Planning for Climate Change

United Utilities
helping life flow smoothly

Adaptation Progress Report 2015
under the Climate Change Act 2008

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1 EXECUTIVE SUMMARY

The Climate Change Act 2008 gives government the power to ask certain organisations to produce reports on:

- the current and future predicted impacts of climate change on their organisation
- their proposals for adapting to climate change.

This applies to organisations that are responsible for essential services and infrastructure, including United Utilities.

In 2011 we submitted our first round report, “Report on adaptation under the Climate Change Act 2008” to Defra which described how we understood the risk to our services from climate change and how we planned to respond in line with our existing risk management processes.

This is our second report and seeks to provide a progress update on delivering the activities we identified in our first report as well as our intentions for 2015-20 and beyond. We have used the structure suggested in the guidance notes issued by DEFRA for “organisations who want to update the government on progress since the first round of adaptation reporting. “

We already had a well-established framework for risk management and climate change is one of many risks to our business and it is managed in the same way as any other. This report sets out how our understanding of climate change risks has developed and what actions have been implemented to address these risks. It expands on the supplementary documents on climate change adaptation that were submitted for our regulatory business plan in December 2013, and the information in our Water Resources Management Plan.

The government will use the information within reports from all organisations invited to participate to feed into the next national Climate Change Risk Assessment (CCRA) which is due to be published in 2017 and subsequently into the next National Adaptation Programme (NAP) expected to be published in 2018. An assessment of the reports will allow a greater understanding of the risks, any gaps in information, and identify priority areas for work in the future.

2 INTRODUCTION

United Utilities holds licences to provide water and wastewater services to a population of approximately seven million people in the North West of England. We serve domestic and business customers from Cumbria in the North to Cheshire in the South, taking in the sub-regions of Lancashire, Merseyside and Greater Manchester.

The impact of the environment on our activities, and the impact of our activities on the environment influence how we deliver water and wastewater services to our customers. Consequently any environmental change, in particular driven by climate change, has the potential to have a significant effect on our business.

The feedback that we received from customers together with the research we commissioned to support the development of our business plan for 2015-20, has enabled us to create Customer Promises.

We promise to:

- Provide great water
- Dispose of wastewater
- Give customer's value for money
- Deliver customer service and
- Protect and enhance the environment.

These customer promises are supported by eleven outcomes which represent how we will deliver an exceptional customer experience. The importance of climate change to our business is reflected in the following outcome

A business fit for a changing climate

where we state "we'll ensure our water and wastewater services and assets are resilient to a changing climate" but we also, as part of our **Provide great water** and **Dispose of wastewater** promises, commit to building our resilience so we have enough water for future generations and sewer network is resilient to severe weather events. In this way we have integrated commitments to adapting to climate change into our promises in the same manner that we have integrated adapting to climate change into our ways of working.

3 UNDERSTANDING CLIMATE RISK

Climate change has been the subject of strategic concern to United Utilities for over two decades and we are aware we need to be aware of it in our long term planning so that we can improve our resilience to the effects. Climate change is just like any other risk and we recognise that building resilience today delivers adaptation tomorrow.

Our aim is therefore to maintain a consistent and sustainable level of service to customers and the environment, taking climate change and customers' and stakeholders' views into account.

3.1 CLIMATE RISK UNDERSTANDING – OUR INITIAL RISK ASSESSMENT

For our first round report a complex risk assessment was undertaken utilising an industry best practice methodology to inform an expert judgement-based approach to assessing our strategic risks.

Recognising that climate change touches all parts of our organisation, not just the operational assets, we considered all parts of our business in our climate change risk assessment and adaptation programme. We separated our risk assessment into three sections to reflect our organisation, specifically:

- Water services,
- Wastewater services,
- Support services

The assessment was based on the most up-to-date climate projections available which at that time were those in UKCP09. These projections are still the latest available and therefore we believe the risk assessment undertaken in 2011 is still highly relevant. The risks that were identified then are still the main issues that we, as a utilities provider, are addressing and these have been considered when developing our long term business plan and in activities such as our resilience planning.

The first round report of the Adaptation Reporting Power (ARP) that we submitted to Defra in 2011 was independently evaluated by Cranfield University and it was found that:-

- The risk assessment and the methodology was well evidenced
- The risk assessment was completed by referring to existing good practice; and
- The adaptation measures are focussed on key risk priorities identified.

The evaluation showed that no specific information gaps were identified which shows that we have a good level of understanding climate risks within the different sectors of the business. The evaluation has been useful in advancing our understanding by highlighting the areas where we could have improved our management of adaptation.

Of the eight key attribute areas that Cranfield assessed, we were 'complete' or 'fully complete' in six and in two areas we needed further work. However, overall the evaluation was that we performed at, or better than, the average classification of other reporting authorities.

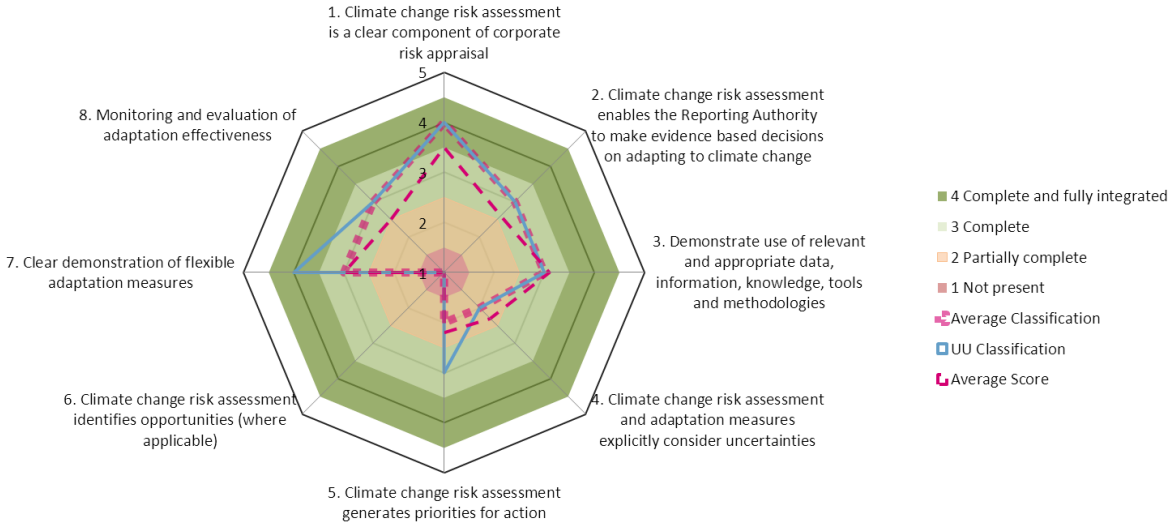


Figure 1 Illustration of Cranfield assessment scores of Adaptation reports produced by United Utilities and other reporting authorities

	Attribute Area	Assessment
1	Climate change risk assessment is a clear component of corporate risk appraisal	Complete & fully integrated
2	Climate change risk assessment enables authority to make evidence-based decisions on adapting to climate change	Complete
3	Demonstrate use of relevant and appropriate data, information, knowledge, tools and methodologies	Complete
4	Climate change risk assessment and adaptation measures explicitly consider uncertainties	Partially complete
5	Climate change risk assessment generates priorities for action -	Complete
6	Climate change risk assessment identifies opportunities (where applicable)	Not present
7	Clear demonstration of flexible adaptation measures	Complete & fully integrated
8	Monitoring and evaluation of adaptation effectiveness	Complete

The two areas which needed further work are to explicitly consider uncertainties and to identify opportunities both of which are key topics in this second round of adaption reporting.

The ARP process has been helpful in raising the profile of climate change adaptation (CCA) within United Utilities. It has provided a ‘mandate’ for CCA, a means of gaining board level interest and a mechanism for helping to integrate climate risks into business planning.

Business resilience is now becoming embedded in our organisational culture and our Business Continuity department focus on enabling the business to continue to operate effectively and efficiently.

3.2 ADVANCEMENT OF CLIMATE RISK UNDERSTANDING

Since our first report in 2011 we sought to build our knowledge on climate change implications for organisational functions by activities such as:

- Local climate change partnership membership; members of Climate Change North West where we network with local organisations and exchange knowledge and expertise
- Water UK climate change network group participation: sharing information through sector networking and joint lobbying on industry issues
- UKWIR (UK Water Industry Research) involvement: Contribution to and involvement in projects
- Climate change adaptation publications review for relevance to our business
- Met office: using / considering published information and updates
- Climate Ready Service (Environment Agency); following guidance and using shared resources
- UK Climate impacts programme involvement
- Climate change seminars attendance.

Involvement has typically been by a few subject matter experts who have been able to incorporate their experiences and increased knowledge into strategic planning and work to embed the key requirements of climate change adaptation into general business development, maintenance and planning.

3.3 USING CLIMATE CHANGE RESEARCH

The projections used in our first adaptation report risk modelling exercise are set out below. They were based on the 50% probability results for the high emissions scenario of the UKCP09 projections for the North West of England and were interpolated to give 2035 values to align with our 25 year planning horizon starting in 2010.

	Mean temp increase ^{0}C		Mean Daily Maximum ^{0}C		Annual Preciptation Change %	
	-	+	-	+	-	+
Winter		1.65				8.50%
Summer		2.25		2.9		-11.50%
Annual						0.00%

Figure 2: 2035 Projections used in 2011 Adaptation Report

It was clear from these values that the impact of climate change to us in the North West is most likely to come from the increased seasonal variation in the precipitation patterns rather than the annual rainfall levels or absolute increase in temperatures.

Although the predicted annual precipitation remains steady over the coming years if the changes to the means in summer and winter are added together it totals 19% which implies a greater fluctuation in precipitation levels day to day and season to season. This implication is consistent with one of the key findings stated in the UKCP09 that the number of **heavy** rain days is going to increase. See extract below.

Other Key findings © Crown Copyright 2009. The UK Climate Projections (UKCP09)

Number of days with heavy rain (>25 mm)

Central estimates are for heavy rain days (rainfall greater than 25 mm) over most of the lowland UK to increase by a factor of between 2 and 3.5 in winter, and 1 to 2 in summer by the 2080s under the medium emissions scenario.

In summary the projections indicate that there is greater likelihood of:

- more frequent and/or higher magnitude drought events in summer,
- more rainfall in the winter, and
- more occurrences of heavy rainfall.

Our risk assessment and action planning in our first round report therefore had two focus areas,

- **wastewater** reducing flooding events and the impact of them and
- managing our interconnected **water** resources effectively whilst promoting water efficiency.

Since 2011 we have increased our use of the climate change research data in two ways.

- Increased sophistication using more climate change scenarios and more detailed projections in our modelling
- Improve our detailed understanding at more local levels rather than just at an overall regional level

An example of this is how we have used climate change research to inform Wastewater Planning in the Sewerage Management Plan (SMP) improvements, see section 3.3.1 below. Having detailed predictions at a very local level has also enabled us to transition towards a more proactive approach to Wastewater Network Management to including

- Increased network monitoring and control,
- Developing a real-time understanding of risk on the network,
- Ability to predict and resolve incidents before they impact on the customer.

3.3.1 Sewerage Management Plan/ Drainage Strategy Framework process

Our modelling capability has increased following roll out of a more sophisticated GIS (geographic information system) and the ability to incorporate additional data sets that either were not available previously or could not be combined together easily.

Our hydraulic models have been completely overhauled and continue to be updated. Now allowances for potential future climate change are routinely incorporated to inform our SMP. This risk based process which we have developed and continue to improve, enables us to better understand implications for our wastewater operations for different scenarios. The hydraulic models include both a 10% uplift of rainfall intensity for storm events and an increase in frequency of storm events and can provide outputs for different time epochs out to 2045.

The initial outputs from the SMP process were checked by a core team of experts including the Asset Manager for the area and the Network Operations personnel who have detailed knowledge and experience of each area giving further confidence that the output of the model is meaningful. Areas which showed highest risk (of wastewater flooding) were identified as “hot spots”

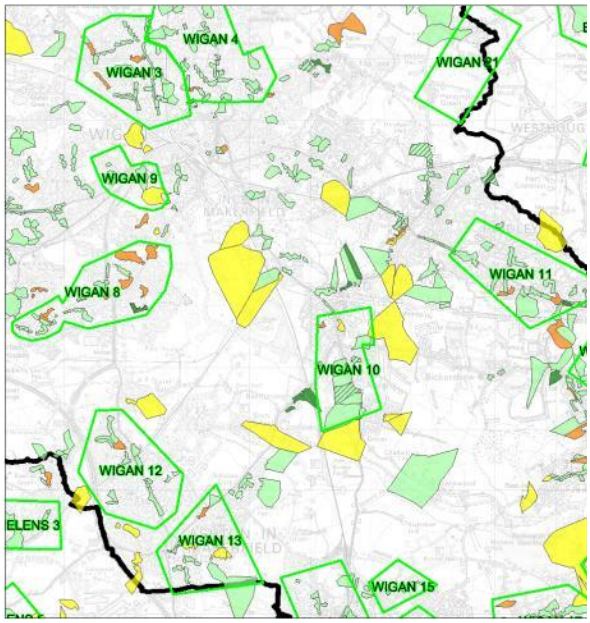


Figure 3 An example of the SMP ‘hot-spotting’ exercise.

Key:

- “Hotspots”.
- Current flood risk,
- Current flood risk, worse by 2020.
- 2036 flood risk (with climate change)
- Changing infrastructure leading to potential risk for flooding due to other causes.

Figure 3 shows a typical example of an SMP hot spotting area we carried out to identify areas which will be priorities for further investigation and potential proactive investment over the next 5 years.

Hotposts were then considered by the Asset Manager through our Integrated Asset Planning process and prioritised based on benefits for customers through our investment prioritisation tool. Interventions could include major capital schemes, maintenance work, and targeting areas for customer education campaigns. Hotspots might also be considered for potential partnership schemes, working with the Lead Local Flood Authority and the Environment Agency to achieve mutual benefits and improvements at lower overall cost to customer. The SMP process allowed risk based integrated solutions to be developed and our business planning uses SMP risk assessment outputs to develop our flooding, supply demand and investigations programmes.

3.4 THRESHOLDS OF CLIMATE IMPACT

We have not established the magnitude of climate change above which we would experience a business impact but to test how robust our Water Resources Management Plan is we have undertaken scenario testing on the overall supply-demand balance. For each factor a high impact scenario was defined and the impacts on forecast water surplus / deficit for each of our 4 resource zones were considered in isolation and in combination. This testing enabled us to understand the impact of climate change (and other factors) if climate change should turn out to be more severe than in our baseline (midpoint) forecasts.

The high impact scenario for a drier climate accounted for up to the 85th percentile of climate change severity, compared to the mid estimate included in the baseline plan. These results

showed that more severe climate change alone would not trigger a new supply-demand deficit within any of our resource zones; it only served to increase the deficit where this was already evident in the baseline, or in combination with other scenarios.

Although we have not calculated what magnitude climate change would mean that our supply- demand balance switched from surplus to deficit we have determined that extreme climate change is unlikely to trigger a deficit by 2040 unless in conjunction with other (some of which are controllable) factors.

3.5 QUANTIFIED ASSESSMENT AND ANALYSIS OF RISK LIKELIHOOD AND IMPACTS

3.5.1 Risk assessment - Overall

We have revisited the results of the risk assessment exercise that was undertaken for the 2011adaptation report and considered the risks to see if they are still relevant. We have not recalculated risk scores so these are still as set out in the table in 9.3.

Figure 4 Risk Assessment Matrix.

				Likelihood			
				Remote	Unlikely	Likely	Very Likely
				<10% chance consequence will occur by 2035	11-40% chance consequence will occur by 2035	41-70% chance consequence will occur by 2035	>70% chance consequence will occur by 2035
				1	2	3	4
Consequences	Severe	Failure of corporate objectives with a detrimental impact to the corporate strategy. Total lack of confidence from a large number of stakeholders. Actual reduction in shareholder value.	8	8	16	24	32
	High	High impact to corporate objectives. High levels of stakeholder concern with a potential impact to shareholder value.	6	6	12	18	24
	Medium	Detrimental to meeting corporate objectives but not necessarily of a material nature. Would attract the interest or interaction from various stakeholders.	4	4	8	12	16
	Low	Impact to the efficiency and effectiveness of meeting corporate objectives, but largely insignificant to corporate materiality.	2	2	4	6	8

Progress of the actions, including where appropriate the extent to which they have mitigated the risk, benefits and challenges experienced are described in section 5.

We already have a robust and comprehensive corporate risk assessment processes that is fully embedded throughout United Utilities so this on-going assessment, tracking and use of controls has continued since our first round report.

Where quantified risk assessment of likelihood and risks has advanced since 2011 is in respect of specific issues, topics and projects for example improvement of our water resources' planning by embedding UKCP09 climate projections into our supply modelling and calculations. Water resource modelling now uses a representative sample of combinations of climatic factors (see section 3.5.1.1) and is supported by our demand modelling which has been updated with the latest methodologies and approach set out in The Impact of Climate Change on Water Demand (UKWIR, 2013) . Furthermore we also considered the impact of different percentiles of climate change by accounting for variation within our headroom calculations.

3.5.1 Quantified Assessment Water

3.5.1.1 *Water Resources Management Plan (WRMP)*

An area where we have made detailed consideration of climate change and incorporated the projections of the UKCP09 is in our long term water resources management planning. This is an on-going activity, continually incorporating newly available data and insight to make appropriate predictions of the challenges to provide a safe and reliable water service. The work is summarised in our Water Resources Management Plan (WRMP) available on our website.

The supply-demand balance for a water resource zone can be described by the following equation:

Figure 5 Water supply - demand equation.

