United Utilities
helping life flow smoothly

Revised Draft Water Resources Management Plan

November 2013

Contents

SUMMARY OF OUR WATER RESOURCES MANAGEMENT PLAN

United Utilities is committed to providing high quality and reliable drinking water to its customers. It is important to have enough water for people to use at home. It is also important to have enough water for businesses, to enable a vibrant economy. Local communities and wildlife need water left in lakes and rivers to ensure their well-being. We need a detailed and robust plan to ensure we have enough water for all these needs, even with future challenges such as growth and climate change.

We have a statutory duty to produce a Water Resource Management Plan under the Water Act 2003. The Act includes a requirement for consultation on the plan so that stakeholders can understand the planning process and contribute to development of the plan.

This document is the revised draft 2014 Water Resource Management Plan, updated following consultation in summer 2013.

PURPOSE OF THE 2014 WATER RESOURCE PLAN

This plan describes in detail our assessment of the available water supplies and the demand for water by our customers over the 2015 – 2040 period. The plan also sets out our proposed strategy for water resources and demand management to ensure we have adequate water supplies to serve our customers.

In particular, there are some challenging water supply issues in West Cumbria. Here we need to make some tough decisions about how we balance some of our legal obligations with demand for secure water supplies in that area and we have listened carefully to views expressed in our consultation that on the whole support our draft plan.

Key Issues

To successfully meet the demand for water resources in the North West, we recognise that there are several key issues to address, including:

- Balancing the needs of all customers
- Planning for future uncertainty and climate change
- Providing evidence based plans to enable people to make informed decisions
- Carrying out our statutory duty to protect the water environment
- Protecting the landscape and amenity of the areas we live, work and play in

BALANCING THE NEEDS OF ALL CUSTOMERS

Ensuring a reliable water supply for our customers

Our customers have consistently informed us that having a reliable water supply is a top priority and have indicated that water use restrictions should be relatively infrequent.

Unlike other areas of the country, we aim to implement water use restrictions and drought permits, on average, once in 20 years; ban non-essential use only once in 35 years; and consider it unacceptable to plan for rota cuts or standpipes even in the most severe droughts.

Ensuring sustainable water abstraction to protect the environment

In most cases, and for most of the time, in North West England, there is adequate water available for abstraction. However, we are working with the Environment Agency to protect environmentally sensitive species and habitats – particularly in West

Cumbria. It is an area of great environmental importance, all the natural lakes and rivers contain rare species and sensitive habitats, protected by law, including England's only viable population of the internationally protected freshwater mussel. The actions that are needed to help protect this species will result in a significant reduction in water available for supply in this area.

Ensuring that water prices are affordable

Actions to improve the environment or minimise the frequency of water use restrictions can be very costly and it is important to customers that these activities do not increase water bills unnecessarily. This is particularly important in a region like North West England where incomes are often well below the national average and affordability is a real issue.

PLANNING FOR FUTURE UNCERTAINTY AND CLIMATE CHANGE

Customers demand for water

A key part of our plan is knowing how much water customers need now and are likely to need in the future.

Total demand for water in the region has reduced in 18 out of the last 20 years. Over this time, we have more than halved the amount of water that leaks into the ground from our pipes, from 945 million litres per day in 1992 to 457 million litres per day now. We have achieved this by monitoring our network for leaks, replacing old pipes, finding, and fixing leaks. Right now, we find and fix leaks that are breaking out at a rate of more than 7,500 leaks per year on our own pipes and customer's underground pipes. Leakage in North West England is currently below the 'sustainable economic level', this means that the cost of finding and fixing the leak, including costs to society (e.g. additional traffic disruption) and the environment (carbon emissions), are more expensive than the cost of taking the water from our water sources. Nevertheless, we are committed to combating these leaks and preventing leakage levels rising.

Since 2010 we have really increased our effort to help customers be more water efficient in homes and businesses. We offer primary schools in the North West a free water efficiency education programme, including fun freebies. We also give away other water efficient products to help customers save water in the home such as water efficient shower heads and tap inserts. We visit businesses and suggest ways in which they can use less water. We have also invested in research into new ways customers can be more water efficient.

We have sponsored the Kids TV character Gabi H20 dedicated to educating children about saving water

We have won awards with this campaign

We know that customers with a water meter use less water than those without a meter. We offer free water meters to customers to help manage water use and reduce bills. All new houses and businesses are also given a water meter.

Total demand for water in the region has reduced in 18 out of the last 20 years and we expect it continue reducing over the next 25 years.

In preparing this plan, we expect the number of people in the North West England to increase from 6.9 million in 2012 to 7.9 million by 2040 and believe the number of houses we will need to supply water to will increase from 3.0 million to 3.7 million. Water demand from businesses and industry in the North West has reduced in recent decades. We believe it will continue to fall between 2012 and 2040 by a further 17%, even with the expected economic growth in the region. This is because of a continuing trend of industry changing to become less water intensive and households becoming more water efficient.

With the current levels of water efficiency promotion, pipe leak detection and repair and providing water meters to customers free of charge continuing for the next 25 years, we think demand will continue to reduce despite the expected population and housing growth.

Available water supplies

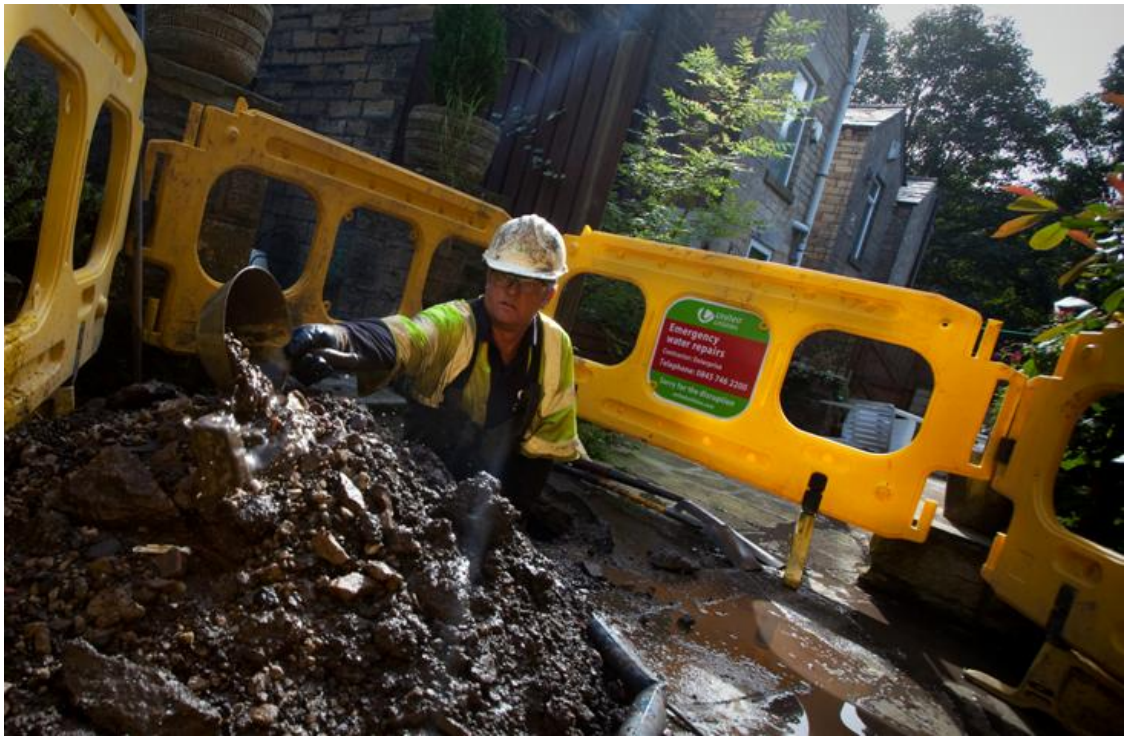
As well as forecasting customers' demand for water we also need to understand how much water we have available in the North West to supply to our customers taps, now and in the future.

We are continually working to improve our water supply resilience and to make sure there is enough water available for our customers to use. In 2012, a new 55 km West-East two-way water pipeline was completed between Merseyside and Manchester, doubling the capacity of water that can be transferred between these areas. This helps us to maintain adequate supplies to major areas of the Integrated Resource Zone in times of dry weather, this is our largest water resource zone and covers most of North West England. This pipeline also allows us to undertake important maintenance on our existing water pipe network.

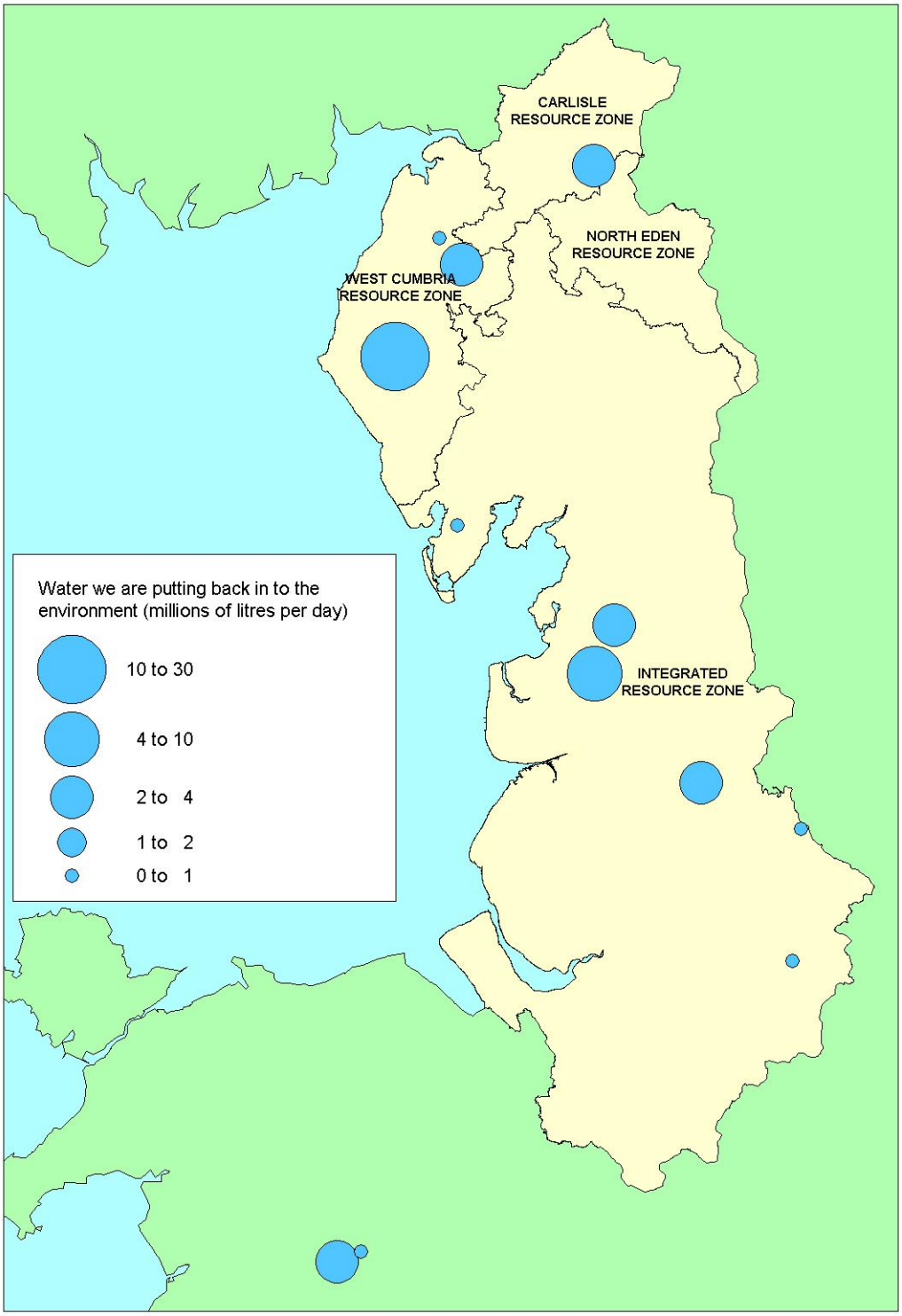
Since our last plan we have also improved the water resource models that we use to work out how much water is available in each resource zone, now and in the future. We have developed more detailed models of our water network including all our main water sources, water treatment works and areas of water demand across each resource zone, using software called Aquator™. This is advanced software and one of the most widely used in the water industry. It has enabled us to better represent the water supplies we have available and to understand the effects of any possible future changes on our water availability.

One of the changes we need to know is the impact of climate change on future water supply. For this plan we have greatly improved our climate change assessment and have applied a risk-based approach using the best current climate change information available (UK Climate Predictions 2009). This means where it is thought climate change could have a large impact on water availability we have carried out a very detailed assessment.

We also need to include the impact of planned environmental improvements on water available for supply. We know in the future there will be a reduction in the water we can take from some sources, to leave more to improve the environment. The ecologically sensitive areas that require more water are still being decided by the Environment Agency, but our assessment indicates that the effect of these changes will have a modest impact on the water we have available for supply across most of North West England. Please see the map over the page for an indication of where these environmental improvements may be. However, this is not the case for our West Cumbria Resource Zone. West Cumbria is home to England's only viable population of the internationally protected freshwater mussel. The actions that are needed to help protect this species will result in a significant reduction in water available for supply in this area.



We have more than halved the amount of water that leaks in to the ground from our pipes since 1995



We are leaving more water in our lakes and rivers right across the North West

Taking account of uncertainties

It's really important that we have more than enough water available than is forecast to be needed. For example, climate change may be worse than predicted or pollution may mean that some water sources can't be used for a while. We have assessed the

uncertainty in our forecasts and have allowed sufficient headroom between supply and demand forecasts.

We have also considered scenarios with more extreme outcomes and identified sufficient options in the plan to meet any potential deficit.

PROVIDING EVIDENCE BASED PLANS TO MAKE INFORMED DECISIONS

Environmental sensitivity of West Cumbria

West Cumbria is known for its stunning landscape and areas of almost pristine environment. All the main surface sources of water in West Cumbria contain rare species, protected by law. Atlantic salmon, charr and many rare aquatic plants are present. The area also hosts England's only viable population of the internationally protected freshwater mussel. Without changes to our abstraction from Ennerdale Water, this species could become extinct in England.

UK and European Law protects the environment in West Cumbria. Ennerdale Water is a designated Site of Special Scientific Interest (SSSI) and, downstream of the lake, the River Ehen is both a SSSI and a Special Area of Conservation (SAC). Crummock Water and the River Cocker are both part of a SSSI and a SAC. Overwater is also a SSSI. All three sites are in the Lake District National Park and therefore the visual amenity and landscapes are legally protected.

The Lake District currently attracts 15.2 million visitors each year, sustains 14,865 tourism jobs and generates £935m in spending per year. Many of these tourists visit to see the stunning mountain and Lakeland landscapes and the leisure opportunities that this presents.

West Cumbria is a major part of Britain's Energy Coast's vision for the nation's energy security, including the generation of low carbon energy and other clean forms of energy. Significant investment is anticipated that will contribute to the local economy for the next 15 years, including the potential generation of 3,000 jobs. The area is already home to one of the UK's largest concentrations of high tech, advanced manufacturing employment[1].

Providing secure water supplies and protecting the aquatic environment in this setting is a fine balance. The Cumbrian mountains mean that the water network in West Cumbria is separate from the rest of our water supply areas, and public water supplies are reliant on the local sources. All of this means that the water supply options in West Cumbria are limited.

During the pre-consultation and consultation periods, many Cumbrian stakeholders have expressed views that we need to take a strategic long-term view of the overall water resources situation in West Cumbria. These include the Lake District National Park, Friends of the Lake District, The Derwent Owners' Association and the West Cumbria Rivers Trust.

Our stakeholders, the scientific evidence and the law all tell us that we need to change the water supply arrangements in West Cumbria significantly to make them resilient, reliable and sustainable for the long term.

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[1] www.britainsenergycoast.co.uk/blueprint

Demand management

Demand management has an important role to play in securing reliable water supply in the light of future challenges.

We are committed to reducing demand by increasing levels of household metering, continuing to offer water efficient devices, advice and education and maintaining a sustainable economic level of leakage.

We have assessed the benefits of our baseline demand management strategy. Without the reductions in demand from our free meter option programme and water efficiency programmes there would be a supply demand deficit in the Integrated Resource Zone of 107 million litres per day by 2040. This means that we avoid having to develop a large number of new water sources because of our demand management programme.

