



Adapting to a changing climate

The Environment Agency's second adaptation report under the Climate Change Act

Our organisation

We are the Environment Agency. We protect and improve the environment.

Acting to reduce the impacts of a changing climate on people and wildlife is at the heart of everything we do.

We reduce the risks to people, properties and businesses from flooding and coastal erosion.

We protect and improve the quality of water, making sure there is enough for people, businesses, agriculture and the environment. Our work helps to ensure people can enjoy the water environment through angling and navigation.

We look after land quality, promote sustainable land management and help protect and enhance wildlife habitats. And we work closely with businesses to help them comply with environmental regulations.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to make our environment a better place for people and wildlife.

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Foreword



As we publish this report, some communities and businesses will still be recovering from the devastating impact of the winter storms over December 2015. We saw record breaking weather during this period, with temperatures over 4°C warmer than average. It was also the wettest month in the UK since records began. This extreme and persistent rainfall caused devastating flooding and huge amounts of disruption, particularly in the north of England.

The Environment Agency is on the front line of such severe weather. We build flood defences, warn and inform communities at risk, reduce risks from flooding, manage and minimise the impacts of floods, and help communities to recover. We are not always able to prevent flooding, but we work to reduce the risks from events such as the recent winter storms, and reduce the impact on communities.

Although it is difficult to link individual storms, floods or droughts to climate change, the scientific consensus is clear that climate change will alter weather patterns and increase the frequency and severity of extreme events, resulting in greater risks to the country. The Met Office have said that the UK's temperature has already increased by nearly 1°C above pre-industrial levels, doubling the risk of heatwaves and perhaps leading to more intense rainfall. We have seen a run of severe weather over the past few years, with devastating flooding during winter 2015/16 and winter 2013/14, a storm surge on the east coast in 2013, and a drought in 2012. We should regard these events as a warning for the future, and a reminder that we need to plan ahead to prepare for such weather, and understand how it may change in the long-term. It is not a matter of if we will see the impacts of a changing climate, but how soon and how severe they will be.

We know that climate change will significantly affect the Environment Agency's work, especially on flood and coastal risks, water availability and freshwater habitats. These are among the priority risks in the government's National Adaptation Programme, and so our climate adaptation work is also important for national resilience. We are well placed to support communities, councils and businesses to adapt, and indeed we offer adaptation advice to many of our customers and partners.

We have been factoring long-term climate change into our work for over a decade, and can do this with more confidence as scientific projections of future climate improve. We can point to areas of our work that have already changed significantly to accommodate climate change, for example our plans to manage long-term flood risk, and our work with government to reform water abstraction licensing. We have also changed our pension investments to make them more resilient to a changing climate. We will continue to refine our adaptation work in light of new evidence and policy developments such as Defra's 25 year plan.

A handwritten signature in black ink that reads "Emma Howard Boyd". The signature is written in a cursive, flowing style.

Emma Howard Boyd

Acting Chair of the Environment Agency

Executive summary

This is our second report to government under the Climate Change Act on our climate risks and adaptation plans.

Climate resilience starts today

The severe weather that we've seen in recent years, including the recent floods in the north of England, show that we need to be resilient to the weather we face today, regardless of climate change. Investing in today's resilience is also a natural first step towards climate adaptation.

Our strategic overview role for flood and coastal erosion risk in England means that we can help communities manage flood risk from main rivers, the sea and reservoirs. Our work to protect and enhance England's natural capital lets us take a long term and integrated view of river catchments. Our environmental protection role means we can balance the needs of the economy and ecology, a competition which will intensify with climate change.

Finally, we are on hand to support communities and work with others when the worst happens, because natural disasters can never be prevented entirely. We can expect this to be an increasingly important part of what we do and of what we need to plan for.

A changing climate affects the way we work

Records show us that the weather is changing, with warmer temperatures, heavier rainfall and higher risk of drought. The Met Office's UKCP09 projections show us how this change could continue during this century, and we have used these projections to explore climate risks to the Environment Agency's work.

Higher temperatures, more extreme rainfall and sea level rise will put pressure on the environment and, in turn, on society. Flood risk will increase, water demand may start to exceed supply in places, and wildlife will suffer as rivers heat up and water levels fall. We have identified over 150 separate climate risks that the Environment Agency has to manage, affecting everything from how we design flood defences to how we manage our offices.

Thinking big, acting early

The good news is that many of these risks have been understood for some time, and that we already have plans in place for them.

Our long term investment plans for flooding show that the expected annual damage caused by flooding could be reduced by 12% over the next 50 years despite climate change. The government has committed £2.3 billion to reduce flood risk to at least 300,000 households by 2021. This is boosted by the 2016 budget announcement of an additional £700 million for flood resilience.

We are also reducing risks to the water environment through improving habitats, by working with natural processes to manage catchments, and our abstraction reform work with government.

We recognise that more needs to be done to prepare for climate change. Our key commitment is to climate-proof all our new strategies and plans, putting adaptation at the heart of everything that we do. We have made nearly 100 other adaptation commitments for the next five years. These range from ensuring our flood investment decisions are climate resilient, to working with industry to reduce water demand, to using natural processes to manage flood risk and water availability at a catchment scale.

Our adaptation strategy will also benefit from Defra's forthcoming 25 year environment plan. This will set out government's long term environmental ambition, recognising that pressures on the environment, including from climate change, will continue to increase and need a smart, integrated response.

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Introduction

This is our second report under the Climate Change Act. It shows how today's weather and a changing climate affect our work and sets out our strategy to help communities, businesses and wildlife adapt to a changing climate.

About this report

This report explains the Environment Agency's strategy for adapting to a changing climate. It is our second report under the Climate Change Act (2008), and is written in response to an invitation from government ministers.

The report has two parts. The first part forms the main body of the report, and discusses how we respond to severe weather today, how climate change will affect our work, and how we will manage that risk. The second part of the report is formed of three annexes that provide the technical information requested by government from organisations that were invited to report.

In 2011, we were one of the first organisations to report our adaptation plans under the Climate Change Act. Over a hundred bodies have since published their own reports. Our first report showed that climate change will affect nearly everything we do, and that our adaptation priorities were flood and coastal management, managing water resources and aquatic habitats.

That overall message is still true today, but we can now be more confident about both the scale of the challenge and our response to it.

About the Environment Agency

The Environment Agency is an executive non-departmental public body, sponsored by the Department for Environment, Food & Rural Affairs.

We are the leading public body for protecting and improving the environment in England. Our vision is to create a better place for people and wildlife. We have three main business areas:

- Flood and coastal risk management.
- Water, land and biodiversity.
- Regulated industry.

Severe weather and climate change affect our work across all three areas.

Our climate change roles

Acting to reduce climate change, and helping people and wildlife adapt to its consequences are at the heart of everything we do. We have responsibilities for reducing the emissions of greenhouse gas (mitigation) and preparing for the inevitable impacts of a changing climate (adaptation).

Managing the impacts of a changing climate (adaptation)

We factor the impacts of severe weather and a changing climate into our daily work:

- As a regulator, we need to understand how today's weather and climate change affect our customers and the environment so that our planning assumptions are correct, for example on water demand and availability.
- As an operator, we need to make sure that our flood defences and other assets are designed to perform effectively in a changing environment, and also ensure that we have the right plans to respond to emergencies such as floods and droughts.
- As an adviser, we need to make sure that our customers and partners have the right advice and technical information to account for climate change, for example we advise local planning authorities on future flood allowances.

Climate change is particularly important in our work on flooding, coastal erosion, water management, habitat protection and creation, and as a statutory adviser in the land-use planning system. Flooding, coastal erosion and water availability are also identified as key climate risks in the government's National Adaptation Programme (NAP).

We work with many other organisations on climate adaptation. In particular, we support government in producing the national climate change risk assessment and adaptation programme under the Climate Change Act. Our technical advice and data are an important resource for other organisations working on climate change, such as the Adaptation Sub Committee. We also host the UK climate projections (UKCP09) and are helping government to shape the next set of updated projections.

Reducing climate change (mitigation)

We implement some of the UK's main regulatory schemes to reduce greenhouse gas emissions on behalf of the Department for Energy and Climate Change. These are the European Union Emissions Trading System, the CRC Energy Efficiency Scheme, Climate Change Agreements and the new Energy Savings Opportunity Scheme. These apply to a wide range of businesses and public sector organisations, and collectively cover more than 50% of the UK's greenhouse gas emissions.

Our regulatory duties on environmental protection also reduce greenhouse gas emissions by requiring site operators to improve their energy efficiency. Our environmental permits for landfills restrict uncontrolled methane emissions. We also regulate the environmental impacts of some low-carbon and renewable technologies, including hydropower schemes, anaerobic digestion, tidal barrages and ground source heat pumps. We advise on new applications to build power stations to ensure that they can install technology for carbon capture and storage in the future.

We aim to reduce our own greenhouse emissions by reducing energy use from our pumping stations, offices, transportation and infrastructure construction.

We also strive to lead by example in tackling climate change. For example our pension fund is the first in the world to change its investment choices to help meet the internationally-agreed target of limiting global warming to 2°C. To do this we will reduce our exposure to coal, and oil and gas by 90% and 50% respectively by 2020.

Embedding adaptation in our pension investments

The Environment Agency Pension Fund policy leads the way in considering climate risks for sustainable investment. The policy includes an evaluation of the risks and opportunities presented by a changing climate in relation to our pension fund investments. We now have more confidence that our investments will still deliver long-term financial returns as the impacts from a changing climate materialise.



Learning from today's climate

In recent years we have seen the devastating impacts of severe weather on communities and businesses. These events can help us to plan for climate change, by showing us the impacts we should expect and the steps we should take to prepare.

Preventing and responding to natural hazards

Recent years have shown us that we need to be resilient to severe weather, regardless of future climate change:

- In December 2015 and January 2016, winter storms Desmond, Eva and Frank brought record breaking rainfall and devastating flooding, especially in Cumbria and Yorkshire. Although there was widespread flooding, 23,400 properties were protected by our assets.
- Between December 2013 and February 2014, the country suffered prolonged periods of heavy rain, gale-force winds, tidal surges and large waves. We issued 155 severe flood warnings and 4,500 of our staff were involved in the response, issuing warnings, running pumping stations, erecting demountable defences and clearing blockages from rivers. The total economic cost of this flooding event in England and Wales is thought to be around £1.3 billion¹.
- In December 2013, a storm surge coincided with spring tides to cause the highest water levels recorded along the English east coast and also affected the north-west, east and south coasts. We issued 71 Severe Flood Warnings and the emergency services evacuated towns and villages around the east coast, notably Boston, Great Yarmouth, Jaywick and Sandwich. In total 2,800 properties flooded along the east coast and properties collapsed into the sea at Hemsby, Norfolk. As a result of the warnings and preparations by ourselves and others, there were no fatalities due to flooding and 800,000 properties were protected by flood defences.
- The UK had heat waves in 2003, 2006 and 2013, with summer temperatures in 2013 more than 6°C hotter than average. It is estimated that this heatwave caused up to 760 excess deaths in the UK², a number of large fires, and flash flooding from thunderstorms. Heatwaves also cause environmental harm through fish kills, increased fire risk at regulated sites, and poor air quality.
- Much of England saw drought in 2012 when a run of particularly dry winters resulted in low reservoir levels, hosepipe bans, and impacts on agriculture and the environment from low water levels. There were pressures on water abstractions for people and agriculture, in some cases resulting in temporary use bans. We also saw significant short-term impacts on ecology and water quality compliance due to low flows, an increase in canal closures, and reduced performance of hydropower activities due to low flows.

