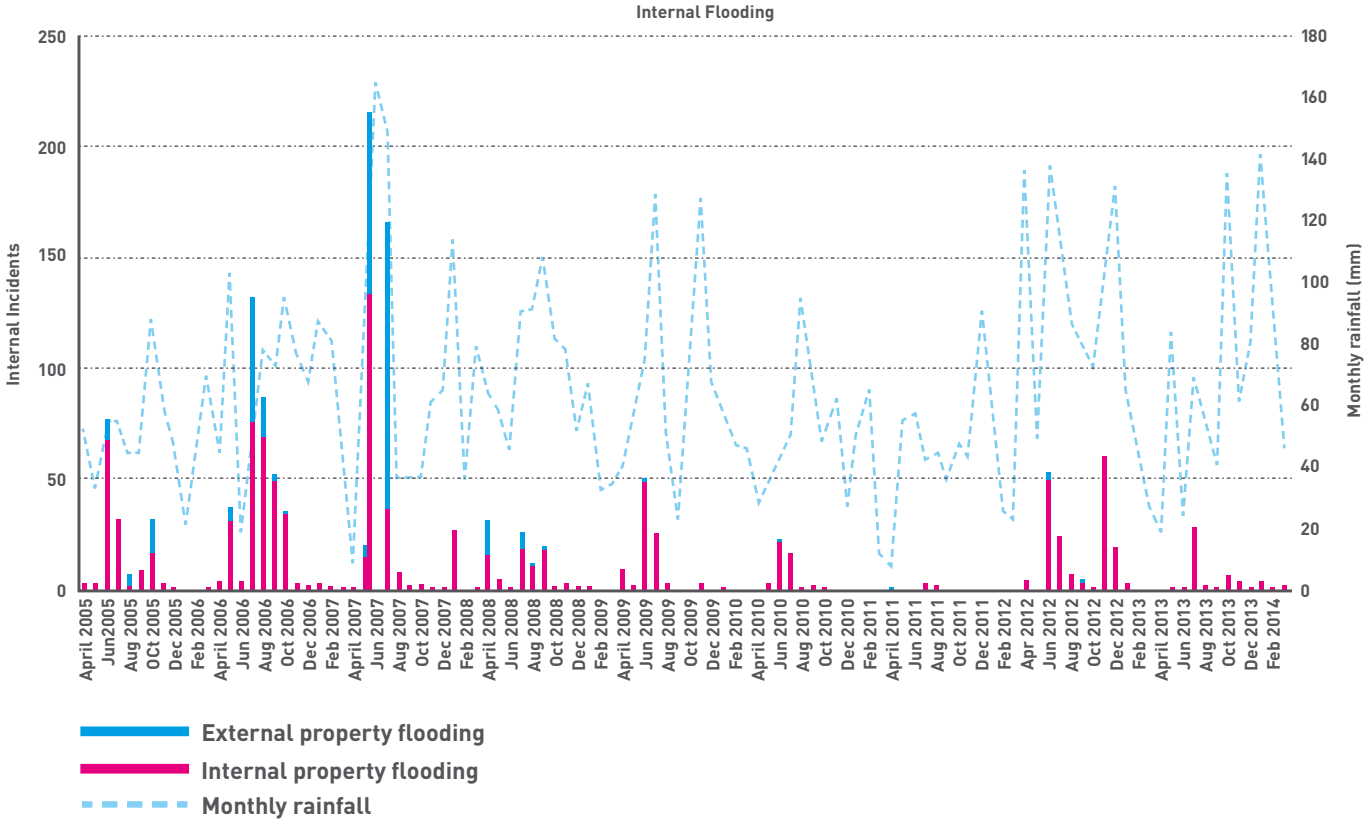


Figure 11: Timeseries of rainfall related sewer flooding incidents.

Objective: We will protect your local environment

Climate change is likely to alter our relationship with the environment, which affects both the water we abstract and the treated effluent we discharge.

Impact of climate change on quality and quantity of water in the environment

Risks Associated:

Lower river levels

Tighter discharge consents

Flooding to waste water treatment works

Hotter drier summers are likely to reduce both the quality and quantity of water in the environment both in areas where we abstract and areas where we discharge treated wastewater. To protect the environment, we'll have to abstract less where and when water is scarce. Changes in the ecological conditions of watercourses we discharge to could also mean we are required to treat our effluent to higher standards in the future.

River flooding can also inundate sewage treatment works. The impact on customers is less severe than when water treatment works flood as the sewerage service will still operate at point of use. The inundation of our sewage treatment works has not resulted in significant environmental damage during past flood events. However, there are safety hazards and remediation action to be considered and they can present a threat to the local environment if sewage treatment works are not quickly brought back online after the flood recedes.

Objective: We will provide you with excellent customer service

Impact of adverse weather on our customer experience

Risks Associated:

Poorer customer experience

We receive high volumes of customer contacts both during and after adverse weather, as it puts pressure on our network and exacerbates problems such as leakage and floods. We are one of a number of agencies with responsibility for managing water, so customers often call us to resolve problems, even where we are not necessarily the responsible agency. For example, a rainfall event in Leicestershire of over 15mm in a 3 hour period generated over 15 times the number of calls we normally receive.

We know from experience that if we don't have enough people, with the right training and the right resources to deploy, operating during these adverse weather events, there is a risk that we do not provide an excellent customer service. In 2014 we experienced a severe weather incidents which increased the amount of time it took for our customers calls to be answered, and as a result the number of customers abandoning their calls before being answered increased from around 3% to 46%.

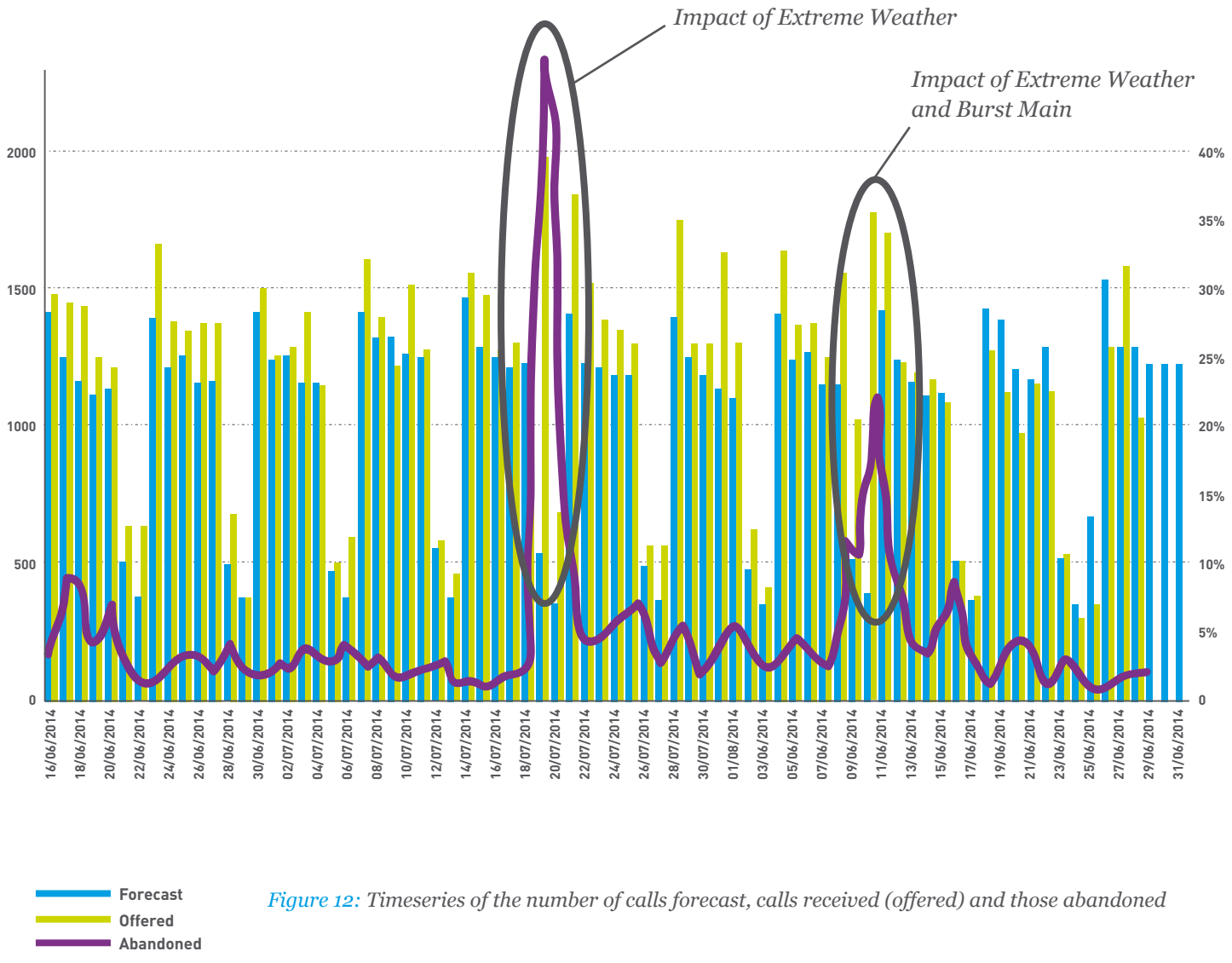


Figure 12: Timeseries of the number of calls forecast, calls received (offered) and those abandoned

Our Priority risks and how they have changed since 2010

Although broadly similar to our 2010 climate change risk assessment there are some changes to our updated risk assessment. These have mainly been driven by our experiences over the last 5 years that have improved our understanding of the weather impacts on our operations, assets and customer service. The main differences between our 2010 and 2015 risk assessments are:

Largest movers

- Most significantly, the climate change risk to raw water quality is now deemed to be higher and this is directly associated with the increased use of metaldehyde by farmers affecting the quality of runoff into water courses.
- The climate change risk to sewer blockages caused by dry weather has increased based on our improved understanding of our sewer network and events encountered over the last five years.

New entries

- We have identified some new climate change risks such as the risk to customer service. Customers are at the heart of our business and although all the risks identified impact on our customers in some way, we had not previously specifically identified their experience with us as a separate risk.
- The risks associated with increased land movement are also new, and has arisen based on experience of events during the last five years and growing research, some of which was commissioned by us as part of our 2015 - 2020 business plan, which suggests more future land movement due to climate change.