The total net present value of the avoided new water source development is over £300 million

Our plan

We identified three possible ways to meet the challenges in West Cumbria. We presented these alternatives in our draft plan and have listened carefully to views expressed in the consultation. We have also conducted further customer research to inform our final plan. As a result, our preferred plan is to use some of the spare water available in our Integrated Resource Zone. We will build a new water treatment works and a pipeline between West Cumbria and Thirlmere Reservoir, one of our largest water sources. This will form the UK's largest interconnected water resource zone. The pipeline will be sufficiently large, so it could provide all our customers' needs including any future increase in demand, above which we have forecast.

A lower-cost alternative plan to provide this water was considered in the consultation. This was to build a number of new water sources in West Cumbria including boreholes and a pipeline from Wastwater, a lake owned by another party. This remains the lowest cost combination of options to maintain water supply to our customers in West Cumbria. However, there is considerable concern about the long-term viability of this scheme, impacts on the environment and a lack of stakeholder and customer support. We therefore consider that together with the urgency to resolve the underlying environmental issue, it is not in our customers' interest to consider this alternative plan further.

Another alternative plan considered in the consultation was to buy water from Northumbrian Water. This would have been from Kielder Reservoir in the North Pennines and required a new water pipeline from Kielder Reservoir to a new water treatment works near Carlisle, and then a new drinking water pipeline to West Cumbria. This had similar benefits to our preferred plan, Thirlmere, but was slightly more expensive to build and a lot more expensive to run due to the requirement to pump water over a long distance (70 km). The very high cost of this option and the fact that it would take longer to design and build than the other alternatives mean that it is not in our customers' or the environment's interest to consider this alternative plan further.

Although the preferred Thirlmere plan is more expensive than the lowest-cost alternative in the draft plan we think that is the only plan that can provide certainty that enough water is available in West Cumbria and we meet our legal obligations to protect the environment. It will mean we no longer need to take water from the most environmentally sensitive sites in West Cumbria; so the habitats can return to a more natural condition. It provides our customers with a more reliable water supply in times of dry weather. We can size the pipeline to meet water demands greater than currently expected because of the possible future economic growth in the area. Being part of the UK's largest water resource zone will increase the reliability of customers' water supply to other factors, such as future climate change.

The preferred plan involves more water being taken from Thirlmere Reservoir, but this would be within the existing allowed amount and will not impact the environmentally sensitive sites around Thirlmere. As it is part of the Integrated Resource Zone the use of Thirlmere can be balanced with other sources across the region to make sure we are using water where it is available, depending on where it rains. Demand reductions in this zone mean that water is available to supply West Cumbria without increasing abstraction above current limits.

We have forecast that there is still enough water for our customers in the Integrated Resource Zone even when we build a pipeline from Thirlmere Reservoir to provide water to our customers in West Cumbria.

Whilst working on our plan we have identified lots of new ways we could provide more water to customers living in our Integrated Resource Zone and ways to further reduce customer demand. However, should customer demand for water and water available for supply in the future be as we expect it, we will not need to use any of these new ideas.

In addition, the government has asked us to look into the possibility of buying and selling water between water company regions. The purpose is for water to be transferred from areas where it rains a lot, such as North West England, to areas where it does not rain as much and where there are many people, like the South East of England. This will help to make sure that everyone in the country has enough water and that water is not being taken unnecessarily from areas that are environmentally sensitive, causing damage.

Thanks to our baseline demand management activities, see text box above, we have more water than we need in the Integrated Resource Zone and lots of potential to make more water available. We have considered the possibility of trading water with companies that need water to maintain customer's supplies in the future. This is mainly during dry weather conditions. However, we would only do this if it was beneficial to our customers in the North West and the customers of the water company we would be providing water to. No water transfers have been confirmed as needed by other water companies, so they are not included in our preferred plan. We will continue to work with other interested companies and other third parties to investigate how these water transfers could work in the future.

CARRYING OUT OUR STATUTORY DUTY TO PROTECT THE WATER ENVIRONMENT

We take seriously our duty to carry out statutory obligations under UK and EU law.

- We recognise we have a statutory duty to produce a Water Resource Management Plan under the Water Act 2003;
- The Water Resources Management Plan Direction 2012 (Defra, 2012) sets out specific requirements for the preparation and publication of a Water Resources Management Plan. We have demonstrated we have complied with these;
- The Environment Agency, Ofwat and Defra have issued a Water Resources Planning Guideline (EA, 2012) which provides detailed guidance on how water companies should prepare their Water Resources Management Plans. We have comprehensively followed the guideline in preparing our Water Resources Management Plan;
- The Guiding Principles for the Water Resources Planning Guideline make clear the importance of the government's Water White Paper and Draft Water Bill in water resource planning. In following these Guiding Principles, we have included the following in our water resource planning approach:
    - Delivery of the best value to customers. Water Resource Management Plans should be environmentally sustainable including; full consideration of demand management option, water trading, cross boundary solutions and third party supplier solutions to ensure efficient allocation of available resource; and
    - Plans must be adaptable and take account of uncertainty through full scenario testing. This should be focused on the main areas of uncertainty such as future climate change and environmental requirement for water.

- As a competent authority we have met our responsibilities under the relevant legislation protecting European Designated sites (SSSIs and SACs), we have undertaken a Strategic Environmental Assessment and Habitats Regulation Assessment of our plan.

PROTECTING THE LANDSCAPE AND AMENITY OF THE AREAS WE LIVE, WORK AND PLAY IN

We have closely considered the value our customers place on their surroundings. We have considered the environmental and social costs of our proposed options in the West Cumbria Resource Zone. Cost-benefit valuations were carried out following the detailed methods in the Benefits Assessment Guidance.

The environmental and social issues evaluated include a wide range of issues, such as:

- Environmental impacts of water supply schemes, during construction and/or during scheme operation. Examples of impacts considered include those on aquatic flora and fauna, informal recreation activities such as walking, cycling or birdwatching, in-stream recreational activities such as boating, canoeing or rowing, other water abstractors, heritage, archaeology and landscape;
- Social impacts of water supply schemes, during construction and/or during scheme operation. Examples of impacts considered include those of noise, dust, odour, or time delays to people's journeys as a result of work in highways to lay or repair pipelines; and
- Increases or reductions in carbon emissions that could result from the abstraction, treatment and distribution of water. Examples of impacts considered include: fuel consumption of vehicles used in construction, leakage management, installation of water meters or water efficiency devices, energy use at work sites, emissions from road traffic as a result of diversions or disruptions, embodied carbon in materials used, changes in water use (and thus changes in energy use) within the home.

We have also taken in to account specific legislation for any works proposed within designated landscapes in the region, such as National Parks and Areas of Outstanding Natural Beauty.

SUMMARY AND NEXT STEPS

Our water resources and demand strategies ensure that our water supply reliability will continue to be achieved across the region over the 2040 planning horizon. It also ensures sustainable water abstraction and meets the challenges of climate change.

We propose to resolve the forecast shortfall in supply in West Cumbria by connecting the area into the Integrated Resource Zone. This will allow long-term environmental protection for this environmentally important area, make it resilient to changes in the climate and support economic growth.

No deficits of supply are forecast elsewhere in the North West region.

We will continue to operate the most economically sustainable level of leakage, finding and fixing repairs where it is of economic benefit to our customers to do so.

We will continue to encourage our customers to take up the Free Meter Option available to them and we will look into new and engaging ways to help customers monitor and manage their own water consumption. We will also undertake more targeted promotion of the free meter option to those customers who will financially benefit the most.

We will continue to be leaders in the area of water efficiency, to deliver a continued reduction total demand for water.

Over the medium term, we will continue to consider the potential for exporting water to other parts of the UK, where it is economic to do so and will result in benefits for our customers.

We have produced a plan that is not only compliant with the Environment Agency's guidelines and incorporates current best practice, but a plan that is robust, flexible and helps the North West be ready for the future.

We will review this plan every year to take account of changes in demand and supply availability, and revise the plan if required. We will produce a full new Water Resources Management Plan for public consultation in 2018.

1 INTRODUCTION

Key Messages

- We have adopted a comprehensive approach to water resource planning to ensure our plans are fit for purpose
- We have published a draft plan for consultation and used changed the plan to reflect customer and stakeholder views

1.1 BACKGROUND

United Utilities Water PLC is the main licensed water company for North West England. We provide water and wastewater services to 6.9 million people and over 200,000 businesses across the region.

In preparing its 2014 Water Resources Management Plan, United Utilities published a draft for consultation. We invited many organisations and individuals to make comments on how we could improve the draft plan. This revised plan takes account of views expressed by stakeholders in the consultation. We expect to publish the final plan in early 2014.

This plan describes in detail our assessment of the available water supplies and the demand for water by our customers over the 2015 - 2040 period. It also sets out our proposed strategy for water resources and demand management to ensure adequate water supplies to our customers.

The way in which this draft plan is structured to address these issues is set out in Table 1 on the following page.

1.2 WHY DO WE HAVE A WATER RESOURCES MANAGEMENT PLAN?

We are committed to providing high quality and reliable drinking water to our customers. It is important to have enough water for people to use at home. It is also important to have enough water for businesses, to enable a vibrant economy. Local communities and wildlife also need water left in lakes and rivers to ensure their well-being. We need a detailed and robust plan to ensure we have enough water for all these needs, even with future challenges like population growth and climate change.

United Utilities has a statutory duty to produce a Water Resource Management Plan under the Water Act 2003. The Act includes a requirement for consultation on the draft plan so that stakeholders can understand the planning process and contribute to the development of the plan.

This Water Resources Management Plan is complemented by our Drought Plan[2], which sets out the short-term operational steps we will take as a drought progresses. This water resources management plan sets out our strategy to minimise the effects of drought or prolonged dry weather conditions, and ensure that water use restrictions and other drought powers are required no more frequently than our customers' would expect.

Every five years we are required to undertake a detailed review of service and expenditure needs for all our water and wastewater services, known as the "Price Review". This review determines the water prices that we will charge over the following five-year period (2015 - 2020). The price limits are determined by Ofwat, the economic regulator for the water industry. The needs for water supply enhancement, leakage reduction, new customer metering, additional water efficiency or other supply-demand activities as set out in our revised Water Resources Management Plan are included in the Price Review and will be included in the Business Plan for the period 2015-20.

[2] corporate.unitedutilities.com/waterresourcesplan

Table 1: Topics covered and structure of the Water Resources Management Plan

Topic	Where?
What is a Water Resources Management Plan and how is it put together?	Sections 1.2 and 1.3
How does United Utilities' long-term strategy affect the Water Resources Management Plan?	Section 1.4: Strategic direction and water resources management plan aims
How has United Utilities taken account of customer and stakeholder views in preparing this Water Resources Management Plan?	Section 2: Customer and stakeholder involvement
Where do we get our water from and how are water supplies managed in North West England?	Section 3: Our water supply system
What is the supply capacity of our water sources and how will it change in the future?	Section 4: Water supply availability
What is United Utilities doing to reduce leakage and help conserve water?	Section 5: Demand management
What are the demands for water and how will they change in the future?	Section 6: Customers' future demand for water
How are uncertainties taken account of in the Plan?	Section 7: Target headroom
How has the impact of climate change been taken in to account in preparing this plan?	Sections 4, 6, 7 and 11
What water supply options and demand management options have been considered, and how have they been compared?	Section 8: Options
What are the environmental implications of the options and findings of the strategic environmental assessment?	Section 8: Options environmental appraisal
If no further action is taken what will the water supply- demand balance be?	Section 9: Initial supply-demand balance
What is United Utilities proposing to do, and what will happen if things change?	Section 10: Water resources and demand strategy
How have United Utilities tested the proposals of this plan to ensure it is robust?	Section 11: Scenario testing and sensitivity analysis
What are the key findings of this document?	Section 12: Conclusions

1.3 OUR APPROACH TO WATER RESOURCES PLANNING

We promise to provide our customers with great water and a service they can rely on, while protecting and enhancing the environment. We consider long-term reliable and resilient water resources, through robust water resource planning, fundamental to this. Therefore, we have adopted a comprehensive approach to water resource planning to ensure our plans are fit for purpose.

The Water Resources Management Plan Direction 2012 (Defra, 2012) sets out specific requirements for the preparation and publication of a Water Resources Management Plan. A list of the Directions is presented in Appendix 6 together with an explanation of how we have complied with them.

The Environment Agency, Ofwat and Defra have issued their *Water Resources Planning Guideline* (EA, 2013) which provides detailed guidance on how water companies should prepare their Water Resources Management Plans. We have comprehensively followed the guideline in preparing our Water Resources Management Plan.

The Guiding Principles for the Water Resources Planning Guideline make clear the importance of the government's Water White Paper and Draft Water Bill in water resource planning, emphasising the need for sustainable use of water resources. An extract from this document is presented below. In following these Guiding Principles, United Utilities recognises the need to consider the following in our water resource planning approach:

- Delivery of the best value to customers. Water Resource Management Plans should be environmentally sustainable including: full consideration of demand management option, water trading, cross boundary solutions and third party supplier solutions to ensure efficient allocation of available resource; and
- Plans must be adaptable and take account of uncertainty through full scenario testing. This should be focused on the main areas of uncertainty such as future climate change and environmental requirement for water.

Figure 1: Guiding Principles from the Water Resources Planning Guideline.

"The key policy priorities that Government expects water companies to address in their plans are all aimed at providing secure, sustainable and affordable supplies of water to customers. They include:

- taking a long term perspective, beyond the 25-year planning horizon, to make companies' systems more resilient to future uncertainties, such as the impacts of climate change, and to allow efficient, sustainable water resources planning to meet the needs of customers and the environment;
- taking better account of the value of water by reflecting its scarcity and the environmental and social costs of abstraction in order to make the water sector's activities more sustainable;
- considering all options to balance supply with demand, including water trading, cross boundary solutions and third party supplier solutions, and providing up to date information about the availability of water to third parties (including any future entrants to the market), in order to reduce costs, ensure efficient allocation of available resource and improve innovation within the sector;
- reducing the demand for water by managing leakage and providing services to help customers use water efficiently where there is a reasonable prospect that the benefits of doing so will outweigh the costs; and
- ensuring the views of customers are properly taken into account on service levels and costs."

We have been actively involved in a wide range of research programmes. Many current best practice methods for water supply-demand and climate change have been developed by UK Water Industry Research (UKWIR) and actively supported by us. The Environment Agency, Ofwat and Defra have also been involved in many projects. We have initiated various water efficiency research projects with local universities (see Section 5.3 for more details). The latest UKWIR research on the effects of climate change on demand was completed after we published our draft plan, and we have now included them in this revised plan.

1.4 STRATEGIC DIRECTION AND WATER RESOURCES MANAGEMENT PLAN AIMS

This Water Resources Management Plan has been built on the principles set out in our strategy document "Playing Our Part", with consideration of legislative, social and environmental issues.