We undertake a range of activities to protect the nation against natural threats and hazards, such as severe weather. Our flood risk assets are vital in protecting homes and businesses from flooding. Our work to protect water resources is increasing the preparedness of the country to drought events, helping to ensure there is enough water for both people and wildlife. Our work with Catchment Partnerships to develop and implement a more integrated approach to catchment management will improve the natural resilience of catchments to climate change, for instance by improving flood storage in the upper parts of catchments.

Natural hazards such as floods can never be prevented entirely, so we must ensure that we can deal with them when they happen.

As a Category 1 responder under the Civil Contingencies Act, we work with other agencies to respond to incidents and improve local and national resilience. We work with partners to develop multi-agency contingency plans, put in place warning mechanisms and encourage people to sign up to our free flood warning service, and develop training and exercises that test our procedures and plans regularly.

Severe weather can disrupt the continuity and performance of any business, including ours. We need to make sure that we have the right equipment, systems and manpower in place to respond to incidents whilst delivering our normal duties. We also have to make sure that our critical assets can perform under severe weather, and are reviewing our resilience measures as part of the Cabinet Office's National Flood Resilience Review.

Habitat creation at Spurn Point, Yorkshire

We have worked in partnership with the local community to develop coastal habitat in East Yorkshire, at the mouth of the Humber Estuary near Spurn Point.

The scheme has provided an immediate boost for wildlife, with a dramatic increase in wading birds. In total, 43 hectares of new habitat have been created, offsetting six hectares of old habitat lost to 'coastal squeeze' caused by rising sea levels.



Our weather is changing

It is difficult to say if individual weather events are caused by climate change, but we do know that climate change is already making some events more likely. The average temperature in central England has risen by about 1°C since the 1970s, and research by the Met Office tells us that:

- The risk of a heatwave exceeding the temperatures experienced in the European heatwave of 2003 has at least doubled. By 2040, we expect more than half of summers to exceed 2003 temperatures.
- The character of UK rainfall has changed, with days of very heavy rain becoming more frequent. What in the 1960s and 1970s might have been a 1 in 125 day event is now more likely a 1 in 85 day event.
- An extended period of extreme winter rainfall as we saw in December 2015 is now thought to be 7 times more likely as a result of human emissions of greenhouse gasses.

The Met Office's UKCP09 climate projections show how climate change could continue throughout the century, based on different plausible greenhouse gas emission scenarios. These show that the climate will change throughout the century, even under the most conservative assumptions. It is therefore certain that we will see significant environmental changes during this century and the only uncertainty is over when this will happen - not if it will.

Our future climate risks

Climate change presents a profound and ongoing challenge to our work. Almost everything we do will be affected by climate change, and we have identified over 150 climate risks up to the end of the century. We expect all of these risks to increase from today. Our most important vulnerabilities concern our work on flooding, coastal erosion, water management, habitats, and the wildlife that depend on them.

We are already undertaking significant adaptation action to reduce these risks and will continue to do so. We can manage many of our risks by adapting the way we work, but others will require careful long-term and flexible planning, or even a complete change in approach.

Our priority risks

Climate change will alter rainfall patterns, river flows, sea levels and water availability. This will inevitably affect our work on flood and coastal risk, water management, biodiversity and freshwater fisheries. In particular, climate change could impair our ability to:

- Make sure there is enough water for people, agriculture, business and the environment.
- Reduce the consequences of flooding and coastal erosion.
- Enhance biodiversity in water and wetlands.
- Ensure the sustainable management of fish stocks and promote angling.

Even taking into account the significant work already underway to reduce our vulnerabilities in these areas, climate change could make it difficult to achieve these objectives in the long-term without further action.

We have assessed climate risks across all our objectives by exploring if they could be delivered under a scenario of high-end climate change towards the end of the century, assuming that current adaptation plans are delivered. The results are summarised in Table 1 overleaf (and the technical approach is explained in Annex 2).

Climate risks to our main areas of work are discussed below.

Increasing resilience to flooding and coastal erosion

The Environment Agency takes a strategic overview of flood and coastal erosion risk in England, and is responsible for managing flood risk from main rivers, the sea and reservoirs.

Approximately 2.4 million properties are at risk today from flooding from rivers and the sea, and around 3 million properties are at risk from surface water flooding. Current estimates suggest that around 740 properties in England are vulnerable to coastal erosion by around 2030, with a further 1,500 vulnerable by around 2060. The total area of agricultural land that is at risk of flooding is around 12% (1.3 million ha).

The impact of climate change on flood and coastal risks will vary locally, but we can expect some general trends. Sea levels will continue to rise around England, as they have done for the past century. Even small rises in sea level could add to very high tides, affecting places inland, as well as coastal areas. Wetter winters and more intense rainfall will increase river flows and cause more surface run-off, leading to local flooding and erosion. This may in turn increase pressure on drains, sewers and water quality. This interaction between rising water levels and drainage can transmit flooding far from its original source.

Table 1: Summary of the vulnerability of our activities to climate change

Climate vulnerability		Current weather vulnerability		
(End of century, high-end climate change scenario, assuming current adaptation)		Minor	Moderate	Substantial
Extremely vulnerable	Ensure investments in flood and coastal risk management provide economic and environmental benefits where possible	x		
	Target resources to reduce the risk of flooding to communities with the highest flood risk			x
	Enhance biodiversity in the water environment and wetlands		x	
	Minimise our own environmental impact		x	
	Ensure the sustainable management of fish stocks			x
	Promote opportunities for people to enjoy water and wetlands through angling			x
Vulnerable	Reduce the consequences of flooding & coastal erosion			x
	Make sure there is enough water for people, agriculture, business and the environment		x	
	Protect and improve waters so that they are clean and healthy		x	
	Promote more sustainable and integrated management of land and water		x	
	Work with partners to take forward an integrated catchment-based approach		x	
	Work with businesses to reduce emissions, discharges and pollution incidents, and help ensure resources are used sustainably	x		
	Take action to improve compliance of poor performers and reduce their impact on the environment	x		
Some vulnerabilities	Help develop and promote a better understanding of flood and coastal erosion risk		x	
	Promote opportunities for people to enjoy water and wetlands through navigation		x	
	Reduce environmental crime, including waste crime, in order to protect both the environment and legitimate businesses	x		
	Play our part in helping the UK meet greenhouse gas emissions targets	x		
	Support sustainable growth by making it easier for businesses to know what they need to do to comply with regulatory requirements, without compromising environmental and public health protection and improvement	x		
	Contribute to creating better local environments that enhance people's lives and support a sustainable economy.	x		
	Work with others to ensure new and existing developments have a reduced environmental impact and a well-planned environmental infrastructure	x		
	Use evidence and knowledge to guide and inspire our own actions and the actions of others	x		
	Provide a safe and healthy working environment	x		
	Work with partners to develop our incident management capability further	x		

Note: table omits duties that are resilient to climate change because we are already doing the right things (for example the way we regulate radioactive waste sites), are inherently flexible (for example our regulation of industrial emissions), or are relatively unaffected by climate change (for example much of our advisory work). Annex 2 gives a full summary of our risks.

Although climate change will increase flood and coastal risks, other factors will determine the absolute level of risk and could be locally more significant, including:

- Land use planning in the floodplain.
- The maintenance and design standards of defences.
- The ability to provide reliable public warning and flood awareness messages.
- Prioritisation of local and national funding for flood and coastal management.

In 2014 we published our Long Term Investment Scenarios³ (LTIS) that set out the economic case for reducing flood and coastal risks over the next 50 years. These show that an optimal approach to investment could reduce the expected annual damage caused by flooding by 12% over the next 50 years even with moderate climate change. However it also shows that 200,000 houses will remain at significant risk. We will continue to review this assessment as our understanding of climate change and other risk drivers evolves.

The government is investing £2.3 billion by 2021 to reduce flood risk to at least 300,000 households through more than 1,500 capital projects. On top of this, the 2016 budget announced an additional boost to spending on flood defence and resilience of over £700 million by 2021. This level of planned investment is consistent with an optimal investment strategy, and the additional investment will provide an opportunity to adapt more quickly to a changing climate.

We will complement traditional 'hard' defences with approaches that work with natural processes and slow the flow. For example we work with partners to create wetlands that act as natural flood defences and have the additional benefit of providing important wildlife habitats and amenity. We also work with planners and flood risk management authorities to account for climate change in their own decisions.

Flexible adaptation at the Thames Estuary

London has world class tidal flood defences, but even so the risk of flooding is increasing from changes in climate and population growth. Our Thames Estuary 2100 strategy pioneers an 'adaptation pathways' approach to account for climate uncertainty and ensure that decisions to upgrade or replace assets are made at the right time.

We believe this adaptation pathways approach can enable many other organisations to make long term and flexible plans in the face of climate uncertainty, and we are actively promoting the approach more widely.



Protecting and improving water, land and biodiversity

We have an important role in protecting and enhancing England's natural capital, focusing on water quality and quantity, land quality, fisheries, biodiversity and geomorphology.

We know that the future water environment will be different to today, with increasing pressure on water supplies and changes in freshwater species.

Our adaptation approach centres on working in partnership through integrated catchment management, and increasing the resilience of the natural environment to cope with variations in weather, climate and other pressures. We will need to use the best available evidence to do this, and follow a flexible adaptation approach where appropriate. We are already developing ways of working with our catchment management partners to better consider severe weather and climate change, especially by using natural systems, such as increasing vegetation cover on slopes to slow run-off and reduce flood risk downstream.

Keeping rivers cool

Hot summer temperatures can kill fish, especially trout and salmon that are sensitive to oxygen levels in the water. Through the Keeping Rivers Cool Programme, we have worked with landowners and other partners to encourage planting of trees on river banks to reduce summer water temperatures by up to 5.5°C.

We have now handed over running of the programme to the Woodland Trust.