- Water available for use is the amount of water that can be reliably supplied from our water sources during prolonged dry weather
- Dry weather demand is the total customer demand for water including leakage during prolonged dry weather and
- Target headroom is the calculated allowance for uncertainties that are outside the control of the water company

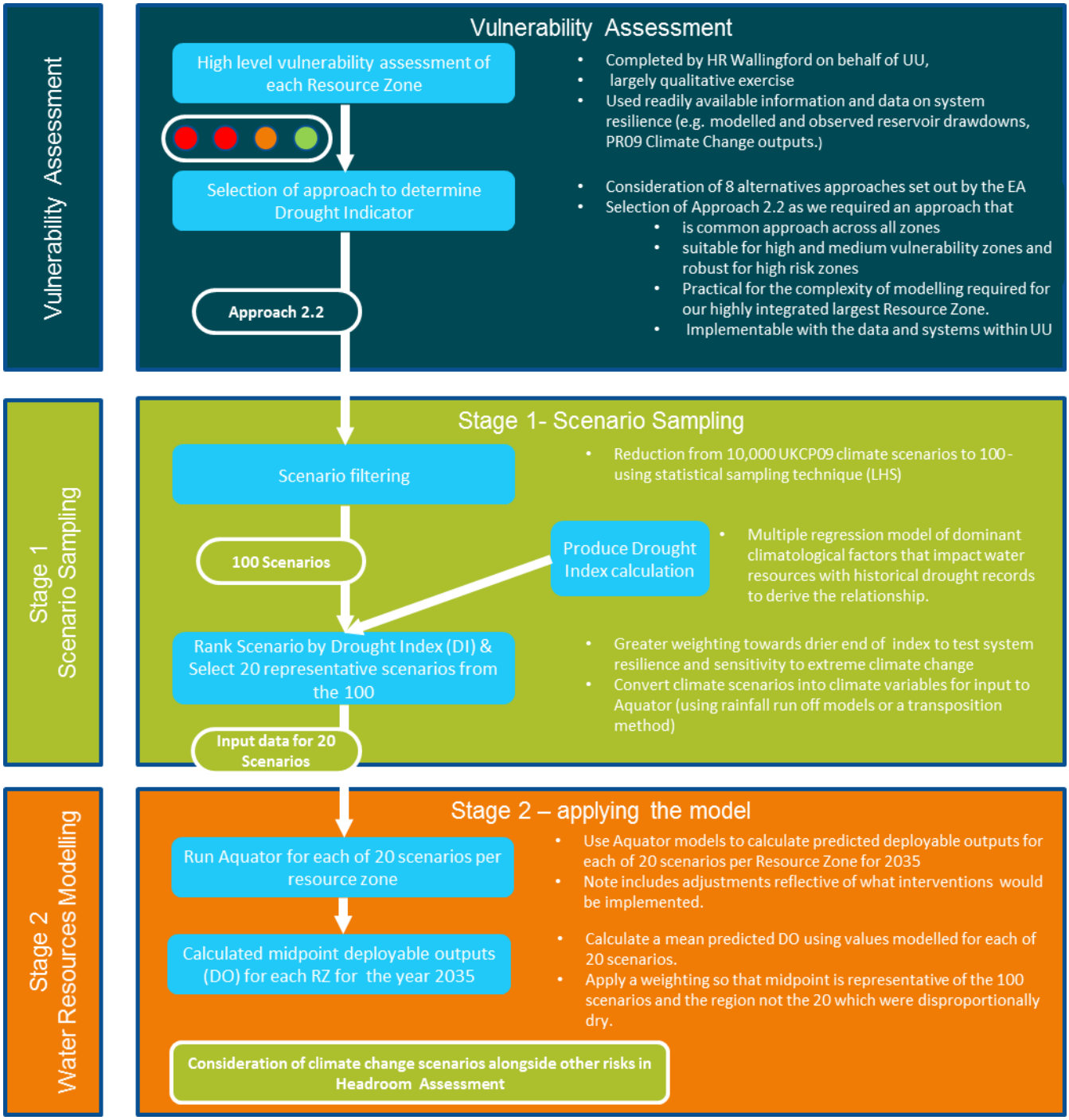
If the supply-demand balance in a water resource zone is positive, then we have adequate water supply capacity to meet forecast water demand in that zone and achieve our target level of service.

If the supply-demand balance is negative for any future years, then we need to carry out a combination of supply enhancement and demand reduction measures in that resource zone to maintain an adequate supply-demand balance. Otherwise water use restrictions or other drought powers are likely to be required more frequently than our customers and other stakeholders want.

Climate change could impact each of the three components of the supply-demand balance and is incorporated in different methods for each.

Water supply drives the water available for use and in turn climate change is the key factor in how this is predicted to change over the next 20 years. Figure 6 summarises how scenarios used in the UKCP09 climate change projections have been applied to our water resource zone models to calculate a mean impact of climate change on deployable output over the period to 2035.

Figure 6: Impact of Climate Change on Water Resource Supply



The total demand forecast is built up from separate predictions of the various components of water use, as shown in Figure 7 one of which is climate change.

National best practice methods and current guidance have been used in the preparation of the population and water demand component values. For the Climate change factors the Impact of Climate Change on Water Demand (UKWIR, 2013) was used to provide the estimated impacts.

The uncertainty in potential impacts on water demand, as represented by the lower and upper impacts derived from the UKWIR findings, was included separately in different combinations as part of our assessment of headroom.

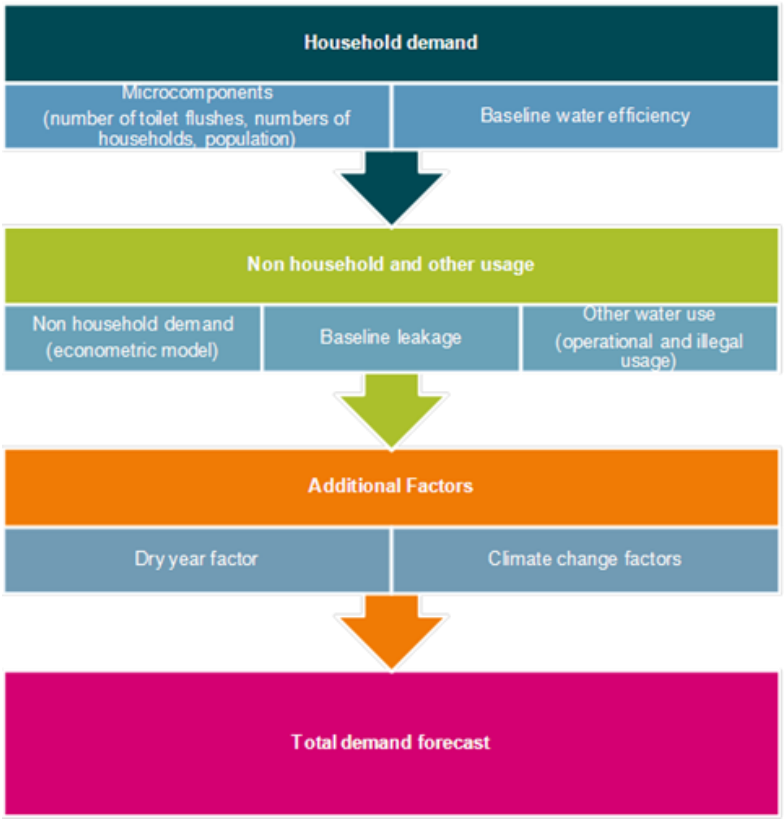


Figure 7: Building blocks of the total demand forecast

3.5.1 Quantified assessment –Wastewater

Another specific area where our quantified assessments have developed since our previous submission is in our wastewater supply demand risk assessment.

Figure 8 Cockermouth WwTW- a site with planned development due to supply demand reassessment.

3.5.1.1 Supply and Demand Risk Assessment - Wastewater treatment works

The initial wastewater supply demand assessment was carried out in 2012 and the methodology has recently been revised for a repeat assessment in early 2015.

The main driver for assessing vulnerability is population growth and each of the main treatment works has had a headroom calculation completed to determine what increase in demand could be accommodated without compromising compliance. Local demand might increase for any of the following reasons:

- population growth,
- climate change driving an increase in water usage or
- climate change and subsequent altered rainfall patterns leading to increased peaks of demand even if the overall annual demand is unchanged.

We developed a methodology for collating information on future growth together with current performance. Population estimates are developed by combining multiple sources including local authority plans, planning applications and demographic population forecasts. This enables an objective assessment of whether individual wastewater treatment works are likely to be impacted by increased demand and therefore be at greater risk of failure in the future. For example a works might have to receive and treat flows generating discharges greater than its permitted levels.

The objective of the assessment is to assign a risk category to each wastewater treatment works in relation to its supply and demand. Those identified as 'vulnerable' will have the potential consequences of failure assessed, may be investigated further and appropriate solutions developed.

4 UNDERSTANDING UNCERTAINTIES

4.1 REMAINING UNCERTAINTIES

The following key uncertainties were outlined in our first adaption report and have implications on the actions that we are taking. We cannot be certain that all of the 'risks' may be realised so it is not prudent to spend large sums of money mitigating something that may never occur therefore we have made some assumptions for our adaptation planning. These assumptions are summarised in the table below along with any updates to our position regarding the uncertainty.

Note: All uncertainties identified in our 2011 report remain even though we have progressed in our knowledge or in our ability to use the available information.

Uncertainty	Impact	Related Assumption	Rationale	Response	Update
High level of uncertainty with UKCP09 projections	Minor for 25 year horizon	Climate change will continue to be a relatively gradual, incremental change rather than materialise in a catastrophic, step-change event.	UKCP09 data suggest that is the likely path and these are the best projections available	UKCP09 data was interpolated using linear trends to give 2035 values for 25 year horizon (from 2010) to 2035. High emissions scenario was chosen for the wastewater modelling as no international legally binding agreement to reduce global emissions For water resources 50% probably levels were used.	A subset of the 10,000 projections has been built into the water resources models and representative midpoint values used for planning purposes though headroom allowance allows for fluctuations and uncertainty CMIP5 (Climate modelling Inter-Comparison Project) models' results have been published and suggest UKCP09 is still a good predictor, although UK summer rainfall could remain similar or become wetter than it is today which would be beneficial to our water resources.
Future structure of the water industry in England and Wales	Minor but within 5-10 years. Prioritisation and coordination of adaptation actions would be more difficult.	Current structure of the water industry in England and Wales may change in the future with the introduction of retail competition.	Competition will be coming into the water industry by 2017.	Assume current structure continues. Assume UUW continues with this structure.	Competition as already been introduced in Scotland and for large water users in England and Wales. It will be in place for non domestic water and wastewater customers from 2017 as part of Ofwat's Open Water programme. UU has already restructured in advance of full competition into Wholesale', 'Domestic 'retail' and 'Business retail' functions with activities segmented

Uncertainty	Impact	Related Assumption	Rationale	Response	Update
					accordingly.
How environmental legislation and associated policies of the EU, UK Government and our regulators will be adapted in the face of climate change.	Major Climate conditions make targets and legislation harder to achieve.	Water Framework Directive objectives and targets may be altered to reflect future climate conditions.	We need to be working towards our part in achieving 'good' status of all water bodies by 2015.	Every effort will be made to meet legislative requirements. We will work with agencies like EA to reduce conflicts between environmental drivers and ensure an integrated and sustainable approach to future regulatory requirements.	Implementing Water Framework Directive measures are part of our business planning from 2015. United Utilities will be looking to work with environmental regulators if and as the climate changes to understand what "good" looks like as the baseline shifts from our current view. In the mean time we will continue to assess WRMP in line with the UKWIR / EA industry agreed guidelines and contribute to the development of future approaches.
How national, regional and local planning will respond to climate change threats.	Minor for 25 year horizon	We will attempt to model demographic changes with associated implications for demand for water and wastewater services. UUW will continue to work in partnership with other utility companies and the public sector on integrated urban drainage and Surface Water Management Plans.	Legislation is driving all parties down the partnership route.	Already using the best available information. Current partnership working should be further enhanced in future.	We have incorporated local development plans into our Supply Demand methodology for Wastewater which will highlight areas where increased demand will make sites vulnerable to permit failure. United Utilities responded to the 2014 government consultation on Sustainable Drainage Systems. The outcome was that though the Government agreed that long-term maintenance must be guaranteed it will be the responsibility of local planning authorities to impose effective planning conditions that require effective maintenance arrangements to be put in place and to enforce these conditions.
How other key stakeholders will adapt to climate change	Could be major	Any changes will not be a step change but will be gradual and agreed on consultation.	All parties are learning what climate change might mean to them	Partnership working and collaboration is the best approach.	We will continue our engagement with our stakeholders to work together to meet emerging challenges.

4.2 NEW UNCERTAINTIES

The list above illustrates that you cannot consider climate change in isolation as there are many other factors to consider which have their own inherent uncertainties. The uncertainties that we have become more aware of, or have recently recognised, tend to be where climate change might interact with other factors to increase risk. Depending on the risk, climate may be a factor in the magnitude of the risk but it may not be the biggest or only factor in the realisation of the risk. It is also difficult to be confident about the extent to which the adaptation activities will mitigate the risks as for many of the activities climate change is just one of the drivers.

Uncertainty	Possible changes	Potential impact
Economic growth in conjunction with climate change	As the UK emerges from the recession economic growth is likely to impact the demands on water services. Patterns of growth over the coming years and the impact on demand (and also emissions and thus climate change) are unlikely to be the inverse of the changes observed during the period of decline. It is therefore difficult to make accurate forecasts on the requirements to our services.	Increases in demand could be broadly across our networks or localised. Impacts compounded with impacts of climate change may increase the vulnerability of our networks resulting in an unreliable water / wastewater service. Decline in industrial demand during recent years may have masked reduced asset capacity therefore a subsequent demand peak could cause unforeseen impacts to service. New development on green field sites could increase surface water runoff and in conjunction with storms lead to wastewater network capacity being exceeded and more flooding.
Demographic changes in conjunction with climate change	Population increases and moves within the region will change where water services are required which could cause difficulties to provide. This factor might be exacerbated by economic growth patterns too and the government's Northern Powerhouse plans.	There is particular concern over the development of certain areas in West Cumbria which could be difficult to support with our infrastructure because of the lack of interconnectivity of this part of our water network. It is this risk that has driven our innovation in how we manage water resources in this area. Continued increase in population in urban areas such as Manchester which feeds into Davyhulme WWTW also has to be accounted for by additional capacity.
Land use changes- Agricultural and other	Climate change might drive changes in agricultural land use to different crops or switches between arable, livestock and alternative income sources. Changes might also be driven by the economic climate, international factors, legislation or new technology. Land use changes in urban and suburban areas could also occur. For instance reduced heavy industry or	It is unclear what changes are most likely and what the impact of them might be. They could include: • changes to run off speed and patterns impacting water quality and wastewater network performance.

Uncertainty	Possible changes	Potential impact
	increased density building in residential areas, continuing urban creep.	• geographical changes in demand profiles; • temporal demand profile changes for instance shifts from steady water use to peak use at key times of year or during particular weather patterns, changes to run off speeds and patterns changing the profile of treatment required. . Impacts could be exacerbated by climate change for instance where nutrient levels in water courses rise at the same time as temperatures increases encouraging faster algal growth..

4.2.1 West Cumbria: Managing Water Resources

4.2.1.1 Blue sky thinking finds leaks

We are always on the lookout for innovative ways of improving the way we manage our water resources. As part of our work to tackle leakage in West Cumbria, where there is an especially pressing need to save every drop, we took the innovative approach of using aerial surveys.

Digital aerial survey specialists APEM captured hi-tech images across a 400 sq km area in Copeland, Cumbria. The aircraft were fitted with hi-tech thermal and near infra-red sensors, resulting in high resolution images of the vegetation above our pipes. 100 km of pipes were photographed, allowing image analysts to then identify areas with potential leaks. For example, areas where vegetation was growing more vigorously provided an indication that leaks could be present. Potential leaks were investigated by our engineers, and repairs carried out.

The project was recognised at the Water Industry Achievement Awards 2014, when we won the award for the "most innovative use of existing technology". Following the success of the project, we are now looking at using this technique in other parts of Cumbria.

4.2.1.2 Watertight: a water saving campaign in West Cumbria

How do you encourage customers to save water in a part of the North West where it often rains, and lakes are common? That's the challenge we've taken on this year in West Cumbria.

Unlike the rest of the region, which is served by a vast network of interconnected pipes, the local West Cumbrian population relies on water sources close to home, including Ennerdale Water, a naturally-occurring lake which plays host to protected wildlife.

To keep local wildlife wet and wonderful, we need to reduce the amount of water we take from the lake, and ultimately, cease abstraction entirely. Consultation has already begun on a long-term solution to the area's water supply needs. In the meantime, we need to encourage customers to do their bit, by saving water around the home and garden.

In early spring 2014, we launched an awareness raising campaign in the area called Watertight. The campaign uses a combination of media relations, advertising on local radio, customer events, and partnership building to promote our water efficiency message, and provide customers with some easy to follow tips. Given Cumbria's reputation for rain, and its proliferation of lakes, our campaign messages could be perceived as counter-intuitive! However, by explaining the environmental situation, and also the fact that saving water is good for the bank balance (it can help reduce energy bills, as well as water bills) we are starting to make headway. We do, however, recognise that widespread change won't be achieved

overnight, and that our messages need to be continually reinforced.

In just four months, we:

• Gave away thousands of water saving devices, at events across the area.

• Reached 159,000 radio listeners each morning with our messages, by sponsoring the local breakfast show.

• Engaged with more than 100 grass roots organisations, from local community groups to environmental charities.

• Teamed up with local newspapers for competitions and news stories.

Plans for the future include exploring links with social housing providers (30 per cent of West Cumbria's housing stock is social housing), and looking for opportunities for our colleagues to promote water efficiency during their day-to-day interactions with customers on the doorstep.

4.3 FURTHER IMPLICATIONS OF UNCERTAINTIES

Some uncertainties have no further implications other than we just don't know what will happen until it does and for these types of circumstances there is little action that can be done in advance apart from building awareness because it could lead to abortive costs. For example in respect to changes to our industry structure we will have to accept and work with plans once are published though of course we can be involved in industry discussions whilst they are being developed .