The aims of our Water Resources Management Plan are aligned with our future long-term priorities which have been reviewed through a public consultation on the "Playing Our Part" document during summer 2013. Our aims are expressed as promises to our customers

- **We promise to provide great water.**
  You have a reliable supply of water now and in the future
- **We promise to protecting and enhance the environment**
  The natural environment is protected and improved in the way we deliver our services
  A business fit for a changing climate
- **We promise to give you value for money**
  Bills for you and future customers are fair

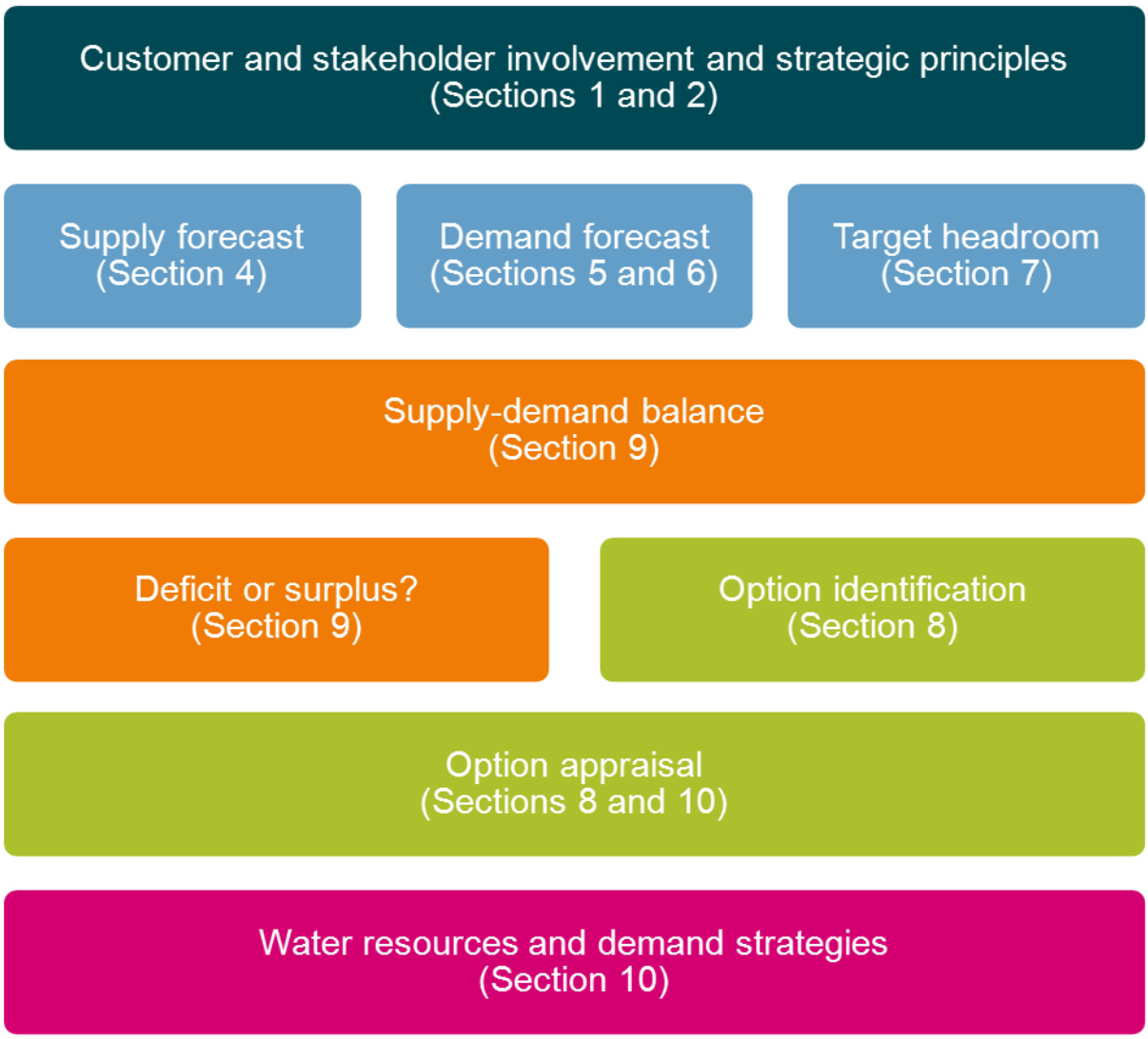

Figure 2: Summary of United Utilities Water Resources Management Plan

2 CUSTOMER AND STAKEHOLDER INVOLVEMENT

Key Messages

- We have listened to the views of our customers, regulators and other stakeholders in preparing this plan
- We have used these views to decide on the best level of service to offer our customers
- Our plan is for water use restrictions and drought permits to occur no more than once in 20 years, on average
- We have also used these views to inform our selection of options to address a forecast supply demand deficit

2.1 CUSTOMER INVOLVEMENT

United Utilities serves 6.9 million people and over 200,000 businesses and we value their views. We wish to provide them with the services they want at prices they are willing to pay. We have obtained their views on water supply issues on several occasions, and incorporated their suggestions for improvement where appropriate.

One of the most severe droughts in North West England was in 1995, which included a 14-month period of hosepipe bans[3]. We undertook extensive consultation with customers in preparing for the 1999 Price Review. At that time customers expressed concern about the frequency of hosepipe restrictions at once in every 10 years, and over 90% expressed a preference for an improvement in the level of service. This provided strong support for us to undertake investment to achieve an improved level of service of hosepipe restrictions to no more than once in every 20 years (see Section 3.6 for details). This higher level of service was also supported by the results from the 2004 Price Review national and regional market research.

During 2007, we carried out further research of customer views in preparation for the 2009 Price Review. A detailed willingness-to-pay study asked our customers to express the extent to which they would be willing (or otherwise) to see their water bills increase for an improved level of service. Customers showed that they highly valued a secure water supply and most were willing to pay higher bills if the frequency of water restrictions was reduced from the current level. However, the amount customers were willing to pay to reduce the frequency to once in 30 years was insufficient to achieve the improvement. Therefore, the existing hosepipe ban frequency was maintained.

Alongside willingness-to-pay in 2007, we carried out customer preference surveys to explore the views of customers about what supply-demand solutions they preferred. These demonstrated strong support for leakage reduction, or a mixed programme of leakage reduction, water efficiency promotion and some additional water supplies. These options were preferred to solely implementing new water supplies.

Since the 2007 research, the North West experienced a less severe drought in 2010 during which a hosepipe ban was implemented for eight weeks during the summer. In order to support development of our draft Water Resources Management Plan and 2014 Price Review, we obtained customer views through new willingness-to-pay and customer preference surveys, summarised below.

Following publication of our draft plan in spring 2013, we received 55 consultation responses and have considered these views in developing this revised draft plan. We have also carried out further customer research, including a more detailed assessment

[3] Since 2010, Hosepipe bans have been replaced by 'Water use restrictions' under the Flood and Water Management Act 2010. This Act introduced a new Section 76 within the Water Industry Act 1991 and allows water companies to temporarily restrict a range of water uses by customers. It allows companies to restrict a greater range of water uses than before (the powers under the original Section 76 were generally referred to as a "hosepipe ban") it also requires companies to publicly consult before such restrictions are imposed

of customer's willingness to pay for service change and specific focus groups in West Cumbria on the three alternative options proposed.

2.1.1 Customer preference survey 2012/13

We commissioned a study involving 631 interviews in customers' homes. These customers expressed their preferences for the types of solution that we should adopt to avoid future shortages of water. This demonstrated reducing leakage and increasing water efficiency in the home are customers' preferred options, with and without consideration of the impacts on bills. When financial and environmental costs were taken into consideration, the majority wanted to keep their bills the same or reduce them by accepting more frequent water use restrictions (formally known as hosepipe bans) and drought permits/orders[4]. Customer metering and new water supplies were generally the least preferred options.

We took account of these views in preparing our draft plan.

2.1.2 Willingness-to-pay surveys January 2013 and August 2013

Detailed willingness-to-pay studies asked our customers to express the extent to which they would be willing (or otherwise) to see their water bills increase in order that increases in level of service could be obtained. In stage 1, we obtained the views of 800 household customers and 376 non-household customers. These studies demonstrated that customers do not value fewer water use restrictions and were not willing to pay higher bills for the frequency of water use restrictions to be reduced. However, they do not want to see deterioration in level of service i.e. more frequent water use restrictions.

We accept stakeholder feedback that a simplistic survey focusing on hosepipe bans, may not adequately capture the way customers value avoidance of the environmental, recreational and economic impacts of drought permits and non-essential use bans. Therefore we conducted a second stage survey looking at these issues and customers' relative values for different types of water resource option. In this second phase a total of 694 interviews were conducted with household customers and a further 605 interviews with business customers.

This second phase research was peer reviewed by Ken Willis, Emeritus Professor of Economics of the Environment at Newcastle University. He said it was *"an outstanding and commendable piece of research…. The whole analysis is an excellent and meticulous piece of work, providing detailed information on customers' preferences if water use restrictions are required; and also customers' preferences for augmenting water supplies."*

The willingness-to-pay studies support maintaining the existing hosepipe ban frequency of no more than once in 20 years. However they have revealed a higher willingness to pay for a reduction in the frequency of drought permits. This is explored further in Sections 2.5 and 11.1.

2.1.3 Acceptability testing, June to August 2013

As part of developing our business plan for 2015-2020 we asked customers to consider the overall acceptability of the package of service levels and the bills that

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[4] Drought permits or drought orders are granted by the Environment Agency or Secretary of State, respectively, and allow water companies to continue to abstract water from sources beyond the existing abstraction licence conditions. The result of this is that more water is taken from the environment, albeit for a relatively short duration.

they will pay. The objectives of this customer "acceptability testing" research are to engage customers in the shaping of the overall Business Plan, to help establish the most acceptable combination of investments for customers; and to identify limits in acceptability and affordability of customers.

This research included our proposals to maintain the supply demand balance in West Cumbria, and our proposed approach to leakage control. Our proposals were acceptable to over 75% of customers. Affordability was a very significant factor in determining whether the proposals were acceptable to customers. The survey results indicated that a package with further service improvements and a higher bill would be overall less acceptable to our customers.

2.1.4 Customer focus groups, August 2013

In August 2013 we commissioned focus group research to gather views from customers in West Cumbria on the alternatives for their future water supply. Six focus groups were held covering different socio-economic groups of domestic customers and two focus groups were held with business customers. The focus groups were held in Workington, Whitehaven, Wigton and Cockermouth.

The majority agreed in principle that freshwater mussels should be protected, though some are less concerned. Most, but not all, agree that alternative water sources should be found. Others would prefer to continue to take water from Ennerdale Water. The three alternative plans for West Cumbria from our draft Water Resources Management Plan were presented to respondents (rotated per group) who were then asked for their initial feedback.

We then provided more detail about the potential options to aid decision making, in regards to environmental impact, resilience to droughts and cost. Respondents were asked to rank each option again. Of the three alternative options put forward, building a new pipeline from Thirlmere reservoir to serve the West Cumbrian region came top. Developing a lower cost, less resilient set of local water sources came second. This option particularly appeals to older residents and some micro businesses, largely because is utilises local resources. The majority reject the idea to import water from Kielder reservoir, other than the larger businesses who are mostly in favour of this option as they see the wider national benefits. The small change in preferences in round two after more detail was provided about each option indicates that cost is not the most important factor when considering the options.

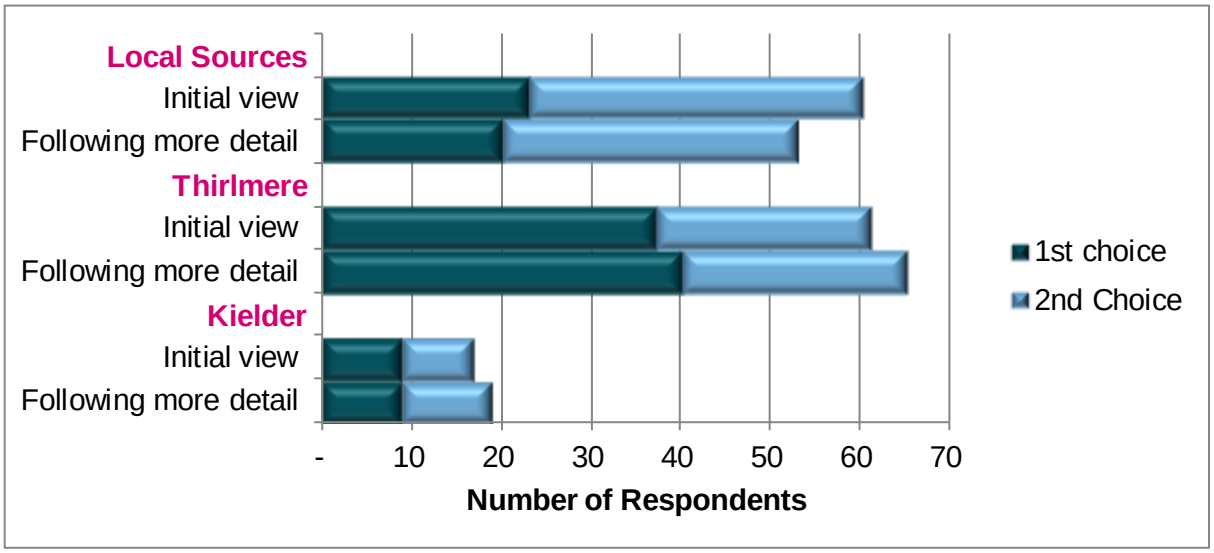


Figure 3 West Cumbria customer preferences from focus group research

2.1.5 Involving the Customer Challenge Group

As part of the process for developing our business plan for 2015-2020, we have appointed an independent Customer Challenge Group. This group have helped shape our consultation process with customers and stakeholders and will report to Ofwat on whether the process has been effective; and whether customer and stakeholder views have been appropriately reflected in the business plan.

The Customer Challenge Group have been involved in developing the customer research that we used to shape this plan. A sub-group reviewed the Willingness to Pay and Acceptability Testing research proposals, and a number of improvements were made to the research methodology as a result. The Customer Challenge Group were advised of the Water Resources Plan consultation and some organisations represented on the group responded to the consultation. The alternative plans for meeting the West Cumbria deficit have been discussed extensively by the group and their environment sub-group.

2.2 REGULATOR INVOLVEMENT

The Environment Agency, Ofwat and Defra have issued detailed guidance on how water companies should prepare their Water Resource Management Plans (EA 2012). We have worked closely with the Environment Agency at national and local level to ensure that we are following their guidance. In addition, we have worked hard to ensure that this draft Water Resources Management Plan meets the needs of Environment Agency, Natural England and other regulators as well as our customers and other interested parties. Other key documents concerning water resources and demand planning issues from regulators have been taken in to account; these are discussed throughout this report.

We have met regularly with the Environment Agency throughout the preparation of the draft Water Resources Management Plan to discuss our methodologies and approaches and to ensure that we are following best practice. We have also discussed in detail the options we are considering and how we are taking full account of environmental implications to ensure sustainable use of water now and in the future.

We have liaised closely with the Environment Agency to agree abstraction licence changes and other environmental improvements to be included in this draft Water Resources Management Plan to comply with the requirements of the European Union Habitats Directive, Water Framework Directive and the Environment Agency's Restoring Sustainable Abstraction programme. Where there remains uncertainty with the environmental impacts of our abstraction we have agreed scenarios for further abstraction licence changes, should these be required. Natural England and the Countryside Council for Wales have also been involved in this process. See Section 4.4 for more details.

On1 April 2013 Countryside Council for Wales and the Environment Agency in Wales became part of Natural Resources Wales. We have continued our liaison with this new body.

We also meet regularly with Ofwat to discuss our water and wastewater services and potential investment needs. Discussions took place at the tri-partite meeting in June and at regular progress meetings. In July 2013 Ofwat published their business planning expectations for the 2014 Price Review. Relevant parts of companies' business plans are expected to be consistent with Water Resources Management Plans and this is the approach we have used.

We have quarterly meetings with the Consumer Council for Water to discuss our performance and customer priorities for our services. At these meetings, we report on the water supply position and our progress on leakage reduction and demand

management. The Council takes an active interest in our water supply and demand issues and feeds back comments to us.

Ofwat, the Consumer Council for Water, the Environment Agency, Natural England and Natural Resources Wales all responded to the consultation on our draft plan. We have taken their views into account in preparing this revised draft plan.

2.3 PRE-CONSULTATION ON THIS WATER RESOURCES MANAGEMENT PLAN

In preparing our draft plan, we undertook formal pre-consultation with statutory consultees and engaged more widely with many stakeholders.

In June 2012, in accordance with Water Resources Management Plan regulations, we invited statutory consultees to inform us of any issues they wished us to include in our draft Water Resources Management Plan. Responses were received from the Environment Agency, Defra, Ofwat and Natural England. The key issues and the way in which we have addressed them are presented in Table 2.