Water resources

Water resources are under pressure from population growth, urban development and changes in land use. Without appropriate long-term planning, the demand for water will exceed supply throughout much of the UK by the 2050s⁴. Future water resource availability pressures will not be limited to the south and east of England. Under many of the scenarios Wales, south west and northern England are likely to see significant unmet demand in the future. We expect climate change to alter the frequency and distribution of rainfall, to increase temperatures and increase the frequency and severity of severe weather events. Higher temperatures will increase evaporation and the demand for water. These effects are likely to be most severe where rivers are fed primarily by surface run-off rather than groundwater, and therefore rise and fall rapidly in response to rainfall.

Water resources availability in the future is uncertain. Notable climate risks include:

- The availability of sufficient water to support healthy aquatic ecosystems. This is important for improving and maintaining water body status to meet Water Framework Directive (WFD) requirements. We will need to reconsider the requirements for future water ecosystems and the implications on the water available for abstraction.
- The ability of water companies to deliver a secure public water supply.
- The availability of water to support economic activity and not present a barrier to growth.
- Agricultural productivity, since farmers need water to irrigate their crops and provide water for their livestock, especially during warmer weather.
- Ensuring that water management infrastructure is resilient and continues to function effectively as the climate changes. This includes our own assets such as weirs and pumping stations that are used to control surface water flows and transfer water between water bodies. It also includes the assets used by water companies and other abstractors (for example farmers and the power sector). This could result in the need for significant new resources to be developed.

The action we are taking to manage these risks sit under six themes: natural resource demand management, restoring sustainable catchments, planning for uncertainty, regulation of abstractions and discharges, drought and incident planning and integrated water management.

The pressures on water resources vary at a strategic and local level and across England. The approach for managing them will need to be adaptive and flexible.

Fisheries, biodiversity and geomorphology

The impact of climate change on biodiversity should be seen in the context that many priority species are already in decline due to other factors. Climate change will increase the pressure on these species and cannot be addressed in isolation.

Changes in temperatures and river flows are likely to have large ecological impacts on freshwater and wetland communities. Some impacts will be obvious, such as the arrival of new species. Others will be less apparent, such as changes in habitats and their dependant plant and macro-

invertebrate communities. Changes in climate could lead to the loss of important habitats that are sensitive to environmental change, such as saltmarsh and fens.

Rising temperatures will change the distribution of species, with some species moving northwards and being displaced by those tolerant of warmer climates, which could be either native species or non-native species from Europe. Rising temperatures in freshwaters are also likely to affect invertebrates and fisheries, with salmonid populations being the most at risk. However, generally warmer conditions should favour warm water species such as members of the carp family.

Hot dry summers also increase the frequency of algal blooms and fish kills in standing waters, and droughts can significantly reduce river flows and have an adverse effect on water quality. An increase in the frequency and duration of droughts would change our wetlands and the species that depend on them. This could have knock-on effects for the people who depend on them for recreation or business.

An increase in prolonged wet periods with more frequent flooding could increase sediment movement, shifting river channels, depositing sediment on floodplains and perhaps even increasing the risk of landslides.

Changes to native species composition

Cold-water fish communities are changing and will continue to do so under a changing climate. The salmon family is particularly sensitive to warming and there is evidence that the decline of char and the Atlantic salmon is in part related to recent changes in the climate



Our main response to help wildlife adapt to climate change is to reduce pressures on the environment and make ecosystems more resilient. Evidence suggests that improvements in urban water quality has off-set climate impacts on invertebrate communities. We are also working with partners to improve and increase habitats to increase resilience. For example, we are working with the Woodland Trust and Rivers Trusts to plant trees on small streams to provide cooling shade for young salmon and trout.

Water quality

Surface water quality is already under pressure from increasing development and population growth. Climate change is likely to alter the frequency and distribution of rainfall. Reductions in river flows would impact their ability to dilute pollutants, in turn lowering water quality. It is likely that this will increase the costs of water treatment services to meet increasingly tighter effluent discharge standards and to prevent deterioration of water quality.

Higher water temperatures increase the risk of eutrophication and algal blooms, which harm aquatic flora and fauna. More work will be necessary in the future to reduce nutrients being discharged from wastewater treatment works to help prevent eutrophication in our watercourses.

Increased and intense rainfall will mean more sewage effluent entering waters, affecting bathing water quality. High flows also increase the pollution and sediment levels of waters, which makes it harder to treat. We are working to improve our understanding of these risks and how best we can adapt to them.

Agriculture and land management

The pressures of climate change are already beginning to have an impact on British agriculture. Soil erosion is accelerating due to more intense rainfall, leading to the loss of valuable topsoil and pollution of watercourses. Heavy rainfall can also cause local pollution directly, for example when slurry stores become flooded and overflow.

The unpredictability of intense rainfall can make it difficult for farmers to plan their harvesting and planting. If harvesting and cultivation are carried out in wetter conditions, surface capping and soil

compaction can result. It is increasingly important for farmers to reduce compaction to improve infiltration and reduce the risk of localised flooding.

Hot and dry summers will increase the demand for water abstraction and irrigation, putting pressure on our natural water environment. A lack of moisture inevitably reduces crop growth, and both crops and livestock are susceptible to heat stress and disease during hot spells. The spectrum of pests and diseases that agriculture and forestry faces is increasing, exacerbated by milder winters as pests are not killed off during the cold weather.

Protecting the environment and supporting growth

We expect our ability to provide environmental protection and support growth to be challenged in the future by severe weather and a changing climate. We expect to see a range of impacts across our regulatory activities, for example:

- An increase in heavy rainfall could increase pollution incidents, for example leaching of pollutants from landfill sites.
- Hotter and drier weather could increase the number and impact of waste fires and lead to an increase in issues with dust and odour.
- The dilution capacity of surface waters will be reduced by higher water temperatures and reduced flows, which is likely to affect industrial discharges.
- Severe weather could increase waste stockpiling due to an inability to recycle or dispose of waste in the usual way.
- Coastal surges and flooding will impact vulnerable regulated sites, causing pollution incidents if these sites do not have adequate plans in place. The flooding of major industrial sites (covered by COMAH legislation) is likely to cause the most significant impacts.
- Low and high water levels and high water temperatures could make navigation more dangerous due to flow changes, bank erosion, increases in weed growth or increases in invasive species.
- A change in river flows and sea level may affect water-based renewable energy such as hydropower schemes as well as tidal and coastal energy infrastructure.

We need to improve our understanding of future risks, and work with others to ensure our permitting and regulatory roles are effective under a changing climate.

Working with others to create better places

We provide technical advice to address the impact of climate change on flood risk, water quality and water resources, in order to create sustainable communities and businesses. We do this by working with local authorities and wider partnerships through the planning and development process.

We provide advice as a statutory consultee to strategic plans and planning applications, as well as wider planning advice to other bodies such as Local Enterprise Partnerships and Local Nature Partnerships. It is likely that we will have more detailed engagement in some areas of our work if there are more significant environmental issues due to climate change. To address this we will ensure our staff have the correct tools and resources to provide effective and timely advice to others on how climate risks could change in the future.

Sustainable urban drainage systems (SuDS), at the Dings, Bristol

Sustainable drainage is the practice of controlling surface water run-off as close to its origin as possible, before it enters a watercourse or the ground. SuDS can also remove particles and pollutants from surface water run-off before it enters water bodies. We promote the use of SuDS in developments to avoid aggravating existing or creating new flooding problems, either on the site or elsewhere, and to protect water quality and resources.



Our business continuity

The business continuity of many organisations is tested by severe weather, and this risk will increase with climate change. The main climate risks to our business continuity are:

- An increase in travel disruption, loss of power to our sites and assets from storms and flooding.
- Flood risk to our offices and depots, many of which are near rivers, the sea or impacted by surface waters.
- Disruption to our supply chain that could lead to significant delay, increased costs or inability to obtain resources.
- An increase in our carbon footprint during severe weather due to increased water pumping and transportation.

We build resilience into our incident rooms, IT services and other critical equipment to ensure they are operational at all times. We also exercise and test contingency plans on a regular basis to ensure they are fit for purpose.

Building our climate resilience

We are acting now to adapt to a changing climate and address the risks we are likely to face.

Our adaptation journey

We have made huge progress in increasing our climate resilience and have been planning for climate change in our work since the 1990s.

We published our first adaptation report under the Climate Change Act in 2011 and have already delivered 90% of the nearly 200 actions that it set out (for more detail see Annex 3). These have improved our resilience, strengthened our evidence base and in some cases established best practice for adaptation.

We have also delivered commitments in the government's National Adaptation Programme, published in 2013⁵, and between 2012 and 2016 provided the government's Climate Ready service to support adaptation in priority national sectors.

The new actions that we set out in this report build on our experience to date and support government initiatives such as Defra's 25 year plan.

Climate Ready Support Service

We provided the government's Climate Ready Support Service to enable other organisations to increase their resilience to a changing climate. The service has contributed significantly to resilience by translating complex issues into guidance and tools that connects with its different audiences. Practical examples of the service's work include:



- Facilitating co-operation across sectors for example through establishing an Infrastructure Operators Adaptation Forum.
- Supporting organisations to produce their adaptation reports, including the recent report published by the Prudential Regulation Authority.
- Providing data and information, for example to the Department of Health to help them better understand which hospitals are at risk from flooding – both now and in the future.
- Working with the Met Office to improve the presentation of the UK climate projections.
- Delivering advice and guidance to others, for example through our supply chain guidance which helps businesses ensure they have the information they need to develop robust continuity plans and avoid disruption during extreme weather events.
- Directly influencing others, for example working with Ofgem to embed strong requirements on adapting to a changing climate in the price control period for electricity network operators.
- Assessing and filling adaptation gaps, for example through surveying the built environment sector to identify its guidance, data and tools needs. This resulted in the development of a business case toolkit for planners and architects.
- Working through umbrella organisations to spread resilience messages, for example providing information and support on flood resilience for Business in the Community, Federation of Small Businesses, the Business Emergency Resilience Group and a number of trade associations.

Our approach to adaptation

One of the organisational problems of adaptation is that climate change is a systemic risk that cuts across our whole business. Our experience is that adaptation works best when it is embedded (or mainstreamed) into existing businesses processes, rather than treated as a separate concern.

We also recognise that adaptation is still a relatively new discipline, and that we are learning continually about both the risks we face and the best way to manage them. This means that our adaptation plans are inevitably imperfect, but also that we need to allow them to evolve. We will therefore monitor, review and update our plans annually.

Our adaptation strategy

We have recently published an action plan to set out our ambition for the next four years. We commit in this to helping people and wildlife adapt to climate change and reduce its adverse impacts, including flooding, drought, sea level rise and coastal erosion, through:

- Better protection for people and businesses against flooding and coastal erosion.
- Strong preparedness to respond to emergencies.
- Greater resilience to climate change.
- Enhanced resilience to drought and loss of water supply.