Where there might be implications to uncertainty are where assumptions are needed to decide on a course of action or what magnitude of response should be employed. If extreme events are planned for there is the direct implication of higher, and potentially unnecessary, costs. If too conservative assumptions are made then if subsequent events are more severe then there will be additional impacts and associated costs of dealing with the issues which might outweigh the savings made from preparing to a moderate vs. extreme scenario.

There are some actions that can remove the implications of uncertainty. For example if sustainable drainage solutions (SuDS) are deployed and alternative drainage options are made available then the uncertainty about the frequency and intensity of rainfall events becomes irrelevant because the surface water has been diverted from the network.

4.4 PROGRESS TO ADDRESS INFORMATION GAPS

Some of the actions in our previous adaptation report were specifically to increase awareness or understanding in respect to either the impact of a climate change scenarios (e.g. incorporation of UKCP09 projections into our water resources modelling) or the effectiveness of a proposed solution to address a risk. Many of these questions have now been resolved for example action 36 was to investigate the piston effect and identify the best solution to protect from wastewater treatment works from its impact. The results showed that the risk is smaller than feared and therefore the proposed solution of recirculation would not be cost effective.

An area we have not considered in great detail is the pace of change. Basic assumptions have tended to assume that all change will be incremental and linear but we have no insight into if this is likely and the additional impact of more rapid change. Recent experiences of drier summers and wetter winters could continue or could just be anomalies in a slow progression. Our current view is still all based on interpreting historic data so we need to develop our understanding on how the composition of events may change. This will require more tracking and monitoring and contributing to scientific research and projects in this area, perhaps through our UKWIR activities.

4.5 STRATEGIC BUSINESS AND METHODOLOGICAL ASSUMPTIONS

We have incorporated UKCP09 projections into both our water resources modelling and our assessment of both water and wastewater facilities' vulnerability to climate change. Detailed methodologies include mean / midpoint scenarios projected to 2035 to assess if and where action is needed to resolve any supply demand deficit predicted. We have also modelled for other risks to service for instance in the supply and demand methodology for wastewater where we have assessed the capacity of wastewater treatment facilities against predicted growth in that area.

In our business plan for 2015-2020 consideration of climate change is embedded in the way we operate our business rather than as a standalone area of investment. Our climate change promise to deliver a "**Business fit for a changing climate**" is therefore delivered through expenditure assigned to achieving our other promises and outcomes. In practice this means that in schemes being delivered for other purposes sizing may take into consideration climate change but only to a moderate extent e.g. increases in size of a tank or pipework to account for a 10% uplift in storm rainfall but it is not foreseen that any scheme would be invested in purely to counter the potential effects of climate change.

The following are examples of where assumptions have been made in our current business planning which focusses on the period 2015-20. These are not directly related to climate change but they are factors that could combine with climate change to impact our service.

Factor	Assumption
Rainfall and River levels - Wastewater	Annual levels of rainfall that we receive in the North West will remain constant to 2020 and will have the same impact on our assets. River levels will also remain consistent with historical trends, and therefore existing discharge permits will not be changed.
Development - Wastewater	Whilst we seek to encourage development into areas where increases in population could be most readily absorbed by our existing assets we cannot control where development takes place. No specific allowance has been made for development which we had been previously unaware of, and would have to make investment to be able to accommodate.
Surface water disposal - Wastewater	In our models we have assumed surface water from new developments will be separately drained where there is a surface water sewer or watercourse within 200m of the development, and no major obstructions such as railway lines, rivers or motorways between the two points. This is a risk as it may not always be practicable to avoid surface water connections to our combined systems.
Urban creep - Wastewater	Urban creep arises from the conversion of existing permeable areas, such as gardens, verges and paths to impermeable areas for example to provide parking areas or a conservatory. Such changes serve to increase the volume of surface run-off and the speed at which it discharges to the sewer and wastewater treatment works. We have used a model derived from a recent UK Water Industry Research study that links rates of growth in demand from urban creep to property density. We have not included the allowance for foul only catchments. There is a risk that urban creep may occur at a different rate to that forecast in individual catchments.
Population - Wastewater	We have worked with several agencies to develop the most accurate population figures for the North West and incorporated these into our supply demand assessment. We recognise that there will always be inaccuracies within this dataset. For example hidden populations such as migrant or transient people within a region will be difficult to account for within population numbers, but could create significant issues at smaller works. We have made no allowances in our programme for population movements within our region other than those incorporated into the population forecasts.

Factor	Assumption
Non-household consumption - Wastewater	Our econometric forecast predicts a slow decline in trade flows before recovering in the 2020's back to current levels by around 2040. For network modelling, we have assumed all trade flows remain at the current level to the design horizon. There is a risk that we may observe a variation to this forecast particularly at a local level.
Asset failure rates - Wastewater	Rate of asset deterioration and failure is consistent with historical experience.
Rainfall and reservoir levels - Water	Use of Aquator to combine observed rainfall and reservoir levels combined with long term daily hydrological records and projected weather scenarios (from UKCP09 projections) to estimate deployable output. Midpoint results used to drive water resource planning.
Outage allowance-water supply modelling	An outage allowance is applied to recognise that some sources will temporarily become unavailable due to planned and unplanned events such as: • Short-term water quality problems and pollution incidents; • Seasonal effects on surface water sources, e.g. algae problems, turbidity; • Asset failure or underperformance at Water sources and treatment works; and • Reservoir safety works requiring a drawdown of reservoir level. The assessment is based on our actual recent experience of events, coupled with an assessment of the risk of events happening in the future and it follows the methodology detailed in the report "Outage Allowance for Water Resource Planning" (UKWIR, 1995) and is in line with the water resources planning guidelines (Environment Agency, 2013).
Other supply factors	Predictions were made for Raw Water exports and bulk supplies based on existing agreements and trends.
Population - Water	ONS forecasts of population growth due to house building have not been observed in our new connections rates and as unrealistically high levels of projected connections could mean planning unnecessary investment, which customers would pay for the following approach has been taken. 2014-15 – current best estimate of household growth based on economic research; 2016-20 – number of new households will increase by an additional 6.5% year on year; 2021-25 – number of new households will increase by an additional 10% year on year; and 2025-40 – gradual increase back to absolute level forecast by ONS, with additional higher growth rate to allow for alignment to overall ONS figures. Projected occupancy rate reductions have also been included in the latest planning.
Demand - Water	Household: Forecast average per capita consumption rate in a normal year at 2030 is 113 l/hd/d reducing to an average of 107 l/hd/d at 2040. Reductions in individual household demand will occur due to growth in

Factor	Assumption
	customer metering, increased use of low volume toilets and efficient appliances and on-going water efficiency measures. Non household: Non-household water demand will fall by a further 18% between 2013 and 2040 based on the results from detailed econometric modelling of water consumption in North West England across different industrial sectors, due to changes in the economic mix in the North West, and on-going water efficiency measures. NB climate change demand is very small in the context of our system as a whole.
Dry weather demand –Water	Replaced use of Defra 2003 method for estimating impact of climate change on dry weather demand with Climate Change on Water Demand (UKWIR, 2013) data. Estimated the impact of climate change on regional dry weather demand as 2.0Ml/d in 2020, 4.2 Ml/d in 2030 and 6.7 Ml/d in 2040. This is a 9.2Ml/d reduction on the previous estimate for 2040.

5 DETAILS OF ACTIONS

Actions specified in response to the residual risks identified in our 2011 report are outlined below, followed by new activities that have arisen as a result of those activities carried out or based on new information now available.

We now consider climate change impacts in in our operational practices and investment programmes more than ever before We do, however, recognise that constructing ever bigger assets is neither affordable nor sustainable in the long term and that sustainable adaptation to climate change will involve more partnership working, innovation and behavioural change.

It should also be recognised that for many of the risks identified climate change is an important contributing factor but it is not typically a driver for change on its own when building a business case or estimating hazards and risks.

5.1 ACTIONS – IMPLEMENTED AND IN PROGRESS

The tables below lists actions identified in our 2011 report and provide an update on what progress has been achieved since 2011 and what we are planning to do in the future.

In Appendix A and B there are tables which map the risks listed in the previous report to the action proposed and vice versa.

If actions have mitigated the risk since 2011 we have noted this however we have not repeated the formal scored risk assessment process undertaken for the 2011 report and therefore cannot comment on whether the residual risk score has changed. As can be seen in the table in section 9.3, the ranges of consequence and likelihood are rather broad (especially for those in high or severe categories) therefore we do not believe many of the risks being addressed will have reduced in magnitude sufficiently to warrant a change in category or cessation of the planned actions.

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
A01	Carry out 2010-2015 flood protection programme. Review flood risks for the next regulatory submission and extend to include service reservoirs.	2010 - 2015	Protection work has progressed well. Of the sites deemed to be higher risk, upgrades at Heronbridge have been completed and, following further investigation, deemed unnecessary at Townsend Fold. For cost-efficiency reasons, we have deferred the River Eden scheme into AMP6 to coincide with planned maintenance at this facility.	Partial mitigation	n/a

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			Service reservoirs were included in the programme but no high risk sites were identified.		
A02	Review emergency electricity supply arrangements for all key assets.	2010-2015	Arrangements have been reviewed and advice from our insurers sought with respect to implementation of additional flood mitigation measures.	Partial mitigation	n/a
A03	Carry out flood protection programme (2015 onwards) and continue resilience activities at sites at highest risk of flooding. Include service reservoirs in flood risk work and develop risk plans for all sites through asset planning.	2015-on	We have assessed whether our wastewater facilities are in a flood risk zone (identified by EA flood risk maps) and as a result resilience work is proposed for 5 facilities. All sites categorised as at risk of flooding now have a Flood Emergency Response Plan (FERP). To safely minimize the business and environmental impact of a flood or spillage event affecting the facility and to ensure a return to normal operation as quickly as possible.	The outputs from this programme of work have confirmed that we have no Wastewater facilities designated as Critical National Infrastructure (CNI). The resilience projects will mitigate the risk of flooding at CNI sites in the future.	The EA have published new flood risk maps since our assessment and we have new GIS systems available. Flood risk assessments will be completed on a tactical and targeted basis.
A04	Review Climate Change impact on Water resources using UKCP09 and rainfall run off modelling. Also, review drought plan and standby sources available.	2010-2015	We have worked with UKWIR and the Environment Agency to apply the UKCP09 projections to our latest revised Water Resources Management Plan (WRMP) using best-practice methods. We fully reassessed the effects of climate change on water source yields, water demand and target headroom within the revised draft plan. It shows that while the overall effect of climate change is greater than in the 2009 plan, the additional impact on supply availability for 2013/14 is negligible. This is because the impacts of climate change are smaller at the start of the planning horizon, and do not trigger a deficit in any of our water resource zones. In addition to the five-yearly WRMPs,	Increased understanding.	Additional scenarios and updated methods and we can do more detailed modelling and have more confidence in the results.

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			climate change is now factored into all long term planning and investment decisions. The drought plan has been reviewed and updated. It sets out actions for drought events including those significantly worse than on historic record.		
A05	Reassess climate change risk on borehole Deployable Output using more sophisticated UKWIR methodology (looking at more intense rainfall events and increased evapotranspiration).	2010-2015	Ground water is now considered as integral part of our WRMP that uses UKCP09 data and scenarios.	Increased understanding	n/a
A06	Complete 2010-2015 WTW and SCaMP investment and continue to maintain WTWs and water supply catchments.	2010-2015	Planned water treatment quality investment and to maintain water treatment works (including significant schemes at Lancaster, Watergrove and Piethorne) has been completed. In addition, some water treatment works have been fitted with water quality failsafe shutdown triggers. For surface water sources these are based on a series of water quality triggers at key stages of the treatment process. For groundwater sources turbidity monitors have been installed. Catchment investment through SCaMP planned for 2010-2015 has been completed, see section11.1.	Planned work complete and expected mitigation achieved.	n/a
A07	Understand risks for those sites without appropriate treatment capability.(Algal growth and micro-organisms)	Not stated	Algal blooms can necessitate the requirement for secondary treatment to reduce the occurrence of taste and odour issues. We have identified sites that have repeated circumstances of algal growth and therefore are at risk of taste and odour issues. We have installed GAC (Granular Activated Carbon) treatment at these sites but we also	Increased understanding	Understanding water treatment options only addresses the secondary impact i.e. taste and odour. Other techniques and interventions are being explored to reduce frequency of algal blooms such as reservoir mixers to even up water temperatures and reduce the surface

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			use PAC (Powder Activated Carbon) as a temporary treatment option for other sites that need it on an ad hoc basis.		temperature of the water body and catchment practices to reduce temperature of incoming water.
A08	Continue to closely monitor and review chlorine residual requirements throughout WTW to tap.	Not stated	Monitoring at supply points is routinely done to meet both company and regulatory standards. Since our first report a 'Site Specific Disinfection Policy' has been established where chlorine treatment protocol (Concentration and duration of contact-CT) is specified for each site, rather than having regional / catchment standards. This allows for local variations to be accounted for and titrated against. Monitoring enables appropriate CT values to be defined and also the effectiveness to be assessed.	Increased understanding	n/a
A09	Review risks, to identify likelihood regarding Tidal limits moving upstream and increasing salinity at intakes (e.g. constant or spring tide) and develop mitigation/adaptation measures for River Dee and River Lune intakes.	2015-2010	The flood protection programme indicated that only one site has the potential to be affected by tidal intrusion; Low Shaw Pumping Station (Millom, Cumbria). We are investigating the most appropriate intervention at this site.	Increased understanding	
A10	Continue statutory 10 yearly inspections of dams, supervising engineer reservoir inspections and maintenance programme.	2010-2015	Dam inspections have been completed as required with no significant issues arising. Whilst we might anticipate the frequency of extreme events to increase due to climate change, it has been deemed that there is no significant risk of a corresponding increase in reservoir failures during 2015-20.	On-going action required	
A11	Complete programme of work to enhance spillways design to prevent damage to masonry structures during intense rainfall events.	Not stated	Work to enhance spillways is underway and work at nine sites should be completed by the end of 2015-20. Therefore, we intend to continue with inspections as required. We will also	Partial mitigation	

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			maintain our on-going asset portfolio risk assessment.		
A12	Carry out studies on impact of climate change on increased drawdown and duration of drawdown on earth embankments. Assess measures to protect upstream face of earth dams if required.	2015-2025	Reviewed probability of earth slips causing overtopping. During 2015-20 we will carry out studies on the impact of climate change on increased drawdown and duration of drawdown on earth embankments and assess measures to protect upstream face of earth dams if required.	Further work required	
A13	Sustainable Catchment Management Programme (SCaMP) investigation into correlation between land condition and raw water quality.		The SCaMP programme includes monitoring to observe and measure the effectiveness of the intervention actions taken. Comparisons are made between locations impacted by project activity and historic data and control sites elsewhere in the region. So far the results show water quality as measured by observed trends in colour production and delivery in stream flow are beneficial, with many SCaMP catchments showing a stationary, or else slightly declining trend in colour production and delivery, which is opposite to many untreated, un-restored upland blanket bog catchments in the UK uplands, where colour appears to be continually increasing year on year. http://corporate.unitedutilities.com/documents/SCaMP_Interim_Monitoring_Report_July_2014.pdf	Partial mitigation	Values of water quality measures (e.g. colour, turbidity (POC), pathogens) fluctuate by seasonal, weather and local activity (e.g. lambing / land application of manure) as much as by interventions intended to improve the land condition therefore long term trend and repeated sampling of both SCaMP catchments and control sites is needed to see how changes in water quality correlate with changes to land condition.
A14	Continue to deliver catchment management activities on United Utilities owned and non owned catchments.	2015-2020	During 2015-20 our focus for catchment management will be the Water Framework Directive safeguard zones which are designated areas to be carefully managed to prevent pollution and deterioration of raw	On – going action required	Whilst climate change was not the primary driver for this programme, it is considered to be a contributing factor as increased temperature and sunlight can

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			water. We will utilise knowledge from the pilots to work in partnership on non UU owned catchments to work with the variety of different stakeholders. See also A13 and section 11.1		increase algal productivity and any changes in precipitation patterns, and thus run-off, can alter pesticide concentrations. In addition, climate change can also lead to change in land use which may lead to increased nutrient and pesticide runoff. The partnership approach of the SCaMP programme has been so successful we are expanding the approach wastewater catchment areas through our Catchment Wise programme.
A15	Increase use of turbidity monitors for sites at risk of elevated turbidity as a surrogate for adverse water quality.	Not stated	Turbidity adversely impacts the effectiveness of chlorine treatment with the potential consequence of residual pathogens. Turbidity measurements (ntu) can therefore be correlated to water quality challenges and can be used to titrate chemical dosing for instance of coagulants. Monitoring has been increased and is carried out throughout the process (rather than just at the end) to calibrate processes and track effectiveness of treatment. All 84 sampled sites have intake turbidity monitors and there is now a regulatory requirement to ensure a turbidity of 1ntu at the point of disinfection so monitoring is carried out at this point and earlier in the process to enable us to meet this requirement.	On-going action required.	
A16	Deliver Climate Change Investment (supply and demand actions) including West-East Link pipeline and South Egremont	2010-2015	Construction of the 50km West-East Link pipeline was completed in 2012 and South Egremont boreholes are on track to be	Partial mitigation by improving water network resilience.	