Table 2: Issues raised by Statutory Consultees at pre-consultation, June 2012

Issues raised by Environment Agency	United Utilities Response
United Utilities should comply with the Water Resources Planning Guideline 2012 issued by the Environment Agency and Ofwat.	We have comprehensively followed the Guideline in preparing the Draft Water Resources Management Plan.
United Utilities should undertake a Habitats Regulation Assessment for this plan	We have undertaken a Habitats Regulation Assessment for this plan see Section 10 for details.
Work with local stakeholders and customers to manage the supply-demand balance in the West Cumbria Zone.	We have included stakeholder and customer views in development of this plan, described in more detail in sections 2.1, 2.2 and 2.3.
United Utilities should reduce demand for water through managing leakage and helping customers use water more efficiently.	We recognise demand management is an integral component of our plan to balance supply and demand. We have more than halved leakage (from 945 Ml/d in 1992 to 453 Ml/d) to help achieve and maintain a high standard of water supply reliability. Water efficiency promotion has been significantly enhanced since 2010 and overall water demand is at its lowest level for at least 20 years. See section 5 for more details.
United Utilities should consider all options to balance supply and demand including water trading and cross boundary solutions.	We have investigated all types of options to balance supply and demand; this is described in Section 8 Options.
Take into account sustainability reductions in the plan including scenarios agreed with the Environment Agency.	We have used the sustainability changes issued by the Environment Agency (August 2012) to develop and agree a baseline scenario of changes and scenarios for further reductions. See Section 5 for more details.
Undertake community and stakeholder engagement (in particular Windermere)	We have included stakeholder and customer views in development of this plan, described in more detail in sections 2.1, 2.2 and 2.3.
Issues raised by Defra	**United Utilities Response**
United Utilities should comply with the Water Resources Management Plan Directions 2012 and Water Resources Planning Guideline and Guiding Principles 2012 issued by the Environment Agency and Ofwat.	A list of the Water Resources Management Plan Directions is presented in Appendix 6 together with explanation of how we have complied with them. We have also comprehensively followed the Guideline in preparing the Draft Water Resources Management Plan

United Utilities should have made significant progress on areas of concern raised in your 2009 Water Resources Management plan, such as: • Completing a Habitats Regulation Assessment; • Developing rainfall run off models to better understand the uncertainty around climate change ; and • Adequately accounting for the social and environmental costs of leakage reduction.	We have undertaken a Habitats Regulation Assessment for this plan see Section 10 for details. The Climate Change assessment for this draft Water Resources Management Plan is of significantly greater scope than that undertaken in the 2009 plan. We have also developed rainfall-runoff models for our main catchments to apply the outputs from the latest United Kingdom climate projections (UKCP09) and alter the base inflow sequences. See Section 4 for more information. We have updated our environmental and social costs for leakage reduction, following the latest Environment Agency, Ofwat and Defra guidance, Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning. This has formed part of the leakage assessment.
Issues raised by Ofwat	**United Utilities Response**
United Utilities should comply with the Water Resources Planning Guideline 2012 issued by the Environment Agency and Ofwat	We have comprehensively followed the Guideline in preparing the Draft Water Resources Management Plan
Issues raised by Natural England	**United Utilities Response**
United Utilities should progress towards a more environmentally sustainable solution for public water supply in the West Cumbria Resource Zone.	An environmentally sustainable solution for water supplies in West Cumbria is included in this plan.
United Utilities must demonstrate how it intends to meet its responsibilities under the relevant legislation protecting European Designated sites (SSSIs and SACs), as well as its duties to provide a secure public water supply, through all possible means to reduce pressure on these sites.	We have undertaken a Strategic Environmental Assessment and Habitats Regulation Assessment of our plan. This will ensure we will meet our responsibilities in relation to European Designated sites, see Section 10 for more details.
United Utilities should undertake a Habitats Regulation Assessment for this plan.	We have undertaken a Habitats Regulation Assessment for this plan see Section 10 for details.
United Utilities should take the following legislation in to account when carrying out any works within the designated landscapes in the region: • National Parks - Section 11A of the National Parks and Access to the Countryside Act 1949, as amended by Section 62 of the Environment Act 1995; and • Areas of Outstanding Natural Beauty - Section 85 of the Countryside and Rights of Way Act 2000.	We have undertaken a Strategic Environmental Assessment and Habitats Regulation Assessment of our plan. This will ensure we take in to account this legislation, see Section 10 for more details.

We maintain active liaison on key water resources issues with a large number of other interested parties including Natural England, Natural Resources Wales, national park authorities, local authorities, environmental organisations and committees, river trusts, wildlife trusts, angling associations, Water UK, other water companies and others.

Our links have been particularly strong with stakeholders in Cumbria, for which we have been involved in two stakeholder events. A workshop for stakeholders in Cumbria was held in March 2012 and a West Cumbria water supply options workshop was held in September 2012. These workshops, held jointly with the Environment Agency, provided feedback on water resources planning issues from Cumbria stakeholders prior to producing the draft Water Resources Management Plan.

We undertook extensive consultation on our draft Drought Plan 2012. Three stakeholder consultation meetings were held in December 2012 across North West England. We used this opportunity to inform stakeholders that we were in the process of updating our Water Resources Management Plan and allowed opportunity for comment. The Drought Plan consultation pages of the United Utilities website also provided the chance for interested stakeholders to comment on the Water Resources Management Plan. Through the Drought Plan consultation, we received a number of helpful responses relevant to the draft Water Resources Management Plan (Appendix 7).

In developing our draft plan we took into account the issues raised in the pre-consultation phase.

2.4 CONSULTATION ON THE DRAFT WATER RESOURCES MANAGEMENT PLAN

We published our draft plan on 14 May 2013 and invited organisations and individuals to comment through the formal consultation process. We emailed over 500 parties to encourage them to respond to the consultation, contacted organisations directly by telephone and also issued a press release. We held five consultation meetings across the North West to talk through the key elements of the plan with interested parties to help inform their responses. The consultation events were attended by over 50 people.

We had 55 responses to the consultation, significantly more than for our previous plan in 2008. These responses raised over 200 specific points and we have prepared a separate Statement of Response detailing how we have addressed them all. It is published on our website corporate.unitedutilities.com/water-resources-management-plan. Some of the main points are summarised in Table 3.

Table 3: Main issues raised in representations on the draft plan, August 2013

Summary of Issue	Number of respondents raising the issue	United Utilities Response
Some respondents questioned why abstractions at Ennerdale need to change at all, especially as any alternative will be costly to implement, and questioned whether there was sufficient evidence to justify the investment.	5	It is the Environment Agency's role to review the evidence, advised by Natural England, relating to abstraction licences and determine what changes are required to comply with legislation. The proposed licence revocation at Ennerdale are based on evidence from leading international experts and are required to comply with the requirements of the Conservation of Habitats and Species Regulations. The Environment Agency is also conducting its own consultation on significant water management issues in the North West. United Utilities has supported a significant number of studies and investigations relating to Ennerdale, the Ehen and the freshwater mussels. We have also commissioned a peer review, which concluded that the licence revocation was required. We accept the view that it would be helpful to set out more evidence in the water resources management plan, and have therefore included this in Section 2.6.
Many respondents expressed a preference in relation to the alternative plans for West Cumbria.	16	We have considered these views carefully and included them in the selection of our preferred plan. This is discussed in Section 10.

Some respondents raised concerns over abstractions from Windermere due to effects on the environment, tourism and other businesses in the area.	3	We have undertaken further water resources modelling to test the effect of the transfer on Windermere, Ullswater and other sources in our Integrated Zone. No change to our existing rules of operation are required to enable the transfer to West Cumbria. The effects on abstraction from Windermere and Ullswater as a result of the transfer are insignificant.
Some respondents raised issues about the effects of our plans on Thirlmere flood risk and on opportunities for alleviation measures.	5	We confirm that flood management and flood releases form a critical part of the operation of Thirlmere reservoir. No changes to the flood management operational rules are required to enable the transfer of water to West Cumbria. We will consider infrastructure changes to enable greater releases to reduce flood risk as part of the detailed design work for the West Cumbria transfer.
Some respondents said that we should consider more ambitious demand management, including meter uptake and leakage reduction.	5	Looking only at the supply demand balances there is no benefit to further demand management and therefore it is difficult to justify the cost of further demand management, which would increase the bills paid by our customers. However, we have identified ways of further increasing meter uptake that will help our customers reduce their bills. We have included these in our revised plan and, as a result, forecast demand is lower than in the draft plan.
Some respondents raised concerns regarding using our land by shale gas companies, effects on tap water quality, availability of water to support the shale gas industry and pollution risk to groundwater.	15	We have a statutory duty to provide water and wastewater services to those who request them. We do not consider provision of such services for shale gas companies would impact on our resources. The strong regulatory framework to grant the licence for shale gas exploration to proceed will take into account environmental concerns and risks to water supplies.

2.5 LEVEL OF SERVICE: BALANCING CUSTOMER AND ENVIRONMENT NEEDS

The fundamental aim of our water resources and demand strategy is to strike the right balance between potentially competing requirements:

- **Ensuring a high level of reliability of water supply for our customers.**

  Historically, our customers have consistently informed us (see Section 2.1) that having a reliable water supply is a top priority and have indicated that water use restrictions should be relatively infrequent.

- **Ensuring sustainable water abstraction to protect the water environment.**

  In most cases, and for most of the time, in North West England, there is adequate water available for abstraction. However, as described in Section 4.4, we are working with the Environment Agency to further protect environmentally sensitive species and habitats. This will reduce the amount of water available for abstraction

- **Ensuring that water prices are affordable.**

  Actions to improve the environment or to minimise the frequency of water restrictions can be costly, and it is important for our customers that the impact on their water bills is low. This is particularly important in a region like North West England, where incomes are often well below the national average, and many find it difficult to afford an increase in the price.

We are committed to doing all we can to meet these needs and to achieve the right balance in its plans. We derived our strategy for achieving the best balance by listening to the views of our customers, regulators and other stakeholders, as described in

Sections 2.1 to 2.3. These considerations have led us to decide the best level of service for our customers, as shown in Figure 3.

Figure 4: United Utilities' minimum level of service for water supply reliability standards

- Water use restrictions and drought permits to augment supply on average once in 20 years
- Drought orders to ban non-essential water use once in 35 years on average
- United Utilities considers that it is unacceptable to plan for rota cuts or standpipes even during extreme drought conditions

Customer research undertaken for the draft Water Resources Management Plan indicated that customers may consider a lower level of service (more frequent water use restrictions) to keep their bills the same or reduce them. The preliminary results from the willingness-to-pay survey for our 2014 Price Review indicated that customers do not value fewer water use restrictions and were not willing to pay higher bills for the frequency of water use restrictions to be reduced. However, they do not want to see deterioration in level of service i.e. more frequent water use restrictions. In the willingness-to-pay survey for the 2009 Price Review customers showed that they highly valued a secure water supply and most were willing to pay higher bills if the frequency of water restrictions was reduced from the current level. Therefore, on balance in our draft plan we considered that more frequent water restrictions were unacceptable proposed to maintain the same level of service for customers. This reflects the same level of service in our Drought Plan.

Further customer research, taking into account views raised in consultation, has shown that customers place a higher value on reducing the frequency of drought permits, compared to water use restrictions. Drought Permits allow us to take more water out of lakes and rivers when water levels are already low due to dry weather. By investing to reduce demand or develop new sources of water, the frequency of needing drought permits could be reduced. However, there was no clear view from consultation respondents that we should improve the level of service for drought permits. Four out of the 55 respondents said that the 1 in 20 level of service was appropriate. One respondent thought that the frequency should be increased to 1 in 10 or 15 years and only one respondent said that drought permit applications were currently too frequent.

We have considered the results of acceptability testing on our overall business plan for 2015-2020, and concluded that increasing bills in this period to reduce the frequency of drought permits would result in a plan that would not be acceptable to a sufficient majority of our customers, especially in light of the limited stakeholder support for improving service levels. On balance, we will therefore maintain current service levels in this plan. However, we commit to exploring the possibility of improving service levels in this area and considering whether we should improve the frequency of drought permits in our next draft water resources management plan in 2018. This is discussed further in Section 11.1.

2.6 ENVIRONMENTAL SENSITIVITY OF WEST CUMBRIA

West Cumbria is known for its stunning landscape and areas of almost pristine environment (Figure 4). All the main surface sources of water in West Cumbria contain rare species, protected by law. Atlantic salmon, charr and many rare aquatic plants are present. The area also hosts England's only viable population of the internationally protected freshwater mussel. Without changes to our abstraction from Ennerdale Water, this species could become extinct in England.

The environment in West Cumbria is protected by European Legislation. Ennerdale Water is a designated Site of Special Scientific Interest (SSSI) and, downstream of the lake, the River Ehen is both a SSSI and a Special Area of Conservation (SAC). Crummock Water and the River Cocker are both part of a SSSI and an SAC. Overwater is also a SSSI. All three sites are in the Lake District National Park, and therefore the visual amenity and landscapes are legally protected.

The Lake District currently attracts 15.2 million visitors each year, sustains 14,865 tourism jobs and generates £935m in spending per year. Many of these visitors come because of the stunning mountain and Lakeland landscapes and the leisure opportunities that this presents.

West Cumbria is a major part of Britain's Energy Coast's vision for the nation's energy security, including the generation of low carbon energy and other clean forms of energy. Significant investment is anticipated that will contribute to the local economy for the next 15 years, including the potential generation of 3,000 jobs. The area is already home to one of the UK's largest concentrations of high tech, advanced manufacturing employment[5].

Providing secure water supplies and protecting the aquatic environment in this setting is a fine balance. The Cumbrian mountains mean that the water network in West Cumbria is separate from the rest of our water supply areas, and public water supplies are reliant on the local sources. All of this means that the water supply options in West Cumbria are limited.

During the pre-consultation period, many Cumbrian stakeholders expressed views that we need to take a strategic long-term view of the overall water resources situation in West Cumbria. These include the Lake District National Park, Friends of the Lake District, The Derwent Owners' Association and the West Cumbria Rivers Trust. We took a long-term view in setting out three alternative plans for West Cumbria in our draft plan. We have listened to further views expressed in consultation to inform selection our preferred plan in this revised draft water resources plan.

Our stakeholders, the scientific evidence and European law all tell us that we need to change the water supply arrangements in West Cumbria significantly to make them resilient, reliable and sustainable for the long term. Section 10 sets out how we will do this.

We recognise that the environmental pressures at Ennerdale and the River Ehen cannot wait until the long-term solution is built and we are already taking steps to reduce the risk in the interim. We are maximising our leakage control and water efficiency activity and increasing the size of our new groundwater scheme at South Egremont that will deliver water into supply in 2015. We have used innovative approaches, including aerial surveys for locating trunk mains leakage. We are also investigating the potential of other measures to reduce abstraction from Ennerdale in the interim period.

The Ennerdale abstraction licence is being revoked under instruction from the Environment Agency. It is their role to review the evidence relating to the abstraction licences in accordance with advice from Natural England to determine what changes are required in order to comply with legislation. There has been new evidence from leading international experts, in relation to freshwater mussels in the River Ehen. We have commissioned a number of studies into the health of the mussels and a peer review of the evidence. These support the conclusion that the abstraction needs to

[5] www.britainsenergycoast.co.uk/blueprint

cease. The current abstraction licences do not allow for sufficient flow in the River Ehen in order to provide the mussel population with the volumes of water they require. If the licence is not revoked, England's only viable population of the internationally protected freshwater mussel could become extinct. Therefore, the Environment Agency have stated the existing licence needs to be revoked in order to protect this species.

Due to this revocation of the licence, we have conducted testing of this zone's vulnerability to further changes. If abstraction remains from Crummock Water, it would become of increasing importance as a water source for West Cumbria during times of drought. We have identified a requirement for occasional drought orders at Crummock Water. These issues are discussed in 11.3.1.

Figure 5. Ennerdale in West Cumbria is a shining example of the area's pristine environment.

3 OUR WATER SUPPLY SYSTEM

Key Messages

- We reliably supply water to 6.9 million people across the North West
- We have improved our water supply capability since our last major drought in 1995
- The key future challenges for maintaining adequate water supply in the North West are environmental improvements, climate change, demand uncertainty and water trading

3.1 WATER SUPPLY IN NORTH WEST ENGLAND

We supply water to 6.9 million people and 0.2 million non-household customers. These customers are in Cumbria, Lancashire, Greater Manchester, Merseyside, most of Cheshire and a small area of Derbyshire. We own and operate over 100 water supply reservoirs, various river and stream intakes, as well as lake abstractions and numerous groundwater sources. More than 90% of the water supplied by us comes from rivers and reservoirs, with the remainder from groundwater. This contrasts with the rest of England, where an average of only 60% is supplied from rivers and reservoirs. Abstracted water is treated at water treatment works before being supplied to customers through an extensive network of aqueducts and water mains. In total we currently supply less than 1,750 Ml/d of drinking water in a normal year but this would be higher in a dry year.

3.2 OUR WATER RESOURCES ZONES

A water resource zone is an area within which water sources can be shared effectively to provide a consistent service to customers. Our region is split into four water resource zones (Figure 5).

Water supplies to the majority of the region are managed in a fully integrated manner and constitute a single resource zone, known as the Integrated Resource Zone. The Integrated Resource Zone comprises more than 95% of the total population served. Only sources in North and West Cumbria are not supported directly or indirectly from the major regional supply system; this area comprises the Carlisle Resource Zone, North Eden Resource Zone and West Cumbria Resource Zone.

Our water resources zones have been reviewed following the Environment Agency's 'Guidance for ensuring water resource zone integrity' (2011) and have been concluded to be 'fit for purpose' and therefore remain unchanged from the 2009 Water Resources Management Plan. These will be reviewed again following completion of the final Water Resources Management Plan.

Table 4: Population and supply statistics for United Utilities region in 2013

Water resource zone	Population served ('000)	Average potable water supply (Ml/d)
Integrated	6,760	1,635
Carlisle	109	26
North Eden	14	6
West Cumbria	149	49
Region	7,031	1,715

3.2.1 Integrated Resource Zone

The Integrated Resource Zone is the largest of our water resource zones and serves about 6.7 million people living in South Cumbria, Lancashire, Greater Manchester, Merseyside, most of Cheshire, and a small part of Derbyshire.

The Integrated Resource Zone is centred upon major aqueducts, which deliver water from the Lake District to Keswick, Penrith, South Cumbria, Lancashire and Greater Manchester, and from Lake Vyrnwy reservoir and the River Dee regulating reservoirs, to Cheshire and Merseyside. There are connections from the aqueducts to all towns and centres of population in these areas, so that local sources (impounding reservoirs and boreholes) operate in an integrated manner with the major regional sources.