Based on the risk assessment in this report, our priority adaptation actions are to:

- Ensure that all our new major plans and strategies are climate resilient by 2020, taking a long term view of climate change and using an adaptation pathways approach where appropriate to manage uncertainty.
- Develop adaptation indicators so that we can measure how our risks are reducing.
- Review and update our adaptation plans annually.

We have also developed nearly 100 detailed actions based around six themes. These are discussed below, with full details in Annex 1.

1. Work with our customers and partners to adapt

Working with our partners is vitally important, so that we can support them in finding the best way to adapt their activities and manage climate risks within our remit. We will work with partners and customers to provide advice, guidance and data to help us all play our part in adapting to climate change. For example we will work with:

- Defra, other government departments and partners to undertake activities such as integrating approaches to manage the flood risk on agricultural land, and reforming agricultural initiatives to consider a changing climate.
- Water and sewage companies on projects such as improving the resilience of water supplies, providing drought planning guidance and developing catchment drainage strategies.
- Regulated industries, supporting sectors to produce their own adaptation action plans.
- Highways authorities on developing resilient infrastructure to control flooding and prevent pollution.
- Members of the public through activity to improve flood communication and warnings, and promote the impacts of climate change on water resources.
- River Basin District Liaison Panels and Catchment Partnerships to develop and implement appropriate actions to manage water such as reinstating water flow processes and water storage across catchments.

Reducing flooding from agricultural land

We have been working with Yorkshire Farming and Wildlife Partnership and Yorkshire Wildlife Trust to reduce run-off and flooding from agricultural land. Two different types of leaky timber dams have been constructed on a livestock farm in Yorkshire to hold back water in high flows and attenuate the flood peak.

The aim was to reduce the risk of flooding to the farm below. It is also thought that these “slow the flow” interventions will improve water quality by reducing bank erosion and therefore sediment and phosphate loads.



2. Climate resilient investment

We invest significant amounts of money in flood, coastal and catchment management schemes, often working with partnership funding models. Capital projects to reduce risk to communities, businesses and infrastructure between April 2011 and March 2015 produced total whole-life benefits of £16.7 billion against whole-life costs of £1.41 billion. This investment provided a net present value of £13.7 billion and £12 of economic benefit for every £1 investment. Taking into account other capital expenditure, the overall programme benefit-to-cost ratio achieved since April 2011 is 9.8 to 1⁶. We are committed to ensuring appraisals of our flood risk capital investment account for uncertainties associated with a changing climate, by considering more adaptable solutions, and support the wider needs of communities.

We will also take a flexible approach that fits within the strategic context of taking a managed adaptive approach. This could include developing and embedding a long-term adaptation pathways approach in our key strategies and investments.

Incremental adaptation through the Oxford Flood Alleviation Scheme

As climate change increases the risk of flooding in Oxford, a scheme is required that will adapt incrementally to increased risk of flooding in the future.

As a result the Strategy Appraisal Report recommended options for Oxford were split into immediate (0-9yrs), medium (30-70yrs) and long term (70-90yrs) solutions to tackle flood risk. This approach will ensure future solutions are easily implemented as and when required, and can be regularly reviewed.



3. Climate resilient regulation

We are committed to adapting and improving regulatory mechanisms and approaches to take climate change into account, and to make it easier for those we regulate to mitigate and adapt to its impacts. This is especially important for our work on environmental protection, and protecting and improving waters.

Actions under this theme include addressing unsustainable abstraction and continuing to work with Defra to reform the abstraction management system, developing flexible water quality permitting

options, ensuring regulated industry sector plans reflect a changing climate, and ensuring environmental permits contain adequate plans to respond to severe weather conditions.

Working to restore sustainable abstraction

Our Restoring Sustainable Abstraction programme identifies and resolves problems caused by unsustainable abstraction. Since 2008, the programme has minimised environment harm from approximately 230 unsustainable abstraction licenses.

We are also supporting the government to reform water abstraction in England and Wales with a more flexible system. This will promote resilient economic growth while protecting the environment.



4. Building the evidence base

About a third of our adaptation actions involve improving our understanding of climate change. This broadly falls under three major types of activity.

Firstly, we will incorporate the latest science and evidence in our work and advice to others. For example we will continue to develop and improve Shoreline Management Plans to accommodate new climate change evidence. We will also work with partners to explore the impact of climate change on water bodies as part of river basin and catchment management. To ensure we are using climate science and impact information in a consistent way across the business, we will produce climate scenarios for use in planning for a changing climate.

The second strand of activity relates to better understanding our risks from weather and climate, for example:

- Mapping our supply chain vulnerabilities.
- Better understanding the links between severe weather events and incidents such as environmental permit breaches.
- Working with partners to improve water quality modelling capability that assesses impacts of changing pressures.

The third strand of work relates to improved decision making under a changing climate, such as economic approaches for public water supply management, and quantifying the impact of land-use planning on long term flood risk.

We will also develop a set of indicators to monitor our adaptation progress and evaluate the effectiveness of our adaptation activity.

Flood risk assessments: climate change allowances' guidance

We have used current climate change science to update our climate change allowances and advice. This guidance is used by land use planners to ensure new housing and other developments remain safe and resilient to flooding for their lifetime without increasing flood risk elsewhere. The guidance is available here: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>



5. Integrated catchment working

Our adaptation work at a catchment scale works with natural systems to provide multiple benefits for people and the environment. Our updated plans under this theme includes actions to protect coastal habitats, integrate water and the natural environment, prevent diffuse pollution from agriculture, promote and restore wetlands and prevent the spread of invasive non-native species. There are also actions to work with partners to ensure climate change is considered when setting and assessing progress against the objectives in River Basin Management Plans, and in selecting measures for river basin and catchment management.

River basin management plans are updated every 6 years, meaning we can continuously improve how we account for climate change in water management and build the evidence base to inform decisions to manage climate change impacts. Flood Risk Management Plans (FRMPs) are also updated every 6 years. Embedding adaptation into our integrated strategic planning will be an important part of improving resilience to the impacts of climate change.

Updated River Basin Plans and climate change

Our River Basin Plans include climate change assessments for each management catchment in England. These use local judgement to consider which aspects of climate change are likely to pose a long-term risk for the catchment.

Measures have been included in the plans to address the impacts from climate change that are flexible, or increase resilience to severe weather and a changing climate.



6. Building our adaptive capacity

We need to provide our staff with the right tools, training and information on climate change and adaptation. We will increase our organisational resilience through strengthening our incident management capability. We will also ensure our business continuity through better accounting for future pressures, and building resilience into our procurement and supply chain processes and procedures.

Building resilience into our supply chains

We have conducted a screening exercise to identify areas of our spending where a better understanding of our present supply chain vulnerabilities to climate risks would be beneficial.

To support this we are adjusting our procurement tools and guidance to include consideration of risks from a changing climate. This will help raise awareness of climate risks with our suppliers, and help to make our own supply chains more resilient and sustainable.



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Annex 1: Our detailed adaptation plan

Our priority actions are to:

- Ensure that all our new major plans and strategies are climate resilient by 2020, taking a long term view of climate change and using an adaptation pathways approach where appropriate to manage uncertainty.
- Develop adaptation indicators so that we can measure how our risks are reducing.
- Review and update our adaptation plans annually.

The following tables set out our updated adaptation plans based on our updated risk assessment. The actions are designed to address each of the main risks identified in the risk assessment, and are generally set to be delivered within our next corporate planning cycle (2016 to 2020) or longer term commitments.

1. Work with our customers and partners to adapt

Actions planned	Timescale
Use our statutory consultee role to continue to ensure that inappropriate development in flood risk areas is avoided through effective engagement with stakeholders and clear advice	2016 - 2020
Continue to support Defra initiatives that assist local authorities in managing adaptation to coastal change	2016
Support Defra, and others, in integrating approaches to manage flood risk of agricultural land	2018
Improve capacity to deploy temporary interventions to reduce flood impacts on communities	2016 – 2017
Improve communication of flood risk and flood warnings to the public to reduce flood impacts on communities	2016 – 2020
Continue to advise Government, Water Companies and other water users on the efficient use of water and options to help manage demand (such as metering and leakage control) that will be resilient to the impacts of climate change	2016 – 2020
Develop drought planning guidance so that water companies can maintain security of supply and protect the environment during droughts	2016 - 2020
Work with government and water companies on future demand and resilience of water users	2016
Support water and sewerage companies with developing catchment drainage strategies for priority catchments through AMP6	2016 - 2020

Work with others to develop an industry wide strategy for water industry sewage responsibilities, which accounts for changes in climate	2016 - 2020 and 2021 - 2025
Work with Government, Highways Authorities and others to plan and deliver infrastructure improvements to control flooding and pollution from the road network and new developments	2016 – 2020
Advise farmers on measures to adapt to changes in rainfall patterns and low flows, and risk of flooding	2016 – 2020
Work with Government and other stakeholders ensure the reform of agricultural initiatives supports farmers to adapt to a changing climate	2016 – 2020
Support Natural England and Forestry Commission to deliver measures through Countryside Stewardship in order to help the natural environment adapt to the effects of climate change	2016 – 2020
Promote and support the partnership initiative ‘keeping rivers cool’ with Woodland Trust to increasing riparian shade for salmon and trout	2016 - 2020
Create, restore and enhance freshwater and intertidal dependent habitats such as mudflat saltmarsh, wet woodland, floodplain meadows and grazing marsh to meet Biodiversity 2020 and Natural Capital Committee goals	2016 - 2020
Empower catchment partners to help them adapt through provision of relevant evidence in particular through open data, and engage in planning processes such as river basin and catchment management	2016 - 2021
Provide adaptation advice to regulated businesses in areas of flood risk	2016 - 2021
Hold a series of workshops with regulated businesses and sectors, helping them to understand how to assess climate risks and develop their own adaptation plans	2016/2017
Provide advice to illustrate how future flooding can be addressed in plans and developments using built in resilience and the ‘managed adaptive approach’	2016 - 2020
Review proposals for tidal power lagoons to ensure schemes maintain the resilience of existing flood defence assets, and protect against increasing risks from storm surge and sea level rise.	2016 - 2020
The Forecasting Impacts project (Flood Forecasting for the Future programme FF4F) includes improved visualisation and access to flood forecasts	2016 - 2020
Work with FCRM on their initiative to support communities where permanent defences are uneconomic or impractical	2016 - 2020
Support Flood Digital and open data initiatives to nurture and promote community resilience activity	2016 - 2020
We will work with other government partners such as the wider Defra network and Crown Commercial Services (CCS) to ensure that the climate risks associated with joint contracts and work areas are identified and influence the	2016 - 2020

management of them as appropriate	
Longer term commitments	
Communicate and engage with all water users to raise awareness of the impact of climate change on water availability, to influence attitudes and behaviours	
Work with farmers and supermarkets to advise on increasing the resilience of agricultural supply chains	
Continue to ensure that climate change is adequately accounted for in our regulation of proposed or existing nuclear and non-nuclear sites and in our advice to our partners	
Communicate and engage with all public and private sector partners and navigation customers to raise awareness of the impact of climate change on navigation, influencing attitudes and behaviours	
We will work with our supply chain to help them understand and adapt to the climate risks their business are exposed to, in relation to the contract provision that they have with us.	