Improved understanding

- We also identified some new, lower priority risks associated with new areas of our business which have emerged in the last five years, such as renewable energy generation from crops and food waste.
- Our assessment of impact for some risks has increased to reflect our new understanding of our customers' priorities, which came out of the engagement exercise we carried out for our 2015-2020 business plan. Risks associated with sewer flooding in particular have increased compared to their previous rating, and this is reflected in the Outcome Delivery Incentives (ODIs) penalties and rewards in this area (this is discussed further below).
- As a result of the large investment we have made in flood resilience schemes during the last five years, the climate change risk associated with flooding of our clean water assets has reduced in comparison to other risks. We will keep this risk under review.
- Through the calibration and engagement processes of our risk assessment we consolidated several risks in order to make our assessment easier to understand and act upon. A common finding from our engagement was that our risk assessment needs to be simple and easy to understand in order to influence business decisions.

Some key factors which remain consistent with our 2010 risk assessment are:

- Water resources and supply-demand balance risks remain a priority, consistent with our previous 2010 risk assessment and the national climate change risk assessment. These risks are assessed and managed on 25-year timescales and within the national statutory framework of water resource management planning.
- Although we are improving our own resilience, we have not seen a significant step change reduction in our reliance on third parties. Therefore our indirect risks relating to power infrastructure, telecommunications and goods and services from the supply chain also remain consistent with our 2010 assessment.

Our adaptation strategy

Our approach to climate change adaptation

We developed our adaptation strategy in 2012 to influence the preparation of our current 2015-20 plan. Although we have continued to refine and improve our strategy, its three main elements remain unchanged:

1. Have the right people and processes in place to identify and respond to the challenges.

2. Take action to systematically reduce our priority climate change risks.

3. Actively seek wider opportunities to transform what we do in response to climate change.

Our risk assessment provides focus for delivering our strategy as it identifies and prioritises areas of our operations that are likely to be impacted by climate change. It is important to recognise that we don't consider climate change risks in isolation and we view them alongside all the challenges we face.

Our approach is to identify adaptation options that deliver multiple benefits, beyond climate change. The solutions can take different forms; for example, they can be:

- **Programmes that we would have carried out in the absence of climate change yet deliver climate change benefits (e.g. reducing leakage).**
- **Areas of existing work that we accelerate because of climate change (e.g. SUDS – sustainable urban drainage systems)**
- **New areas of work that deliver benefits now and in the future (e.g. Birmingham resilience)**

This multiple benefit approach significantly reduces the likelihood of what is known as "maladaptation", which is investing in an adaptation option that is subsequently not needed. This acts to protect customers and is a pragmatic way of managing the uncertainty in future climate change scenarios.

Regulation changes: encouraging adaptation

There have been two changes in our regulatory framework which mean that our ability to successfully identify and adapt to climate change is now intrinsically linked to our financial performance. This helps to further embed adaptation in to the way the business is run.

The first of these is the introduction of Outcome Delivery Incentives (ODIs). Outcomes reflect the long term needs that our customers are seeking. Each outcome has performance commitments that reflect these needs and allow progress to be measured. Some of the performance commitments are underpinned by financial penalties and rewards – these are the ODIs.

Severn Trent's performance over 2015-20 will be measured through 45 performance commitments, 33 of which have ODIs associated with them. The majority of these ODIs are related to the weather either directly or indirectly and this creates a link between our financial incentives and the impacts of climate change. This is why the introduction of ODIs acts to further embed climate change adaptation into the core of our long term strategy.

The second change is the move from separate price regulation mechanisms covering operating expenditure and capital investment to a single one covering total expenditure (totex). This change enables us to deliver our service through the most efficient and sustainable route, whereas the traditional route may have focused on delivery through capital expenditure.

This totex approach means our plan includes a wider range of solutions and innovation than ever before – including more catchment management, sustainable sewage treatment solutions, customer education, SUDS and improved operational effectiveness. Our plan does also include significant capital investment but the freedom of totex allows us to address climate change in the most appropriate and sustainable way. The range of solution types we are adopting is discussed further below.

Resources we have used to inform our approach

In addition to our own adaptation strategy and the economic framework in which we operate, we used a wide variety of resources to help shape our approach to climate change adaptation. Here we highlight the key guidance and publications that helped influence our strategy:

- The **Water Resource Management Plan guideline** provided by the Environment Agency is the basis of our assessment of water supply and demand balance risks and informs our approach to dealing with the threats in this area.
- The Cabinet Office Resilience Guidance **Keeping the country running: natural hazards and infrastructure** has informed our approach to assessing both short and long-term risks and our resilience and contingency planning.
- The Royal Commission on Environmental Pollution's 2010 report on **Adapting Institutions to Climate Change** helps to explain the role of leadership and integration of climate change adaptation within the fabric of an organisation.
- The Capital Maintenance Common Framework is the basis of our approach to understanding and maintaining our networks and assets. It is a risk-based approach with a long-term focus.
- Guidance produced by Defra and the Environment Agency for reporters from both rounds of the **Adaptation Reporting Power.**
- The annual reports from the Adaptation Sub-Committee of the Climate Change Committee. It is valuable to see the views from an independent body on UK progress and policy. The reports from 2012 and 2014 were particularly useful, focussing on issues highly relevant to our sector.

Highlights

Our adaptation strategy was used to shape our 2015-20 plan. Below we summarise the highlights of the adaptation actions from our plan. The risks and actions are aligned with our company objectives.

	We will ensure water is always there when you need it	We will provide water that is good to drink	We will safely take your wastewater away	We will protect your local environment	We will provide you with excellent customer service
Climate change risks	Climate change puts additional pressure on meeting our supply-demand balance. Hotter drier summers **increase customer demand for water**, but they also reduce the amount of water available to abstract, by **lowering water levels**, which could **result in abstraction restrictions.** More extreme weather could pose a threat to our services through **flooding of water treatment works** or **increased land movement.** Heatwaves would lead to more customers with **low water pressure.**	Increased heavy rainfall events will accelerate runoff from land, increasing concentrations of pollutants such as pesticides and nitrates entering the watercourse and **decreasing raw water quality.** Increased temperatures may have an impact on our water treatment through **increased bacteriological growth.**	Climate change increases the likelihood of sewer flooding as a result of two different drivers; Wetter winters and more extreme rainfall events are likely to **exceed the capacity of our sewers,** and hotter drier summers will reduce carrying capacity and result in **blockages causing flooding.**	Climate change impacts both the quality of water in the environment. It is likely to mean **lower river and groundwater levels** and may require we treat our effluent to a higher standard, **tightening discharge consents** in order to protect the environment.	Adverse weather puts additional pressure on our networks, for example high rainfall events increase the volume of customer contacts and could result in **poorer customer experience.**
2015-2020 apaptation actions	• We will reduce leakage by 6% and fix leaks within 24 hours • We will save 25Ml/d through water efficiency • We are investing around £250m in providing an alternative water supply for Birmingham and surrounding area • We are protecting vulnerable communities from failure of three sections of aqueduct at a cost of around £67m	• We are collaboratively working with land owners to improve water quality in 21 catchments, investing £21m • We are investing over £230m in our water treatment works to improve our treatment processes and reduce risk	• We are doubling the number of sustainable urban drainage projects • We are aiming to reach over 125,000 people with our customer education programme about sewer misuse by 2020	• We are giving up around 85Ml/d of abstraction licenses which are currently deemed to be environmentally unsustainable as part of the national environment programme • We are tripling the number of projects where we work with others to improve our local river environments	• We are using weather forecast information which is tailored to our thresholds to plan our resources and maintain our service levels 365 days a year • We are becoming more digitally savvy, increasing the accuracy and speed of our information and response times in order to make better decisions during extreme weather events

In the next section we build on this summary and set out the details of the adaptation actions we are taking under each of our company objectives. Under each objective we provide a reminder of the priority climate change risks in that area, grouped by the business impact, and explain our strategy and planned adaptation actions. We then use case studies to explore some of our adaptation actions in more detail.

Our adaptation actions 2015-20

We will ensure water is always there when you need it

Impact of climate change on meeting our supply-demand balance

Risks Associated:

Failure to meet customer demand

Abstraction restrictions

Reduced water levels

Strategy: Our strategy is to reduce the overall demand for water and to make the best use of our existing water resources. We will flexibly adapt over the next 25 years so we can meet future demands for water and be able to better cope with long term uncertainties such as those posed by climate change. We will continue to plan for all of the risks to our supply demand balance together as part of our water resource management plan.

6% *reduction in leakage by 2020*

25Ml/d *saved through water efficiency*

£39m *investment in R&D including water efficient technologies*

Increase household metering

Summary of adaptation actions related to the supply-demand balance	
Action	**Delivery**
Our water resources management plan ensures we have enough water available over the next 25 years. These statutory plans are produced every five years and signed off by the Secretary of State. We modelled a range of potential deployable outputs from UKCP09 projections to ensure that our resources are resilient to the potential impacts of climate change.	**Business as usual (BAU)**
Our drought plan sets actions to provide a continuous water supply during a drought. Drought plans are kept up to date and reviewed every three and a half years.	**BAU**
We will reduce leakage by 6%. This includes a commitment to fix all visible leaks within 24 hours.	**2020**
We will save 25Ml/d through our water efficiency programme. This includes increasing the number of people who will benefit from our high quality education programme to 125,000 per year by 2020.	**2020**
We will invest in R&D on water efficient technologies. In total we are investing around £39m in R&D between 2015-20.	**Beyond 2020**
We will improve the flexibility of our supply system allowing us to move water around our network. During AMP6 and 7 we will be increasing the deployable output of our Strategic Grid (serving two thirds of our customers) by around 80Ml/d.	**Beyond 2020**
We will increase household metering at a pace lead by customers. We expect to install around 672,000 meters free of charge over the next 25 years.	**BAU**
We will improve the resilience and sustainability of our existing water supplies. In AMP6 we will invest around £30m to provide new sustainable sources and associated treatment and distribution to address long term abstraction risks at our groundwater sites.	**2020**

Case studies and examples:
Impact of climate change on meeting our supply-demand balance

Marcus O'Kane, Business planning – Environment:

"Our water resources strategy means that we're confident that we'll have enough water available, in the right place and at the right time to supply our customers in an affordable and sustainable way, not only this year, but over the next 25 years."

Climate change modelling as an integral part of our water resources management plan

All companies must consider climate change in their water resource management planning. However, we have chosen to use the most sophisticated approach available. Using statistical and hydrological modelling, we first obtained a representative selection of 100 temperature and precipitation scenarios from the original 10,000 in UKCP09 and further refined this to 20 based on indicators relevant to catchment types in our region. This data was used to create flow factors to apply to our 'Aquator' water resources model to create a distribution of potential impacts resulting from climate change.