During, and following, the 1995/96 drought, a bi-directional pipeline between Liverpool and Manchester was constructed to link the River Dee and Vyrnwy aqueducts to the Thirlmere aqueduct, supplying Manchester. In 2012, a new West-East bi-directional link main was completed between Cheshire/Merseyside and Manchester, doubling the capacity of water that can be transferred west to east, or vice versa. This helps us maintain adequate supplies to Greater Manchester or Merseyside in the event of needing to temporarily reduce supply from a major reservoir in times of dry weather. These pipelines provide wider benefits through making the supply system more flexible and resilient. For example, it enables us to temporarily shut down aqueducts to clean them, by providing an alternative pipeline.

3.2.2 Carlisle Water Resource Zone

The Carlisle Water Resource Zone serves about 109,000 people in the Carlisle local authority area and a small part of Allerdale District. The Carlisle area is served by water abstractions from the River Eden and the River Gelt. There are no non-potable supplies in this zone. There is no transfer of water between the Carlisle Zone and any other zone or any other water company.

3.2.3 North Eden Water Resource Zone

The North Eden Water Resource Zone is our smallest and serves a population of about 14,000 in the rural, northern part of the Eden District of Cumbria. Most of the zone is supplied from boreholes in the Sherwood Sandstone aquifer, whilst the Alston area is supplied from a bulk water supply from Northumbrian Water.

There are no non-potable supplies in this zone. There is no transfer of water between the North Eden Zone and any other zone or any other water company, except for the import from Northumbrian Water.

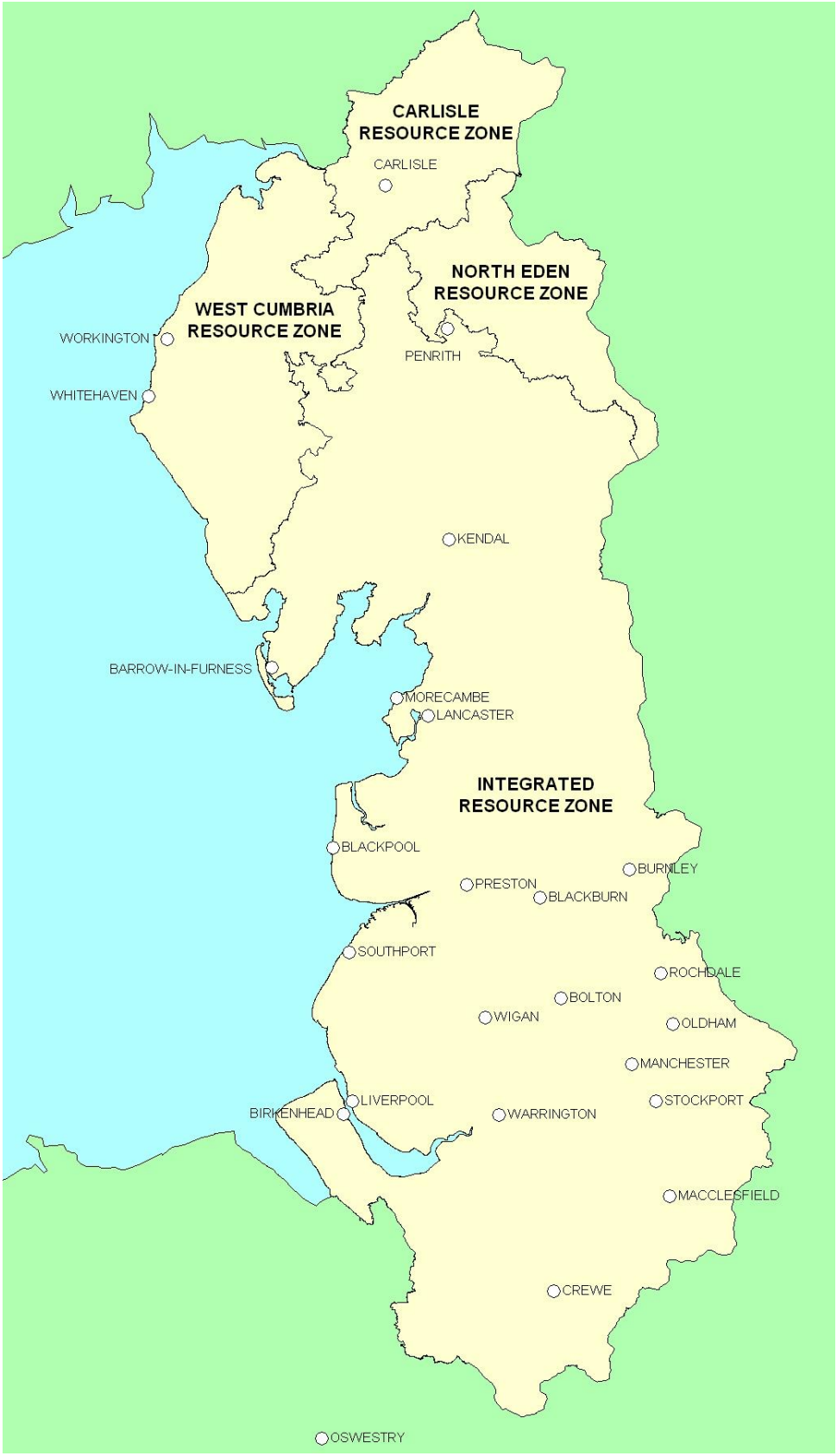
3.2.4 West Cumbria Water Resource Zone

The West Cumbria Water Resource Zone serves about 149,000 people and is mainly supplied from Ennerdale Water and Crummock Water, which supply the Whitehaven and Workington areas. These are raised natural lakes with level control which provide storage of water for public supply.

Other sources comprise Chapel House and Overwater Reservoirs and Scales Boreholes which supply the Wigton, Bassenthwaite and Solway areas. There are connections between the Whitehaven, Workington and Wigton systems which have been strengthened to further integrate the water sources and increase the ability to transfer water around the zone.

There is a non-potable water supply from the River Derwent to our non-potable customers near Workington. There is no transfer of water between the West Cumbria Zone and any other zone or any other water company.

Figure 6: United Utilities water supply area & resource zones



3.3 AGREEMENTS WITH OTHER LICENSED WATER SUPPLIERS

There is currently one licensed water supplier operating within our area. Another company, Peel Water Networks Limited (PWNL), operates as an Inset Appointee for the Media City development in Salford, Greater Manchester.

United Utilities shares three water resources with other water undertakers:

- **The River Dee**

  We abstract water from the River Dee at various locations to supply both potable and non-potable customers, including a supply of raw water from the River Dee to Dŵr Cymru Welsh Water and a non-potable supply of raw water from the River Dee to industrial customers in the Wirral (80 Ml/d on average). In addition to ourselves, other abstractors from the River Dee include Dŵr Cymru Welsh Water, Dee Valley Water PLC and the Canal and River Trust. The River Dee is managed by Natural Resources Wales through a regulation scheme. Our abstractions are governed by the River Dee General Directions (EA, 2009) which set out rules for abstraction during drought conditions and are approved by the statutory Dee Consultative Committee.

  We have a very small bulk supply import from Dee Valley Water (less than 0.1 Ml/d) and there are a few very small bulk supply exports to Dee Valley Water and Severn-Trent Water (totalling about 0.12 Ml/d).

- **Lake Vyrnwy**

  Lake Vyrnwy is owned by Severn Trent Water Ltd. However we have an abstraction licence allowing us to abstract water from the reservoir to supply customers in Merseyside and parts of Cheshire. Lake Vyrnwy is also used to regulate the River Severn, from which other water companies abstract including; Severn Trent Water, South Staffordshire Water and Bristol Water. The Environment Agency, working with Severn Trent Water, manage the River Severn regulation system.

  Severn Trent Water Ltd. has a bulk supply agreement with us to receive up to 16 Ml/d of treated water sourced from Vyrnwy. However, this is for emergency use only up to a maximum period of 28 days in any instance.

- **Burnhope Reservoir**

  We have a bulk supply agreement with Northumbrian Water Ltd. to supply treated water to the Alston area of Cumbria (North Eden Resource Zone). Northumbrian Water's Burnhope reservoir supplies raw water to its Wear Valley Water Treatment Works, which supplies drinking water to Northumbrian Water as well as the small export into our supply area. The agreement is for Northumbrian Water to provide a bulk supply of non-fluoridated, potable water up to a maximum of 1.3 Ml/d.

3.4 WATER RESOURCE MANAGEMENT

Our water sources are managed in accordance with operating policies and control rules to provide a secure water supply to our customers. These policies and control rules show the actions to be taken at any time of the year to protect water supplies against the worst drought conditions on record (such as pumping from rivers or lakes when river flows are high enough to enable the conservation of water stored in our reservoirs). We carry out frequent hydrological and hydrogeological monitoring in conjunction with the Environment Agency. Assessments of this data provide the basis for optimising the supply of water to our customers, recognising drought conditions at an early stage and identifying the need for, and timing of, any drought management measures. Many of our drought management

actions are an integral part of our normal water source operational activities. Only in serious drought conditions will the use of specific legal powers and/or other exceptional measures be required.

Our assessment of water supply security indicates that, even with a repeat of the worst drought on record, our reservoirs will not empty but will reach very low levels (with the remaining storage equivalent to a minimum of 20 or 30 days of supply). However, before reaching these very low levels, it is necessary to take action to conserve water supplies in case the drought is more severe than any previously recorded. Consequently, water use restrictions and drought permits/orders need to be implemented before reaching the very lowest reservoir levels to safeguard water supplies.

Full details of our drought management plans are presented in the United Utilities Statutory Drought Plan, which can be found on our website at corporate.unitedutilities.com/waterresourcesplan

3.5 HISTORIC DROUGHTS

The following historic droughts were the most severe within the United Utilities supply area:

- 1933/4: a two season drought event concentrated in the south of the region;
- 1963: a two month winter drought event affecting the West Cumbria Resource Zone;
- 1975/6: a two season drought event that particularly affected the south of the region;
- 1984: a single season summer drought event that particularly affected the north of the region including the Pennines; and
- 1995/6: a two season drought event that affected the whole of the region.

The 1995-96 drought was one of the most significant droughts on record to affect North West England. During the drought, reservoirs declined to record low levels, and abstractions from most sources were reduced to well below the previously assessed reliable yields. The region also experienced extremely high temperatures and record peak water demand. The high level of demand caused localised problems of low pressure or temporary loss of supply. In most cases, this was the result of demand exceeding the capacities of trunk main, aqueducts, service reservoirs or local source links.

In order to safeguard essential water supplies, a hosepipe ban was introduced which remained in force over most of the region for 14 months. A drought order to restrict non-essential uses of water was also introduced for a period of 6 months. It was necessary to obtain 19 drought orders and nine drought permits to enable additional water to be abstracted from reservoirs, lakes and boreholes.

Two more recent drought events, in 2003 and 2010, were not as severe as those listed above. In both these years, we implemented drought plans and applied for drought permits/orders, but the powers were never implemented because of subsequent rainfall. However, a hosepipe ban was implemented for eight weeks during summer 2010 as a precautionary measure (note that “hosepipe bans” have now been replaced by new water use restrictions following new legislation See section 2.1 for more details).

3.6 STEP CHANGE IN WATER RESOURCE CAPABILITY SINCE 1995

Following the 1995-96 drought we have committed, through Water Resource Planning and Drought Planning, to improving the resilience of water supplies in the North West.

The following section describes the improvements that have been achieved since 1995. Following these enhancements to our network and service we are confident that should we experience a dry weather event, as seen during 1995-96, the impact on water resources, our customers and the environment would be much less severe.

3.6.1 Level of service

Following customer experience of the drought event in 1995/6, we introduced an improved level of service for water supply, with implementation of statutory water use restrictions and drought permits/orders not more than once in every 20 years on average. This improved level of service was effective from the year 2000 onwards.

Since this change, there has been one hosepipe ban implemented in 2010 but no drought permits/orders have been implemented.

3.6.2 Leakage and demand management

Since 1995, we have actively reduced demand for water, through leakage reduction and other demand management activities, thereby reducing the amount that needs to be abstracted from the environment. Demand for water has decreased by more than 25%, from around 2400 Ml/d in 1995 to 1,740 Ml/d in 2012. A large proportion of this reduction is due to the fact that leakage has been almost halved during this period. A wide range of activities to promote water efficiency have occurred and the number of households that are metered has increased significantly. More details can be found in Section 5.

3.6.3 Integrated Resource Zone

As described in Section 3.2.1, following the 1995/96 drought we now have two bi-directional pipelines between Merseyside and Manchester. The latest pipeline was completed in 2012. This has greatly enhanced our ability to transfer water within the zone and in particular to improve the security of supply to Greater Manchester and Merseyside.

In 2002 we constructed a new water supply for the Keswick area from our Thirlmere Reservoir to greatly improve the supply security.

We built a new pipeline during 2004 to connect the Penrith area to a supply from the Integrated Resource Zone, whereas the area had previously been a separate supply zone. This enhancement has overcome the risk of water shortages during dry weather in the Penrith area.

Work is currently on going to provide increased regional supplies to the Blackburn area. This will increase water supply resilience for the area and offset a reduction in local abstraction due to environmental improvements at the Rivers Brennand and Whitendale.

Over the last 15 years, we have undertaken several large projects to refurbish parts of our aqueduct system, and have carried out major investment at many water treatment works in the Integrated Resource Zone to improve the quality and security of our water supplies. More recently, this includes Thirlmere Aqueduct refurbishment, and Vyrnwy Trunk Main cleaning and refurbishment.

3.6.4 Carlisle Resource Zone

In 2004, we increased the supply from the River Eden to provide an additional 5 Ml/d. This source enhancement was required to overcome future predicted water shortages due in part to new development in the Carlisle area (United Utilities' Water Resources Plan 1999).

3.6.5 North Eden Resource Zone

In 1999, we identified water shortages during prolonged dry weather for the Alston part of the Eden local authority area. As a result, a new bulk supply of drinking water from Northumbrian Water was constructed in 2004 to serve the Alston area.

3.6.6 West Cumbria Resource Zone

Our 1999 Water Resources Plan identified the need for water source enhancement schemes in the West Cumbria Resource Zone to enable sustainable water abstraction during prolonged dry weather. In consultation with the Environment Agency, Lake District National Park Authority, Friends of the Lake District, National Trust and other organisations we implemented changes in 2001 to the operation of Ennerdale Water to improve supply reliability by 10 Ml/d. In addition, we constructed reinforcements of the supply network to enable water to be transferred more effectively within the zone. This work, coupled with a large decline in industrial demand for potable water in West Cumbria had resulted in elimination of the supply-demand deficit.

In 2009, the Environment Agency informed us that because of their review of abstraction licences to comply with the European Union Habitats Directive, they would be modifying the abstraction licences for Ennerdale Water and Dash Beck in 2015. This resulted in a forecast supply-demand deficit which the following schemes are currently underway to alleviate:

- Leakage reduction and enhanced water efficiency promotion;
- Increased connection between the Crummock and Quarry Hill areas of West Cumbria; and
- Development of South Egremont boreholes to reduce Ennerdale Lake abstraction.

More recent evidence from summer 2012 indicates that further abstraction licence changes will be required at Ennerdale, and this is discussed in Section 4.4.

3.6.7 National methodologies

Since the 1995/96 drought the UK water industry has carried out major reviews of the methods and approaches that are used to manage water resources and to assess water supply and demand. This has been supported by many research studies sponsored by UK Water Industry Research (UKWIR), the Environment Agency and other organisations.

We have adopted the current national best practice methods in the management of our water resources and in the preparation of this Water Resources Management Plan.

The best practice methods we have used are similar to those used for our previous (2009) water resources management plan. The key methodological changes for this plan are:

- More detailed assessment of climate change in our supply forecasts using UK Climate Predictions 2009;
- Increased emphasis on demand management measures; and
- Revisions of our water supply, demand and target headroom (i.e. uncertainty analysis) forecasts based on new data and updated studies.

3.7 FUTURE CHALLENGES

The main future challenges for maintaining adequate water supply-demand balances in the North West are outlined below. It is widely recognised there is uncertainty around the impact of these factors on the future supply-demand balance. Therefore, these

factors form the basis of scenario testing used to validate this plan, as detailed in Section 12.

3.7.1 Future sustainability reductions

The 2012 Water White Paper and draft Water Bill outline the government's intention to increase environmental responsibility and for all water abstractions to be sustainable by 2027. Reduction in abstraction from environmentally sensitive sites has the potential to significantly reduce the quantity of water that we can reliably abstract from some water sources and result in the need for significant expenditure to enhance our water supply capability and/or reduce demand for water.