2. Investment decisions account for a changing climate

Actions planned	Timescale
<p>Appraisals that account for uncertainties associated with a changing climate support investment decisions that take into account designing for adaptation. This will apply for all new schemes through the 6 year FCRM capital investment programme and future iterations.</p> <p>We will take a considered and flexible approach that is tailored to projects and catchments that fits within the strategic context of taking a managed adaptive approach. This will apply for all new schemes through the 6 year FCRM capital investment programme and future iterations.</p>	2016 - 2021

3. Improve our regulatory approach to account for a changing climate

Actions planned	Timescale
Continue to address un-sustainable abstraction as provisioned for in the 2003 Water Act, ensuring more resilient catchments	2016 - 2020
Working with government to reform the abstraction management system to ensure it is more flexible to respond to climate change by improving the link between water availability and use	2016 - 2022

Continue to develop flexible permitting options that minimise carbon emissions whilst meeting water quality objectives	2016 - 2020
Monitor CSO spills to establish thresholds and track changes in performance in order to influence our regulatory approach to permitting CSOs	2016 - 2020
Ensure all our permits and daily operational activities, such as flood risk maintenance activities, sampling and collection work and hydrometry and telemetry as well as projects and schemes, take climate change into account	2016 - 2020
As part of the review of quality protocols, establish how sensitive the risk assessments (on which they are based) would be under a changing climate by using climate scenarios	2016 - 2020
Continue to ensure that environmental risk assessments and other appraisals for radioactive waste disposal sites take account of climate change	2016 - 2020
Revise sector plans and annual action plans to ensure environmental protection under a changing climate	2016 - 2020
Ensure permits contain adequate plans in place to respond to severe weather conditions	2016 - 2020
Review the pollution reduction plan to investigate ways to reduce pollution incidents in reaction to reduced incident response resource	2016 - 2017
Longer term commitments	
Use monitoring to assess changes to the water environment and determine if we need new research/action	

4. Improve our understanding of climate risks and opportunities for innovation

Actions planned	Timescale
Maintain and develop advice for risk management authorities and planners using current credible scientific information on climate projections	2016 - 2020
We will use the best information we collectively hold about new development and flood risk to inform future long-term investment scenarios	2017
Understand the potential benefits, costs and limitations of including climate change flood risk assessment scenarios in our future flood risk assessment approach for use at local and national scales	2016/2017
Continue to develop and improve Shoreline Management Plans so that new climate change evidence can be accommodated as it emerges and ensure these developments are reflected in future review of Flood Risk Management Plans	2016 – 2020

Supporting the corporate sustainable procurement strategy, we will map our supply chain vulnerabilities and take action where severe weather and climate change could cause disruption and risk delivery of our core flood risk objectives	2016 - 2020
Continue to support and commission further research into the impacts of climate change on flooding and ensure research outcomes are translated into business practice	2016 - 2020
Complete research and development to identify the effects of sea level rise projections on coastal erosion rates in elected parts of England, and embed results in Environment Agency and local authority planning and modelling of coastal systems	2015 - 2017
We will use existing evidence on future flood risk, and further work to improve our understanding in this area, to inform investment plans	2016- 2020
Develop new planning and economic decision making approaches for public water supply water resources planning to predict, manage and plan for increasing uncertainties	2016 - 2020
Through environmental monitoring and assessment, ensure we understand and communicate the environmental impacts of water resource activities set against a background of a changing climate	2016 - 2020
Develop Environment Agency drought plans to consider and prepare for different and more extreme weather scenarios	2016
Continue ongoing work into innovative phosphorus treatment trials for treating sewage effluent	2016 - 2020
Continue to monitor new and emerging mitigation technologies in other sectors and their potential impact on fisheries, biodiversity and geomorphology, providing guidance to government on their predicted effects	2016 - 2020
Work with external partners (particularly catchment partnerships) to identify evidence to clarify the impact of climate change on water bodies as part of River Basin and Catchment Management. Use this evidence to ensure third cycle RBMPS are based on pressures from long-term climate change.	2016 - 2021
Raise awareness of the potential links between climate change and waste management to enable horizon scanning for issues that will arise from climate change early on	2016 - 2020
Whilst using the waste stream approach, identify and understand the limitations and effects of a changing climate	2016 - 2020
Improve our understanding of the links between weather events and environmental permit breaches	2016 - 2020
National Navigation team and Area Waterway Managers to further understand impact on navigation users from high/low flows, bank erosion, increase in invasive species, increase in weed growth or severe weather events	2016 - 2020
Identify and prioritise local flood and water resource risks to target our planning advice	2016 - 2020

Use latest scientific research to inform our climate change allowances advice for planners	2016 – 2020
We assess innovation opportunities that prevent, detect or improve our response to incidents, and build these into existing improvement projects or new research projects	2016 - 2017
Undertake a piece of work to understand which of the incidents we respond to are driven by weather, and understand how they may be likely to change in the future	2016 - 2020
Input into a review on innovative construction materials to assess whether they can improve the performance of assets, extend design life and reduce on-going maintenance costs	2016 - 2020
Understand and identify the vulnerabilities to future climate risk in our supply chain for our key goods, works and services that are essential for carrying out our core duties. We will look at mapping these key areas to identify suitable interventions.	2016 – 2020
The Strategic Review of Monitoring and associated information gathering will take into account future risks and monitoring requirements as a result of a changing climate.	20116 - 2020
We will identify any potential contribution from weather events to H&S incidents in order to understand any impacts on providing a safe and healthy working environment, and update our operational instructions accordingly	2016 – 2020
Longer term commitments	
Work with partners to assess the need for additional research into future water quality engineering solutions	
Work with partners to improve water quality modelling capability that assesses impacts of changing pressures	
Develop and communicate better understanding of how our rivers and coasts respond to climate change and a range of human pressures such as land use change, river maintenance, urban development, flood protection and water resource use	
Take into account adaptation to a changing climate within navigation asset maintenance where appropriate	
Review our assessment of environmental risks in our regulation of water-based renewable energy to maintain a balance between their environmental and low carbon benefits as water availability is affected by climate change factors	
Review the impact of low water availability and flooding on oil and gas exploration	
We will make the best use of evidence such as the climate projections (including UKCP18) and the government's climate change risk assessment	
We will develop adaptation metrics and indicators to monitor if our residual risks are increasing or decreasing	

5. Implement integrated catchment working with multiple benefits

Actions planned	Timescale
Continue to take action to ensure there is no net loss of internationally protected coastal habitats by 2025 as a result of coastal squeeze	2016 to 2025
Continue to work to integrate water and the natural environment, linking with Catchment and River Basin Management to deliver improved status of water bodies	2016 – 2020
River basin planning includes measures to prevent diffuse pollution in agriculture that takes into account changes in rainfall patterns and increased levels of pests, diseases and weeds	2016 – 2020
Account for priority water dependent species (determined by legislation or strategy) in our programmes and projects, and in any species focussed projects/partnerships that we engage with such as pearl mussel and crayfish work	2016 - 2020
Prevent or minimise the spread of invasive species in our daily operational work such as flood risk maintenance activities and follow the Non Native Invasive Species Framework Strategy for GB	2016 - 2020
Promote and restore wetlands and catchments to enhance summer base flows	2016 - 2020
Deliver river basin management to improve habitat resilience for wildlife, fish and eels, especially through improving water quality, restoring sustainable abstraction and removing barriers to species movement	2016 - 2020
Continue to use and promote the ‘landscape scale approach’, implementing the Natural Environment White Paper ethos of better, more, bigger and more connected sites”, adaptation tools and no-regrets measures internally and to partners in order to build more resilient freshwater and intertidal ecosystems	2016 - 2020
Work across Defra, devolved administrations and UK Technical Advisory Group for Water Framework Directive to better consider a changing climate when setting, monitoring and assessing progress against Water Framework Directive objectives (including no deterioration)	2016 - 2021
Work with external partners (particularly catchment partnerships) to ensure that third cycle RBMPs are based on pressures from long term climate change, and try to ensure that projects delivered in second cycle plans are also resilient to long term climate change	2016 - 2021
Understand and manage the impact of incident response on the delivery of river basin and catchment management	2016 - 2018

6. Build our adaptive capacity

Actions planned	Timescale
Update the Technical Development Framework for catchment coordinators to increase knowledge of climate change	2016 - 2017

adaptation	
Update the Technical Development Framework to encourage regulatory officers' knowledge of climate change adaptation	2016 - 2017
Ensure our local staff have the skills and resources to advise customers on flood risks and water availability as part of new developments, plans and strategies.	2016 - 2020
Assess the capability for resourcing incident response with current and likely future impacts on our staff structure	2016 - 2017
Strengthen our incident management capability through the Major Incident Ready programme	2016 - 2017
Incorporate into our ISO14001 certified environmental management system, the new ISO requirements to look at how environmental conditions can impact upon our business and how we consider our resilience to future climate change. This will include our supply chain.	2016 – 2018
Our long term Business Continuity Plan includes actions to address risks from an increase in severe weather and a changing climate	2016 - 2025
Update our sustainable procurement guidance and tools to incorporate the consideration of those category purchases which have a high vulnerability to climate related risks that may affect the goods, services and works we buy, seeking alternatives through innovation and market development where relevant.	2016 – 2017
Continue to deliver against our sustainability strategy targets that look to separate the relationship between our incident response activities and our carbon emissions, enabling us to carry out these activities without negatively impacting on our ability to reduce our environmental impact.	2016 - 2020
We will work closely with our flood and coastal risk, water resources, Operations, Fleet, Estates and procurement teams to ensure that they continue to meet the targets that are set out in our sustainability strategy. We will continue to reduce the impact that our incident response activities has on our ability to continue to improve our environmental performance.	2016 - 2020
Develop and implement a monitoring programme to measure the effectiveness of our adaptation programme	2016 - 2020
Monitor our adaptation plans on an annual basis to ensure actions are delivered and any new evidence is included	2016 - 2020
Develop approaches based on adaptive pathways and planning scenarios to ensure all of our major new plans and strategies are resilient to long-term climate change,	2016 - 2020
Better understand the influence of current severe weather on environmental incidents and our performance	2016 - 2020
Longer term commitments	

Adopt a lifecycle approach to our work on our supply chain to cover the risks wherever they occur where possible, even if this is beyond our direct supplier e.g. at raw material extraction stage.