This modelling has shown that our surface water sources are vulnerable to weather variability under the medium to dry weather scenarios. In order to adapt we need to build flexibility into our system. Consequently our plan details the options we can take over the next 25 years to offset these impacts and our 5-year plan includes investment to reduce demand, increase leakage control and develop new resources.
Separate groundwater modelling has demonstrated that the majority of our groundwater sources are resilient to climate change risks.

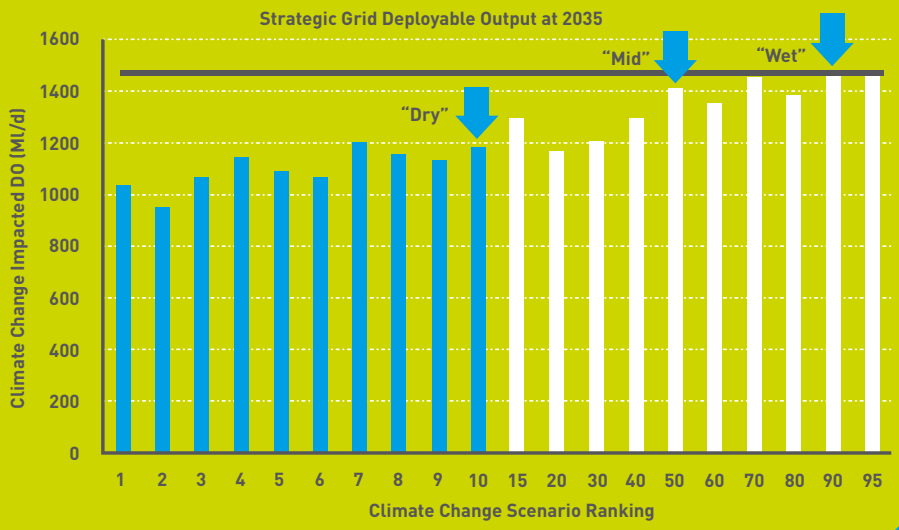


Figure 13: Deployable output in the strategic grid zone by 2035 under the 20 UKCP09 scenarios selected from the full 10,000 scenarios

R&D Leakage detection on plastic pipes

As part of our efforts to reduce leakage even further, we are developing a leak detection system to detect leaks on plastic pipes (rather than traditional metal pipes), in conjunction with Loughborough University. Now under commercial development, this solution could significantly improve the efficiency of leak detection, helping us find more and cut waste more quickly.

This is a good example of where our customers' priorities and our climate change adaptation actions align.

Impact of adverse weather on our assets

Risks Associated:

Increase in land movement

Flooding of water treatment works

Low pressure water supply

Strategy: Our strategy for managing risks from landslips and flooding is part of our overall resilience strategy to improve how we cope with a range of extreme events. Our strategy is to increase flexibility in the way we work and the way we control our network whilst continuing to invest in our assets for the long term. During the next five years we are focussing on major strategic assets like the Elan Valley Aqueduct (EVA) and the Derwent Valley Aqueduct (DVA).

Over
£250m
investment on an alternative water supply for Birmingham

Divert
3 sections of aqueduct
from communities at risk

Maintain
1:10,000
year resilience for critical dams and reservoirs

A second source of supply for 3 isolated communities

Summary of adaptation actions related to adverse weather	
Action	**Delivery**
We will provide Birmingham with an alternative water supply, investing over £250m, which will allow long term maintenance of the EVA to take place and reduce the threat of flooding and landslides affecting service.	**2020**
We will continue to improve the flexibility of our strategic grid by targeting our maintenance work at areas that deliver the greatest risk reduction.	**BAU**
We will invest around £67m in three schemes to divert sections of large aqueduct away from communities that could be at risk in the event of a catastrophic failure. Failures could be driven by landslips or other natural hazards.	**2020**
Dams and reservoirs are subject to a stringent monitoring, maintenance and governance regime. This includes monitoring of any known ground movement. In addition, design standards are sufficient to accommodate the wider impact of climate change.	**BAU**
Mutual aid is in place to facilitate inter-company borrowing of equipment or services to supplement their own stocks during long duration water supply interruptions.	**BAU**
We will provide resilience to our three highest priority isolated communities. We use a population threshold of 20,000 to guide our prioritisation of schemes.	**2020**
We will continue to improve our response to no supply incidents (driven by a number risks, including landslides and extreme weather events) and reduce the number of minutes customers go without supply from 15 minutes to 8 minutes.	**2020**

Case studies and examples:
Impact of adverse weather on our assets

Birmingham Resilience Project – securing sustainable water supplies now and in the future

Weather and climate related risks present challenges to the Elan Valley Aqueduct (EVA) which is one our most strategically important assets. The EVA is a 118km aqueduct which transports water from mid-Wales to Birmingham. It carries nearly 20% of our raw water and has served us reliably for over 100 years. It plays a key part in delivering strategic resilience to our network.

It is also a low carbon source of water as it requires no pumping to bring it to Birmingham and it is also good quality water which means the energy requirements for treatment are relatively low.

The EVA passes through some rugged terrain – straddling mountains and rivers on its route. Both landslides and flood related river scour can cause significant damage to the structure of the EVA. Research shows that these risks are increasing over time due to climate change. Our structural analysis of the EVA indicates that now is the right time to invest to protect this asset for the future.

We plan to invest around £250m to develop an alternative source of supply for Birmingham by 2020. This will allow us to provide an uninterrupted service in the event of an EVA failure and give us the ability to shut-down the EVA for planned maintenance periods. This ensures a resilient supply of water to Birmingham and surrounding communities for generations to come, securing an economical and low carbon source of water, which itself is robust to the impacts of climate change.

Ian Hope - Dams and reservoir manager

"As a business reliant on over 700 dams and reservoirs we fully appreciate the potential risk of dam failure and the magnitude and impacts of the downstream consequences. Our dams and reservoirs are stringently operated and maintained to the highest standards which we rigorously review. Our large impounding reservoirs are designed and maintained to withstand well in excess of a 1:10,000 year event. This can extend to a flood in excess of a 1:10,000 year event combined with a similarly severe storm causing massive wave action on the dam face. Through our assessed governance procedures we are therefore confident that we are managing these critical assets to fully withstand the potential impacts of climate change."

We will provide water that is good to drink

Impact of climate change on runoff rates and water quality

Risks Associated:

Decrease in raw water quality

Strategy: Our strategy is to protect raw water quality by implementing Catchment Management techniques; working with farmers and land owners to tackle the root causes of water quality issues. Proactive catchment management measures also underpin our long term water resources plan by maximising the amount of water we can safely abstract and use. This contributes to our supply-demand balance.

£21m

investment in 21 catchments to improve raw water quality

Contributing matched funding for projects to reduce agricultural run-off

Substituting metaldehyde slug pellets for a less polluting product

Summary of adaptation actions related to run off rates and water quality	
Action	**Delivery**
We are building on our leading position in catchment management and investing £21 million across 21 catchments to reduce the number of drinking water quality failures and minimise / delay future expenditure on water treatment whilst supporting wider environmental benefits.	**Deliver by 2020**
We will offer matched funding grants for small scale infrastructural investment on farms to reduce agricultural run off.	**Deliver by 2020**
We will introduce a tool box of catchment schemes to address pesticides and nutrients through a programme of farmer advice, training and support from dedicated catchment officers.	**Deliver by 2020**
We have a range of specific actions to reduce metaldehyde, including product substitution; clean runoff rewards, and play an active role in metaldehyde stewardship group.	**BAU**
We will continue to use vegetation and peat management to slow the flow of water in our catchments	**BAU**

Case studies and examples:
Impact of climate change on runoff rates and water quality

Jodie Rettino - Principal Catchment Management Scientist

"The weather, especially the rain, has a massive influence on the work we do in the catchment team. 2012 was one of the wettest years on record, and as a result we experienced very high pesticide concentrations and our water quality was severely affected. If climate change brings more years like 2012, with high slug pressure and run off, we need to encourage farmers to use alternative 'water friendly' slug treatments and find ways to hold water back in our catchments. This will help improve water quality now but also build resilient farms, safeguarding soils and water bodies for years to come."

Tittesworth Catchment

Tittesworth reservoir in Staffordshire has suffered with high peak pesticide concentrations because of high run-off potential of the surrounding land. Since 2011, our catchment management team have been working with south west peak landscape partners to develop the 'Slowing the Flow Project'. The project aims to reduce agricultural runoff, siltation and acidification by establishing vegetated buffer strips, areas of woodland and 'roughening' slopes through changes in vegetation and grazing regimes.

Since the project started there have been no peak pesticide events above our tolerance level. This has saved the need to invest in new water treatment solutions and improved our resilience to heavy rainfall events in the area. The benefits extend beyond water quality; the roughening of the surface will improve water management in the catchment, encouraging more water uptake and reducing the risk of flooding downstream. Woodland creation also provides shade for watercourses, reducing evapotranspiration. For every £1 invested in the scheme we estimate £3.44 of benefits in environmental and ecological improvement and cost savings.

Bamford catchment management and MoorLIFE 2020 project

Bamford water treatment works is affected by upstream runoff from peat, causing water discolouration. Without action, this problem will continue to increase, as it has done since 1989 and it will be further exacerbated by an increased frequency of heavy rainfall events. Treating discolouration is costly and can cause water treatment works output to be reduced.

We are working with the EA and other partners to support an EU-supported project led by Moors For the Future. The project will restore degraded peat and improve the quality of peat bogs and habitats, which will help to reduce discolouration and improve water quality in the area. Restoration of peatland is also a vital means of reducing greenhouse gas emissions from peatland degradation. Our planned budget for this catchment over the next five years will be tripled through EU match funding.

Wetter winters, more slugs, more metaldehyde.

Metaldehyde is a persistent pesticide, widely used to treat slugs and snails in cereals and oilseed crops. It is particularly troublesome because we don't currently have a cost-effective way of removing it from water. It is one of the threats to water quality which we expect to increase with climate change, unless we act to control it. Our approach therefore focusses on prevention. We are active in the national Metaldehyde Stewardship Group, who educate farmers about pellet application to prevent pollution and explore national solutions to the problem.

Best practice alone will not bring levels of Metadeldhye below drinking water standard in some catchments, so it is necessary for farmers to use alternative products, namely Ferric Phosphate which has no impact on drinking water quality. We are trialling a metaldehyde free catchment around Staunton Harold reservoir, which is a small contained catchment in Leicestershire. Our plan for 2015-20 includes support for product substitution in high risk zones throughout our region.