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
	Boreholes.		constructed by the end of 2015.		
A17	Reduce leakage by 28.4Ml/d and demand by 16Ml/d through demand management activities such as the water efficiency programme and customer metering	2010-2035	We implemented a wide range of activities to encourage our customers to be more water efficient, and exceeded the water efficiency targets set by Ofwat of 1 litre per property per day saving each year between 2010 & 2015. In West Cumbria where there is an urgent need to promote water efficiency we launched a bespoke water efficiency campaign called 'Watertight' (see 4.2.1.2) We have maintained an extensive programme of leakage control actions and met or outperformed our regulatory target every year since 2007. We also took to the skies to in an award winning project using aerial surveys to detect leaks on rural large diameter pipes in West Cumbria. See 4.2.1.1.	Note that the measures in the original action are no longer applicable because the most recent Water Resources Management Plan has a target to manage leakage at the long run sustainable economic level (462.7 Ml/d) to 2040. We are meeting this objective.	
A18	Review WTW treatment capabilities for sites where ground water and surface water sources are blended during droughts.	2015-2020	Our latest Drought Plan sets out the actions we will take to protect water supplies should a severe drought occur. Only one of the proposed actions during drought involves blending of water, in this case water abstracted from Worthington reservoirs. Abstraction is likely to result in drawdown of the reservoir below normal levels, which may have implications for water quality but this has been assessed as minor adverse, temporary and reversible.	Increased understanding	

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
A19	Continue to upsize priority sections of sewer (increase sewer network capacity) to alleviate hydraulic inadequacy and provide mitigation to customers.	2011-	We have been delivering our hydraulic flooding and unsatisfactory intermittent discharge programme 2010-15 which includes increased capacity to alleviate hydraulic inadequacy. To date we have delivered 107 DG5 flooding projects (benefitting 520 properties) at a cost of £119m. The programme for 2015-20 plans to further reduce sewer flooding. One way in which this is being implemented is by including in all projects allow for an additional 10% storm rainfall volume specifically for climate change.	Upsizing of priority sections of sewer and tanks has helped to alleviate hydraulic inadequacy in the short term and post 2020. Our predictive modelling shows that the uplift will further limit the impact on the receiving watercourse during storm events.	Securing the uplift for our 2015-20 solutions had the challenge of requiring buy-in from senior managers as there is an increased cost, albeit small compared to the overall cost of the scheme. 520 properties have benefitted from capital projects to alleviate flooding however there are financial constraints and it is not possible to solve all flooding issues due to excessive cost per property and/or constructability issues however mitigation and activities can reduce the flooding related consequences of high intensity storms. Although partnership working is a focus area (e.g. SuDS and surface water separation) it can be a slow process to progress issues.
A20	Investigation to enhance network models (coverage and capability).	2010-2015	We continue to develop our models as part of the Sewerage Management Planning (SMP) process. Our models are now more detailed and have wider coverage than before to assess future flood risk.	Improved models, as well as increased network monitoring both in sewer and on CSOs, will enable us to effectively monitor and control the wastewater network. Real time monitoring and enhanced data means we can better understand flood risk and how to manage it.	Our Integrated Control Centre (ICC) will allow increased automation and optimisation. The benefits are expected to be realised post 2015. Predicting development can be a challenge and flood routing analysis is technically difficult.

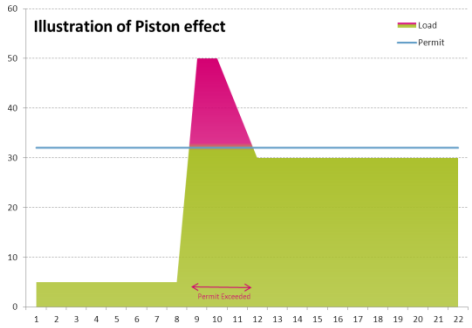
	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
A21	Joint working with the Environment Agency and Local Authorities on surface water management issues.	2010 on	We have initiated flood partnership meetings across our region with LA and EA representatives. Jointly funded solutions were considered in priority areas (for delivery in 2015-20) where it is cost effective to do so. We attend Local Resilience Forums (LRFs) with response partners including EA, LAs and emergency services We have developed a fully integrated hydraulic model of the entire drainage system with in the with Liverpool City Council area and worked with them to assess the interaction with our drainage systems in the catchment. We are actively involved in the Defra working groups advising on the implementation of the Flood and Water Management Act 2010. We are actively involved in the Defra working groups advising on the on the encouragement of more SuDS on new developments now being implemented though changes to national planning guidance.	Our 2015-20 programme is better developed and we have good evidence to instigate partnership working None of the SuDS schemes considered for hot-spot areas were found to be cost beneficial but we will continue to look at small scale structural and non-structural intervention opportunities rather than major strategic schemes.	It can be challenging to get the parties to work together as it is a new way of working and all organisations are facing increasing financial constraints, however it is beneficial to work together on the areas where there is joint responsibility.
A22	Continue with our Integrated Asset Planning (IAP) approach. Prioritise WwTWs and drainage networks according to their relative exposure to the impact of climate change.	2010 on	We have developed our IAP (see section 11.2) with specific methodologies for identifying integrated solutions for network and treatment assets which includes the impact of climate change.	Solutions will be delivered during 2015-20. This includes the real time dashboard as part of the Integrated control centre and the embedding of supply demand headroom assessment.	Integrated Asset Planning was a new way of working within United Utilities and it can be a challenge to change.
A23	Sustainable Drainage (SuDS)		The SuDS retrofitting demonstration project	No impact but	We are committed to delivering

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
	demonstration project.		has been completed and we assessed 4 sites for possible SuDS solutions. See Section 11.3.1	increased knowledge of localised risk due to improved modelling capability.	the most cost effective solution for customers and it appears that in most cases retrofit SuDS solutions are unlikely to deliver value for money.
A24	Implement recommendations from the SuDS demonstration project.		See section 11.3 .	n/a	Challenge to United Utilities SuDS schemes is that they may not be cost beneficial on their own which decreases their likelihood of implementation. There are also likely to be further challenges to encouraging third parties to deliver SuDS projects (e.g. in new builds) as the legislative framework is unclear and largely voluntary.
A25	Use UKCP09 scenarios to review climate change risk assessment and adaptation plans as part of on-going wastewater asset planning.	2015-20	UKCP09 has been compared with the Climate Modelling Inter comparison Project (CMIP5) published in 2104. There are differences in the model outputs in relation to summer rainfall patterns but broadly they are consistent and UKCP09 is still considered to still to provide the most a valid UK climate predictions.	On-going action	With so many emission and weather scenarios it has been a challenge to select the most appropriate and representative scenarios and projections into our modelling. By using these UKCP09 scenarios and projections in our modelling for 2015 onwards we are confident we are basing our solutions on the best available information in order to mitigate the risks.
A26	Improved sewer monitoring and targeting of intervention on network to reduce service failure.	2011-2020	Our Wastewater network management Project considered different activities to improve how the network performs examples include sewer monitoring, remote control capability, improving asset records, and using models with accurate forecasting.	The process has allowed us to see which of the 10 activities prove to be most beneficial to improve our network service and then rolling	The benefit is having a single source for data that increases productivity and reduces the number of incidents and supports great decision making. The real time performance analysis will prevent failure and trigger

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			The objectives of the project are to improve decision making as the data will be available and consistent, enable interventions at the right time and place as a result of monitoring and performance analysis and to build scenario and fact based response plans to reduce the impact on our customers if an incident occurs. In addition to our Wastewater network management our Sewerage Management Planning (SMP) modelling (see 3.3.1) allows us to identify places at particular risk of flooding and enable preventive and mitigation actions.	out across the business where possible.	interventions at the right time. Forecasting tools put us in control of our network but would be costly to roll out across the region so will be delivered in a targeted approach.
A27	Identify Sewer monitoring investment requirements for 2015-2020.	2014-2015	We will progress the roll out of a wider programme of in sewer monitoring in prioritised areas. This includes monitoring on Combined Sewer Overflows. UU will install spill monitoring on 239 named intermittent discharges by March 2018. These discharges impact on high amenity water bodies. An additional 1800 storm discharges require event duration monitors by 2020.	n/a	For these high significance discharges telemetry links will be provided to allow data to be available in real time. Spill monitoring data from these discharges will be monitored, recorded and reported on from the Integrated Control Centre.
A28	Integrated Catchment Modelling (ICM) work with the EA to identify future water quality improvements required by legislation.	2010-2015	We have completed ICM modelling for all high priority catchments. We will embed the outputs into our Integrated Asset Planning approach and Sewerage Management Plans and use outcomes to inform investment plans for future water quality improvements. We will focus efforts on using ICM to justify interventions at source, for example, surface water separation to reduce spills.	The process of undertaking ICM in conjunction with the EA means that the risk of consent failure and pollution is mitigated to a great extent. We jointly agree what standards are required at which assets and these are then phased over an appropriate and affordable	Our aspirations and the willingness to pay of our customers are not always aligned with those of the EA so there can be protracted dialogue on occasion. Benefits of using the ICM modelling are the outcome of an agreed position over specific timescales.

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
				timescale so the risk of tighter an unachievable consents is managed.	
A29	Long term – surface water management activities.	2011 on	We are actively involved in pursuing a more sustainable approach to surface water drainage at many levels; involvement with Defra / DCLG on SuDS implementation, working with the Regional Flood and Coastal Committee, liaison with the Lead Local Flood Authorities and local partnerships with LAs and the EA. During 2015-20 we will deliver schemes identified through our partnerships with LAs and the EA to reduce flood risk. See also section 11.3	n/a	The EA are underwent a major re-structure during 2014 which may impact on their available resources to be involved in partnership working. Benefits to be realised post 2015.
A30	Short term – continue to maintain assets.	2011 on	We have an appropriate maintenance operating regime to ensure customer service does not deteriorate. All asset failures are logged for input to our common framework tool enabling us to predict the expected long term performance of our assets. Consequences are reviewed based on failures to obtain an updated consequences model to feed back into the system.	Does not mitigate risk but ensures visibility of asset condition.	Action ensures awareness of when asset intervention is required. Issues occur when asset information is incorrect.
A31	Long term – change asset design standard to -accommodate changed usage profile, -accommodate or withstand corrosion and -remove the need for recirculation.	2015 on	We will continue to maintain our assets and review asset standards taking account of climate change impacts when planning over the next 25 years for instance to account for increased rainfall. Asset standards will be amended if appropriate. Asset design standards have been updated to take account of future hydraulic conditions. Appropriate hydraulic assessments are also undertaken to take account of current and future inflow	n/a	A review programme has been put in place for asset standards so that the impacts of climate change can continually be reviewed Climate change is only considered for the period of the design horizon however we will keep our asset design standards under review.

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			compared to pumping capacity.		
A32	Review asset design standards against CP09 scenarios to identify unsustainable practices and amend for 2015-2020.		The network modelling team have reviewed the UKCP09 scenarios and amended asset design standards against them. We have uplifted the rainfall intensities over 25 years as projected which is in line with EA/Defra guidance. Revised asset standards have been updated to take account of climate change.	Expansion of the WwTW reduces the duration of flow to full treatment and subsequent asset deterioration because pumps will spend less time action at maximum capacity.	A review programme has been put in place for asset standards so that we can ensure that climate change continues to be considered appropriately in design as our understanding develops. Large capital investment is needed to apply updated asset design standards so the number of sites we can apply them to is limited by budgets. However initiatives such as the Sewerage management plan mean we can target effort and investment in a risk based manner.
A33	Short term – increase chemical dosing into sewers and at WwTWs to prevent gas creation.	2011 on	We are continuing to use chemical dosing where it is appropriate to do so.	n/a	n/a
A34	Involvement in national work on the management of flooding from sewer to land under the Waste Regulations.		It has now been confirmed that wastewater escaping from the sewerage network is classed as controlled waste under the EU Waste Framework Directive. We are actively involved in the Defra working groups to advise implementation of the Flood and Water Management Act 2010 and with the EA and other parties on SuDS implementation.	The activities identified to more sustainably manage surface water will contribute to reducing such flooding in future. We will also manage the issue through working with the EA alongside effective network and incident management processes.	The activities identified to more sustainably manage surface water will contribute to reducing such flooding in future but agreement of how to implement and manage on a wide scale will be difficult. See also section 11.3 for more information in regards to SuDS.

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
A35	Work with our energy supplier to identify critical sites and develop a plan to manage the risk of outages and service failure.	2011-25	We are working closely with Electricity North West's (ENW) innovative schemes, - Capacity to Customers (C2C) and - Customer Load Active System Services (CLASS) which uses voltage control to manage electricity consumption at peak times. These schemes increase resilience in supply. We are diversifying our portfolio of supplies by investing in generation of more renewable energy (e.g. wind, solar, maximising CHP outputs). This will reduce our reliance on the grid in order to build resilience to power outages. We also have contracts set up with back-up generator suppliers for critical sites. Energy management plans for each area aim to reduce energy consumption through site specific initiatives.	ENW'sC2C Solution enables significant additional network load and generation to be connected without traditional network reinforcement. The risk of outages has also been mitigated to a great extent by having on-site generators and the contract set up for provision of back-up generators at critical sites. Energy management plans assist in mitigating the risk to a certain extent.	The benefit of this approach is that as well as reducing our carbon footprint it also supports the Governments objective to increase renewable energy generation. The challenge with our energy supply strategy is consideration of the government policy and incentives and striking a balance between affordability (need to reduce imports), reducing carbon emissions and increasing renewable generation. Reduced reliance upon continuous grid power supply builds resilience
A36	Piston effect study to investigate solutions to relieve the impact of rapid variation in inflows/dilution to WwTWs. 	2010-2012	The piston effect is a theoretical steep increase in load caused by a "first flush" increased flow in a storm. This higher concentration may not be treatable causing permits to be exceeded. Studies on a sample of works gave mixed results. The observed piston effect varied according to site but it was typically lower than previously estimated. Further investigation revealed that investment was not economically viable though recirculation will continue to be considered as an option for the future. In the meantime the effect will be managed at site level.	We now have a better understanding of assets prone to the piston effect although the risk of consent failure/pollution is considered to be lower than previously thought.	Recommendations which could mitigate risk have been identified; however these haven't proved economically viable.

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
A37	Implement the investment identified by the piston effect study.		No viable investment identified.	n/a	n/a
A38	Implement the investment identified by Integrated Catchment Modelling (ICM) and carryout further modelling to identify future water quality improvements in light of better information on climate impacts on base flows.	2015-2020	We have a programme of work identified in the National Environment Programme based on the modelling outputs to deliver Water Framework Directive requirements. Climate change projections have not been updated since CP09 however the comparison against CMPI5 shows that UKCP09 continues to provide a valid assessment of the UK climate and can still be used for adaptation planning.	Solutions to be delivered 2015-20 and model outcomes predict that this risk will be mitigated.	Should new climate predictions be issued we will review the need for further modelling on the new forecast river base flows.
A39	Short term – adjust the flow control at WwTWs.		Business as usual practice is to manage and monitor, in real time where appropriate.	n/a	n/a
A40	Produce an odour management plan for all sites using a risk based approach. Identify sites where there is a case for investment.	2010-2015	Odour management plans are in place for all Wastewater treatment sites. These individual plans vary in scale and complexity, depending on the nature of the site in question and the level of odour related complaints, from high level odour assessment to detailed assessments and investment plans.	Partial mitigation	n/a
A41	Implement the investment identified by odour management plans. Review the plans and identify further investment required.	2015-2020	Highest priority sites have odour control investment included in our business plans for 2015-2020. Odour management planning includes communications and publicity of the investments undertaken to assure customers we are taking action.	It is considered that higher temperatures will exacerbate existing odour control issues rather than create new ones therefore planned investment at sites with odour issues will address the additional risks of climate change.	n/a

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
A42	Continue involvement in national Research & Development work regarding changes in domestic waste disposal practices impacting dry weather flow pollutants		In 2011 it was expected that use of domestic macerators would increasingly cause additional network issues (e.g. blockages) and nutrient load challenges. Since then local authorities have dramatically extended their door to door food waste recycling reducing the shift towards domestic maceration.		Although we do not promote maceration we recognise that there may be some benefit gained through an increase in energy production from the waste at the treatment works. However more research is required by the industry to fully understand this potential and whether the benefits outweigh the risks.
A43	Investigation / trial UV treatment of storm discharges. Identify investment required in 2015-2020.	2010-2014	A study has been undertaken on UV storm treatment of discharges however this method will not be taken forward as the EA had concerns regarding this method of treatment.	Risk will not be mitigated by UV storm treatment. Increased monitoring on the network will be important for treatment.	
A44	Implement the investment identified by the UV trial.		No longer applicable	n/a	n/a
A45	Increased capacity of sludge incineration plant.		Additional capacity has been delivered through developments at Shell Green and Davyhulme facilities (see section 11.4).	Increased capacity through Incineration and thermal hydrolysis has resulted in an alternative disposal route should use of the land bank be restricted.	Benefits include reduction in cake/ sludge that needs to be disposed of to land and enabled flexibility to use incineration or sludge to land routes as operational management requires.
A46	Produce detailed action plan identifying alternative disposal routes.	2015-2020	Additional incineration capacity plant has provided an alternative disposal route. Detailed planning will be achieved through rollout of the Regional Sludge Operational Management programme (RSOM (see section 11.4).	There is a reduction in reliance on cake/ sludge disposal to land thanks to increased incineration capacity and better management across	As Shell Green incinerator stream 3 is always operational (except for maintenance) the intake into the stream can be increased quickly should an event occur. Maintenance on the stream could become more

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
				the region giving flexibility.	efficient to maximise operational time.
A47	Carry out modelling work to identify land areas for sludge recycling at risk from flooding.		The land bank has been mapped against the EA Flood Map, zones 2 and 3. A report has been produced on flood risk, implications for the land bank and mitigation measures should flooding take place. The report found that only 11.63% of previously visited fields were affected by flooding in a 1:100 year river flood event and 1:200 year sea flood event. For a 1:1000 year flood event only 13.96% of fields are affected. This loss in land bank can be absorbed and mitigated against by disposing of sludge to non-flooded areas, particularly once the RSOM is effective (see section 11.4).	The work showed that flooding is not a significant risk to the land bank and any loss of land availability can be absorbed by alternative disposal routes.	n/a
A48	Review the type and number of insurance claims to inform work to reduce or remove the risk where appropriate.	2010-2015	We have continued to monitor the claims numbers and values across our assets and public liability. As our exposure in the immediate (2010-2014) has not increased this suggests our exposure has not increased. We have produced 21 'facility resilience assessments' for our insurers based on our high value / high risk sites from climate change impacts. These document the risk of the sites flooding.	We have not seen significant increases from our various insurers because of perceived climate change impact. We have had storm events that have resulted in claims, but this is considered as "business as usual exposure". A significant storm in Cumbria did cause damage to our assets but also demonstrated the existing resilience in that area.	Our action helped in making representations to the insurance market and the "watching" brief continues to keep us focused on this issue. Because of the recent floods in other areas, there may be an impact on our premiums but to date this has not been evident.