We will promote long-term adaptation through flexible adaptation pathways and consistent planning scenarios for the next 25 and 50 years, especially for flood and coastal risk and water resource planning

Annex 2: Technical background

This annex provides the technical information on our risk assessment and adaptation approach, as requested in government guidance to reporting authorities.

Understanding climate risk

How has your understanding of climate risks, impacts and their effects on your sector/organisation and stakeholders advanced since your first round report?

We have made significant improvements in our understanding of climate risks since our first adaptation report. In particular we have improved our ability to better account for pressures that exacerbate the effects of climate change, such as population growth. Our projections of future water availability and flood risk underpin important parts of our work and account for such multiple drivers of change. An improved evidence base also allows us to be more confident in our future projections, and to plan for climate impacts further into the future.

Our statutory duties, primary legislation and government policy have all changed since our first report, not least because our responsibilities for Wales have passed to National Resources Wales. These changes in our duties and way of working affect our climate risks, because we are now trying to deliver different outcomes than when our first report was written. In our second report, we have also looked more closely at how climate change affects our work on incident management, procurement, health and safety, monitoring and our own environment performance.

Since the publication of our first report, England has experienced spells of severe weather that have captured public attention, not least the winter floods during December 2015. These events have improved our understanding of our corporate vulnerability to today's weather and future climate. This will help us to improve our resilience and adaptation response.

Our updated risk assessment

Our updated risk assessment explores how the organisation is impacted by current severe weather and will be impacted by future climate change. Our main findings from this risk assessment are summarised below and in Table 2.

- We have seen moderate or substantial impacts from severe weather in over half (59%) of our corporate objectives. In particular these are around our work to increase the resilience to flooding, and protect and improve water land and biodiversity.
- In the future we expect this picture to get worse. We do not expect any of our objectives to be completely unaffected. We expect over half (54%) of our objectives will have moderate to significant issues with delivery under the future high-end scenarios we tested them against.
- We have prioritised our risks through analysing the potential impact on the delivery of the organisation now and in the future.
- For some areas of our work we are seeing little impacts now and we expect our activity to be fit for the future, for example our work on radioactive substances regulation.
- There are areas of our work where we expect our risks to be about the same today as in the future, this includes our work on navigation.
- There are a number of areas in which we have seen little impacts from current weather, but we expect to see more impacts under a changing climate, for example our work in regulated industry.
- Finally there are areas where we are seeing impacts now, and we expect this picture to continue or become more significant in the future. This is particularly true for some of our work within flood risk, and in fisheries and biodiversity.

	Flood & coastal risk	Water resources	Water quality	Agriculture	Fisheries & biodiversity	Regulated industry	Our business
Increasing air temperature		Increase in evaporation		Increase in pests and diseases from fewer frosts	Changes in species compositions	Increase in waste fires & odor issues	Increased cooling in offices
Increasing water temperature		Impact on natural environment	Risk of eutrophication		Risks to cold water species	Impact on water discharges	
Drought		Impact on water supply resilience	Reduction in effluent dilution	Pressure on abstractions	Impact on species and habitats	Water abstraction for industry	Increase in carbon intensive water movement
Rainfall intensity	Change to distribution & frequency of floods	Impact on reservoir recharge	Increase in run-off & pollution events	Increase in diffuse pollution & sediment loss		Pollution incidents from heavy rainfall	Impact on ability to harvest rainwater
High river flows	Increase in defenses & maintenance			Loss of agricultural land from flooding		Flooding to regulated sites & waste infrastructure	More water pumping, risk to our buildings & assets
Low river flows		Impact water supply resilience	Reduction in dilution, increased eutrophication	Pressure on abstractions	Impact on wetlands & fisheries	Increase in water pollution from lack of dilution	Pumping to maintain river levels
Sea level rise	Loss of agricultural land and & habitats			Loss of agricultural land	Loss of coastal habitats & saline intrusion		
Storm & coastal surge	Impact on coastal communities	Saline intrusion to groundwater		Loss of agricultural land		Risk to regulated sites	
Other	Risks to supply chains, damage to infrastructure		Impact on coastal economies	Risks to supply chains & food security	Impact on designated sites	Stockpiling of waste in poor conditions	Inhospitable working conditions

Table 2. Example risks by Environment Agency function and climate variable

What climate change evidence or research have you used to better understand the implications for organisational functions?

In recent years there have been significant improvements in climate change information as well as new research on how climate impacts could be experienced in different environments and sectors. This evidence is helping us to better understand our risks, and what activity we need to take to address these.

Developing our evidence base

We ensure our work is supported by the latest climate evidence and research. We have supported better access to the most recent climate change projections (UKCP09) that provide probabilistic projections of UK climate. We are also helping to shape the next set of long-term climate change projections (UKCP18) by identifying user needs.

The government's national Climate Change Risk Assessment will be updated in 2017, and we are contributing to this research. We expect that the updated CCRA will include a synthesis of the latest science on climate risks and impacts, and will provide more detail on priority areas for the UK such as flood and coastal risk, water availability and natural capital.

As well as supporting and synthesising research undertaken by others to inform our work, we have undertaken research ourselves and in partnership to provide a better understanding of climate impacts within our own work. Our 'Case for Change' analysis supported the government's Water White Paper in 2011, and sets out current and future water availability based on projections of changes in population and climate.

We also published our latest Long Term Investment Scenarios (LTIS) for flood risk in 2014. LTIS updates the evidence linking investment to future risk, and identifies for the first time the optimal level of investment to manage flood and coastal erosion risk in England.

In addition, we have looked at the resilience of water supply systems to drought⁷, and the changes in concentration of phosphorus as a result of changing river flows that might change the risk of eutrophication⁸. We have also developed the use of short-term projections providing an 18 monthly forward look for river and groundwater levels across England.

We have undertaken research to directly inform adaptation and provide advice to a wide range of sectors through our Climate Ready Support Service with a number of case studies and guidance on how to produce good case studies⁹, risk to supply chains¹⁰, the costs of adaptation¹¹ and guidance on developing a business case for adaptation¹².

Evidence to support risk assessment in this report

As well as building on new research undertaken, for the first time in our risk assessment we have used climate projections and the latest evidence on climate impacts to create 'screening scenarios' which we have used to test the resilience of our organisational objectives and current adaptation plans (see Table 3 and Figure 1). We use climate scenarios for adaptation planning in some parts of the business already. However, the scenarios are tailored to the contexts they are used in and the range of available evidence on climate impacts - from detailed quantitative research to high level statements.

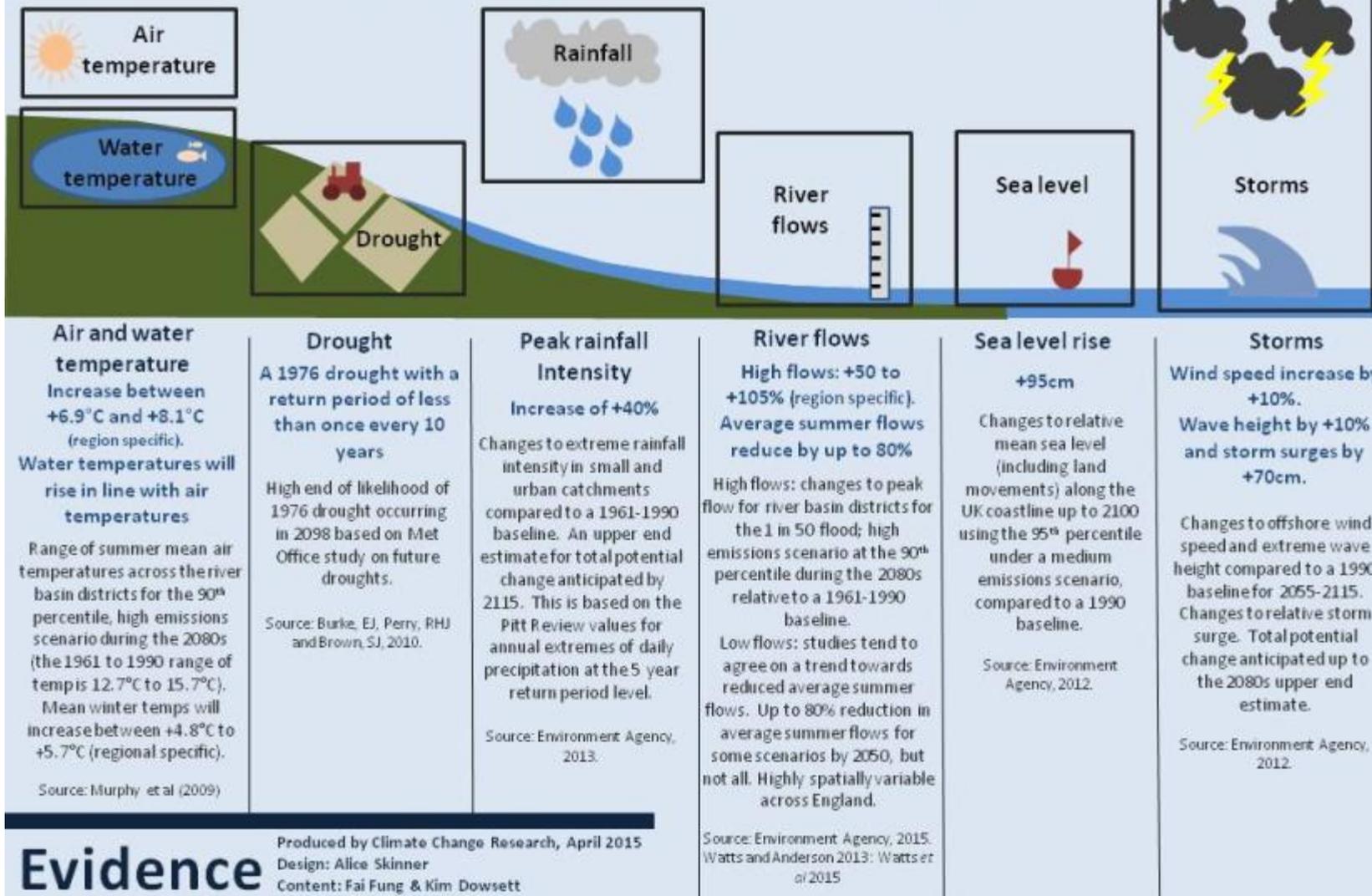
The new scenario was used to facilitate discussions to understand long-term risks to meeting our corporate objectives, by providing a single high-end representation of future climate to the end of the century. The scenarios were designed to encourage long-term thinking, and to facilitate discussions around climate extremes rather than averages.