Impact of warmer temperatures on water treatment

Risks Associated:

Increase in bacteriological growth

Strategy: Our strategy is to reduce the number of drinking water failures in an efficient way by maintaining our water treatment works, improving our processes and skills and investing in treatment solutions where required. Our strategy is centred around having an effective maintenance regime in place for our water treatment works. Although the actions outlined here are maintenance related, this emphasises the point that resilience to climate change can be built through getting the day-to-day activities right and does not necessarily require a bespoke programme of work.

£167m
maintaining key water treatment processes

Improved chlorine management
in 8 water supply zones

Over
£30m
investment in maintenance of assets to improve water quality

Summary of adaptation actions related to warmer temperatures affecting water treatment	
Action	**Delivery**
We will develop intelligent abstraction management systems; providing us with real time water quality data to inform abstractions and therefore prevent abstraction during peak concentrations, minimising the impact of runoff on our water quality.	**Beyond 2020**
We will invest over £30m in mains cleaning, mains renewals, removal of abandoned assets and optimisation and renewal of chlorine dosing equipment, all contributing to improvements in water quality for customers, which will help to safeguard against future discolouration caused by climate change.	**BAU**
We will invest over £167m in maintaining and installing key treatment processes at our Water Treatment works.	**Deliver by 2020**
We will continue to maintain and optimise our coagulation and clarification processes which will improve our ability to remove pollutants and increase our resilience of water treatment to drier weather	**BAU**
We will improve chlorine management in eight of our water supply zones to the mitigate risk of bacteriological growth	**Deliver by 2020**
We will continue to use barley straw to successfully control blue green algae growth in our reservoirs	**BAU**

Case studies and examples:
Impact of warmers temperatures on water treatment

Matt Lovell, Non Infrastructure Planning and Performance Manager

"Our customers told us that being able to rely on the quality of the water we supply to their homes and businesses is their highest priority."

Increasing the resilience of our water treatment during drier weather

In scenarios of lower river flows there is a risk we will need to treat higher concentration of pollutants. We plan to invest around £24m in maintenance and optimisation of clarification and coagulation that will contribute to effective solids and pollutant removal. Whilst this is not primarily driven to improve our resilience to drier weather, it will reduce our quality risks during dry periods. Part of this is the R&D project rolling out coagulation control optimisation (COMPASS) which will improve our ability to treat higher concentrated pollutants.

Controlling bacteriological growth

Bacteriological growth in the water distribution network creates water quality risks and must be avoided. Currently we only see isolated failures affecting small sections of the distribution system but higher temperatures will exacerbate this risk. One adaptation to deal with this is better chlorine management in the water distribution system. Our plan over the next five years is to invest £18m in new chlorine dosing equipment in 8 of our water supply zones and continue to maintain our assets in the remaining zones.

This investment will mitigate the risk of bacteriological re-growth which may result from increased temperatures in summer and reduced die off in winter. Similarly, we are investing around £16m over the next five years to address changing raw water bacteriological risks at our groundwater sites by installing new UV treatment plants, which will increase our flexibility when quality risks are higher.

Using barley straw to control blue green algae

The majority of our surface water reservoirs are classified as 'eutrophic', which means they support high concentrations of algae under the right temperature and nutrient conditions. This can present a direct risk to people who come into contact with it and its presence can also reduce the amount of water we can safely abstract from the reservoir. The changes expected with climate change can exacerbate existing algal issues. Heavy rainfall events elevate phosphorous concentrations from run-off and hotter drier summers will result in lower reservoir volumes. To date, blue green algae populations have been effectively controlled by installing barley straw. This prevents disruption to water treatment processes and the production of algal toxins. We will continue to monitor whether this methods remains suitable as the risk increases with climate change.

We will safely take your wastewater away

Impact of climate change on sewer performance

Risks Associated:

Exceeding the sewer capacity

Blockages causing flooding

Strategy: Our approach to sewer management has been developing over the last decade and over the next five years we will:

- Place a greater emphasis on more effectively managing surface water flow into our sewers by working with others to find joint solutions to common problems
- Educate customers to prevent unsuitable material that can cause blockages being put into the sewer network
- Improve the condition of our sewers through investing 6% more in cleansing, repairing and rehabilitation of our network.

Doubling
Sustainable urban drainage solutions

Investing over £150m
on activities to proactively prevent blockages

Installing 1,800 live network monitors

Educate 125,000 customers per year
to reduce sewer misuse

58% reduction
in internal hydraulic sewer flooding incidents

Summary of adaptation actions related to the impact of climate change on sewer performance	
Action	**Delivery**
We will prioritise investment based on flooding severity/impact and likelihood. By verifying historic risks together with hydraulic capacity modelling we have improved on our previous methodology, where properties had to flood before being added to the register that triggered investment.	**BAU**
We will double the number of sustainable urban drainage solutions. By improving surface water management as part of retrofit solutions we will be able address current capacity issues and improve future resilience in our networks.	**Deliver by 2020**
We will continue to proactively manage our waste water assets based on a bespoke weather forecast	**BAU**
We will invest in R&D focusing on technologies to develop resilient drainage solutions for the future	**Beyond 2020**
We will continue to use our asset deterioration model to predict pipes most likely to suffer blockages resulting in sewer flooding and pollution of watercourses. The model suggests proactive interventions, such as cleaning or replacing sewers.	**BAU**
We are investing over £150m on activities to proactively prevent blockages that could result in sewer flooding; this work includes sewer cleansing, repair and rehabilitation.	**BAU**
We will be rolling out a much wider programme of customer education in AMP6, aiming to reach 125,000 people per year by 2020.	**BAU**
We are installing 1,800 live foul sewer network monitors into our system, allowing us to proactively identify blockages to prevent flooding and pollution.	**Deliver by 2020**
We will increase the coverage of our live sewer management plans to 100% of our region, up from 53% coverage in 2015.	**Deliver by 2020**

Case studies and examples:
Impact of climate change on sewer performance

Tim Smith, infrastructure business planning:

"Our customers told us we should invest proportionately to reduce incidents of sewer flooding. Sewer flooding, particularly in people's homes is comparatively rare, but it's extremely distressing when it does happen."

Flood risk mapping in Holt Drive, Leicester. Areas in red at risk of internal flooding. Model used to inform investment.

A new approach to targeting sewer investment

We now target our investment based on historic flooding records combined with hydraulic modelling. This means we target investment more effectively. In the past, properties had to flood before being added to a register for potential investment.

Now, using hydraulic model simulations, Ordnance Survey maps and ground contour data (LiDAR) we can model potential overland flood risk to identify areas at risk of sewer flooding both now and in the future when climate change is factored in. This will lead to more proactive investment to ensure we continue to meet our targets to reduce sewer flooding for customers.

A new SUDS scheme in Leamington. This scheme uses land at the back of a school to collect surface water.

More partnership working, more sustainable urban drainage solutions

Changes in rainfall patterns and more intense, localised rainfall events affect the whole urban environment, not just the sewers. Simply increasing sewer design standards to accommodate more rainfall to adapt to climate change, besides being prohibitively expensive, cannot be the sole solution to future water management. This is why we have now put a greater emphasis on addressing sewer flooding problems by working collaboratively to manage surface water.

We plan to deliver 21 'flooding partnership' projects by 2020. We will work closely with other flood risk partners (including the Environment Agency, Lead Local Flood Authorities, Internal Drainage Boards) to develop joint solutions to reduce the risk from multi-source flooding.

We are also strong advocates of more sustainable urban drainage systems (SUDS). Surface water drainage methods that take account of quantity, quality and amenity issues are the best way to mitigate the threat of more sewer flooding driven by climate change. Over the next five years we plan to double the number of such solutions we deploy as part of schemes to address sewer capacity problems. This approach will not only address the immediate sewer flooding risks but also provides a more resilient network.

SMART Water Butts

We are trialling 'SMART' water butts in our area. Usually water butts are considered a good way to conserve water. However, they can also be used to relieve the burden on the sewerage network by collecting water that would normally go straight down the drain. Individually their capacity is small, but collectively this solution could help to provide a much cheaper alternative to building additional rainwater storage in the sewer system. They offer a potential way to reduce sewer flooding whilst also reducing water demand.

Case studies and examples:
Impact of climate change on sewer performance

Educate 125,000 customers each year to reduce sewer misuse

The root cause of the majority of our blockages is from customers putting the wrong things into sewers. The largest cause of blockages is sanitary items (towels, nappies, wipes etc) followed by Fats, Oils and Greases (FOG) from cooking.

To tackle this, we are increasing our programme of customer education. We are investing £4m over the next five years on direct engagement with our domestic customers, large commercial outlets in our region, and future customers in schools. We are also engaging more widely with others at the national level to get messages onto packaging and other routes. We aim to reach 125,000 people per year by 2020.

Trialling new sewer flushers

As an alternative to traditional sewer cleansing options like high pressure jetting, we are appraising the benefits of sewer flushing devices in sewers particularly prone to repeat blockages. Sewer flushers work by holding back some flow and then releasing it to create a 'wave' of flow that has sufficient velocity to break up solids and wash them down the system.

Improving sewer monitoring and control

We are installing 1,800 live foul sewer network monitors over the next five years, which let us proactively identify blockages as well as get long term feedback on general sewer performance. Live monitoring will allow us to identify blockages much earlier so we can rectify the problem before flooding occurs. The monitors also allow us to better track pollution during wet weather events. For some catchments we will be able to advise customers to ensure property level protection is ready and working. In some of our larger catchments we could also use active system controls to optimise sewer capacity more flexibly.

Across the Birmingham network we have several large attenuation tanks which could be upgraded and automated so they could be used to hold back flow in dry parts of the catchment so that wetter parts of the system do not get overloaded. We are proposing to undertake a pilot study on several of our strategic storage tanks to optimise capacity. This will address sewer flooding risk and release capacity to accommodate planned new development across the catchment.

We will protect our local environment

Impact of climate change on the quality and quantity of water in the environment

Risks Associated:

Lower river levels

Tighter discharge consents

Flooding to waste water treatment works

Strategy: We will continue to be one of the most resource efficient companies through reducing the amount of water we need to take from the environment by returning unsustainable abstraction licences, further leakage control and encouraging water efficiency. We will ensure we don't pollute the environment by:

- investing in our sewage treatment and digestion assets which treat our final effluent and biosolids
- optimising our current processes to meet the needs of the environment in the most efficient manner
- expanding our partnership working to secure common environmental goals.

Giving up 85Ml/d
of abstraction licenses.