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
A49	Work with suppliers to help them adapt to the impacts of climate change.	2011 on	We have a Sustainable Supply Chain Charter which suppliers sign up to and adopt the standards within their supply chain. Over 75% of our annual spend is with suppliers who have signed up to the charter.	Through signing up to this charter all of our suppliers will recognise and support the commitment we have to use resources sustainably, mitigate and adapt to climate change and to prevent pollution.	We do not expect a 'one size fits all' approach and will enter into dialogue with signatories to understand which areas of the charter apply most to them.
A50	Identify lessons learnt from previous events and put measures and actions in place.	2010-2015	Business Continuity Plans produced for each business area stipulate arrangements for severe weather/emergency situations. All business areas are advised to document postcodes where staff members live to assist with planning during these events. Severe weather arrangements are also put in place during winter. This involves HR communications regarding staff responsibilities and the provisioning of 4x4 vehicles to assist with getting staff in to work. Teams are also advised to cross-skill and document procedures and for office based staff there is now increased provision for remote working including on own devices.	If these actions are followed by each business area the company will be well prepared in the event of an extreme weather event.	Although plans are put in place it is down to each business area to a certain extent to how well they keep information up to date and have appropriate cross-skilling capacity.
A51	Work with operational delivery partners to identify potential resources for these events.	2010-2015	Business Continuity Plans are in place for each business area and stipulate arrangements for severe weather / emergency situations. These include reprioritising work, including that done by partner organisations, so that resources are effectively utilised in the circumstances.	Partial mitigation	n/a
A52	Use study by NHS to inform actions.	2010-2015	The latest heat wave plan for England has been obtained (see link below) and advice will be used to inform actions in the event of	Partial mitigation	n/a

	Action description	Planned timescale	Progress on implementation of actions since 2011	Assessment of extent to which actions have mitigated risk since 2011	Benefits/challenges experienced
			a heat wave. NB Threshold maximum day and night temperatures defined by the Met Office National Severe Weather Warning Service (NSWWS) for the North West region are daytime 30ºC & night time 15ºC. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/310598/10087-2902315-TSO-Heatwave_Main_Plan_ACCESSIBLE.pdf		
A53	Continue to monitor and implement health and safety policies related to hot weather risks.	2010-2015	UU has a belief for health and safety which aims to make UU a safer place to work; "Nothing we do is worth getting hurt for". This applies to all of our business regardless of the nature of the work or the particular risk entailed.	On- going action	

5.2 NEW ACTIONS

Action ref	Action Description	Action details	Planned Timescale	Risks addressed by action
N01	Minimise the impact of flooding by providing mitigation to customers	Our mitigation team are delivering local bespoke solutions such as non-return valves, flood gates and doors, sump and pumps, ground re-profiling, waterproof coating and smart air bricks. By end of March 2014 we fitted flood mitigation to 1643 properties.		WR8 – Direct asset flooding leading to asset loss WwN1 – Increased volumes of storm water in combined sewers exceeds sewer capacity and causes customer flooding Actions are generally considered to be temporary solutions to reduce the impact of sewer flooding until a permanent solution is implemented to protect the properties. Whilst customers are pleased to see progress there is an expectation to have a permanent

Action ref	Action Description	Action details	Planned Timescale	Risks addressed by action
				solution which is not always affordable. Mitigation is cost beneficial per property and reduces the impact of sewer flooding – a particularly unpleasant service failure for customers. Some customers do not take up the offer of mitigation but this is their choice.
N02	Establish Integrated Control Centre ICC	Since 2013 we have established the Integrated Control Centre to centrally monitor, control and report on performance for both water and wastewater sides of our wholesale activities. As the wastewater network management pilots deliver enhanced monitoring and control of our wastewater system outputs will, where possible, be integrated into the ICC. The centralisation of this capability will allow efficient interventions to be undertaken either remotely or efficiently scheduled in a consistent manner.	2015-2020	WwN4 – Lower average and peak sewer flows leading to settlement of solids with shock loads causing point and unconsented discharges. WwN5 – Lower average and peak sewer flows leading to settlement of solids with shock loads causing more frequent blockages and customer flooding. The implementation of enhanced monitoring is central to our wastewater operating model. The outcomes of the pilots will also inform our future business plans to Ofwat to further develop our monitoring and control capabilities for implementation during the period 2020-25 and beyond.
N03	Investigate further opportunities for Sludge treatment and use.	We are reviewing other low cost, flexible routes for sludge such as treating to use as top soil post construction or in wider agricultural settings. SBAP reduces pathogen levels which will increase the potential locations / sale opportunities In addition to more incineration capacity we are considering de-watering and storage and other technologies. Assessment of flood risk every 5 years where the land bank is most affected by flooding, especially around the River Alt catchment.	2015-2020	WwS2 – Flooding / saturated ground prevents access to fields

Action ref	Action Description	Action details	Planned Timescale	Risks addressed by action
N04	Develop framework for implementation and maintenance of SuDS for new developments	In December 2014 the government announced that they would not be enacting the SuDS element of the Floods and Water Act 2011 but would be seeking to encourage more SuDS by strengthening planning policy. We are disappointed that the automatic right to connect surface water to sewers has not now been removed as this weakens the incentive for developers to install SuDS and therefore our ability to adapt to climate change. We are still in the process of assessing our response to this change in approach but we are looking to take a positive approach and seek to support developers to build effective drainage solutions to more sustainably manage surface water runoff in the North West.	2015 – on	WwN1 – Increased volumes of storm water in combined sewers exceeds sewer capacity and causes customer flooding WwN7 – Higher storm intensity means CSOs spill more frequently, impacting on receiving water quality.
N05	Reduce impact of freeze /thaw events	Install more insulation to water treatment works to prevent freezing. Implemented following 2010 -11 winter which was the coldest since 1890.	Complete	N/a

6 ADDRESSING BARRIERS AND UNDERSTANDING INTERDEPENDENCIES

6.1 INTERDEPENDENCIES

We have recognised that there are many interdependencies associated with delivering our adaptation activities and the actions of others are likely to impact on our ability to manage climate change risks. Our assessment shows that we need to work closely with Ofwat and the Environment Agency to ensure an integrated and sustainable approach to future regulatory requirements. Closer working with local and central government will help us to better understand upcoming legislation as well as coordinate climate change adaptation activities.

The table below outlines the interdependencies we have identified along with mitigating actions and comments regarding the extent to which they have assisted or hindered actions to address climate change so far.

Interdependencies with our adaptation activities	Mitigating action	Comment
Energy: Ability to ensure a consistent supply.	Develop a more integrated approach to risk management with our energy suppliers.	We are working closely with Electricity North West's (ENW) innovative schemes, Capacity to Customers (C2C) and Customer Load Active System Services (CLASS) which uses voltage control to manage electricity consumption at peak times. C2C Solution enables significant additional network load and generation to be connected without traditional network reinforcement. These increase resilience in supply. We are also diversifying our portfolio of supplies by investing in generation of more renewable energy (e.g. wind, solar, maximising CHP outputs). This will reduce our reliance on the grid in order to build resilience to power outages. The area energy management plans aim to reduce power consumption by site specific initiatives. We still experience difficulties engaging with other utilities regarding climate change potentially as they regard climate change as less of a risk to their business or a less imminent risk than others or are not willing to share their vulnerability. We have found that a better approach is to further engage with them on the basis of understanding levels of resilience in general and then moving the discussion onto climate change.
Telecoms: Ability to ensure a consistent supply No visibility of the potential climate change impacts on them and therefore on us	Develop a more integrated approach to risk management with our telecoms provider.	We still experience difficulties engaging with other utilities regarding climate change potentially where they regard climate change as less of a risk to their business or a less imminent risk than others or are not willing to share their vulnerability.

Interdependencies with our adaptation activities	Mitigating action	Comment
Environment Agency: Knowledge of how they will alter our discharge consents in the future Knowledge of how our abstraction licences will change in the future Future flood defence strategies Awareness of flood risk	Improve existing working relationships across all these areas to ensure an integrated and sustainable approach to future regulatory requirements.	We recognise the need to undertake further work with the Environment Agency at both a local and national level to fully understand the future implications of climate change on our consents/permits. Currently we are working closely with the Environment Agency on:- • Mapping our asset, actions and events • Joint scenario planning for 1:1000 year event. • the Regional Flood and Coastal Committee along with other relevant bodies • Flood and Coastal Erosion Management - local role in guiding flood and coastal risk management activities within catchments and along the coast. • North West River Basin Management Planning panel - the catchment based approach focuses on improving the water environment at a local level. Potential further activities could include working with bodies such as UKWIR on the future abstraction licence reform and how climate change might impact on ecosystem services and their use in the regulatory system. .
Ofwat: Current regulatory framework and the 5 year investment periods does not always facilitate delivery of sustainable investment.	Work with Ofwat to ensure an integrated and sustainable approach to future regulatory requirements.	We believe that the move to outcome based regulation together with Ofwat's duties for sustainability and resilience should encourage their support for us to implement our climate change adaptation plans given our customers support for no deterioration in service although the challenges to efficiency targets and budgetary constraints may restrict solutions which could address climate change risks. There remain challenges in how to fund large scale regional or national infrastructure projects that would deliver long term benefits to resilience of the UK water network but would not be deliverable through company based 5 year funding cycles.
Local Authorities: Impact of their new flood risk management duties and responsibilities and their ability to undertake them Impact of SuDS on the whole	Improve existing working relationship to further support LA's in implementing their new duties.	Partnership working is fundamental in adapting to climate change in a cost effective and sustainable manner. Local Authorities are the key player in this process and their Flood and Coastal Erosion Management duties should further the development of this work. The NW Regional Flood and Coastal Committee is responsible for reviewing flood defences and we are working with the relevant bodies to engender

Interdependencies with our adaptation activities	Mitigating action	Comment
planning process		mutual understanding of flood and coastal erosion risks. Whilst we welcome the introduction of the new SuDS legislation we have concerns about the level of technical expertise within Local Authorities to adequately implement and govern the new framework and the support they will be given by government legislation and guidance. We are also concerned about the reduction in budgets for Local Authorities impacting on their capacity and willingness to engage in joint working activities
Government: For example Defra, Communities and Local Government, implementing appropriate legislation to address the barriers and interdependencies. Coordination of adaptation activities. Customer demand for water and wastewater services. Local and regional plans for development.	We expect the Government to implement the recommendations from the Pitt Review and the Floods and Water Management Act. Improved joint working with government departments and other stakeholders to resolve issues associated with interdependencies. Continue our engagement with planning bodies to forecast future demographic changes and with industry to understand their future requirements.	We continue to play an active role in supporting the implementation of the Floods and Water Management Act. At a local level, the increased resources in the Developer Services team has enabled us to take a more active role with local planning authorities to better understand their development aspirations and include this in our supply and demand modelling (in wastewater in particular).
UKCP09: Climate change experts need to continue to improve forecasting to enable the risks to be assessed and adaptation plans informed.	We will continue to work with UKCP09 to ensure the information produced is appropriate.	UKCP09 was based on the best science available at the time it was produced. However, after comparing one of the core climate model ensembles that underpin UKCP09 results with the latest international modelling assessment from the Climate Modelling Inter-comparison Project (CMIP5) the Met Office found that, the ranges of future change in average climatological conditions across CMIP5 models were generally consistent with the probabilistic projections from UKCP09. There are some differences in relation to UK summer rainfall patterns so once the technical note on the CMIP5 findings is released (spring/ summer 2015) it is advised that CMIP5 results should be considered alongside UKCP09 in making decisions that are sensitive to future changes in summer rainfall.

6.2 BARRIERS TO ADAPTATION ACTIONS

We also identified a number of barriers to our adaptation actions which are common to many organisations. Many of these barriers remain and actions to address them are on-going as described in the table below.

The majority of our stakeholders feel that responding to climate change is important and gain reassurance that United Utilities investment will help to provide greater resilience. Whilst customers think it is important for us to improve the environmental condition of rivers, reservoirs, lakes and coastal waters, they are ambivalent as to aspects of climate change and the impact of the water industry in general. There does seem to be increasing awareness of climate change issues, but most customers still put cost impact ahead of other priorities.

Barriers to implementing the UUW adaptation programme	Mitigating action (how the barriers will be addressed)	Comment
Cost: Adaptation measures for infrastructure enhancement, particularly if based on 'hard' engineering solutions may have a high cost. Therefore adequate funding may not be available to implement these solutions. This may be particularly relevant to adaptation measures proposed for the sewerage network as this has been subject to largely maintenance only expenditure since privatisation and hence resilience is lower compared with other key expenditure areas, although the consequences may also be lower..	Each measure will be subject to cost benefit analysis with the most cost effective measures being prioritised.	We believe that to some extent we have overcome our cost barriers for the adaptation measures outlined in our 2011 report. By making the assessment of climate change risk business as usual the impact is now built into every project we undertake (i.e. the problem we have to resolve becomes bigger). The key to adaptation is ensuring that you resolve the 'bigger' problem in the most efficient and sustainable manner. In future we believe that partnership working will assist us in delivering more efficient and sustainable solutions for our customers whilst cognisant of the fact that funding will always be limited and therefore it is not possible to mitigate to 100% of all risks
Affordability: Affordability, such as impact on individual customer bills. In periods of economic constraints customers may be unwilling or unable to see bills increase to pay for climate change adaptation. This may be reinforced by a limited understanding of climate risks and vulnerabilities and/or a belief	We conduct willingness to pay surveys with our customers to determine the amount (if any) extra they are willing to pay for our service. An up-front explanation and briefing on climate risk is given to customer focus groups as part of the willingness to pay survey.	In the willingness to pay surveys conducted in the build-up to our latest price review process, customers were not asked specifically about their willingness to pay for climate change adaptation activities. They did however place a high value on at least maintaining current service levels and reducing sewer flooding. To achieve this in the

Barriers to implementing the UUW adaptation programme	Mitigating action (how the barriers will be addressed)	Comment
that the uncertainty is currently too great to warrant taking immediate action. Affordability may also be a constraint for the country as a whole, as work on adaptation to climate change may divert expenditure from other areas of the economy.		long term we need to start adapting now. In the future we might consider at we need to do build customer engagement and the value they place on low frequency, high consequence events (i.e. resilience), which is a wider consideration than just climate change. There is strong stakeholder and government support for adaptation activities. Defra in their Statement of Obligations state that they expect water companies to take a long term approach to meeting the challenges of a changing climate. Where we are able to make a sound business case, Defra would expect support for investment in line with our adaptation report.
Skilled Resources: Availability of adequate resources, for example technical, engineering and scientific, across the country to deliver climate change adaptation measures.	Work with government departments, educational establishments, industry bodies etc. to increase capacity in these areas. United Utilities has a huge skills agenda delivering over 25,000 days of training a year as well as supporting over 400 employees in further education. We are particularly proud of our graduate scheme and our apprenticeship scheme. We currently employ 103 apprentices and our scheme is part of the government's Energy and Efficiency Industrial Partnership (EEIP) in which we lead a group of 14 utility firms including Scottish Power, Amey, E.ON UK and Siemens on five pilot projects in Cheshire, Cumbria, Lancashire, Liverpool and Manchester.	Resources continue to be an area of concern especially in the area of engineering expertise. Internal engineering resources are also limited which can restrict our ability to develop sophisticated models to take into consideration all factors including the impacts of climate change.
Knowledge: Uncertainties associated with UKCP09 forecasts and the associated impact on sewerage and water networks may make the definition of effective adaptation measures problematic. In making the	Continue research and development projects, for ourselves and in collaboration with industry bodies and government departments to agree the evidence base necessary to justify investment in adaptation.	The high degree of uncertainty associated with climate change can cause difficulties when you are looking to justify some specific areas of work. Whilst it is still an area that requires further work we have our customer support to protect existing

Barriers to implementing the UUW adaptation programme	Mitigating action (how the barriers will be addressed)	Comment
case for future investment there needs to be a sound evidence base to justify the benefit of potential investment.		performance levels which for the longer term necessitates the inclusion of generic allowances for climate change.
Timing: Future updates to UKCP09 scenarios need to be released in time to inform any price review process, to provide clarity for water companies and their regulators.	Incorporate any future updates.	There was no further publication of UKCP09 scenarios ahead of the 2014 price review submission. We have therefore used UKCP09 throughout our plan. NB a note published by the met office in December 2014 discussed comparison of CMIP5 and UKCP09 and shows that UKCP09 continues to provide a valid assessment of the UK climate and can still be used for adaptation planning.
Adequate visibility of other utility plans: Lack of timely visibility of the adaptation plans of other key infrastructure and utility owners may result in the development of sub optimal adaptation plans by all utility providers. Infrastructure systems are only as strong as the "weakest link" therefore electricity networks that are designed to 1 in 30 year events could impact on the efficacy of the operation of other key infrastructure built to withstand 1 in a 100 year events. For example, if an electricity substation failed in the event of a storm the resulting power cut would impact wastewater pumping and treatment even if the treatment works itself was resilient to the storm. Adaptation plans need to be shared to identify such scenarios of differential planning.	We believe that the requirement for preparing statutory adaptation plans will enable closer working and co-operation on climate change adaptation plans across key infrastructure and utility owners. We look to Defra to help facilitate this as part of their overall assessment of statutory adaptation plans.	Having visibility of plans is useful but it is now becoming apparent that what is required is an understanding of how each utility approaches climate change, how they assess risk and then how they manage that risk within its business processes. Whilst there is a certain amount of work that we can undertake as an individual utility we will continue to work with government to facilitate this on a regional and national scale.
Regulations and legislation: Lack of supportive legislation, guidance, regulations, policies etc., by Government or Regulators, may present impediments to the delivery of cost effective adaptation programmes.	We are currently working with these bodies and plan to continue this work to ensure that appropriate legislation; guidance etc. is produced in a timely manner.	We continue to work with government and regulators to ensure legislation and guidance is driving the right behaviours and supportive of our ambition.