Sustainability reductions are driven by the Environment Agency's Restoring Sustainable Abstraction programme, the Water Framework Directive and the Habitats Directive. Investigations by the Environment Agency and ourselves have been completed and changes confirmed by the Environment Agency are included in this plan. However, some of these do not become a legal requirement until the National Environment Programme and River Basin Management Plans are approved by the Secretary of State. This is expected in January 2016 Therefore there is a risk that the required sustainability reductions may be different to those in this plan. If they are substantially different, it may trigger a review of the Water Resources Management Plan.

Further investigations of waterbodies identified by the Environment Agency as potentially needing improvement will take place between now and the next Water Resources Management Plan, to be consulted on in 2018. Therefore, there is currently uncertainty around the number and impact of any futher sustainability reductions required during 2020 - 25.

3.7.2 Adapting to the impacts of climate change

Our plans include the best current estimates of the effects of climate change on water supply for the baseline scenario. This has been developed using the UK Climate Predictions 2009 and the latest national methodology. However, there are significant uncertainties about the extent and timing of impacts that will occur, resulting in a large variation in potential outcomes which must be considered in order to ensure our plan is robust.

3.7.3 Variation in demand forecasts

Our demand forecasts present the dry year scenario demand for the next 25 years based on forecast population change, customer behaviour and industrial requirements. See Section 6 for more details on this. There is a requirement to consider that the forecast demand could vary due to changes in anticipated population growth, assumed customer behaviour and assumed decline in industrial demand.

3.7.4 Water trading

Options to improve the connectivity between water companies and to better share existing abstraction licences are a fundamental requirement of Defra and Ofwat in the preparation of this Water Resource Management Plan. Section 8 provides details of the potential imports that could be utilised in the preparation of our plan to meet deficits forecast in our supply area.

Throughout the process of developing the potential imports, we also proposed and developed potential exports to other water companies through a process of bi-lateral engagement. We need to investigate the impact of these future exports on our supply-demand balance, should the recipient water company identify a requirement for them.

3.7.5 Abstraction Reform

The government are currently working on proposals to reform the abstraction licencing system. These changes are not expected to be implemented until 2020 and we have made no allowance for changes in this plan. As a precursor to abstraction reform Ofwat are developing an Abstraction Incentive Mechanism for the period 2015-2020. We have made no allowance for changes to abstraction under the incentive mechanism in this plan. This is in accordance with the Water Resources Planning Guideline.

The abstraction incentive mechanism seeks to encourage water companies to reduce abstraction during periods of low river flow at sites particularly affected. All sites identified for inclusion in the incentive mechanism will be improved, either through the sustainability changes in this plan or the wider benefits of the preferred plan (see section 4.4 and section10.2). We think that stakeholders will be interested to see how abstraction at these sites changes over time. Therefore, we will report our abstraction against the incentive mechanism each year in our annual review of the water resources plan.

4 WATER SUPPLY AVAILABILITY

Key Messages

- We have followed national best practice methods and guidelines to assess our supplies
- A new water resources model has been developed, significantly increasing confidence in our assessment
- We have undertaken a detailed investigation into the potential impacts of climate change on our future supplies. Surface water sources are estimated to experience a reduction in water available of 6% by 2040
- From 2020 abstraction licence changes in the West Cumbria resource zone mean that supplies will be greatly reduced

4.1 INTRODUCTION TO THE SUPPLY SYSTEM

A key component of the draft Water Resources Management Plan is the assessment of water supply availability. This is determined over the full 25-year planning period (2015-2040) according to two standard industry measures:

- **Deployable output** is the maximum quantity of water output from a water source or a group of sources that can be sustained during a dry period. In this plan, deployable outputs are quoted here for whole resource zones. As well as the natural availability from river flow, reservoir or groundwater levels, it accounts for any potential restriction on using available water, including water quality, abstraction licence limits, water treatment and supply system capabilities. Deployable output is expected to reduce in the future as a result of sustainability changes (Section 4.4) and climate change (Section 4.5).
- **Water available for use** is similar to deployable output, but also considers outages (Section 4.6), raw water, treatment and operational losses, raw water imports or exports with neighbouring resource zones and potable bulk supplies (Section 4.7). The water available for use is the basis for the supply side of the supply-demand balance comparison.

4.2 SUPPLY ASSESSMENT METHODOLOGY

4.2.1 National best practice

We have followed national best practice methods and guidelines to assess supplies. Since the original Surface Water Yield Assessment (National Rivers Authority, 1995), guidance has been reviewed and updated on a number of occasions. Key documents for this Water Resources Management Plan include:

- The latest Water Resources Planning Guidelines (Environment Agency, 2013);
- The WR27 Water Resources Planning Tools and Project Report on Deployable Output Methods (UKWIR, 2012); and
- The Climate Change Approaches in Water Resources Planning report (Environment Agency, 2012b).

Both the Environment Agency and Ofwat have been consulted on key decisions on the approach taken throughout the supply assessment.

4.3 CALCULATING DEPLOYABLE OUTPUT

4.3.1 Introduction

As explained above, deployable output is the maximum quantity of water that can be provided from a resource zone whilst meeting the agreed level of service (Section 2.5). For this plan, we reassessed deployable output for all four of our resource zones. We adopted different approaches, on a risk basis, depending on the complexity of resource zone. The latest UKWIR guidance (2012) was used to assess the complexity of the

four resource zones. The North Eden resource zone has low complexity, and therefore the yields of the different sources in the resource zone are simply summed together. In the three more complex zones, the supply network means that water from different sources can be moved around the resource zone. System constraints mean that it is not appropriate to simply sum together source yields and we used the water resources model, Aquator™ (developed by Oxford Scientific Software), to determine deployable output.

4.3.2 Water Resources Modelling

Aquator™ is a state of the art water resources model that is widely used across the UK. It represents the key components of a supply network (e.g. reservoirs, rivers, boreholes, pipes, water treatment works and demand areas) and connects them together to simulate the resource zone as a whole (an example Aquator™ schematic is shown in Figure 6). Once running, the model aims to utilise available supplies to meet daily demands across the resource zone. Crucially it contains key constraints including hydrological conditions, abstraction licences and physical constraints such as pipe or water treatment work capacities and reservoir dead water storage levels. In accordance with the water resources planning guidance (EA, 2013) reservoir emergency storage is also included. For us this dictates that either 20 or 30 days (the guidance stipulates between 15 to 45 days, depending on the characteristics of the resource zone) of supplies are retained in reservoirs and do not contribute towards deployable output.

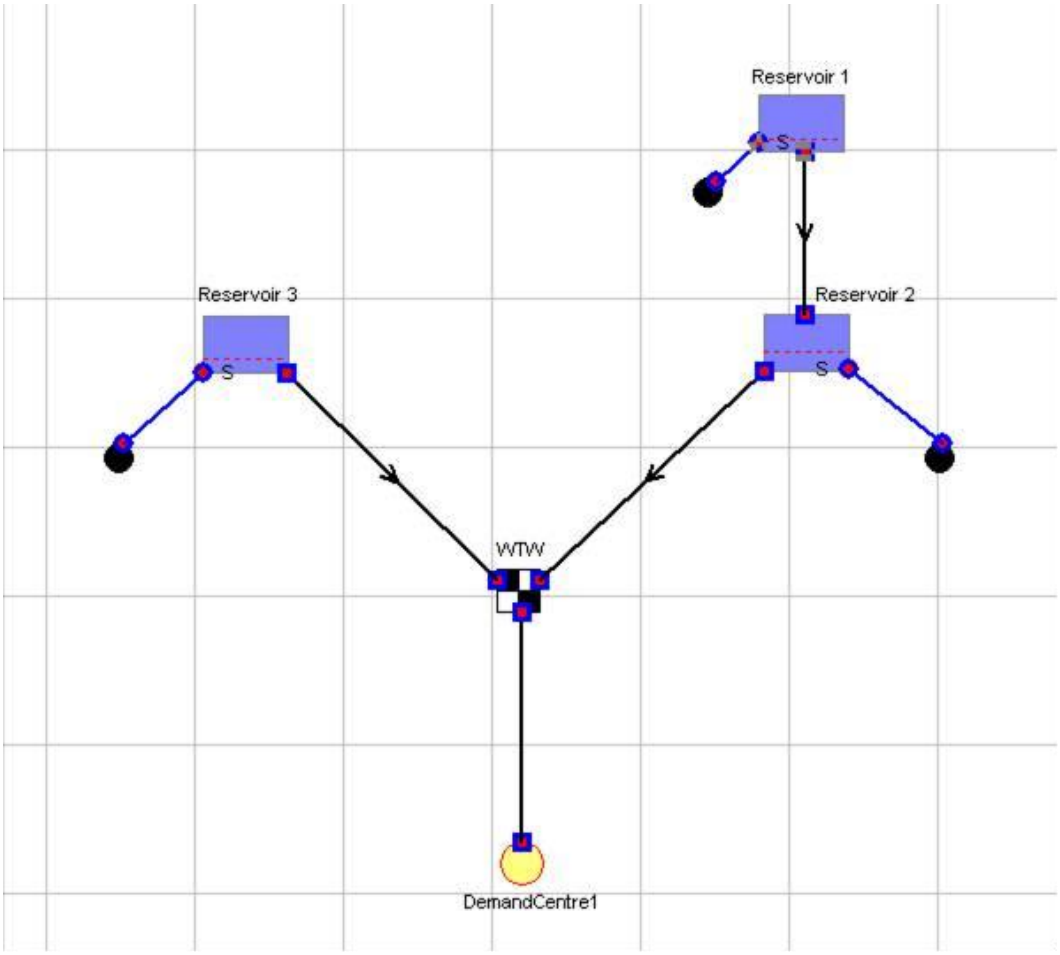


Figure 7: Example Aquator™ schematic demonstrating a simple resource model with three reservoirs, a water treatment works and a demand centre

4.3.3 Testing deployable output

In order to determine deployable output, the models are set up to simulate how the current supply system reacts to historical hydrological conditions. Demand across the resource zone is initially set in line with the annual average dry year demand with a seasonal profile (See Section 6) and is then proportionally increased step-by-step until a failure of the supply network occurs. The result corresponds to the maximum overall level of demand that is met before the system fails. A failure could be a shortage of water at a demand centre, a reservoir emptying, or potentially a drought trigger being breached, more often than the level of service promised to our customers. The deployable output is often defined during the driest period in the record when the system is under the most stress.

There is good correlation between model outputs and actual historic droughts. In the Integrated Resource Zone, deployable output is defined by the 1984 drought, with simulated storage levels in 1995-1996 also becoming very low. The Carlisle model fails during the 1976 drought and the West Cumbria model fails in 1963. As explained in Section 4.3.1, the deployable output of the North Eden resource zone is not determined by Aquator™; it is not defined by a dry period but annual licence constraints. The nature of the failures which define deployable output were used to inform the development of options (See Section 9). The Aquator™ models also allowed the full resource zone deployable output benefit of options to be tested.

Confidence in the deployable output assessment has been graded using UKWIR's classification matrix (UKWIR, 2012), which focuses on the availability and consistency of constraints data, and the length of the hydrological record.

4.3.4 Hydrological record length

Each of the reservoirs and rivers in the models has a daily inflow series which consists of actual flow measurements, rainfall-runoff model outputs or flow data derived by other methods. In order to capture the driest periods in history, the model run period is selected to start as early as possible and end with the most recent complete year of data. For the Integrated Resource Zone the period is 1927-2010 and for our other resource zones the period is 1961-2010. The length of the period is ultimately limited by availability of data, but additional work has showed that all known severe dry events are captured in the analysis of all of the resource zones.

4.3.5 Groundwater sources

Aquifer water levels are not modelled in Aquator™, hence the yield or deployable output of groundwater sources is initially determined separately and in accordance with standard methodology (UKWIR, 1995) and the current water resources planning guidance (Environment Agency, 2013). In reality, the outputs from our groundwater sources are almost all constrained by licence constraints or water treatment capacity, rather than hydrogeology.

The groundwater sources are then included in the Aquator™ model so that they contribute to the resource zone deployable output result. The maximum capacity of each borehole is set to equal the deployable output of the source but the amount taken each day is decided either by operational rules or by Aquator™ itself. This means that in dry periods boreholes will be used to their full potential but in wetter periods other sources might be prioritised.

4.3.6 Changes since the previous Water Resources Management Plan

Over the past five years, we have taken significant steps in our capability to assess water supply availability. This is particularly true for the Integrated Resource Zone where a new Aquator™ model has allowed deployable output to be estimated using a

more reliable method. This step forward has required considerable effort due to the scale of the Integrated Resource Zone but it has meant that we now have much more confidence in our estimates. All resource zone models have been continually tested, improved and updated with all details carefully recorded in our audit trail.

Changes from the 2009 plan to this plan's baseline deployable output are shown in Table 4 below. The figures quoted have been selected to give the best possible comparison between results so, for example, climate change, sustainability changes and compensation over releases have been excluded. The largest changes are seen in the Integrated and West Cumbria Resource Zones. In the Integrated Resource Zone the change of +42.7 Ml/d is entirely due to the improvements in the way the resource zone is represented in modelling.

The new Aquator™ model has provided a more satisfactory representation of the supply network, in particular the recently commissioned West-East link. It has also allowed us to improve the way in which demand is stepped up to determine deployable output (Section 4.3.3). At this point, it is worth noting that whilst 42.7 Ml/d is a considerable volume of water it is less than 2% of the total deployable output of the resource zone. In West Cumbria the majority of the change is due to the actual supply system; the 2010-2015 construction of boreholes in the West Cumbria aquifer.

4.3.7 Changes since the draft Water Resources Management Plan

Since the draft plan, we have completed a review of asset constraints across all resource zones. The demand values applied in the Aquator models have been updated in line with the demand base year data revision.

Changes to the Windermere waterbank agreement agreed in 2013 have been implemented in the Integrated Resource Zone model.

The West Cumbria Resource Zone model has been fully reviewed in line with the current view on sustainability reductions at Ennerdale, Overwater and the River Ellen, which constitutes a significant change to the water resource zone.

The climate change assessment for West Cumbria and Carlisle has been updated. As there were very few changes to the Integrated Resource Zone base model, it was not necessary to repeat the climate change analysis and the original analysis for the draft plan is still fully applicable.

Table 5: Changes in deployable output from 2009 plan to this plan

Deployable output	Integrated Resource Zone	Carlisle Resource Zone	North Eden Resource Zone	West Cumbria Resource Zone
Modelled deployable output 2009 plan (Ml/d) at 2014/15	2115.4	35.0	9.36	51.0
Modelled deployable output (Ml/d) at 2014/15 in the draft plan	2158.1	34.4	8.74	59.1
Change from 2009 plan (Ml/d)	+42.7	-0.6	-0.62	+8.1
Modelled deployable output (Ml/d) at 2014/15 in this plan	2143.9	34.7	8.74	62.0
Change from the draft plan (Ml/d)	-14.2	+0.3	0	+2.9

The largest changes in deployable output from the draft plan are seen in the Integrated and West Cumbria resource zones (a 14.2 Ml/d reduction and a 2.9 Ml/d increase respectively). As noted there have been a number of model updates but in both cases the difference is mainly due to the updated demand data. In West Cumbria our recent efforts to manage demand at Ennerdale are reflected in the revised data. The

proportion of overall resource zone demand at Ennerdale has fallen by more than 3%. This increases deployable output because it makes it possible to meet a higher overall level of demand across the resource zone if the Ennerdale area, where supplies are most critical, uses proportionally less water.

There is a similar effect in the Integrated Resource Zone where demand in areas more reliant on Haweswater has increased slightly compared to other areas. This causes deployable output to fall. However, it is important to recognise that whilst 14.2 Ml/d is a significant volume of water, it is less than 1% of deployable output and hence a small change in this respect.

4.4 SUSTAINABILITY CHANGES

4.4.1 Introduction

A sustainability change (or reduction as it is sometimes termed) is an alteration made to an abstraction licence following an investigation that shows the abstraction is having a detrimental effect on the environment. For this draft plan we assessed a number of sustainability changes, based on information provided in the Environment Agency's initial National Environment Programme, formally issued in August 2012. The key drivers behind this are the Environment Agency's Restoring Sustainable Abstraction programme, the Water Framework Directive and the Habitats Directive. Table 6 presents a summary of the sustainability changes included in this draft plan.

4.4.2 Approach

In the National Environment Programme, sustainability changes are classified as 'confirmed,' 'likely' and 'unknown', depending on the certainty of the abstraction regime having a detrimental effect on the environment. In line with the planning guidance (Environment Agency, 2013), all sustainability changes identified as 'confirmed' and 'likely' have been included in the baseline impact assessment as shown in Table 6. Additionally, we agreed with the Environment Agency that it would be pragmatic to include in the baseline assessment some 'unknown' sustainability changes, where on-going investigations have highlighted an increased certainty of detrimental effects. For the Water Framework Directive-driven changes to heavily modified water bodies, which are classified as 'high', 'medium' or 'low' priority, all of the high and medium priority changes have been included in the baseline.