Tripling partnership working

Investing over £300m
to maintain sewage treatment works

Investing in advanced sludge treatment process at our largest treatment works

Summary of adaptation actions to protect the local environment	
Action	**Delivery**
We will give up 85Ml/d of abstraction licenses as part of the Restoring Sustainable Abstraction programme.	**Deliver by 2020**
We will increase partnership working by a factor of three compared to AMP 5.	**Deliver by 2020**
We will invest over £300m to maintain our sewage treatment works. We are also investing in AMP6 to improve river water quality under the Water Framework Directive.	**BAU**
We will invest in advanced digestion, sludge storage, research and development and improving our end to end sludge route to ensure we can continue to safely dispose of it to land.	**BAU**

Case studies and examples:
Impact of climate change on quality and quantity of water in the environment

Restoring sustainable abstraction (RSA) – protecting our local environment

As part of the national environment programme to restore sustainable abstraction we are giving up around 85Ml/d of abstraction licenses across our region which are deemed to be environmentally unsustainable. Changes to abstraction licenses required by Natural Resources Wales as part of the River Wye habitats directive will also impact us.

Our strategy to balance supply and demand includes the reductions to our baseline projections of available water as a result of the RSA programme. These changes put additional strain on our supply demand balance and mean that finding alternative sources of water is an area of short and medium term focus. However, the measures set out in our Water Resources Management Plan allow us to make these abstraction licence changes, without impacting on customers' security of supply in the climate change scenarios we have modelled.

Birmingham Urban Demonstrator

We are working with Birmingham City Council, the Environment Agency, universities and our supply chain to create a community scale, living laboratory to demonstrate the practicality and benefits of sustainable water management (or Water Sensitive Urban Design) in terms of both water supply and sustainable drainage.

We will work with the local community to help them become more resilient to the impacts of a changing climate through:

- Retrofitting innovative water harvesting, reuse and efficiency measures in around 100 homes and a community school.
- Helping local companies to reduce their demand for potable water and to identify local, more sustainable sources such as rain water harvesting
- Creating sustainable drainage features to attenuate and treat surface water which currently flows directly to our sewers before discharge to the River Cole.

This urban catchment management project has multiple benefits which will increase the resilience of our customers to the impacts of climate change. Through evaluating and demonstrating the impacts of the measures employed we will show:

1. How we can make the management of surface water more resilient to higher rainfall events without reliance on underground assets and pumped sewers.
2. How we can help business and residential customers reduce their usage of potable water which will help ensure that there are always sufficient supplies to meet our customers needs even during projected droughts.

The Southern Gateway development – rediscovering the River Rea

The Southern Gateway is the largest of five 'areas of transformation' identified in Birmingham's Big City Plan – a blueprint for the next 20 years of growth and development. It includes part of the River Rea corridor as it flows close to the city centre. The River Rea is an important part of Birmingham's historic legacy; however, today the river is heavily modified and largely hidden from view after works in the late 19th century straightened and deepened the channel and culverted many stretches.

As part of the regeneration of the Southern Gateway, we are working with partners, including Birmingham City Council and the Environment Agency, to take a strategic approach that places the management and use of water at its heart. The vision for the area is to create a vibrant, liveable and well-connected part of the City Centre, with the integration of water sensitive solutions to deliver a resilient and successfully regenerated area. Importantly the plan will include the transformation of the River Rea in order to realise its potential as a key feature for the City.

By incorporating water at the heart of the plans the following areas can be improved:

- **Flood risk – the River Rea presents a significant flood risk**
- **Surface water flooding – the area has a large amount of impermeable surfaces which are susceptible to flooding**
- **Water sensitive developments – including SUDS, bioretention, rainwater harvesting and water reuse**
- **Biodiversity – the river corridor is currently in a very poor state and the ecological quality of the watercourse is low.**

We will provide you with excellent customer service

Impact of adverse weather on our customer experience

Risks Associated:

Poorer customer experience

Strategy: All of the actions we take to adapt to climate change aim to improve the water and sewage services we provide our customers. To specifically ensure we can improve our customers' experience when they contact us our strategy is to:

- continue to increase the flexibility of the ways our customers can get in touch
- increase the expertise and knowledge of our contact centre resources
- get smarter about the way we use weather information.

Summary of adaptation actions to improve our customer experience	
Action	**Delivery**
We will continue to proactively ensure adequate contact centre resource to meet demand by using bespoke weekly weather forecasts	**BAU**
We will send out proactive communications to customers during adverse weather and we will make more use of other contact channels such as social media, text messaging and web chat to get information to customers quicker.	**BAU**
We will continue to have the flexibility of a back up resource pool of contact centre staff to meet high demand, and we will develop a virtual contact centre so we have a better network of skilled advisors to handle calls in all events.	**BAU**

Case studies and examples:
Impact of adverse weather on our customer experience

Neil Clarke - Customer contact resource manager

"Intense localised weather can make us exceptionally busy in the contact centre, receiving almost 300% more customer contacts than predicted. We use weatherquest, a bespoke weather forecasting system, to pre-empt these occurrences and put plans in place to minimise the impact to our customers, ensuring a seamless service all the time"

Improving the way we use digital technology

We're improving the way and the speed with which we use information and digital communication across our company. In April 2015 we started rolling out our new digital devices with field worker software. Digital technology allows us to improve our resilience, efficiency and connectivity and provides us with better understanding of our relationship with weather.

Proactively using weather forecasts

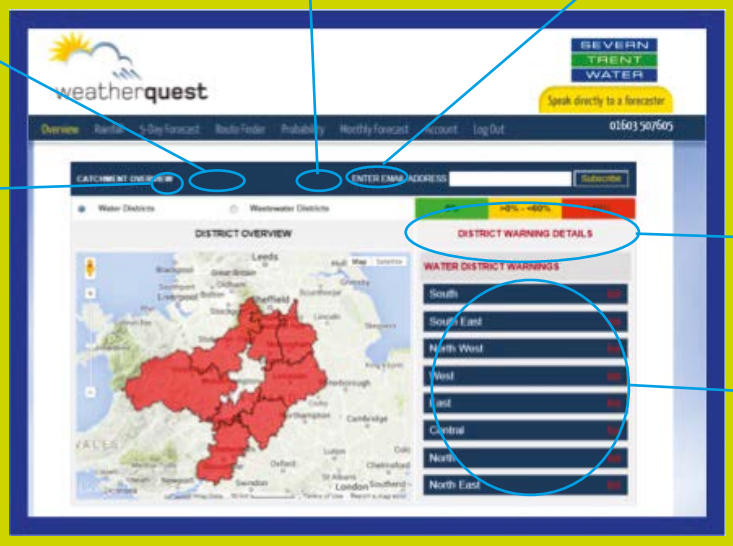
As a weather-sensitive business, we proactively use forecasts to improve our performance. In 2013 we introduced a company-wide weather portal which gives us accessible, tailored weather forecasts which inform our decisions and help us prepare for weather.

The weather portal sends out weather warnings and alerts to our staff based on key thresholds and triggers which we have set and provides data and alerts available on mobile devices at any time of the day. This allows us to prevent problems before they happen and prepare for weather events rather than only reacting to them. For example, wastewater operational staff now check the assets known to be at risk when a high rainfall alert is received whilst our network control staff can use probabilistic rainfall projections to inform network management decisions.

The portal continues to evolve as the number of users grows and demands for weather data increase but it is clear that having consistent and tailored alerts based on reliable weather forecasts improves our ability to cope with the weather of today as well as the weather of the future.

Ross Stokes – Waste Team manager

'Weatherquest allows us in waste infrastructure to proactively monitor our asset base, and adapt to sudden changes in the weather'



Moving to more innovative solutions

As set out above, our plans for 2015-20 continue to build our climate resilience. Our actions cover a wide range of different activities.

Our most significant capital scheme is the Birmingham Resilience Project which is focussed on maintaining a strategically important asset while providing a resilient service. This not only helps reduce our climate change risks, but also mitigates our largest overall company risk.

However, our plans are not only about capital investment in hard engineering projects; instead we have developed a diverse programme of work which considers other, more innovative, types of interventions. These include a significant expansion of our catchment management work to improve water quality and a commitment to working in partnership to deliver more sustainable approaches to drainage. In addition, we will continue to challenge our processes in order to build our resilience; for example, we will continue to improve the way we respond to water supply interruptions to minimise the impact on our customers.

Below we plot some of the highlights of our adaptation action plan for 2015-20. The graph shows whether each solution is a hard engineering option or a change in process and behaviour, and whether the solution represents a business as usual activity or a step change in the way we do things. The results illustrate the diversity of our adaptation actions. There is more activity in the top right quadrant than ever before. This quadrant represents the high impact "softer" solutions. This has been driven in part by the change to "totex" thinking (total expenditure) which is now incentivised through regulation. This means that capital and operational expenditure are considered in the same way, which has helped to remove the perceived bias towards traditional capital solutions.