Barriers to implementing the UUW adaptation programme	Mitigating action (how the barriers will be addressed)	Comment
Carbon impact: Adaptation measures may themselves contribute to carbon emissions and therefore accelerate climate change. This will be particularly relevant to interventions based on 'hard' engineering solutions.	We will work with our regulators to agree a balance between adaptation activities and the increase in carbon that these bring about. During engineering design of projects we consider the carbon emissions embodied in the material used and aim to reduce carbon throughout the project lifecycle.	We continue to work with our regulators and stakeholders on alternative adaptation approaches that do not involve high energy solutions such as sustainable drainage schemes.

6.3 NEW BARRIERS TO IMPLEMENTING ADAPTATION ACTIONS

Many actions have been completed but we recognise that the outstanding actions will present further challenges. As a company we need to keep focus on these actions and monitor and evaluate our progress. One barrier to adaptation that has become more evident, particularly during our recent business planning, is the impact of cost challenges on investment decisions. In order to keep spending down scope of development tends to be restricted to what is perceived as being needed and “nice to haves” are cut. In practice this means planning for the mean requirement rather than making the additional investment to cope with more extreme events. This disproportionately increases our vulnerability to climate change impacts as the predicted differences in the North West climate are primarily greater fluctuation of weather conditions not changes to the average. A practical example of this is that average annual rainfall is not expected to change though it is predicted to come in a pattern that will have more dry periods and more storm events. Storm events require a substantial increase in capacity for drainage and although the rainfall levels we base our asset sizing standards on are being increased this is only by a moderate level and mainly driven by forecasted demand increases due to population growth and urban creep rather than to cope with extreme storm events. In the case of future extreme events it is possible the increased asset capacity would be still insufficient and lead to flooding in some locations.

A more subtle impact is that asset life has been modelled on previous experiences of historic fluctuations of use. If in the future even with the same annual levels of rainfall the range of daily values increases then our deterioration rates, and thus predictions of asset life, may be too conservative causing more asset failures and potentially more service failures. This is illustrated below for 2 rainfall patterns each of which have the same cumulative rainfall over the period. Pattern A has infrequent high intensity rainfall whereas pattern B has higher frequency but less intense rainfall. The dashed lines show an asset deterioration that is proportional to the cumulative rainfall whereas the solid lines show deterioration as a function of duration over an intensity threshold. It is clear that if asset deterioration is a function of duration working under greater load, then an increase in storms (even for the same rainfall) could significantly reduce asset life. This illustration is hypothetical but demonstrates that though we have good models for how our assets perform, we only know how they perform with our prevailing weather patterns. These models may not be appropriate if the patterns change due to climate change.

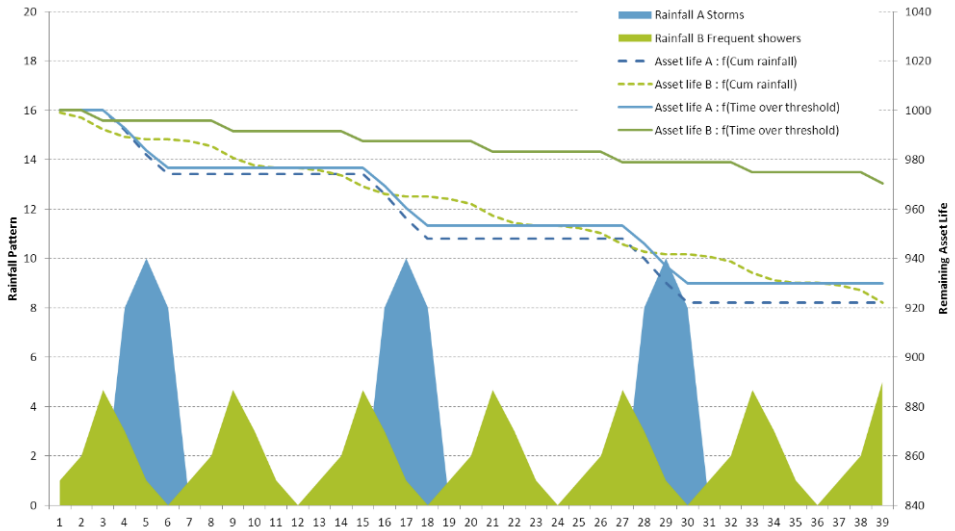


Figure 9 Illustration of differential impact of theoretical rainfall patterns on asset deterioration

7 MONITORING AND EVALUATING

The following section answers the questions related to Monitoring and Evaluating set out in the Guidance for organisations who want to update the government on progress since the first round of adaptation reporting

7.1 CONSIDERATION OF CLIMATE CHANGE RISKS

How effectively has consideration of climate change risks been embedded within your sector or organisation?

Consideration of climate change has been embedded within our organisation. This is partly demonstrated by the fact that within our business plan there is no specific expenditure directly allocated to the regulatory outcome:-

'Our services and assets are fit for a changing climate and our carbon footprint is reduced.'

As such climate change risk is already an integral part of our business risk and asset planning processes and risks and associated adaptation strategies are reviewed on a regular basis by the full board, directors and senior managers.

We feel that in the water side of our business the risks associated with climate change are fully embedded in our methodologies and modelling and the resultant modelling is of suitable rigour and robustness. There have been improvements in incorporating climate change in our wastewater strategic management, for instance including an element of climate change in asset sizing and promotion of sustainable solutions such as SuDS. We do however recognise that there is still more to be done.

7.2 PROCESSES TO ENSURE IMPLEMENTATION OF ADAPTATION RESPONSES

How effective have organisational monitoring and evaluation processes been to ensure adaptation responses are implemented and on track? If these have not been effective, what barriers prevented this?

Most of our projects and activities outlined as adaptation responses are part of our on-going schemes of work with business and operational drivers determining investment choices and adaptation to climate change being just one benefit therefore it may not be clear to those delivering activities that they are preparing for climate change. As climate change adaptation has been integrated with other work there has been no on-going monitoring and evaluation of the progress to implement the adaptation responses though there is of course monitoring of project delivery and benefit realisation.

One example of indirect monitoring of climate change adaptation activity through measuring the results of a scheme is that of the demand monitoring and pressure adjustments in West Cumbria. By reducing water requirements and leakage through this work we have improved resilience for current and future weather conditions.

7.2.1.1 West Cumbria 'Calming the network'

Too high or too low pressure in our pipes can mean problems such as burst mains, leaks and discoloured water.

In West Cumbria we have introduced advanced computer modelling of pressure information which can work with intelligent valves to respond to water pressure changes as customers use more or less water and enable us to predict where valves need maintenance.

Where previously we manually varied the water pressure, this new approach allows us to maintain a minimum water pressure and use intelligent systems to manage this more responsively and achieve better results.

So far over 600,000litres of water a day has been saved and the number of leaks has reduced from a peak of 250 per month in June 2011 to less than 100 a month by February 2013.

The approach has been considered a success and will be rolled out further.

7.3 EFFECTIVENESS OF PROCESSES IN HANDLING RECENT EXTREME WEATHER CONDITIONS

How effective were monitoring and evaluation processes in determining how the organisation/sector handled recent extreme weather conditions?

Unlike other regions there have not been any extreme weather events impacting our region as a whole since 2011. We do feel that our adaptation planning together with experiences of extreme weather events prior to our last report has prepared us for similar events in the future. An example of this is the Winterwise customer campaigns which have educated people on how to prepare their properties for cold weather; the problems caused by frozen pipes and encourage them to take action in advance. The objective is to reduce demand on contact centres in the event of such weather to enable speedy response and restoration of services that are our responsibility.

7.4 FINANCIAL BENEFITS OF IMPLEMENTING ADAPTATION ACTIONS

Has the sector/organisation identified any financial benefits from implementing adaptation actions? Perhaps through cost benefit analysis, fewer working days lost, more efficient operations etc.?

Weather events do not tend to cause many service interruptions that impact our costs or income and when events happen and customers are impacted the services are quickly recoverable so there is minimal opportunity for financial benefits arising from preventing or reducing the impact of future events. Also events such as extreme storms are so rare that any financial benefits from adaptation are small when considered against the long time period when the event has not occurred. Even adaptation changes with a large cost benefit from removing or reducing the impact, have minimal benefit when it can only be claimed for a 1 in a 100 year storm event.

There have been some incidental financial benefits resulting from our actions because investigation and analysis has prevented unnecessary spending e.g. retrofit SuDS project and recirculation projects (A36). Other future spending has been avoided because of the success of early intervention (e.g. reduction in water demand due to water efficiency promotion and more accurate modelling).

7.5 FLEXIBILITY OF OUR APPROACH TO ADAPTATION

Has there been sufficient flexibility in the approach to adaptation within the sector/organisation, which allowed you to pursue alternative courses of action? If not what remedial measures could you take to ensure flexibility?

Cost benefit assessment of projects has worked against resilience objectives because it is difficult to justify large investment when the benefits may not be realised. Our shift from lowest costs solutions towards a Totex approach and considering the whole life costs of assets will help in this matter though as adaptation activities may have cumulatively enough benefits over longer periods even if short term they are minimal. Furthermore having a longer term perspective may increase the options available to resolve business problems and any opportunities to improve resilience might become differentiator between alternative solutions.

8 OPPORTUNITIES AND BENEFITS

In adapting to climate change it is important to recognise that there could be opportunities for us to improve our services resulting from changing weather patterns. Those identified in our first adaptation report are listed below.

Business area	Climate variable	Impact and opportunity
Wastewater treatment	 Increased / intense rainfall	Increased rainfall leads to increased flows in rivers and greater dilution for effluent discharges. Risk of environment impact is reduced and therefore risk of non-compliance to permits is reduced. Potential for seasonal permits with relaxed standards during the winter.
Wastewater network	 Increased / intense rainfall	Increased rainfall leads to increased flows in rivers and greater dilution of intermittent discharges. Water quality impact of sewer overflows is reduced. Overall water quality improves.
Wastewater sludge	 Drought, temperature rise	Drought conditions and increased evaporation leads to a high soil moisture deficit. Sludge becomes a more desirable agricultural product because of its high water content.
Wastewater sludge	 Temperature rise	Warmer temperatures might promote microbial activity and increase biogas production. Processing plants have reduced power costs from self-sufficiency.
Wastewater sludge	 Temperature rise	Warmer temperatures reduce the heating requirement for sludge digestion. The performance of the assets is improved.
Water and Wastewater service	 Increased / intense rainfall, Drought, temperature rise, sea level rise	Better working relationships with key stakeholders and regulators as we address the barriers and interdependencies needed to progress the adaptation activities

Most of these opportunities are results of where climate change might lead to different weather patterns in the long term therefore at this early stage, where no definitive weather changes have occurred, we have not had the circumstance to exploit the opportunity. However even without any human influence, there is a large degree of natural variability in the climate, both in the short and long term. Analysing and planning for climate change has given us the opportunity to better understand our water supply network and how it would respond to multiple climate scenarios and thus enable us to improve our resilience to all hydrological variability either by mitigating actions or preparatory actions for the case of an extreme event. An example of this is planning for periods of water stress. As part of the current WRMP submission we have sought to examine the opportunities presented by reform of water regulation, and we actively promoted and investigated opportunities for water trading with other companies and third parties.

Quantification of climate change risk has also driven a more objective assessment of the impact of future housing growth and socio-economic issues and their impact on demand to both water and wastewater services.

The process of planning for climate change adaptation has also given us an additional opportunity to work more closely with our regulators and other stakeholders on this topic and other resilience planning forums. It has also provided an extra driver to explore innovations that might not otherwise have been explored such as catchment management, SuDS and UV treatment of storm spills.

9 APPENDIX A–RISK REFERENCES MAPPED TO ACTIONS

9.1 RISK REFERENCES

Risk references have a prefix to group by which part of our company is impacted. As set out and colour coded below

Water	WT = Water treatment WR = Water resources
Wastewater	WwN = Wastewater network WwTW = Wastewater treatment works WwS = Wastewater sludge
Support Services	SS = Support services

9.2 CLIMATE VARIABLES / IMPACT

 Increased/intense rainfall

 Temperature rise

 Drought

 Sea level Rise

9.3 RESIDUAL RISK

In the risk assessment described in the 2011 Adaptation report resulted in a score out of 32 for each risk. The “residual risk” score took into consideration the actions already underway in 2011. It was the risks that had highest residual risk scores (Consequence * Likelihood) that formed the list of priority risks to which actions were planned.

These priority risks are mapped by their score in the figure below and which actions were planned for each risk is set out in the table in section 9.4.

				Likelihood			
				Remote	**Unlikely**	**Likely**	**Very Likely**
				<10% chance consequence will occur by 2035	11-40% chance consequence will occur by 2035	41-70% chance consequence will occur by 2035	>70% chance consequence will occur by 2035
				1	**2**	**3**	**4**
Consequences	**Severe**	Failure of corporate objectives with a detrimental impact to the corporate strategy. Total lack of confidence from a large number of stakeholders. Actual reduction in shareholder value.	**8**	WR12 WR30 **8**	**16**	**24**	**32**
	High	High impact to corporate objectives. High levels of stakeholder concern with a potential impact to shareholder value.	**6**	**6**	WR8 WR19 WT15 WwN7 **12**	WwN2 WwN3 WwS1 WwTW2 WwTW3 **18**	WwN1 WwTW1 **24**
	Medium	Detrimental to meeting corporate objectives but not necessarily of a material nature. Would attract the interest or interaction from various stakeholders.	**4**	**4**	**8**	WR28 WT17 SS3 SS8 SS9 SS10 WwN5 WwN6 WwN8 WwS1 WwTW4 WwTW5 WwTW6 **12**	SS6 WwN4 **16**
	Low	Impact to the efficiency and effectiveness of meeting corporate objectives, but largely insignificant to corporate materiality.	**2**	**2**	**4**	WR10 WR27 WT3 WT11 WwN11 WwN12 **6**	WwTW1 WwTW8 **8**

9.4 RISK TO ACTION TABLE

Risk Ref	Climate Variable	Risk Description	Res. Risk	ARP1 Actions See Appendix B for Action descriptions				
WR8		Direct asset flooding leading to asset loss	12	A01	A02	A03		
WR10		Extreme weather events resulting in adverse raw water quality.	6	A06	A13	A14	A15	
WR12		More intense rainfall events resulting in potential impact on dams and associated spillways.	8	A10	A11			
WR19		Tidal limits moving upstream and increasing salinity at intakes.	12	A09				
WR27		Increased evapotranspiration, lower surface reservoir yields; greater reliance on groundwater recharge, reducing security of supply.	6	A16	A04	A17		
WR28		Increased evapotranspiration, lower infiltration and borehole yields reducing security of supply.	12	A04	A05			
WR30		Exfoliations cracks in storage basins affecting coatings/ seals, clay liner failure.	8	A12				
WT3		Reduced raw water volumes reducing dilution and water quality.	6	A18	A14			
WT11		Direct flooding of service reservoirs, contaminants enter underground storage tanks and pipelines.	6	A03				
WT15		Tidal limits moving upstream and increasing salinity at intakes.	12	A09				
WT17		More algal growth and micro-organisms in the water supply system.	12	A06	A07	A08		
WwN1		Increased volumes of storm water in combined sewers exceeds sewer capacity and causes customer flooding	24	A19	A20	A21	A22	A23
WwN2		Direct asset flooding causes service failure and asset loss	18	A03	A25			
WwN3		Direct Asset flooding, storm damage and coastal erosion of planned retreat leading to asset loss and service failure.	18	A03				
WwN4		Lower average and peak sewer flows lead to settlement in the system, with shock loads causing blockage of pass forward flow point and unconsented discharges	16	A26	A27			
WwN5		Lower average and peak sewer flows lead to settlement in the system, with shock loads causing more frequent blockages and customer flooding	12	A26	A27			
WwN6		Lower average peak sewer flows leading to settlement of solids and with shock loads causing increased CSO spills and deteriorating water quality in receiving water. Tighter discharge conditions may be imposed by EA.	12	A26	A27	A28		

Risk Ref	Climate Variable	Risk Description	Res. Risk	ARP1 Actions See Appendix B for Action descriptions			
WwN7		Higher storm intensity means CSOs spill more frequently, impacting on receiving water quality	12	A19	A29	A23	A22
WwN8		Increased volumes of storm water require increased pumping in combined sewer systems, causing accelerated asset deterioration	12	A30	A31	A32	
WwN11		Lower average and peak flows leads to hydrogen sulphide build up causing accelerated asset deceleration.	6	A33			
WwN12		Runoff exceeds combined sewer capacity leading to surface flooding and pollution.	6	A34			
WwS1		Direct asset flooding causes service failure and asset loss	18	A03	A25		
WwS2		Flooding / saturated ground prevents access to fields	12	A45	A46	A47	
WwTW1		Loss of power and treatment process leading to service failure	24	A35			
WwTW2		Direct asset flooding causes service failure and asset loss	18	A03	A25		
WwTW3		Reduced base flow in receiving water courses leading to tighter discharge conditions. Increased risk of consent failure and pollution.	18	A36	A28	A37	A38
WwTW4		Lower average and peak flows increasing need for recirculation and pumping.	12	A39	A32	A31	
WwTW5		Shock loads result in increased asset deterioration and health and safety risk	12	A32			
WwTW6		Increased scepticism levels and odour.	12	A40	A41		
WwTW7		Changes in domestic waste disposal practices lead to changes in dry weather flow pollutants affecting treatment processes.	8	A42			
WwTW8		Extended duration at flow to full treatment due to increased rainfall and / or storage return. Accelerated assets deterioration and failure.	8	A31	A43	A32	A44
SS3		Suppliers are not aware of Climate change risks	12	A49			
SS6		Increase in our insurance premiums as a result of increase in claims related to Climate change impacts	16	A48			
SS8	 	Staff are unable to commute to work during extreme events	12	A50	A51		
SS9		Impact of a heat wave on the health and safety of the staff	12	A52	A53		
SS10		Risk of flooding of office buildings	12	A03			

10 APPENDIX B–ACTIONS MAPPED TO RISK REFERENCES

In the 2011 adaptation report for each of the priority risks we set out lists of adaptation activities.