This approach is consistent with an adaptive pathways approach, such as that used in our Thames Estuary 2100 (TE2100) project.

Variable	High End Projection	Description
High flows	+50 to 105%	Range of changes in peak flow for river basin districts for the 1 in 50 flood for the high emissions scenario at the 90 th percentile during the 2080s. This is relative to a 1961-1990 baseline ¹³ .
Peak rainfall intensity	+40%	Changes to extreme rainfall intensity in small and urban catchments compared to a 1961-90 baseline. An upper-end estimate for total potential change anticipated by 2115. This is based on the Pitt Review values for annual extremes of daily precipitation at the 5 year return period level ¹⁴ .
Sea level rise	+95 cm	Changes to relative mean sea level (including land movements) along the UK coastline up to 2100 using the 95 th percentile under a medium emissions scenario, compared to a 1990 baseline ¹⁵
Storms: Wind Speed	+10%	Changes to offshore wind speed and extreme wave height compared to a 1990 baseline for 2055-2115 ¹⁶ .
Storms: Wave Height	+10%	Changes to offshore wind speed and extreme wave height compared to a 1990 baseline for 2055-2115 ¹⁷ .
Storms: Storm surge	+70cm	Change to relative storm surge. Total potential change anticipated up to the 2080s upper-end estimate ¹⁸ .
High air temp	+6.9°C to +8.1°C	Range of summer mean temperatures across the river basin districts for the 90 th percentile, high emissions scenario during the 2080s. The 1961 to 1990 range of temperatures is 12.7°C to 15.7°C. Winter mean air temperature across the river basin districts for the 90 th percentile, high emissions scenario during the 2080s; 4.8°C to 5.7°C ¹⁹ .
Water Temperature	+6.9°C to +8.1°C	Assume water body temperatures will rise in line with air temperatures.
Low flows	Reduced average summer flows up to 80%	Studies generally agree on a trend towards reduced average summer flows. Up to 80% reduction in average summer flows projected for some scenarios by 2050, but not all. Highly spatially variable across England (medium confidence) ²⁰ .
Drought	A 1976 drought with a return period of less than once in every 10 years	High-end of likelihood of 1976 drought occurring in 2098 based on Met Office study on future droughts ²¹ .

Table 3. Climate scenarios showing high-end projections to the end of the century relative to a 1961 to 1990 baseline

CLIMATE RISK ASSESSMENT: HIGH-END PLANNING SCENARIOS



Evidence

Produced by Climate Change Research, April 2015
Design: Alice Skinner
Content: Fai Fung & Kim Dowsett

Figure 1. End of century, high end climate scenario used to test the resilience of our organisational objectives

Has your understanding of thresholds of climate impacts advanced to better pinpoint organisational vulnerability? If so, how?

In some parts of the business we are able to begin to identify our thresholds or tipping points from a changing climate, for example through our work in flood and coastal risk management and water resource planning. We are also working with partners to identify specific tipping points to species and habitats, for example temperature thresholds for salmon in rivers, or sea level thresholds for freshwater habitats.

However, it is generally very difficult to specify climate related thresholds or tipping points for our work. One reason is because much of our work within catchments and with specific sites we regulate depends on local conditions, and it is therefore difficult to specify a single threshold. Many climate impacts will also be manifested as incremental changes, meaning multiple thresholds need to be identified. Finally, many thresholds will often be driven by cost effectiveness or other determinants of acceptability rather than physical limits.

Even for those areas where we have theoretical thresholds, these are often unknown or uncertain in practice. More research is needed to adequately understand our thresholds and tipping points, in particular in relation to WFD and catchment planning.

We have set out actions in our updated action plan to build our evidence base, which will help to improve understanding of our thresholds and tipping points (for example developing the evidence base for flood risk management authorities, improving our understanding of the links between severe weather and environment permit breaches, reviewing the impact of low and high flows on onshore oil and gas exploration).

How have you developed your quantified assessment and analysis of risk likelihood and impacts?

Our risk assessment method draws upon the UKCIP, Defra and EA risk and uncertainty framework 2003²², and the latest government guidelines for environmental risk assessment, Green Leaves III²³.

1. Identify/formulate the problem

We used our corporate objectives as the basis for assessing our risks. These are not a full list of our statutory or regulatory duties, but represent the range of activities the Environment Agency undertakes and is responsible for. These objectives were tested against known impacts from current severe weather and projected impacts from future climate change using a planning scenario (see Figure 1). This allowed us to understand our risks and vulnerabilities and the actions that we need to take to address these, both now and in the future.

The objectives were screened to understand if they were sensitive to climate or weather, influenced by climate or weather (i.e. not directly impacted but we may want to work differently as a result), or insensitive to changes in both climate and weather.

2. Assess risk

For those objectives that were identified as sensitive or influenced by climate and weather, we assessed current and future risks, and ranked the extent to which these risks would impact on the delivery of our corporate objectives. In completing this risk assessment, we took into consideration the reduction in risk we would already be achieving due to work planned and underway.

Using knowledge and anecdotal experience of current and past severe weather events, we assessed the degree to which each of these corporate objectives is currently achievable under extreme weather conditions, and ranked this on a scale from negligible to severe impact on the objective.

We used a high-end and long-term (to the end of the century) climate scenario developed for this process in order to understand the extent to which our corporate objectives would be deliverable in the future. An assessment of the likelihood of the delivery of the objective was ranked on a scale from extremely unlikely (objective 0 - 5% likely to be achievable) to extremely likely (objective 90 - 100% likely to be achievable). Where possible we also included evidence on known thresholds and tipping points, and a narrative on the limits of the current adaptation strategy or objectives.

This process enabled us to understand the risks to delivery of our organisational objectives, and the relative importance of these risks. The level of detail used in the risk assessment was appropriate in order to come to these broad conclusions. Where there were uncertainties in understanding our risks, these were captured as new strands of research of activity in the next stage of the risk assessment process.

3. Identify and appraise options

We wrote adaptation plans to address the risks identified through the risk assessment process. We developed actions which cover our next organisational corporate planning cycle (2016 to 2020) or representing longer term commitments.

Our functional action plans were reviewed to identify and address cross-cutting risks and interdependencies. Each functional action plan is owned by the relevant Head of Business or Executive Director. To address the many cross-cutting risks and interdependencies that were identified through this assessment, we grouped our actions thematically rather than by department.

4. Monitor actions

We will be monitoring progress on delivery of our adaptation actions as part of our normal business reporting mechanisms. As well as monitoring the process behind our adaptation activity, we are also working to develop outcome-based measures in order to understand if our climate risks are reducing as a result of our adaptation activity.

Understanding uncertainties

Although we have come a long way in increasing our understanding of climate risks and impacts on the organisation, there are still a number of uncertainties that remain, these include:

- Uncertainties in evaluating climate risks to the organisation. This is partly a result of uncertainties in the nature and timing of climate change and the subsequent impacts on hydrological change, hydro-hazards and ecosystem changes. But we also have an incomplete understanding of the sensitivity of different parts of the business to climate change. There are also uncertainties around understanding the impacts of multiple climatic events (for example drought followed directly by a flood).
- Uncertainties remain in understanding our thresholds and tipping points, meaning we do not have a full understanding of when adaptation activity will be needed and at what scale. In addition there are uncertainties in understanding the role or capacity of activity or technology to alleviate or reduce the risks identified (for example SuDS), and therefore what residual risks may remain.
- There are uncertainties in monitoring adaptation risks and activity. It is often necessary to use proxy measures to display increasing resilience or a reduction in risk. Process rather than outcome measures are frequently used for this reason.
- Uncertainties or barriers may also arise from changes to how we undertake our activities. This could be a result of changes to regulation, funding or changes to partnership working.

Given the uncertainties above, we can still be confident in identifying the main strategic risks to the organisation, although quantifying the scale and magnitude of the risks becomes more difficult further into the future. Within our adaptation action plans we have identified actions to improve our understanding of climate risks, which will help to address uncertainties. We will also ensure our plans and approaches are flexible, so can be based on new and evolving evidence as it arises.

The assumptions that underpin the risk assessment can be categorised as:

- The use of climate science in our planning scenarios.
- Our organisational corporate objectives covering all areas of our remit where risks from weather and climate may be seen.
- Staff completing and reviewing the risk assessment have the correct level of knowledge to identify all risks.
- Our adaptation activity will adequately cover the risks identified, or will be modified if it is not found to be effective in reducing risk.

Addressing barriers and understanding interdependencies

We have identified interdependencies between risks and between adaptation actions. In order to successfully address the many cross-cutting and interdependent risks, action plans have been designed to be cross-departmental to encourage collaboration.

Our most important dependencies within the organisation are:

- Impacts due to increased work in responding to incidents and an increase in the number of incidents.
- Impact on the business from repeat events, diverting funds to recovery operations.
- Risks to our supply chains.
- Impact on the health, safety and wellbeing of our staff.
- Interrelated risks at catchment scale.

The risk assessment also highlighted barriers to delivering our adaptation actions. Table 4 below summarises the main barriers and the proposed activity to address them.

Barrier	Activity to address barrier
Investment and funding, in particular for research and development	Partnership working and looking for other funding opportunities, undertaking work in house where possible and promoting the importance of this work
Capability/resources of staff to undertake work	Providing information and training, making processes more efficient to reduce any burden, prioritisation and ensuring we have senior manager support for this work. Also embedding adaptation activity into existing business practices to reduce resource pressures in undertaking this work
Changes or lack of flexibility in policy or regulation	Work closely with government and partners, promote flexible approaches and be clear on our role
Difficulty in presenting a business case for adaptation	Promote a managed adaptive approach and work to develop evidence to support the business case for adaptation
Lack of information or knowledge	Investing in research and improvements, training and sharing best practice
Technical uncertainty /lack of consensus on climate impacts and lack of accessibility of evidence	Producing flexible guidance based on best available evidence, being clear on the science we use, developing scenarios, undertaking research jointly with partners and sharing evidence
Conflicting pressures within functions	Take an integrated approach to addressing risks and undertaking actions
Short term view	Promoting a managed adaptive approach
Insufficient metrics for reporting	Continue to develop metrics and improve our monitoring and evaluation of adaptation approaches

Table 4. Summary of barriers to delivering adaptation activity and activity to address these

We also recognise the long-term challenge of adapting to a changing climate. We have good adaptation plans in place for the next five years and in some cases beyond, but many environmental risks need sustained action over future decades. The risk assessment in this report shows where we need to do more work on our long-term residual risks. In some cases we can adapt our present way of working to accommodate climate change, but we face more structural challenges in other cases where:

- Our objectives today may be unsustainable under a changing climate, for example where salmon fisheries may become unsustainable under higher temperatures.
- Climate change exacerbates tension between our current objectives, for example by intensifying the competition for water at catchment scale between wildlife, public supplies and the needs of businesses.