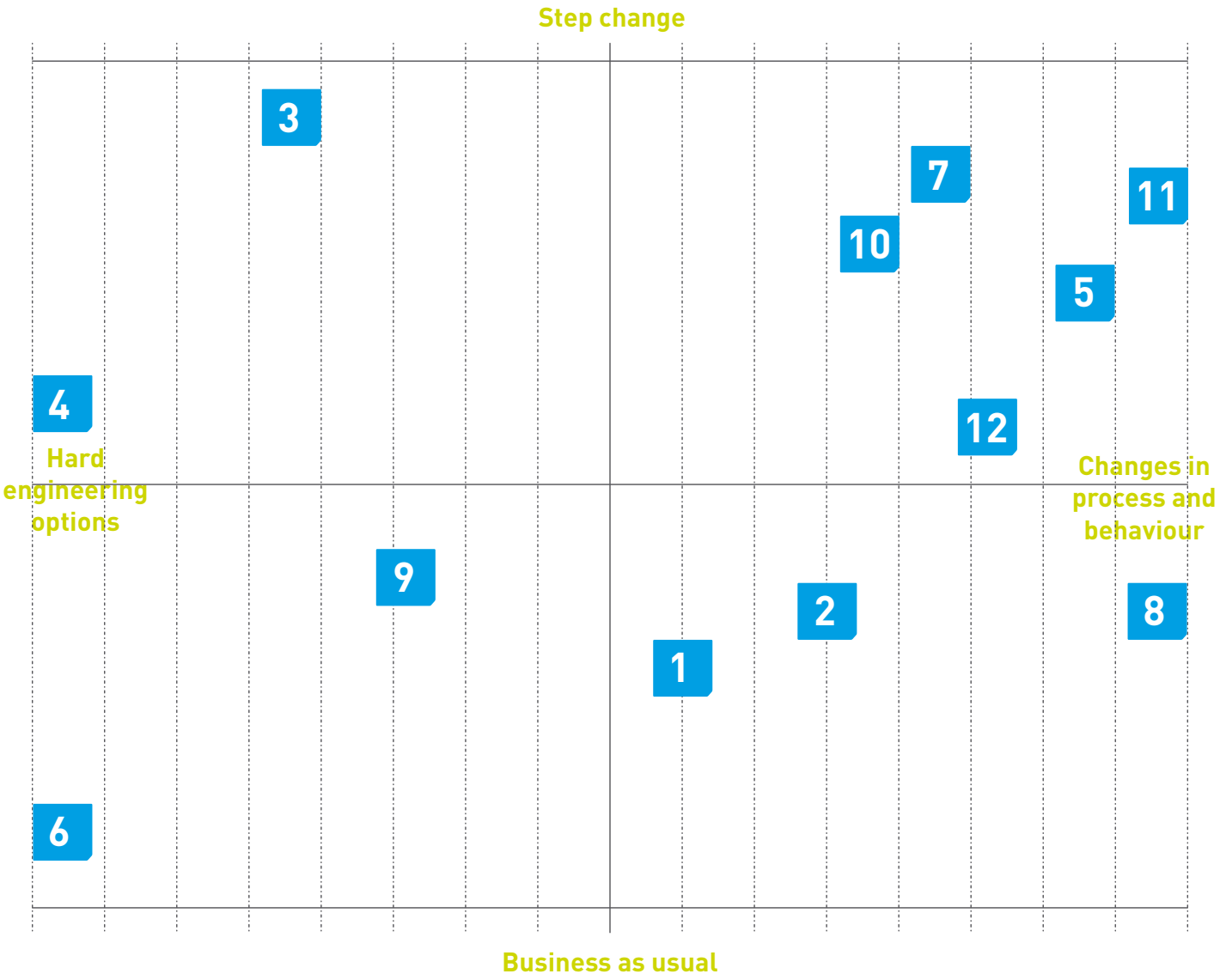
The chart only features the key highlights from our plan and not all the actions described above are included. There is a significant amount of business as usual activity that is not shown. It is important to recognise the value of day to day activities (such as maintenance and customer service) in building a robust business that contributes towards our overall climate resilience.

We are also committed to a significant research and development programme which will deliver further innovation and improvements to help us cope with future climate change. We have seen some previous R&D investments being "pulled through" during the last five years. These include:

- **New ways to identify leakage in plastic pipes, which is a notoriously difficult task.**
- **Development of the "Hybacs" process which is a low carbon way to treat greater volumes arriving at sewer treatments works.**
- **The introduction of "Biobullets" to control zebra mussels, an invasive species that block pumps and pipes.**

In the next five years we will be investing more than ever before on R&D (circa £39m) and we expect this investment to deliver further improvements in the way we work. We understand that adapting to climate change in an efficient way demands responses that are outside our traditional set of solutions. This places an even greater emphasis on these research and development activities to seek innovative solutions.

Adaptation Actions



1 Reduce Leakage by 6%

2 Save 25Ml/d through water efficiency

3 Alternative supply for Birmingham

4 Protecting vulnerable communities

5 21 catchment management projects

6 Upgrading water treatment works

7 Doubling number of sustainable urban drainage projects

8 Expanding education programme

9 Giving up 85Ml/d abstraction licenses

10 Tripling number of partnership working

11 Bespoke weather forecasting

12 Make better use of digital technology

Figure 14: Adaptation action highlights plotted against hard or soft engineering solution type on the horizontal axis and business as usual or step change activity on the vertical axis.

Climate change: Opportunities

Although we focus on planning for and adapting to the negative effects of climate change, it does bring some positive changes. In the course of our assessment, we have found the following opportunities:

1. As a big challenge, climate change provides impetus for change, improvement and reform

2. We expect some direct benefits and business opportunities to arise from a changing climate

3. Taking the time to report on climate change adaptation has helped us find improvements we can make today.

Climate change as an impetus for change

Climate change is a big, global challenge. It can be seen as something remote and impersonal and difficult to do anything about. However, we have found that if it is communicated in the right way and grounded in experience of actual weather events, climate change can be a persuasive and positive impetus for change.

We considered climate change as one of the key challenges in our business plan for 2015-2020 and spoke extensively with our customers about it. It was clear from this exercise that the long-term direction of change on many issues is easily understood and widely supported, regardless of the specific projections for climate change. Climate change also helps drive policy change from regulators and government. This can be seen in the water sector, which is going through a process of reform on water trading, resilience and competition, all at least partly driven by the need to adapt to a changing climate.

Climate change as a subject can also be used to engage and inspire people. For example, our education team always talk about the challenges of climate change in schools and new recruits in our graduate programme are challenged to consider and address this subject. It can also support ideas and actions, particularly research projects, which might otherwise not be supported.

Benefits of changing weather conditions

Of the direct benefits associated with the weather, the three most important for our company are:

01	Warmer Winters	Reduced Leakage	**Reduced number of frost-related bursts and leaks, reducing supply disruptions and saving cost.** There is a close relationship between leakage levels and frost events and even a small reduction in the incidence of ground frost could noticeably reduce leakage. As leakage is so important to service and to customers, this is a substantial potential benefit.

We accept this opportunity but we are not relying on it to deliver our leakage reduction targets, which customers strongly support.

02	Wetter Winters & Increased Storminess	Recharge of groundwater aquifers	**Higher winter rainfall increases recharge to groundwater aquifers, increasing summer base flow. This means there is more water available to abstract, allowing storage to meet supply shortages.**

Although there are significant climate change threats to the balance of supply and demand, particularly during the peak summer periods and drought events, total average annual rainfall is projected to remain relatively stable over the next century. This offsets the threats to some extent but not entirely, as not all the water from high-intensity rainfall events can be captured and stored for later use. Changing rainfall patterns is one of the factors considered in our water resources management planning process and this is an opportunity that we will keep under review.

03	Hotter & Drier summers	Increased value of wastewater effluent	**Higher water demand increases the value of our waste water effluent.**

Our effluent is returned to the local environment. Often the same water is then later abstracted for different uses. With climate change pressures, particularly on supply, our effluent potentially rises in value, making schemes to reuse it more valuable. We understand that not all our final effluent could be reused as in many cases it plays an important role in supporting the flows in receiving rivers; however, in the future the potential for reuse will rise in prominence.

Improvements from the reporting process

Our reappraisal of risks and adaptation actions presented in this report has been a valuable process. It has:

- **Allowed us to sense check and refine our understanding of the risks we face and the range of activities which are helping us to adapt.**
- **Made sure our assessment of all the risks the company faces includes the best information we have about climate change.**
- **Prompted us to do more engagement with our customers, stakeholders and the other water companies.**
- **Raised awareness of climate change risks and adaptation around the organisation.**
- **Accelerated improvements in the company, such as the use of weather data for live decision making.**
- **Improved our analysis of weather causes for service failure events and the way we track these.**

The project has also identified remaining research and understanding gaps which should be addressed. The top priorities which we have identified are:

- **Understanding changes to the frequency of high intensity rainfall events, building on the CONVEX project.**
- **Understanding extreme drought frequency in the UK. There are several projects underway on this subject and this focus should remain as this is a priority risk for water supply and many other sectors.**
- **Understanding the impact of climate change on the frequency of landslips. We believe wider underpinning academic research is required in this area.**
- **Understanding the ecological response of the aquatic environments to changing flow conditions and the consequent impact on wastewater treatment and water abstraction.**
- **Groundwater flooding; which is difficult to predict and hence ignored by most flood risk assessments.**

Uncertainties, Interdependencies and Barriers to Adaptation

We understand the importance of adapting our business to the impacts of climate change, and this report focuses on our own progress and planned actions. There are some issues where we believe wider reform would improve the way the water industry adapts to climate change. For example:

- **The Flood and Water Management Act has made a step forward in enabling adaptation and resilience to flood risk. However the legislative and regulatory framework still operates in favour of more connections to our sewers, at a time when the burden on our system is rising with climate change. We believe that either the automatic right to connect to sewer systems should be completely removed, or charges for connecting new developments reflect the full costs that they impose on the sewerage system. Both these options would lead to more sustainable urban drainage systems (SUDS).**
- **Currently there is a lack of certainty about the resilience of some of the services from other sectors that we rely on. Common standards of resilience for the most critical national infrastructure, particularly electricity and communications, would help reduce interdependency risks.**
- **Reform of the water abstraction regime is urgently needed. Future water scarcity driven by climate change needs to be fully reflected within the allocation and pricing of abstraction licences. Flexibility also needs to be built in to facilitate rapid responses to extreme drought events.**
- **We are moving towards a more competitive water sector in the UK. Retail competition should encourage more adaptation by sharpening companies' understanding of the resilience needs of customers and also help deliver greater water efficiency. In the medium term further upstream competition is likely and some areas, primarily those related to water trading, would have to be implemented with sufficient long-term focus in mind. We believe an evaluation of how upstream competition affects the water sector's capacity to adapt to climate change is worth more investigation.**

We are strong advocates of reform in our industry and we would welcome the opportunity to work with government and regulators on these issues. We welcome reforms that encourage adaptation and strengthen accountabilities for service and performance in a water constrained future with more volatile weather. We have set out further thoughts on some of these key issues in our recent "Charting a sustainable course" publication.

We look forward to the next update of the UK climate projections (currently known as "UKCPnext"). Although producing the scenarios is an academic exercise, there needs to be a much stronger connection with the business community in defining their purpose and scope. We are keen to play a part in helping influence these scenarios so that they can be designed in a way that is accessible and relevant to business users. This is critical because the majority of adaptation in the UK will be delivered by the private sector.

The issue of interdependencies between sectors, and activities in other countries, is a key issue. We think there is an opportunity to learn from the rest of the world on how best to adapt. We have observed important ways of working from our colleagues in the international part of our business, particularly in response to extreme weather events. Our challenge for the future is to embed this learning.

We recognise that overcomplicating climate change can slow down adaptation progress. In particular, the expectation that adaptation action needs to be justified by a precision which currently does not exist in climate modelling. In many cases adaptation can take place without the need for detailed climate scenarios and the direction of travel of a specific climate variable will suffice. We would like to contribute to a wider conversation on the issue of precision and uncertainty within climate scenarios and how they can be used to inform business decisions.