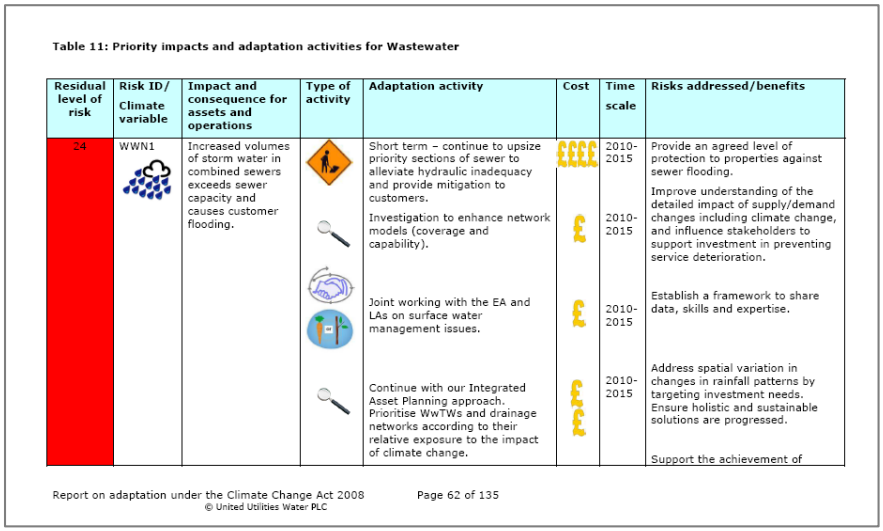


Table 11: Priority impacts and adaptation activities for Wastewater

Residual level of risk	Risk ID/ Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed/benefits
24	WWN1	Increased volumes of storm water in combined sewers exceeds sewer capacity and causes customer flooding.		Short term – continue to upsize priority sections of sewer to alleviate hydraulic inadequacy and provide mitigation to customers.	£££	2010-2015	Provide an agreed level of protection to properties against sewer flooding.
				Investigation to enhance network models (coverage and capability).	£	2010-2015	Improve understanding of the detailed impact of supply/demand changes including climate change, and influence stakeholders to support investment in preventing service deterioration.
				Joint working with the EA and LAs on surface water management issues.	£	2010-2015	Establish a framework to share data, skills and expertise.
				Continue with our Integrated Asset Planning approach. Prioritise WwTWs and drainage networks according to their relative exposure to the impact of climate change.	£	2010-2015	Address spatial variation in changes in rainfall patterns by targeting investment needs. Ensure holistic and sustainable solutions are progressed.
							Support the achievement of

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Figure 10 Snapshot of risk table in our 2011 Adaptation report

10.1 ACTION TO RISK TABLE

These actions are listed below along with a reference for the risk or risks the action was intended to address.

ARP1 Action ref	Action Description	Risk references
A01	Carry out 2010-2015 flood protection programme. Review flood risks for the next regulatory submission and extend to include service reservoirs.	WR8
A02	Review emergency electricity supply arrangements for all key assets.	WR8
A03	Carry out flood protection programme (2015 onwards) and continue to resilience activities at sites at highest risk of flooding. Include service reservoirs in flood risk work and develop risk plans for all sites through asset planning.	WR8 WT11 WwN2 WwN3 WwTW2 WwS1 SS10
A04	Review Climate Change impact on Water resources using UKCP09 and rainfall run off modelling. Also, review drought plan and standby sources available.	WR28 WR27
A05	Reassess climate change risk on borehole Deployable Output using more sophisticated UKWIR methodology (looking at more intense rainfall events and increased evapotranspiration).	WR28
A06	Complete 2010-2015 WTW and SCaMP investment and continue to maintain WTWs and water supply catchments.	WT17 WR10
A07	Carry out risk assessment for those sites without appropriate treatment capability.	WT17
A08	Continue to closely monitor and review chlorine residual requirements throughout WTW to tap.	WT17

ARP1 Action ref	Action Description	Risk references
A09	Review risks to identify likelihood regarding Tidal limits moving upstream and increasing salinity at intakes (e.g. constant or spring tide) and develop mitigation/adaptation measures for River Dee and River Lune intakes.	WT15 WR19
A10	Continue statutory 10 yearly inspections of dams, supervising engineer reservoir inspections and maintenance programme.	WR12
A11	Complete programme of work to enhance spillways design to prevent damage to masonry structures during intense rainfall events.	WR12
A12	Carry out studies on impact of climate change on increased drawdown and duration of drawdown on earth embankments. Assess measures to protect upstream face of earth dams if required.	WR30
A13	Sustainable Catchment Management Programme (SCaMP) investigation into correlation between land condition and raw water quality.	WR10
A14	Continue to deliver catchment management activities on UU owned and non owned catchments. SCaMP	WR10 WT3
A15	Increase use of turbidity monitors for sites at risk of elevated turbidity as a surrogate for adverse water quality.	WR10
A16	Deliver Climate Change Investment (supply and demand actions) including West-East Link pipeline and South Egremont Boreholes.	WR27
A17	Reduce leakage by 28.4Ml/d and demand by 16Ml/d through demand management activities such as the water efficiency programme and customer metering	WR27
A18	Review WTW treatment capabilities for sites where ground water and surface water sources are blended during droughts.	WT3
A19	Short term – continue to upsize priority sections of sewer to alleviate hydraulic inadequacy and provide mitigation to customers.	WwN1 WwN7
A20	Investigation to enhance network models (coverage and capability).	WwN1
A21	Joint working with the EA and Las on surface water management issues.	WwN1
A22	Continue with our Integrated Asset Planning approach. Prioritise WwTWs and drainage networks according to their relative exposure to the impact of climate change.	WwN1 WwN7
A23	Sustainable Drainage (SuDS) demonstration project.	WwN1 WwN7
A24	Implement recommendations from the SuDS demonstration project.	WwN1 WwN7
A25	Use CP09 scenarios to review climate change risk assessment and adaptation plans as part of on-going asset planning.	WwN2 WwTW2 WwS1
A26	Improved sewer monitoring and targeting of intervention on network to reduce service failure.	WwN4 WwN5 WwN6

ARP1 Action ref	Action Description	Risk references
A27	Identify investment requirements for 2015-2020.	WwN4 WwN5 WwN6
A28	Integrated Catchment Modelling (ICM) work with the EA to identify future water quality improvements required by legislation.	WwN6 WwTW3
A29	Long term – surface water management activities.	WwN7
A30	Short term – continue to maintain assets.	WwN8
A31	Long term – change asset design standard to accommodate changed usage profile, to accommodate or withstand corrosion and to remove the need for recirculation.	WwN8 WwTW4 WwTW8
A32	Review asset design standards against CP09 scenarios to identify unsustainable practices and amend for 2015-2020.	WwN8 WwTW4 WwTW5 WwTW8
A33	Short term – increase chemical dosing into sewers and at WwTWs to prevent gas creation.	WwN11
A34	Involvement in national work on the management of flooding from sewer to land under the Waste Regulations.	WwN12
A35	Work with our energy supplier to identify critical sites and develop a plan to manage the risk of outages and service failure.	WwTW1
A36	Piston effect study to investigate solutions to relieve the impact of rapid variation in inflows/dilution to WwTWs.	WwTW3
A37	Implement the investment identified by the piston effect study.	WwTW3
A38	Implement the investment identified by ICM and carryout further modelling to identify future water quality improvements in light of better information on climate impacts on base flows.	WwTW3
A39	Short term – adjust the flow control at WwTWs.	WwTW4
A40	Produce an odour management plan for all sites using a risk based approach. Identify sites where there is a case for investment.	WwTW6
A41	Implement the investment identified by odour management plans. Review the plans and identify further investment required.	WwTW6
A42	Continue involvement in national R&D work regarding changes in domestic waste disposal practices impacting dry weather flow pollutants	WwTW7
A43	Investigation/trial UV treatment of storm discharges. Identify investment required in 2015-2020.	WwTW8
A44	Implement the investment identified by the UV trial.	WwTW8
A45	Increased capacity of sludge incineration plant.	WwS2
A46	Produce detailed action plan identifying alternative disposal routes.	WwS2
A47	Carry out modelling work to identify land areas for sludge recycling at risk from flooding.	WwS2

ARP1 Action ref	Action Description	Risk references
A48	Review the type and number of claims to inform work to reduce or remove the risk where appropriate.	SS6
A49	Work with suppliers to help them adapt to the impacts of climate change.	SS3
A50	Identify lessons learnt from previous events and put measures and actions in place.	SS8
A51	Work with operational delivery partners to identify potential resources for these events.	SS8
A52	Use study by NHS to inform actions.	SS9
A53	Continue to monitor and implement health and safety policies related to hot weather risks.	SS9

11 APPENDIX C–KEY PROJECTS ADDRESSING ACTIONS

11.1 SCAMP

11.1.1 Background

Our Sustainable Catchment Management Programme (SCaMP) aims to apply an integrated approach to catchment management across all of our water catchment land.

Initially the key driver was to support a biodiversity development in particular to protect and improve Sites of Special Scientific Interest (SSSI) to meet SSSI target conditions. In the ScaMP1 Programme between 2005 and 2010 we undertook projects across 27,000 hectares of our water catchment areas in the Peak District and Bowland areas in close association with the Royal Society for the Protection of Birds (RSPB).

Recognising the success of ScaMP1 and that activities to improve SSSIs could also have mutual benefits to water quality and colour the programme of work for SCaMP2 was set up to "extend SCaMP type approaches to other catchment land we own and promote its use on other catchments which we do not own but on which we nevertheless rely for water supplies".

SCaMP2 included land not owned by ourselves so as well as working with Natural England; it involved working with additional stakeholders not least the impacted landowners which includes the National Trust. Key drivers included to restore habitats to meet SSSI1 target condition, to improve water quality, particularly water colour, and to reduce runoff rates, sediment load and downstream flooding. With the exclusion of the habitat improvements each of these drivers will in turn improve the ability of the area to cope with more intense rainfall events that are likely from the climate change predictions and results in a lesser impact to water quality.

The 2010-2015 work undertaken included 53 farms or locations in the UU region which feed into the catchment of 11 water treatment works.

Grouping	Activity examples	How it helps water catchment management
Buildings	Provision of new livestock buildings, Provision of covered middens General farm building improvements to minimise pathogen risks.	Gives alternative housing options for livestock (especially in winter) which is more comfortable for famers and livestock and can reduce impact to land. Reduction in animal numbers reduces impact on catchment particularly at high risk times.
Livestock Control	Livestock control including fencing, walling, crossing points, water troughs to protect watercourses and biodiversity.	Protects vulnerable areas from impact of livestock, restricts impact to where recoverable or mitigatable. Less livestock in turn reduces impact.
Access	Access track improvements to protect water quality and biodiversity	Maximises potential for diversification income. Supports livestock control activities.
Peat moorland restoration	Peat moorland restoration including activities to rewet, grip blocking, bare peat restoration and drip edge re-profiling.	Slows run off, (improves resilience to rainfall including fluctuation as a result of climate change) Reduce the rate of increase in water colour , Reduce sediment load and

		downstream flooding Protect important habitat Improve carbon sequestration
Biodiversity	Creation of new native woodland and scrub woodland	Protects watercourses Provide tenants with an alternative income to livestock

11.1.2 Progress

The following table outlines the scale of some of the activities completed in 2010-2015.

Grouping	Achievements
Buildings	14 Livestock new buildings 8 New covered middens 13 Building improvement schemes
Livestock Control	190, 505m of fencing erected 119 new water troughs 86,792m of watercourse protected
Access	2,845 m of track created/ improved 2,458 m of footpaths created/ improved
Peat moorland restoration	950.9Km of grip blocking 6,995 hectares of peat area improved
Biodiversity	497Hectares of new woodland 331, 298 Trees planted

11.1.2.1 Farm Example – Dry Barrows Farm

Drybarrows farm on our Haweswater Estate in the Lake District is a 50 hectare (ha) farm let on a long term lease that also includes 15 ha of additional land at High Hullockhowe along with grazing rights on Bampton Common. 57 per cent of the land is on the direct catchment for Haweswater reservoir whilst the remainder drains into the River Eden, which is designated as a Special Area of Conservation (SAC).

Sheep and cattle had open access to a number of watercourses which presented an increased risk to water quality. Muck from the cattle building was stored on a hard standing area and presented a significant risk of polluting the local SAC watercourse. There is limited availability of land for the safe spreading of waste. The tenancy included a holiday cottage that was in need of refurbishment.

Figure 11 Drybarrows Farm midden before and after SCaMP

Watercourses throughout the landholding have been buffered from livestock by new fencing and the creation of 4.75 ha of new woodland. Water troughs, a crossing point, conduits and drainage have been provided to minimise the pollution risk, particularly from the moorland drainage passing through the farm and the muck heap during heavy rainfall. A new covered midden has been provided.

To compensate the tenant for the land relinquished and a reduction in cattle from 54 to 30 improvements have been made to the holiday cottage to maximise the potential alternative income. These include access track refurbishment as well as building improvements such as central heating, windows and roofing in order to eliminate damp and heating issues.

The catchment management supported by this project benefits raw water quality, biodiversity and maximise the potential of the tenant to diversify his farm business through holiday lets.

11.1.2.2 Peat Moorland restoration

A monitoring programme was put in place to measure and report on progress and in particular bare peat restoration work from activities such as gully blocking to enhance blanket bog and stabilisation using coir rolls in Longdendale and the grip blocking on the Goyt and Bowland estate. In the latest annual report dated July 2014 the hydrological monitoring data show the continuation of observed trends and continue to demonstrate the positive benefits of SCaMP to water quality and habitat condition.

Figure 12 Coir Roll on Ashway Gap Showing Peat Accumulating and Vegetation Colonising Behind the Coir Roll

(Note: the uneven surface of the exposed bare peat indicating the surface 'downstream' of the coir roll is still highly mobile and vegetation establishment is likely to be compromised)

Blanket bog and peat restoration appears to be effective as the water table levels tend to be elevated, less variable and raw water colour levels remain either stable or declining slightly across the majority of SCaMP study catchments, with only the most degraded catchments still presenting a challenge in terms of colour reduction. This is opposite to many untreated, un-restored upland blanket bog catchments in the UK uplands, where colour appears to be continually increasing year on year.

The innovative use of coir rolls to reduce peat wash-off and surface water runoff on the flatter bare peat pans is indicating that the installation of the coir rolls has allowed the peat surface to retain slightly wetter conditions on the bare peat pans and some evidence of peat wash-off being held back.

11.1.1 Future

Between 2015 and 2020 our focus for catchment management and SCaMP will be Water Framework Directive safeguard zones designated for deteriorating raw water. We will utilise knowledge from previous projects to work in partnership on non-owned catchments working with a variety of different stakeholders to deliver more of the types of activity completed in the last 5 years.

Longer term objectives include planting trees along water courses to reduce run off but also to shade the watercourse protecting the water temperature and in turn reducing quality issues such as those related to algae bloom.

11.2 INTEGRATED ASSET PLANS

Asset Management Planning is the process within our Wholesale business by which we identify the right interventions, at the right time, at the right balance of risk between ourselves and our customers. Through our Asset to Operate (A2O) process we maintain, operate and monitor the assets and deliver the interventions required to achieve our customer outcomes.

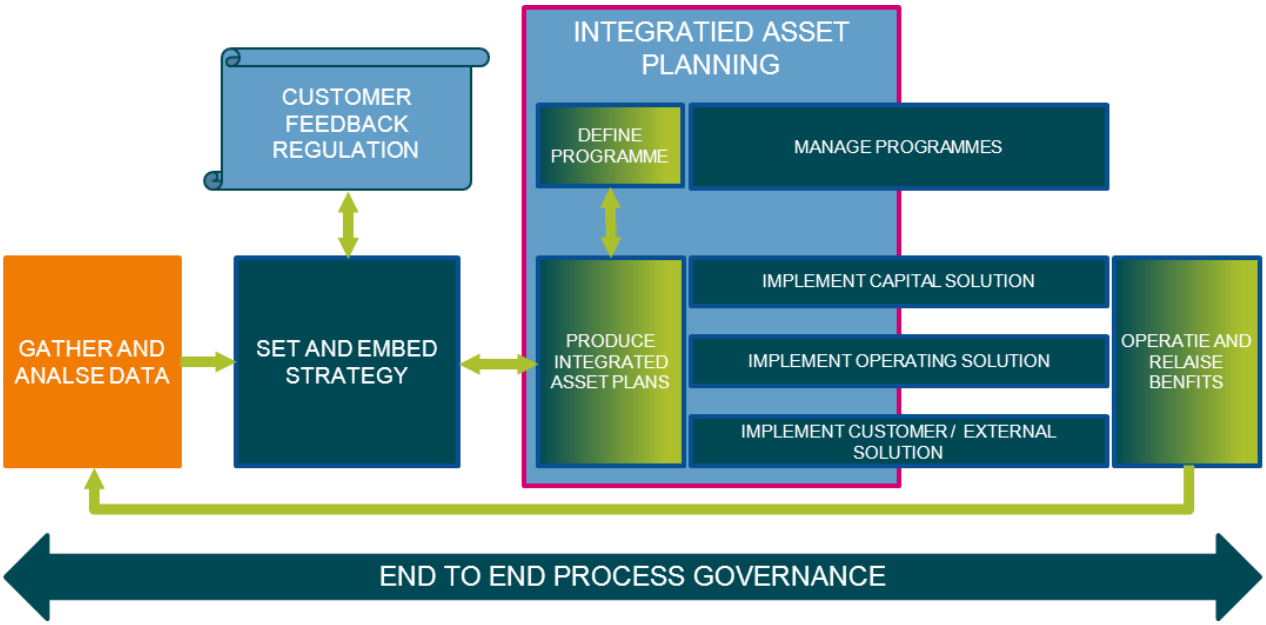

Figure 13: Asset-to-Operate – our end-to-end Asset Management Process

Our A2O process, identifies customer priorities, sets strategies and targets, identifies risks and issues, investment needs and potential interventions, and then prioritises and optimises these into an efficient programme to deliver our targets meeting customer preferences and regulatory obligations. Asset management planning allows us to consider, quantify and capture the balance of risk associated with different types of interventions and the benefits they deliver and is underpinned by a focus on the tools, people, and governance structures.