In order that our plans can adapt to future changes we have included additional scenarios; so that stakeholders may be consulted on potential variants of the plan should the supply-demand balance differ under a range of sustainability change scenarios. The scenarios were set up and agreed with the Environment Agency and appear in the right hand column of Table 6. For the West Cumbria and Integrated Resource Zones, we assessed larger sustainability changes to see how deployable output would change. This assessment included some reductions that are still classified as 'unknown'.

All of the 'confirmed' sustainability changes are statutory changes. Further, where investigations and options appraisal studies are incomplete, there are statutory requirements for the changes and they are judged as likely to be required by the Environment Agency. Cost benefit analyses are being undertaken where investigations are on-going to ensure that the solutions proposed to implement the sustainability changes are cost effective. A greater proportion of the sustainability changes are classified as 'confirmed' following the Environment Agency's issue of the National Environment Programme phase 3 in August 2013, which we have used for this revised plan. There are no voluntary sustainability changes and no allowance has been included for Ofwat's proposed Abstraction Incentive Mechanism, following the Environment Agency's guidance (2012).

4.4.3 Reduction in available water

The reduction in deployable output from both the baseline and additional scenario were tested using the Aquator™ models and are shown in Table 6. In terms of the changes the estimated impact is greatest in the West Cumbria Resource Zone at 37.5Ml/d. The main reason for this is the planned revocation of our Ennerdale abstraction licence. A smaller change of 5.0 Ml/d is estimated in the Integrated Resource Zone. There is no anticipated impact from the sustainability changes in the Carlisle Resource Zone.

For the additional scenarios agreed with the Environment Agency (Section 4.4.2), the impact in both the Integrated and West Cumbria Resource Zones is further increased. The reasons for the revocation of the Ennerdale abstraction licence are detailed in section 2.6.

Table 6: Baseline and scenario sustainability changes for United Utilities Water Resources Management Plan

Water body	Status of sustainability reductions	Key Driver	Baseline Sustainability Change	Scenario Sustainability Change
Integrated Resource Zone				
River Calder (Barnacre)	Confirmed	WFD	New hands off flow of 9 Ml/d	As in baseline
Upper (Tarnbrook) Wyre	Likely 2a	WFD	Retain all intakes with a Q95 flow release at the three main intakes (Grizedale Brook, Castle Syke and Wyre Head) (total 3.9 Ml/d)	As in baseline
Afon Cownwy & Afon Marchnant (Vyrnwy)	Likely 2a	WFD	Introduction of Q99 hands-off flow at Cownwy (2.5 Ml/d) and Marchnant (0.7 Ml/d) offset against main Vyrnwy compensation flow with proportional flow split of 75% to abstraction and 25% to river for flows above the Q99	Introduction of Environmental Flow Indicator release at Cownwy and Marchnant
Heavily Modified Water Bodies High Priority (Holden Wood and Poaka Beck)	Confirmed	WFD	Increase compensation flows to Q95 = 3.6 Ml/d total	Increase compensation flow as per default flow in impoundment licence for Holden Wood and to Q95 for Poaka Beck = 5.8 Ml/d total

Water body	Status of sustainability reductions	Key Driver	Baseline Sustainability Change	Scenario Sustainability Change
Heavily Modified Water Bodies Medium Priority (Horse Coppice and Readycon Dean reservoirs)	Confirmed	WFD	Increase compensation flows to Q95 = 0.8 Ml/d total	As in baseline
Heavily Modified Water Bodies Low Priority (11 Pennine reservoirs)	Unknown*	WFD	Not included	Increase compensation flows to Q95 = 8.6 Ml/d total
Carlisle Resource Zone				
Old Water (River Gelt)	Likely 2a	WFD	New hands off flow of 2.5 Ml/d	As in baseline
North Eden Resource Zone				
No sustainability changes				
West Cumbria Resource Zone				
Overwater	Confirmed	Local priority (SSSI),	1 m hands off lake level	As in baseline
Heavily Modified Water Bodies Medium Priority (River Ellen)	Confirmed	WFD	Increase hands off flow to 2.9 Ml/d (increase of 0.9 Ml/d)	As in baseline
Ennerdale	Likely	Habitats Directive	Ennerdale abstraction licence revoked	As in baseline

* The 11 Pennine reservoirs remain of unknown status and they are not included as sustainability changes in this plan.

Table 7: Results for Sustainability Scenarios

Ml/d	Integrated Resource Zone	Carlisle Resource Zone	West Cumbria Resource Zone
Baseline deployable output at 2015/16	2,127.8	34.7	62.1
Baseline sustainability changes	-5.0	0	-37.5
Baseline deployable output with sustainability changes at 2019/20	**2,122.8**	**34.7**	**24.6***
Additional sustainability changes scenario (Ml/d)	-15.9	N/A	N/A
Scenario deployable output with additional sustainability changes	**2,107.7**	**34.7**	**24.6**

* This is assumed to come into force in 2024/25

4.4.4 Timing of programme

With the exception of the Environment Agency's investigations into the 'low' priority highly modified water bodies that are due to be finalised in 2015, the results of all investigations and appraisal studies will be available in time to inform the final plan. This will ensure that all 'pragmatic' sustainability reductions can be implemented by the end of 2020.

We carried out further engineering assessment of the delivery timescale for the three alternative solutions for West Cumbria identified in our draft plan. This work has led us to conclude that a completion date of 2025 is the best estimate of when the licence changes in West Cumbria can be implemented. This is because of the significant planning and environmental impact assessments required for large schemes in environmentally sensitive areas of the region.

4.5 CLIMATE CHANGE

4.5.1 Introduction

It is important for us to assess the likely impact of climate change on our water resources. Therefore, a climate change assessment has been completed, which meets the requirements of new guidance (EA, 2012) and supporting methodologies (UKWIR, 2012b). Within the framework of the guidance a number of key decisions were taken to determine the most appropriate approach; at each stage these were discussed and agreed with the Environment Agency and Ofwat. An outline of our approach is shown in Figure 7 and explained in the following sections.

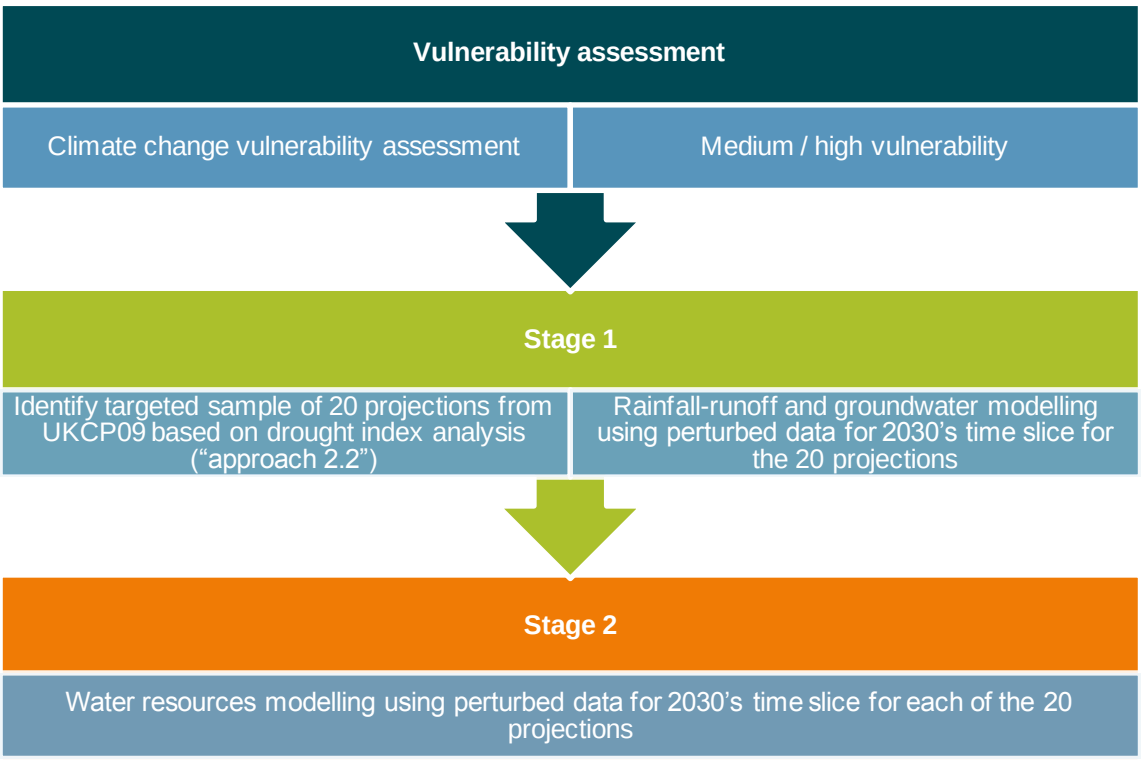


Figure 8: Outline of climate change assessment approach taken which corresponds to Approach 2.2 from the guidance (EA, 2012).

4.5.2 Initial vulnerability assessment

The first stage of the climate change assessment was to determine the vulnerability of each resource zone to climate change. HR Wallingford carried out this work for us and the resulting scores are as follows (HRW, 2012):

- West Cumbria and Integrated Resource Zones are **high risk;**
- Carlisle Resource Zone is **medium risk; and**
- North Eden Resource Zone is **low risk.**

HR Wallingford used these results to determine that the most appropriate approach was 2.2 from the UKWIR 2012 methodology. This approach is suitable for medium and high-risk vulnerability and involves the following components:

- Drought indicator analysis in each zone, to further determine how vulnerable water availability is to changes in the main climatic variables (rainfall, potential evapotranspiration and aridity);
- Targeted sample of UKCP09 projections selected based on the drought indicator analysis;
- Rainfall-runoff modelling for 2030's time slice and 20 projections; and
- Water resources modelling using perturbed data for 20 projections.

It was considered most efficient to use the same approach for all four resource zones including North Eden, which had only been classified as low risk.

4.5.3 Stage 1 - Intermediate assessment and selection of scenarios

The main technical challenge of the climate change assessment was to move from 10,000 UKCP09 climate change projections to 20 representative scenarios for the Aquator™ water resources models.

We used statistical sampling to reduce the number of scenarios from 10,000 to 100 and then used a drought index to select a sub-sample of 20 which was representative of all 100 scenarios. The drought index was based on analysis of historical drought records to identify the dominant climatological factors that caused water resources drought events. In the sub-sampling special emphasis was placed on the driest scenarios and half of the 20 were taken from the driest 10% of the 100 scenarios. A weighting was applied to each scenario so that it was still possible to determine a representative mean impact from this biased distribution.

It was also necessary to convert the information from the UKCP09 climate change projections into hydrological data suitable for water resource modelling. This was done by running the climatological data through United Utilities' available rainfall-runoff models to produce new Aquator™ input flow sequences. For those sites without rainfall runoff models, HR Wallingford derived a transposition method (HRW, 2012) using standard hydrological catchment statistics to derive flow factors which were then applied to the existing Aquator™ input flow sequences.

4.5.4 Groundwater assessment

The vulnerability of our groundwater sources to climate change has been assessed by specialist environmental consultancy ESI (ESI, 2012). The assessment can be thought of as two separate parts:

- The calculation of groundwater levels in the 2030s under a number of climate change projections. This was completed using a combination of numerical and analytical methods.

- The calculation of deployable outputs for sources in the 2030s under each climate change projection.

The results from the study indicated that across the majority of our supply area, the maximum predicted reduction in groundwater levels as a result of climate change perturbations is typically less than one metre. This would not affect deployable output, which would still be determined by licence or infrastructure constraints; therefore it was concluded that there would be no changes to groundwater sources due to impact of climate change.

4.5.5 Stage 2 - Water resources modelling

The water resources modelling of climate change impacts was a significant undertaking but in essence the approach was simply to repeat the deployable output assessment (Section 4.3.3) for each of the 20 climate change scenarios, each time updating the inflow sequences. For the Integrated Resource Zone model, which has long run times, it was impractical to run all 20 scenarios over the full 1927-2010 period. Therefore a "critical periods sequence" was employed which consists of key dry years spliced together. Testing indicated that results were likely to be virtually identical to full period runs.

The climate change impact taken through to the supply-demand balance for each resource zone was based on the mean deployable output from the 20 scenarios. As noted in Section 4.5.3, weightings were applied to remove the bias of the 20 scenarios towards the driest conditions.

4.5.6 Results

The results of the Aquator™ deployable output modelling are summarised in Table 8 and, following profiling, the impacts over the full planning period are shown in Table 9. There is no impact in the North Eden resource zone due to sources being groundwater based (Section 4.5.4). For the other resource zones the simulated impact of climate change in 2035 is between 5% and 11%, with the highest impact simulated in the West Cumbria Resource Zone.

Table 8: Summary deployable output impacts of 20 climate change scenarios at 2035

Resource zone	Simulated baseline deployable output (with sustainability changes) (Ml/d)	Highest simulated impact (Ml/d)	Lowest simulated impact (Ml/d)	Mean simulated impact (Ml/d)	Mean percentage simulated impact
Integrated	2138.9	-327.8	+10.9	-121.7	5.7%
Carlisle	34.7	-6.3	+0.9	-2.1	6.0%
North Eden	8.7	0	0	0	0.0%
West Cumbria	24.5	-21.5	+6.7	-6.6	11.4%

Table 9: Summary of deployable output impacts of climate change over planning horizon

Climate Change Impacts (Ml/d)	2015/16	2020/21	2025/26	2030/31	2035/36	2039/40
Integrated	-19.2	-51.2	-83.3	-111.5	-121.7	-129.8
Carlisle	-0.3	-0.9	-1.4	-1.9	-2.1	-2.2
North Eden	0.0	0.0	0.0	0.0	0.0	0.0
West Cumbria	-1.1	-2.8	-4.5	-6.1	-6.6	-7.1

4.6 OUTAGE ALLOWANCE

An outage allowance is applied to recognise that some sources will temporarily become unavailable during the 2015-2040 planning period 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. 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). The total outage allowance (Table 10) is modest and reflects the high degree of integration of the supply system, which enables us to respond efficiently to planned and unplanned events.

Table 10: Outage Allowances included in this plan

Resource Zone	Outage Allowance (Ml/d)
Integrated	74.3
Carlisle	1.98
North Eden	0.06
West Cumbria	0.92

4.7 RAW WATER EXPORTS AND BULK SUPPLIES

As noted in Section 3.3, there are raw water exports to Dŵr Cymru Welsh Water and non-potable supplies from the River Dee (Integrated resource zone) totalling 80 Ml/d on average. In addition, there are a limited number of very small imports, exports and potable bulk supplies for the Integrated and North Eden Resource Zones.

4.8 SUPPLY FORECASTS

The forecasts of deployable output and water available for use for each water resource zone are summarised in Table 11. Only the start and end of the planning period are shown here; the results for the full period are shown in Section 8 with the supply-demand balance for each resource zone.

Table 11: Water supply forecasts for each resource zone

Component of supply forecast (Ml/d)	Integrated resource zone		Carlisle resource zone		North Eden resource zone		West Cumbria resource zone	
	2015/16	2039/40	2015/16	2039/40	2015/16	2039/40	2015/16	2039/40
Baseline deployable output	2127.8	2143.3	34.7	34.7	8.7	8.7	62.1	62.1
Sustainability changes (from 2019/20)	0.0	-5.0	0.0	0.0	0.0	0.0	0.0	-37.5
Climate change	-19.2	-129.8	-0.3	-2.2	0.0	0.0	-1.1	-7.1
Forecast deployable output	**2108.6**	**2008.5**	**34.4**	**32.5**	**8.7**	**8.7**	**61.0**	**17.5**
Non-potable/raw water supplies	-84.3	-84.3	0.0	0.0	0.0	0.0	0.0	0.0
Raw water and process losses	-64.6	-64.6	-0.26	-0.26	-0.03	-0.03	-1.3	-1.3
Outage	-74.3	-74.3	-1.98	-1.98	-0.06	-0.06	-0.9	-0.9
Imports	0.04	0.04	0.0	0.0	1.0	1.0	0.0	0.0
Exports	-0.41	-1.05	0.0	0.0	0.0	0.0	0.0	0.0
Water available for use	**1885.1**	**1784.3**	**32.1**	**30.3**	**9.7**	**9.7**	**58.9**	**15.4**

4.9 ALTERNATIVE LEVELS OF SERVICE

4.9.1 Introduction

As introduced in Section 2.4, our current minimum level of service is for the implementation of statutory water use restrictions and drought permits/orders not more than once in every 20 years on average, with drought orders to restrict non-essential water use not more than once in every 35 years on average. Aquator™ modelling has demonstrated that these levels of service can be met in all of our resource zones.