Engagement

Engagement with customers and stakeholders is extremely important to us. Our business plan for the period 2015-2020 is founded on the most extensive engagement exercise we have ever carried out. This wasn't just a one-off exercise; in all our work we continue to carry out wide-ranging consultation, seek robust challenge from our external stakeholders and find opportunities to work in partnership with others.

Good external engagement helps us to

- **make sure we've got our priorities right**
- **consider all the risks and the interdependencies that exist**
- **take in new ideas**
- **find better solutions.**

Engagement is especially important on climate change issues because the weather doesn't just affect us; it affects the communities we serve and the organisations we rely on, so we share common challenges and potentially common solutions.

In 2011, our extensive approach to stakeholder engagement on climate change adaptation was praised by Government as "a clear example of best practice". We are keen to remain leaders on this subject so over the last few years we've continued to maintain the relationships we built up, we have built new links and gathered many more opportunities and ideas. Some key examples are described below.

Continuing engagement – over the past five years we've kept close links on climate change issues with:

- The Water UK Climate Change Adaptation Network – Severn Trent now chairs this group, which is a network of climate change managers from across the water sector. In March 2015, we met with other water companies to discuss our adaptation approaches and the risks we had identified; this was helpful both as a sense check and as a source of new ideas. We also collaborated in a joint event with other water companies and the Met Office in April 2015 to share and learn about the latest advances in climate science and climate change projection.
- The East and West Midlands Regional Climate Change Partnerships – we have attended and helped run workshop sessions with these groups, which are an extremely valuable network of contacts. Their regional coverage means we can focus our discussions locally. We sit permanently as a member of the West Midlands Climate Change Partnership.
- Existing and future customers as part of our education programme. When we present to groups, including in schools and universities, we always mention climate change as one of the most important challenges facing the sector and often focus on this topic in detail.
- The Environment Agency (EA) – we maintain links with the EA throughout our organisation on a range of water and waste issues. This includes regular meetings at director level.
- Defra – Not only do we have good links with the Adapting to Climate Change team, we have also helped shape the future market reform agenda by placing a senior staff member on secondment at Defra.
- Ofwat – as part of our business planning for the 2014 price review, we had regular engagement with the economic regulator, including meetings on our largest climate change adaptation proposal to increase the resilience of Birmingham's water supply.

New routes of engagement – In the time since our last report, we've found new ways to communicate and spoke to a range of new audiences.

- 2015-2020 business plan engagement. Our engagement work for our most recent business plan stretched over a period of three years and was our biggest engagement exercise ever. As a part of this, our Customer Challenge Group considered climate change as part of their role to scrutinise and challenge our plan in detail.
- Customer Research. We did specific testing on how much customers are willing to pay for improvements in service resilience and reductions in risk.
- Climate Week. In 2014 we sponsored Climate Week with four other water companies. During this week we ran an external workshop to get stakeholders' opinions on our adaptation and carbon reduction plans out to 2020.
- Welsh Government. Our region covers a significant part of mid-Wales. So it is crucial that we engage with the Welsh government, which has its own powers and policy priorities for water and adaptation. We met specifically with them in 2015 in order to explain our approach to adaptation and how this fitted with their own policies in Wales.
- Supply Chain. In 2010, we did not ask our supply chain partners specifically about climate change risks but we have done so during the last five years, through our supply chain advisory groups and by inviting supply chain partners to the climate change events we have held. This is important because our supply chain deliver many of the goods and services necessary to serve our customers and design and build many of the assets which we manage for decades to come.
- Committee on Climate Change. We've submitted evidence to support the work of the Adaptation Sub Committee in producing their advice for Government over the last five years. We have also contributed to their project work in support of the next climate change risk assessment evidence report.

Learning from others – Adapting to climate change is a common problem that people and organisations across the world face. For that reason there is a lot we can learn from other businesses and from academia. Finding the best solutions means staying open-minded, so we invest time and money learning from others. As company we can further build our capacity to adapt by:

- **Learning from the best available science.**
- **Exchanging knowledge and experience through conferences and events – including policy development and practical solutions.**
- **Incorporating climate change in to our own and joint research programmes .**

Case studies:
Adaptation report workshop

On 25th February 2015, we held an open climate change workshop at our offices in Coventry, at the heart of our region. We invited a broad range of people, including many of those who had contributed to our 2015-2020 business plan through the planning process. There were over 30 attendees representing our supply chain, regulators, customers, academia and local government. Attendees were given the opportunity to hear about our draft risk assessment and feed back on the priorities and actions we had identified. We also discussed others companies' adaptation and resilience actions and opportunities for working in partnership.

The feedback both during and after our event gave us confidence that the priority risks we had identified were the right ones but also gave us some extremely valuable additional insight into some of these risks. Feedback was very positive; everyone agreed their objectives had been met and that the day was worthwhile. The event raised a number of opportunities including collaborations with academia and ways to keep the risks on the businesses agenda after the external report has been completed. There were many areas of commonality, for example councils and water companies encounter similar issues with sewer misuse and areas of shared responsibility like drainage.

Workshop feedback:

"Useful and very interesting."

"Nice to hear how STW have approached their risk assessment - can take back some aspects to apply to our own."

"Good to understand programs the company is undertaking."

"Interesting to hear other people's actions and motivations."

Summary and Next Steps

Climate change poses a significant risk for Severn Trent Water. Adaptation is essential so we can continue to deliver services for our customers now and in the future. This is why we have taken action over the last five years, since our last formal adaptation report, to embed adaptation even more in the way we do things. We have delivered significant adaptation action on the ground and we have increased our understanding of the risks - but we still have more to do to build our climate resilience.

In this report we have set out our commitments to further build our climate resilience over the next five years. Our action is based on our adaptation strategy, which is not only focussed on managing our priority risks, but also looks for wider opportunities to improve what we do. Our approach to building climate resilience looks at solutions that deliver multiple benefits, such as direct improvements for today's customers as well as securing resilient services for future customers.

Our adaptation plans for 2015-20 include our largest ever investment – the Birmingham Resilience Project – which secures a resilient water supply for England's second city for generations to come. Our plans represent a step change in the amount of innovative schemes and partnership working; in particular, in catchment management and in SUDS. We are also stepping up the level of capital maintenance at our treatment works, as we recognise that day to day activities are an essential part of climate resilience. **We are doing all this in the context of a bill that is decreasing in real terms over the next five years. Our plan demonstrates that you can strike the right balance between investing for the future while keeping bills low.**

Changes to the way we are regulated have helped encourage adaptation and there is now a much stronger link between our financial performance and climate change adaptation. In particular, the introduction of ODIs and "totex" place a sharper focus on adaptation action and performance.

The majority of our ODIs are influenced by the weather and we have set ourselves challenging improvement targets over the next five years. Any material underperformance that is related to the weather will act as an early warning indicator that will feed into subsequent reviews of our climate change risk assessment and action plan. Over time, our performance will show whether or not we are successfully adapting to climate change. We recognise that we have to keep our risks and actions under review as we learn more and as new risks emerge. We will review our climate change risks and progress on adaptation with our Board each year.

We would like to see further reform in the water sector that places climate change adaptation at its centre. It is important that any reform strengthens the accountability for service and performance in the context of a water constrained future with more extreme weather.

We are keen to work with others in order to address our climate change risks in the most efficient and effective way possible. In particular, we will work with our supply chain to influence their actions to build climate resilience and we will continue to expand our partnership working to find joint solutions to common adaptation challenges. We would also like to help improve the regulatory regime, industry structure and wider policy landscape so that potential barriers to adaptation are identified and removed.

Our stakeholders made a valuable contribution towards the production of this report, and we commit to keeping them informed on our progress and to share good practice. If you would like to comment on this document or are interested in working with us, then please get in touch at **adaptation@severntrent.co.uk**

Governance of our adaptation report

The content of this report has been signed off by the Severn Trent Executive Committee and has been subject to robust internal verification in order to be approved for publication by the Severn Trent Disclosure Committee. The contents of both this main report and the accompanying summary have been verified following a three tiered structure:

- **Tier 1: the document owners**
- **Tier 2: second line verification from a Severn Trent staff member who played no part in the formation of the report**
- **Tier 3: a member of the Severn Trent compliance team**

The data in this report can either be tracked back to its original source or to documents that have already been published externally. This level of governance not only means the report is robust and accurate, but also ensures that the key adaptation issues are discussed at the highest levels within Severn Trent.

Appendices

Contents

1. References

- ABI, 2009, ABI Research Paper 19. The Financial Risks of Climate Change.
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2. Company outcomes and ODIs

In total 25 out of 27 financial ODIs are affected by the weather and could be impacted by climate change. The ODIs can be used to monitor the impact of changing weather on our business on an ongoing basis. Note that most ODIs are lag indicators reflecting past performance; two ODIs are forward looking measures that reflect how our climate resilience is being built. We have an additional six ODIs related to the delivery of the Birmingham Resilience Programme that are not included in this list.

Outcomes and ODIs	Impacted by Climate Change
We will provide water that is good to drink	
Number of complaints about drinking water quality	**yes**
Compliance with drinking water quality standards	**yes**
Asset stewardship – number of sites with coliform failures	**yes**
Successful catchment management schemes	**yes – lead indicator of climate resilience**
We will ensure water is always there when you need it	
Leakage levels	**yes**
Speed of responses in repairing leaks (% fixed within 24 hours)	**yes**
Number of minutes customers go without supply each year	**yes**
% of customers with resilient supplies (those that benefit from a second source of supply)	**yes – lead indicator of climate resilience**
Asset stewardship (mains bursts)	**yes**
Customers at risk of low pressure	**yes**
Restrictions on Water Use	**yes**
We will have the lowest possible charges	
Customers rating our water services as good value for money (based on Tracker survey)	**no**
Customers rating our waste water services as good value for money (based on Tracker survey)	**no**

Outcomes and ODIs	Impacted by Climate Change
We will safely take your waste away	
Number of internal sewer flooding incidents	yes
Number of external sewer flooding incidents	yes
Partnership working to reduce sewer flooding	yes
Asset stewardship: blockages	yes
We will protect our local environment	
Improvements in river water quality against WFD criteria (water)	yes
Improvements in river water quality against WFD criteria (waste water)	yes
Number of category 3 pollution incidents (waste water)	yes
Asset stewardship: Environmental compliance (waste water)	yes
Biodiversity improvements (waste water)	yes
Sustainable sewage treatment	yes
Overall environmental performance	yes
We will protect the wider environment	
Size of our carbon footprint (water)	yes
Size of our carbon footprint (waste water)	yes
We will provide you with excellent customer service	
Customers' experience of dealing with us (based on Ofwat's SIM)	yes

3. All of the climate change risks in our assessment

This is a complete list of all 36 risks identified which climate change poses to the business. In the main report we focus on the priority risks, defined as having a risk score above 20.