Core to our A2O process are Integrated Asset Plans which reflect our holistic approach to asset management.

Integrated Asset Plans (IAPs) are managed by a specific Asset or Catchment Manager and are held for our

- 33 water Demand Monitoring Zones (DMZs),
- large diameter trunk water main network
- 60 wastewater sub-catchments and
- regional sludge assets.

The Integrated Asset Planning process is managed collaboratively through a core team representing asset management, engineering, operations and strategy. Plans are structured around our Customer Promises and Outcomes and are hosted on our corporate document and collaboration system.

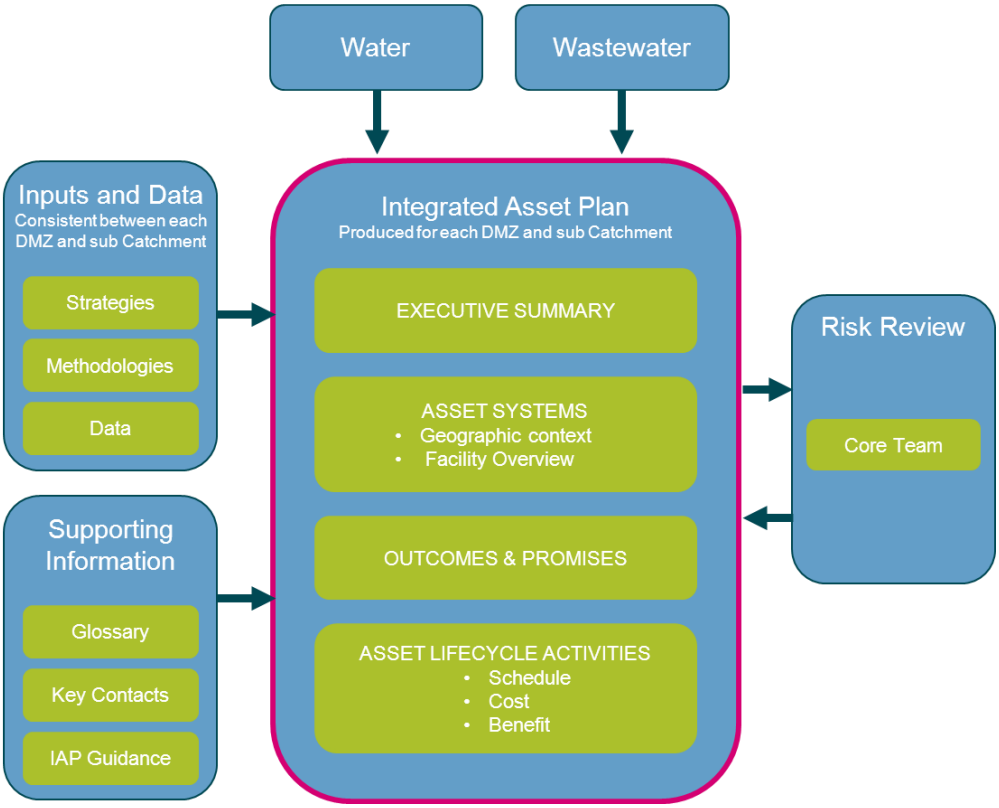

Figure 14 Schematic of Integrated Asset Plan

The Integrated Asset Planning process is an iterative process and during each cycle the current view of asset performance, condition, customer contacts, stakeholder requirements and other key data is collated, validated, and analysed using methodologies to enable a consistent assessment of risks, issues and opportunities to achieve our company's strategic targets. Note risks include those due to the impact of climate change.

In addition, the outputs from a suite of specialist analysis tools, systems and processes are used to ensure that best practice risk modelling is engaged in the initial planning. Depending upon the business area, examples of these tools include; portfolio risk assessment for assessing impounding reservoir safety, Sewerage Management Plans for assessing wastewater flooding and pollution risk, and risk based capital maintenance modelling (using PIONEER (Proactive Investment Optimisation by the Evaluation of Expenditure and Risk).

Our process brings together all these data sources and outputs to develop an integrated view of current or future performance gaps and possible solutions. Solutions may require capital works, operational solutions or customer / external solutions (e.g. catchment management solutions, or engagement with customers on disposals of fats, oils and grease). Where capital solutions are required options are developed and costed by our engineering teams. The output of the IAP process is a prioritised log of interventions at various stages of progress designed to deliver the short, medium and long term targets and therefore deliver our Outcomes.

11.3 SUDS- SUSTAINABLE DRAINAGE SOLUTIONS

Urban drainage systems collect the rainwater and wastewater from urban areas in combined drainage networks and send it via the sewerage system to wastewater treatment works for safe return to the environment. Combined systems such as these come under pressure with intense rainfall, where the volume to be carried and treated increases significantly and abruptly. The predicted impact of climate change, specifically changing rainfall patterns, could exacerbate vulnerability to higher intensity rainfall and increase the instances of problems of flooding, pollution or damage to the environment.

SuDS are Sustainable Drainage Solutions and their objective is to limit and slow surface water run-off and filter out some silt and contaminants without just increasing the capacity of the systems which is an unsustainable and costly approach. Traditionally measures to limit run-off have been below ground, such as underground storage tanks or over-sized sewers whereas SuDS are usually at the ground surface. Common types of SuDS are ponds which fluctuate in level with rainfall, swales (wide grass ditches), soakaways and permeable pavements (block paving, sometimes with gravel beneath). Retro-fitting of SuDS to existing buildings and land is a way of reducing peak flows in drains/sewers and watercourses and so helping to reduce flooding and pollution resulting from storm water exceeding the local network capacity.

11.3.1 SuDS demonstration Project

A demonstration project was carried out to do a comparative cost benefit analysis for four sites where surface water flooding is an issue comparing conventional solutions with solutions that include sustainable features.

Figure 15 Watery Lane, Lancaster

Problem	Solution Options and Estimate	Decision
Watery Lane, Lancaster The properties along Watery Lane are at a flood risk during intense storms because of the inadequacy of the local sewer network to cope with the excess storm water. The properties lie at a lower level than the road surface along Watery Lane so if the sewer capacity is exceeded flooding occurs through inspection chambers within the property boundary and/or overland flow from the highway.	**Conventional**: 184m of upsizing £257k **SuDS**: 800m New surface water sewer and retention basin £2,934k **Compromise/ Combination**: 184m upsizing : 400m New surface water sewer and retention basin £1207k	Conventional option chosen.
Hoyles Lane, Preston The properties along Watery Lane are at a flood risk during intense storms because of the inadequacy of the local sewer network to cope with the excess storm water and the lack of road gullies. If the sewer capacity is exceeded flooding occurs through inspection chambers within the property boundary and/or overland flow from the highway.	**Conventional Online storage**: - Additional large diameter sewer totalling 376m £565k. **Conventional Offline storage**: - 542m^2 Retention tank £1,222k. **SuDS**: - Separation and retention basin-. 1160m new surface water sewer, 450m2 wetland draining and retention basins. £2,610k.	No option was cost beneficial.
Henshall Road, Macclesfield The flooding mechanism in the Henshall Road area is due to a lack of downstream capacity restricting the sewers Henshall Road from discharging effectively. Flooding is generally seen at low spots within the area: the cellar level inspection chambers in the Henshall Road properties and manholes in the low lying Nursery Avenue.	**Conventional**: - 4 different schemes including upsizing and storage combinations £539k up to £1,592k **SuDS combinations**: - 6 different schemes including combinations of upsizing, permeable paving, new sewers, pumped return tank and detention pond £1,169k up to £2,388k	Conventional solution is not cost beneficial and SuDS is even higher cost.
Tyrone Drive, Rochdale The flooding in the Tyrone Drive area is a result of hydraulic inadequacy in both the combined sewer to the rear of the properties and the surface water system in Winsford Drive to the front of the properties. A lack of downstream capacity in Bury Road can restrict the sewers Henshall Road from discharging effectively and if the nearby surface water sewer capacity is exceeded flood water runs down Winsford Rd. towards the effected properties.	**Conventional- combined sewer**: - 5 different schemes including upsizing and storage combinations £1,111k up to £1,626k **Conventional- surface water sewer**: - upsizing £220k **SuDS and conventional combinations**: - 2 different schemes £2,684k up to £3,408k. **SuDS only**: - Permeable paving £649k SW Diversion, upsizing and balancing pond £187k.	To fully resolve the flooding we need to install a foul solution and a surface water solution and no option was both effective and cost beneficial.

The overall conclusion of the project was that retrofit SuDS solutions are unlikely to be cost effective solutions to flooding issues. The project also highlighted that aside from the technological developments and learning required to implement SuDS projects there can be time and cost implications due to other issues which do not occur in conventional solutions. Proposals tend to impact a greater number of properties which increases requirements for consultation, coordination and engagement, practical and legal implications of maintenance of solutions are not yet established and whereas a conventional solution is easy to size and easy to site incorporating sustainable elements leads to multiple options and permutations which each need to be assessed for effectiveness and cost.

11.3.2 The future of SuDS

We are keen to encourage the installation of SuDS in new builds and redevelopments but following this project we are yet to be convinced that the retrofit installation of SuDS features to existing built up areas is likely to be cost effective. However, we are aware of projects elsewhere that claim to have successfully reduced surface water runoff from existing estates by a significant amount and at a competitive price. We will continue to gather information on best practice techniques and new innovations and look for opportunities to test them in our region. The government's proposal to encourage SuDS by strengthening existing planning policy gives us the opportunity to work with developers to build effective sustainable drainage systems on new estates and potentially adopt, own and operate those systems in perpetuity. This will enable us to gather more direct evidence of the long term cost and benefits associated with SuDS systems which can only add to our understanding of how these systems could be integrated in existing built up areas. We are committed to encouraging SuDS to manage surface water in the North West as there are highly urbanised areas with high annual rainfall, we cannot afford for SuDS not to happen given the likelihood that rainfall intensity is set to increase as a result of climate change.

11.4 SLUDGE MANAGEMENT

Sludge treatment and disposal, or sludge management, is an integral part of the wastewater service we provide for our customers. Sludge, which is a by-product of our wastewater treatment processes, is a valuable source of energy and nutrients. With global power costs increasing and the challenge of climate change, sludge management will play an important part in reducing our overall energy consumption and meeting our carbon reduction targets. This in turn will contribute to improving our costs for customers and meeting government targets for carbon.

The majority of our sludge is recycled as fertilizer to agricultural land. Recycling to agricultural land is considered to be the Best Practicable Environmental Option (BPEO), as the high nitrogen and phosphorous concentrations and organic matter are beneficial when added to agricultural soils and compared to manufacturing fertiliser from raw materials, biosolids (resulting from sludge treatment) can offer a more sustainable option in terms of reduced resource use, energy use and carbon emissions.

Increasingly we use incineration (with energy recovery) as our alternative disposal route, as we cannot efficiently recycle all of the sludge we produce. We have a balanced set of sludge treatment facilities across the region, which we need to maintain to enable us to effectively and efficiently manage our sludge, complying with regulations and maximising value

We have various projects implemented recently, or on-going, that will improve our overall sludge management. For instance, construction of an additional incineration stream at Shell Green to increase capacity and the completion of the thermal hydrolysis plant in Davyhulme.

11.4.1 SBAP (Sludge Balanced Asset Programme)

In 2013 the SBAP (Sludge Balanced Asset programme) was completed at Davyhulme resulting in what is currently the largest thermal hydrolysis plant in the world. The hydrolysis increased the digestion capacity as well as improving its performance enabled a significant increase in flexibility to balance between incineration or agricultural disposal routes. This is useful in efficient day to day running but also improves resilience by providing redundancy in capacity which can be utilised for maintenance, or if an agricultural route were limited by extensive flooding.

Figure 16 SBAP at Davyhulme WwTW

11.4.2 Regional Sludge Operational Management (RSOM)

The Regional Sludge Operational Management project began in 2014 and although the core drivers were to optimise the transport of sludge and maximise the value from it, delivery of the project will also mitigate the risks related to sludge referred to in the 2011 Adaptation report.

RSOM Aim: to ensure we utilise the sludge we produce in the most cost effective manner through enhancing quality, improving logistics, focussing on performance, maximising renewable energy generation and marketing of the product.

RSOM will achieve this by implementing advanced modelling, alongside performance and production management at a regional level. Modelling will determine is sludge should be moved or stored, used as fertilizer or as a provider of Heat / Electricity / Bio-methane

depending on the drivers at that point in time. The chosen disposal route will normally be related to operational capacity and requirements but could be impacted by flooding either by restricting transport routes or land disposal options. Management on a regional basis will improve our operation efficiency but also improve our resilience.

11.5 SEWER FLOODING AND PARTNERSHIPS

United Utilities along with all other water and sewerage companies' make a significant difference to communities at risk of flooding by managing their assets to reduce the risk of sewer flooding and working with partners on flood schemes. Companies are Risk Management Authorities (RMAs) under the Flood and Water Management Act (2010) and have responsibilities to co-operate with partners and act in a manner consistent with the National Flood and Coastal Erosion Risk Management (FCERM) Strategy. The Environment Agency are responsible for reporting to government on progress implementing the strategy through an annual report – Managing flood and coastal erosion risks in England to which we contribute information on risk management activities completed each year.

Water companies report to Ofwat on their sewer flooding performance each year. The Ofwat KPI is the 'Number of incidents of internal sewer flooding for properties that have flooded within the last ten years'. We plan to work with Ofwat and the other companies to scope and develop flood related KPIs for the future.

Since 2013 /14 local companies have been working with us, local authorities and others to manage flood risk. They have done this by sharing information to asses flood risk, co-operating on FCERM activities such as the spatial planning and construction of schemes. Discussions over the last year have highlighted the significant opportunities to deliver joint outcomes of reduced risk of sewer flooding, more resilient infrastructure and to protect more properties from all sources of flooding and coastal erosion.

Partnership working has been taking place in three main areas of collective endeavour:

11.5.1 Strategic and investment planning:

Opportunities for the alignment of capital programmes and identification of joint solutions have been discussed at Regional Flood and Coastal Committees (RFCCs) and Lead Local Flood Authority (LLFA) strategic partnership groups. Our companies' business plan submission included commitments to discharge duties as RMAs, with flood risk embedded in outcomes and / or performance measures.

We have contributed to Surface Water Management Plans, local flood risk management strategies and development plans, which promote sustainable solutions to flooding problems

11.5.2 Delivery of solutions:

Partnership working on solutions that tackle sewer flooding and other sources of flooding at the same time means costs can be shared. Water companies (including United Utilities) are providing time and resources to deliver sustainable and cost effective solutions. This provides value for money for customers. This has been supported by collaborating on modelling initiatives to understand flood risk and identify solutions. Working together on 'Keep it clear' campaigns (information campaigns to reduce sewer blockages from unsuitable items being disposed of to sewers) and increased awareness through publicity such as "the Watermen" TV series is reducing the incidents of flood and pollution to the sewer network.

11.5.3 Flood response:

A number of water companies' experienced increased sewer flooding in their area as a result of the heavy rainfall for the East and West coast surges in December 2013, and extensive flooding from January to March 2014. Partnership working between companies and Local

Resilience Forums enables an effective combined response to the flooding by contributing time, expertise and resources. We would work with our partners in similar future events.

Groundwater infiltration into sewers has put pressure on company assets. Companies including United Utilities are working with partners on Groundwater Infiltration Plans to minimise the disruption to services.

12 APPENDIX D– GLOSSARY OF TERMS AND ABBREVIATIONS

Acronym	Description
AMP	Asset Management Plan: • AMP4 covers the period 2005 to 2010 • AMP5 covers the period 2010 to 2015 • AMP6 covers the period 2015 to 2020 • AMP7 covers the period 2020 to 2025
ARP	Adaptation Reporting Power
CCRA	Climate Change Risk Assessment
CMIP5	Climate Modelling Inter-comparison Project (CMIP5). Latest international modelling assessment published in 2014.
CSO	Combined sewer overflow
Defra	Department for Environment, Food and Rural Affairs
Drought Plan	United Utilities action plan for during drought conditions. http://corporate.unitedutilities.com/documents/final-drought-plan-2014.pdf)
EA	Environment Agency
IAP	Integrated Asset Planning
ICC	Integrated Control Centre
ICM	Integrated Catchment Modelling
NAP	National Adaptation Programme
POC	Particulate Organic Carbon Release (Turbidity)
PR09	Periodic Review 2009
PR14	Periodic Review 2014
SuDS	Sustainable Drainage Solutions/ Systems
SS	Support Services
SMP	Sewerage management plans
SCaMP	Sustainable Catchment Management Programme
UKCP09	United Kingdom Climate Projections Climate projections based on the Met Office HadCM3 model
WT	Water treatment
WR	Water resources
WRMP	Water Resources Management Plan http://corporate.unitedutilities.com/waterresourcesplan
WwN	Wastewater network
WwTW	Wastewater treatment works
WwS	Wastewater sludge