Residual risk	Examples
Physical challenges	<ul style="list-style-type: none"> • Risks to salmon fisheries from increasing water temperatures • Improvements could be negligible under increasing risk • Difficulties in achieving statutory WFD objectives
Competing objectives	<ul style="list-style-type: none"> • Competing demand for water from people and the environment • Changes in regulation may be needed to further protect the environment
Risks that depend on external factors	<ul style="list-style-type: none"> • Changes to our role and remit • Risks to supply chains • Changes to regulation • New innovation and technology • Adaptation and maladaptation by others

Table 5. Examples of residual risks and long-term challenges

We will begin to address these long-term challenges by:

- Promoting long-term adaptation through flexible adaptation pathways and consistent climate planning scenarios, especially for flood and coastal risk and water resource planning.
- Making the best use of evidence such as the climate projections (including UK CP18) and the government's climate change risk assessment.
- Developing adaptation metrics and indicators to monitor if our residual risks are decreasing.

Many risks to our objectives will depend on the actions of others. For example, local planning authorities may consent to developments in the flood plain against our advice, which increases the number of properties at flood risk. Wherever possible, we work with our customers and partners to ensure that their decisions are resilient to a changing climate. We can do this by addressing the 'market failures' set out in the government's National Adaptation Programme:

- A lack of accessible information on climate impacts.
- A shortage of technical adaptation skills and tools.
- Interdependencies between industry sectors and organisations.

Opportunities and benefits

The risks of climate change far outweigh its benefits, but some opportunities were identified through our adaptation reporting process. For example some species may flourish which could lead to benefits for agriculture, and within fisheries this could lead to new opportunities in angling. An increase in impacts from severe weather may also lead to an uptake of adaptation activity.

We have been working to ensure we exploit these and other opportunities where possible. In particular since our first report we have been:

- Making the most of a greater awareness of the need to adapt (in particular as a result of recent severe weather) to drive our adaptation work and support others to do the same.
- Identifying and acting on opportunities for partnership working.
- Working on adaptation activity with multiple benefits such as catchment working, land management and the sustainable management of flood risk.

As well as opportunities we have identified as a result of a changing climate, we also expect to realise many benefits from our adaptation activity, for example through undertaking activity with multiple benefits and reducing future costs by investing more effectively now and achieving better environmental or economic outcomes.

Has adaptation reporting helped you?

We consider adaptation reporting to be a valuable process. Although we continually review our climate risks and adaptation activity, updating our previous adaptation report has given this work a new impetus and focus; helping to ensure these important discussions continue to happen, and are live and relevant. It has also been an opportunity to reflect on our capacity around climate change, and ensure our staff are more engaged and informed around impacts and the need to take action.

Our risk assessment and adaptation plans set out in this report will inform our next corporate priorities and future strategies, so we expect the findings of this work to be embedded within the organisation.

Annex 3. Progress since our first adaptation report

Progress on actions in our first report

We have made a significant amount of progress to increase the resilience of the organisation and the country since our first adaptation report. We had almost 200 adaptation actions in our last report, and 89% of these are completed or embedded within our work. We have listed below the few actions where our progress been revised or delayed, and the reason for this.

Summary assessment of the extent to which the actions have mitigated the risks

Since our first adaptation report, activity we have undertaken has reduced risks to the organisation from a changing climate and increased our capacity to respond in a number of ways. These include:

- An improved evidence base on climate change has provided multiple benefits. For example through enabling guidance and standards to be written, helping to identify and establish best practice, and ensuring the work we undertake and decisions made are informed by the most up to date evidence. An improved evidence base is also increasing our confidence that climate risks are being adequately considered and addressed.
- Through building climate change into our economic decision making, we are helping to ensure our investment decisions and physical works are based on a solid assessment of future risk.
- We have been able to support partners to understand climate risks and adapt accordingly.
- Our work has supported government decisions, for example our analysis on water supply and demand for the Water White Paper has led to reform of abstraction licensing.
- Our work is helping to increase the importance and visibility of climate risks. In some cases this has helped to secure resources and action.
- Action we have taken in many areas is increasing our ability and capacity to respond to climate and severe weather risks, and some activity is directly mitigating the risks identified.
- Our staff have a better understanding of climate risks and can build this into our work and advice that we give to customers and partners.
- Our work to reduce other pressures (for example improving water quality, habitats and fisheries) is helping to accommodate pressures from a changing climate.
- Some activity has helped to implement standards to improve the response to climate risks.
- We are clearer on what work needs to be done to address residual risks, which we will use to inform the actions outlined in our second adaptation report.

Due to the long term nature of adaptation responses, much of our activity is ongoing and it is too early for the full benefits of the actions undertaken to be realised.

Monitoring and evaluating

We have used existing corporate reporting mechanisms to track commitments in our previous adaptation report. This ensures adaptation reporting is part of normal business planning processes. Through this business reporting we were able to track progress on actions, and provide some analysis on the extent to which adaptation activity had reduced our risks. We aim to develop outcome measures to monitor and evaluate our adaptation progress in the future

Analysis of our ability to handle recent severe weather conditions is also reported through our existing corporate and risk reporting. However, we aim to improve our evidence base on the impact of severe weather on the business, as outlined through our adaptation actions in this report.

In most cases it is too early to tell if the organisation has realised any financial benefits from adaptation. Financial benefits are also difficult to quantify and are specific to individual risks and locations. However, we do expect to see long-term savings from much of our activity, planned and underway. We can start to see examples of potential financial savings from activity set out in our first adaptation report. For example including climate information in documents such as Reservoir Safety Management guidance and updated Shoreline Management Plans has led to improved long term investment decisions, and therefore cost-savings. Activity to prioritise risks has led to an improved targeting of resources from us and our partners and therefore cost savings, for example through targeting water quality modelling requirements.

We recognise the need to ensure flexibility in our adaptation approach. This can be seen through much of our work, for example through regularly reviewing evidence and building this into our guidance and procedures, and through flexible permitting and licensing options. Such an approach also helps to ensure our activity and that of others results in long term cost savings.

Revised or delayed actions

Summary of actions	Progress on implementation of actions
Flooding and coastal erosion	
Further develop methods to ensure climate change is fully considered in flood estimation of current/baseline conditions.	We have developed a research project to assess this, but have yet to take this work forward. We continue to review research priorities and local flood information to make sure we have the best understanding of current flood and coastal erosion; this is highlighted in our updated adaptation plan.
We will implement better indicators to monitor change in river flows and to compare predicted climate change with the trends observed by our river gauges. This will help us re-evaluate our approach and seek to reduce the risks of under or over-adaptation.	We undertook research to assess the viability of using our river gauge network information to monitor for the emergence of a climate change signal. The research project did not lead to a conclusive strategy for us to use our gauge record data for climate change detection. We continue to review findings from other institutions
Water	
We will advise and provide evidence to the Welsh Assembly Government, Ofwat, Dwr Cymru (Welsh Water) and relevant parties on how to improve water efficiency across all sectors.	This has been passed onto the Welsh Assembly Government (WAG)
Work with the Energy Savings Trust to advise the Welsh Assembly Government and others to ensure that water and energy efficiency are considered together in future retrofit programmes such as the Home Energy Efficiency Scheme and the Welsh Housing Quality Standard.	This has been passed onto the Welsh Assembly Government (WAG)
Seek opportunities to understand how greenhouse gas emissions are generated in other sectors of abstraction and wastewater collection and treatment. We will look to gather baseline energy/water-use data across other sectors (agriculture, industry and power generation), with a view to providing advice to government and assessing options to reduce energy consumption relating to those abstraction and wastewater activities.	We have scaled back this type of activity.

Advise government on water supply resilience, and in particular identify areas for improvement in supply connectivity and integration.	This is no longer our role under revised government guidance.
Wildlife and habitats	
Prioritise research needs to develop a strong evidence base to mitigate climate change impacts on fisheries.	Not proceeded due to insufficient funds available.
We will identify those species and habitats that are most vulnerable by undertaking a vulnerability assessment, especially salmonids. We will: <ul style="list-style-type: none"> - review current investments accordingly. - assess the value of commercial and recreational fisheries as species composition changes and varies spatially. - track effects on angling behaviour and trends in rod licence sales. 	We have relied on vulnerability assessments undertaken by others, and the evidence indicates that Salmonids, chalk streams and wetlands are the most vulnerable. Other strands of work are yet to start.
Embed climate change into the strategic plan to tackle barriers to fish migration. Exploit opportunities to build fish passes in to new schemes (for example, capital asset maintenance and replacement, hydropower development, abstractions/discharges).	Not yet achieved explicitly although we continue to remove barriers and this is an implicit adaptation measure.
Regulating business and waste	
We will ensure climate change adaptation plans are discussed with high risk sites covered by the Control of Major Accident Hazards (COMAH) regime,	Discussed with the Competent Authority Strategic Management Group whether we should take up an inspection topic related to considering climate change adaptation as a part of major accident prevention on COMAH sites. Action taken forward under updated adaptation action plan.
Examine how we record information on our compliance and incident databases to make sure that we can clearly identify any causal link between extreme weather events and permit breaches or pollution incidents.	No current progress on action as we require funding to change the form to isolate weather related events. This activity will be taken forward in our updated action plan.
Continue to monitor trends in pollution events and waste arising's to ensure that we have an accurate picture of the effect of climate change on waste management.	No further progress at the moment. This activity will be taken forward in our updated action plan.
Build climate change adaptation into our responses to strategies, plans and proposals at the regional and local level.	No specific action taken. No further progress at the moment. This activity will be taken forward in our updated action plan.
Identify exemplar sectors, target effort to those least aware, and focus our work with operators who are in the most vulnerable locations.	This activity will be taken forward in our updated action plan.
Develop our understanding of the changes to waste production and the risk to waste management that may be caused by climate change. This may involve research that builds on our current understanding of increasing vulnerability, and how improved site management can help to manage risks. We also need to develop a fuller understanding of the risks	No further progress at the moment. This activity will be taken forward in our updated action plan.

that extreme weather conditions will pose, for example flooding.	
Land quality	
Work with Defra to understand how we might use Water Protection Zones to tackle diffuse pollution and specifically the objectives of the WFD.	Work currently under review
Assess how current and new measures (for example, for Water Protection Zones) perform.	Work currently under review
Provide support to the Rural Climate Change Forum and ensure our existing and future policies are climate change proofed.	The Rural Climate Change Forum no longer exists. We work with partner organisations to ensure that our advice on new and existing policy considers climate change.
Recreation	
We will ensure that implementation of the Strategic Plan for Water Related Recreation in Wales is undertaken with climate change in mind	This has been passed onto the Welsh Assembly Government (WAG)

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