Rank	Climate Driver	Risk	Risk Description	Risk Score
R1	Hotter & Drier summers	**Customer demand**	Increased pressure on our water resources means more risk to service and higher cost to meet customers' needs.	40
R2	Wetter Winters & Increased Storminess	**Exceeding sewer capacity**	Runoff exceeding capacity of sewer system, causing surface flooding; affecting customers and can cause river pollution.	35
R3	Hotter & Drier summers	**Abstraction restrictions**	Reduced reservoir and river levels, resulting in abstraction restrictions. Increased cost of alternative sources threatening customers' supply.	32
R4	Hotter & Drier summers	**Power failure**	Adverse weather e.g. storms/ flooding causes damage to power infrastructure, causing risk to operational failure.	30
R5	Warmer, wetter winters & drier summers including extreme rainfall events	**Raw water quality**	When it rains after long, dry periods, runoff from fields increases the amount of pesticides (including metaldehyde), pollutant concentrations, and sources of discolouration in water sources. Increased water treatment costs, and threatened compliance with water quality regulations.	29
R6	Wetter Winters & Increased Storminess	**Poorer customer experience**	High volume of customer contacts during adverse weather, increasing risk of negative customer experience.	29
R7	Hotter & Drier summers	**Supply chain risk**	Suppliers are unable to procure materials or goods required for our processes or projects e.g. Chemicals due to insufficient water or access restrictions. Increased costs of alternatives / unable to find alternatives.	28
R8	Storminess	**Damaged ICT/ telecoms**	Damage to ICT infrastructure and telemetry, including mobile phone networks and internet. Hampers our ability to react and communicate, causing problems for our customers and increasing costs to find alternative solutions.	28
R9	Warmer, wetter winters & drier summers including extreme rainfall events	**Landslides**	Aqueducts / Pipes swept away affecting customers supply and costing money to fix.	27

Rank	Climate Driver	Risk	Risk Description	Risk Score
R10	Hotter & Drier summers	**Environmental demand**	Compensation from boreholes and raw water reservoirs is required to meet environmental limits of river due to low flows. Reducing water available for customers increasing need to seek more expensive sources.	**26**
R11	Increase in temperatures	**Bacteriological growth**	Increased bacteriological growth requires increased use of chlorine or organics removal at treatment works, increasing costs of water treatment or water quality deteriorates.	**26**
R12	Hotter Summers with more intense rainfall events	**Blockages causing flooding**	Lower average carry flows result in greater sewer deposits and blockages, which result in sewer flooding causing environmental damage.	**25**
R13	Hotter and Drier summers	**Tighter discharge consents**	Lower water quality in the environment, requires us to compensate and increase the treatment of our waste effluent to a higher standard with associated costs.	**25**
R14	Wetter Winters & Increased Storminess	**Flooding risk to water works**	Fluvial inundation of water treatment works can cause failure of treatment processes and therefore ability to meet customers demand. Associated increased costs of alternatives.	**25**
R15	Increase in temperatures	**Lower water levels**	Increased evapotranspiration reduces recharge, causing lower river, groundwater and reservoir levels. The amount we can abstract from resources is reduced, which increases our costs as we use alternative sources and additional resources and can threaten customers' supply.	**23**
R16	Hotter & Drier summers	**Low pressure water supply**	Higher domestic demand on water poses a risk that more customers experience low pressure incidents.	**22**
R17	Wetter Winters & Increased Storminess	**Flooding risk to waste works**	Inundation of sewage treatment works can cause failure of treatment processes which can cause pollution and increase costs.	**20**
R18	Increase in temperatures	**Algal blooms**	Increase in algal blooms in reservoirs affects water quality, reducing the volume of water that can be abstracted and requires more treatment and reduces volume that can be output into supply to meet customer demand.	**18**
R19	Increase in temperatures	**Invasive species increase**	More favourable conditions e.g. extended growing seasons for invasive species such as zebra mussels and Himalyan Balsam, can impact water treatment and increase costs associated with control actions.	**17**
R20	Storminess	**Increased river scour**	Regular high river levels, increases river scour and damage to bridges, aqueducts and pipe crossings, causing supply problems for the customer and associated costs of repair.	**17**
R21	Hotter Summers with more intense rainfall events	**Reduced farmer engagement with catchment management**	Farmers are less engaged with catchment management schemes during extreme weather due to focus on primary farming activities, reducing success of schemes. Pollutants not prevented from entering water course, reducing water quality and increasing treatment costs.	**17**
R22	Hotter Summers with more intense rainfall events	**Risk of contamination from cracks to groundwater**	Desiccation cracks in soil zone creating rapid pathways to groundwater. Increased risk of contamination from bacti, crypto and turbidity in raw water sources. Subsequent increased use or chlorine at treatment works, increasing costs or water quality deteriorates.	**16**
R23	Hotter & Drier summers	**Less dilution of pollutants**	Less dilution of pollutants in river due to higher evaporation. Increased costs of water treatment or risk that drinking water quality deteriorates.	**16**
R24	Hotter & Drier summers	**Ground movement affecting pipes**	Pipes can be affected by changes to soil moisture causing ground movement or shrink and swell in hot temperatures. Burst pipes can increase leakage, affecting customers supply and increasing costs to control.	**16**
R25	Wetter Winters & Increased Storminess	**Resources required to assist local communities**	Increased STW resources required to support communities due to disruption and damage caused by severe weather.	**16**
R26	Wetter Winters & Increased Storminess	**Access restrictions**	Severe weather could cause localised travel problems along road network. Customer service impacted if staff unable to access sites. Ability to dispose waste would be reduced, may need to use higher cost alternatives of waste removal.	**15**
R27	Wetter Winters & Increased Storminess	**Damage to assets**	Severe weather could damage our assets, causing them not to function as required; associated cost of enacting backup plans and subsequent costs of repair work. Increase in insurance claims and associated increased premiums.	**15**

Rank	Climate Driver	Risk	Risk Description	Risk Score
R28	Hotter & Drier summers	**Transfer of invasive species**	Increased need for water movement and compensation due to reduced water availability. Risk of transferring invasive species between river basins and introducing them to new areas, affecting the environment and increasing treatment problems.	**14**
R29	Increase in temperatures	**Vector borne diseases**	A warmer climate increases incidences of vector borne disease such as malaria, air quality and pollution. Affects the health and safety of our staff, absence patterns and productivity.	**14**
R30	Hotter Summers	**Increased energy costs of waste treatment**	Decrease in dissolved oxygen in activated sludge processes, leading to rise in energy consumption to input oxygen required.	**11**
R31	Wetter Winters & Increased Storminess	**Higher volumes of wastewater to treat**	Higher volumes of wastewater to treat. Increased costs from power, chemicals and potentially up scaling of treatment works.	**11**
R32	Wetter Winters & Increased Storminess	**Increased silt movement**	Increased silt movement caused by high river base flows blocks river intakes. Increased number of supply outages or more costly abstraction required from alternative sources.	**10**
R33	Hotter & Drier summers	**Bursts due to increased pumping**	Increase in domestic demand for water requires increased pumping. Over pumping can cause pipe bursts, which increases leakage levels and costs to control.	**10**
R34	Wetter Winters & Increased Storminess	**Increased staff absence**	Changing weather increases likelihood of slips, trips and falls. Varying absence due to adverse weather influencing staff resources available, resulting in potential operational disruption and financial loss due to increased staff absence.	**10**
R35	Wetter Winters & Increased Storminess	**Increased grit at sewage works**	Increased quantity of grit and detritus at sewage works. Increased costs of disposal (currently landfill), cleaning and damage.	**7**
R36	Hotter & Drier summers	**Forest Fires causing runoff**	Forest Fires could cause danger to life, habitat loss, transport disruption, siltation and water quality issues in our water sources when followed by rain and runoff from land.	**6**

4. All climate change opportunities

This is a complete list of the climate change opportunities we have identified, including 'Neutral' scores which represent both threats and opportunities depending upon the outcome.

Rank	Climate Driver	Risk	Risk Description	Risk Score	
O1	Warmer Winters	**Reduced Leakage**	Reduced number of frost-related bursts and leaks, reducing supply disruptions and saving cost.	**Opp**	**30**
O2	Wetter Winters & Increased Storminess	**Recharge of groundwater aquifers**	Higher winter rainfall gives increased recharge to groundwater aquifers, increasing summer baseflow. More water available to abstract, allowing storage to meet supply shortages.	**Opp**	**26**
O3	Hotter & Drier summers	**Increased value of wastewater effluent**	Higher water demand increases value of waste water effluent.	**Opp**	**21**
O4	Warmer, wetter winters & drier summers including extreme rainfall events	**Alterations to land suitability for sludge disposal**	Wetter winters may cause land to become saturated creating unsuitable conditions for sludge application, whereas hotter drier summers may extend suitable period for application - impacts upon costs of storage, value of sludge and need to find alternative routes of disposal.	**Neut**	**17**
O5	Increase in temperatures	**Changes to buildings heating demands**	Higher average temperatures reduce our need for heating in buildings but also increase our need for cooling	**Neut**	**16**
O6	Increase in temperatures	**Changes to energy crop yields**	Changes to energy crop yields; extended dry seasons and damage from storms could decrease yields, however, increase in average temperatures could increase growing seasons. Impacts on energy generation and associated costs.	**Neut**	**15**
O7	Hotter Summers	**Increased biological treatment**	Improvements in biological treatment performance and effluent removal efficiency. Lower treatment costs.	**Opp**	**13**
O8	Warmer Winters	**Reduced risk to drivers of snow on roads**	Reduced frost and snow cover on our sites and road network; reduces risk to our drivers and costs associated with gritting.	**Opp**	**13**
O9	Wetter Winters	**Increased hydroelectric power**	Increased reservoir levels in winter allows greater utilisation of river compensation releases with associated Hydro-Electric Power generation.	**Opp**	**7**
O10	Changing wind patterns	**Changes to wind power generation**	Potential threat of reduced wind power generation, although opportunity of increased wind generation equally likely due to unknown projections.	**Neut**	**5**
O11	Increase in temperatures	**Improved efficiency of biogas production**	Higher ambient temperature increases the efficiency of the biology and mechanical operation of the digestion and biogas process, with small associated cost savings.	**Opp**	**2**

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