In line with planning guidance (UKWIR, 2012) we have assessed different levels of service to understand the impact on deployable output. A willingness-to-pay survey is used in conjunction with these results in Section 11.1 to determine if the current or alternative levels of service should be adopted. To provide a higher level of service, i.e. less frequent water use restrictions or drought permits/orders, would require a greater investment in water supplies, or more extensive demand management. Conversely, the additional reduction in demand triggered by reducing the level of service could have the same effect as creating new supplies and may be considered as an option to meet a supply-demand balance deficit.

4.9.2 Impact of level of service

As outlined in Section 4.3.5, our groundwater supplies are not constrained by resource but by licence, hence current or alternative level of service will have no effect on deployable output in the North Eden Resource Zone.

In the two other Cumbrian resource zones, Carlisle and West Cumbria, the catchments are 'flashy' which means that reservoir and lake levels rise and fall quickly. This has an impact on drought planning and hence the setting of 'drought triggers' which enact statutory water use restrictions or drought permits/orders. As a result, the actual level

of service associated with these resource zones is much better than our agreed level of service; 1 in 50 years for Carlisle and less than 1 in 50 years for West Cumbria. The deployable output results are determined simply by the availability of supplies during the driest periods and are not impacted by aiming to meet level of service. In addition, on the rare occasion that drought triggers are crossed we have assumed no demand saving reductions within Aquator™ modelling for these zones, as it is not considered likely that these restrictions will have a significant impact given the demographics of the area.

Therefore, the impact of level of service on deployable output has only been assessed for the Integrated Resource Zone. Here demand saving restrictions are represented at drought trigger 3 (voluntary restrictions) with a saving of 3% on demand based on historic data analysis. The level of service is dictated by Drought Trigger 4 when mandatory restrictions are enforced and drought permits implemented.

Aquator™ modelling of the Integrated Resource Zone shows that at the stated deployable output the level of service is 1 in 20 years. Alternative scenarios have been completed for this zone to examine the relationship between deployable output and level of service:

- A reduction in level of service to 1 in 10 years by increasing drought trigger levels systematically to bring on demand restrictions earlier and more frequently; and
- An improvement in level of service (1 in 40 and 1 in 80 years) by restricting the number of demand saving events within a model run in Aquator with the existing drought triggers. This effectively keeps more storage 'reserve' in place, with less severe drawdowns in reservoir levels.

4.9.3 Results

The results of our levels of service runs are shown below in Table 12 and Table 13. Table 12 effectively shows the additional amount of water that would need to be made available from new sources or demand reductions in order to have less frequent water use restrictions. Because water use restrictions must be in place before drought permits or drought orders are implemented, reducing the frequency of water use restrictions would also reduce the frequency of drought permits and drought orders.

Table 13 shows the additional amount of water that would need to be made available from new sources or demand reductions in order to have less frequent drought permits and drought orders, but keeping the current frequency of water use restrictions.

The increase in deployable output achieved by reducing the level of service for water use restrictions to 1 in 10 years has been considered as a supply option (Section 9). In addition, this corresponds to the "Reference scenario" in the water resources planning guideline (Environment Agency, 2013) which provides a basis for comparison with other companies' plans.

As also stated in the guideline we show a "No restrictions" scenario which has no water use restrictions imposed, even if drought trigger levels are crossed. This scenario results in a reduction in deployable output. It is not a feasible option in practice because water companies must demonstrate they have taken appropriate steps to manage demand before resorting to drought permits to protect against a prolonged drought.

Table 12: Integrated Resource Zone deployable output under different levels of service for water use restrictions and drought permits/orders

Level of Service Scenario	Supply-demand change from current level of service (Ml/d)
1 in 10 years (reference scenario)	+21
1 in 20 years (current level of service)	-
1 in 40 years	-168
1 in 80 years	-211
No restrictions scenario	-31

Table 13: Integrated Resource Zone deployable output under different levels of service for drought permits / orders alone

Level of Service Scenario	Drought order / permit Frequency	Deployable Output (Ml/d)	Supply-demand change from current level of service (Ml/d)
1 in 10 years	Not considered – United Utilities assumes no benefit from drought permits in assessing deployable output and therefore this would give no benefit to stated supply-demand balance.		
1 in 20 years (current level of service)	4 events in 84 years	2,134	-
1 in 40 years	2 events in 84 years	2,040	-73
1 in 80 years	1 event in 84 years	1,833	-193

5 DEMAND MANAGEMENT

Key Messages

- Leakage is at its lowest ever level and we will continue to maintain this good performance over the next 25 years
- We will continue to promote the need for our customers to use water efficiently and offer advice and devices to support them to do so
- By 2040 we expect that 76% of households will have a water meter

5.1 IMPORTANCE OF DEMAND MANAGEMENT

We recognise the important contribution of demand management in achieving and maintaining an adequate supply-demand balance in each of our four water resource zones. Demand management is an integral component of our strategy to balance supply and demand. We have significantly reduced leakage since 1996 to help achieve and maintain a high standard of water supply reliability. Water efficiency promotion has been significantly enhanced since 2010 and overall water demand is at its lowest level for at least the last 20 years.

In our customer preference research, our customers expressed their recognition of the importance of demand management. Customers gave fixing leaks as the highest priority for the next five years.

Our strategy for managing demand is to achieve:

- a sustainable and economic level of leakage (SELL);
- a sustainable economic level of water efficiency; and
- a sustainable economic level of metering.

The sustainable economic level is the level beyond which, taking into account environmental and financial costs, it is more cost effective to develop new sources of water rather than reduce demand further. Leakage relates to water lost from the distribution network at any point downstream of the water treatment works. Our leakage strategy is to manage a sustainable and economic level of leakage for the supply-demand balance

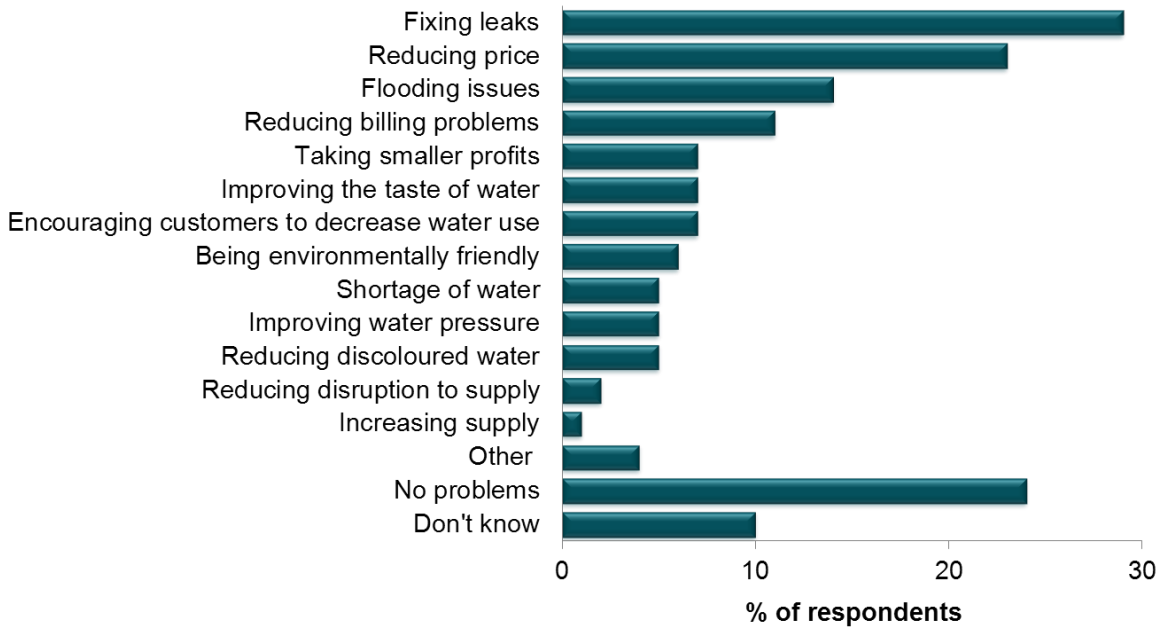


Figure 9: Issues that customers think United Utilities should be focusing on

Customer metering contributes to the overall reduction in consumer demand and plays a key role in the Water Resources Management Plan. Defra's 2008 document, Future Water, aspired to reduce per capita consumption to 130 l/hd/d. It is clear that metering is an enabler in progressing towards this target. In 2012/13, we had a regional average consumption of 128 l/hd/d, which included both measured and unmeasured customers.

It is important to promote awareness of the need to use water efficiently to protect the wider environment. Our Strategic Direction Statement (2010) specifically states that we will help our customers improve the efficiency with which they use water, and describes a number of key objectives related to this.

Demand management may be a more sustainable route to meeting supply-demand deficits than developing new sources, because it can have lower carbon emissions and lower impacts on the aquatic environment through lower abstraction. However, a full assessment of sustainability requires these environmental impacts to be balanced against economic and social impacts of the various options.

5.2 LEAKAGE REDUCTION

Leakage management contributes to the overall reduction in demand and plays a key role in our management of water resources.

In the UK, leakage is defined as loss of water from any point downstream of a water treatment works, up to the customer's supply pipe. It includes water lost from connections to properties (communication pipes) and the associated supply pipes owned by customers, known as supply pipe leakage, see Figure 10. Our assessment of where leakage is occurring in the distribution network is presented in Figure 11.

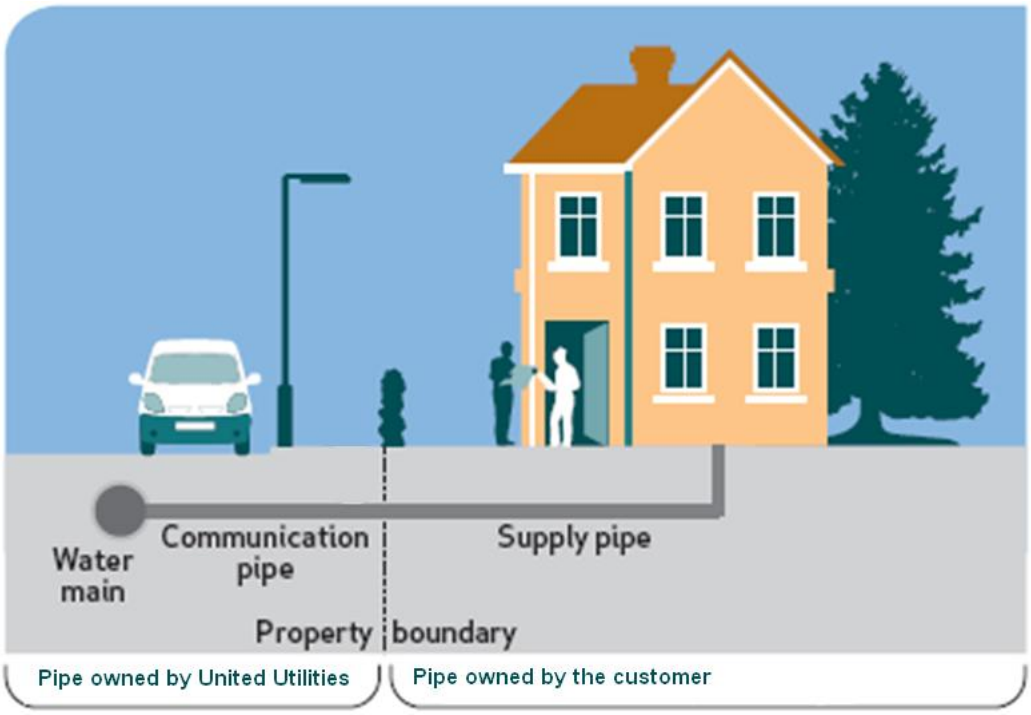


Figure 10: Water lost from customer owned supply pipes is included in leakage numbers reported by United Utilities

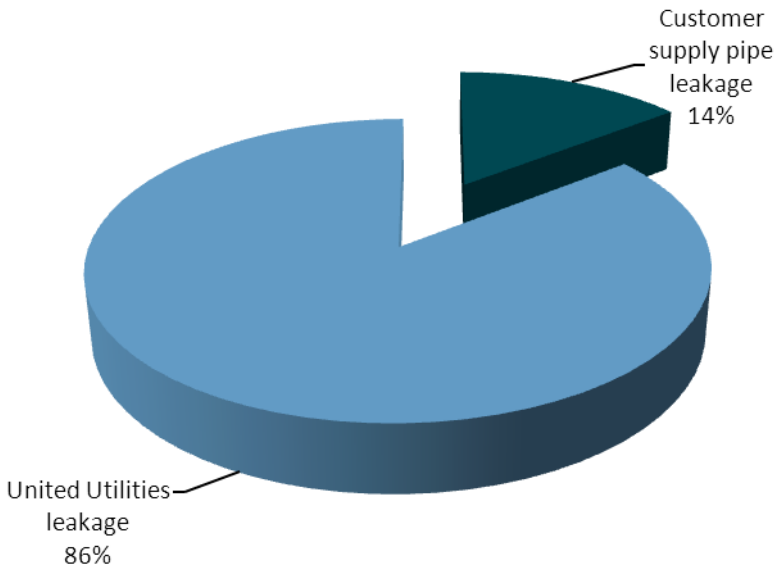


Figure 11: Main leakage components 2012/13

5.2.1 Reducing leakage

We know that customers say managing leakage is really important and it is our policy to manage a sustainable and economic level of leakage. According to our customer preference research carried out in 2012, 41% of customers did not feel that we do enough to control leakage.

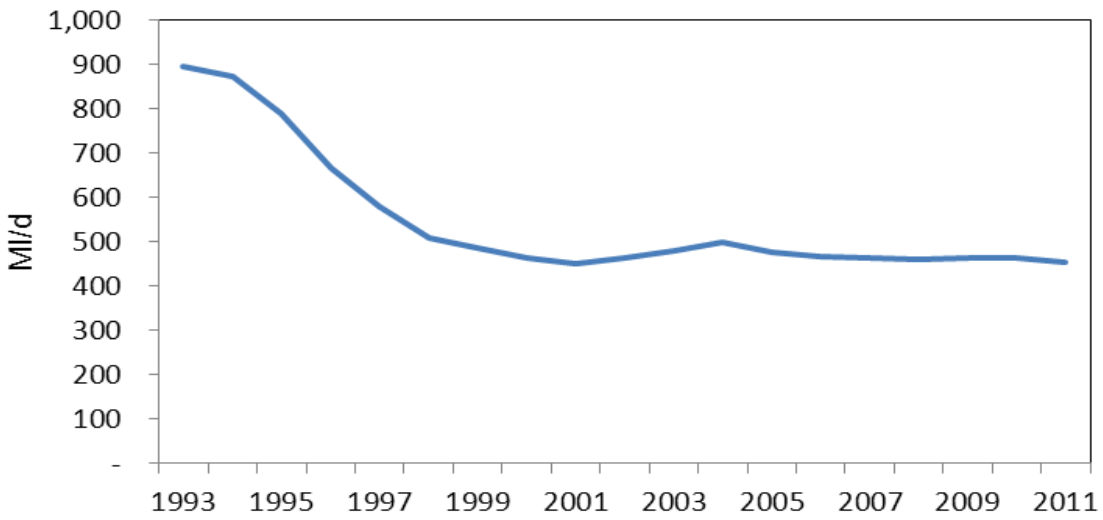


Figure 12: Regional total leakage

As shown in Figure 12, we have significantly reduced leakage over the last 20 years, more than halving leakage from 945 Ml/d in 1992/93 to 462 Ml/d at 2007/08. Leakage has stabilised at between 464 Ml/d and 453 Ml/d since. This has been achieved through expenditure on a combination of measures in accordance with current national best practice. For example, we have:

- Installed a comprehensive network of almost 2,500 meters with GPRS technology to continuously monitor water use and leakage in each district of around 1,200 properties across the region;

- Maintained a sophisticated leakage information system that analyses 15-minute flow and/or pressure data from over 9,000 sites across the region. This identifies the areas where high leakage is occurring and directs our leak detection activities;
- Installed over 16,800 pressure management valves and other pressure reducing methods to optimise water pressure across our distribution networks;
- Employed a large leak detection workforce of around 170 full-time equivalent personnel who have been trained and equipped with the latest leak detection techniques; and
- Provided a free telephone service for customers to inform us of leaks, and a free supply pipe repair service for households.

5.2.2 Further reduction in leakage levels

We are committed to reducing leakage wherever and whenever it is sustainable to do so.

We apply the sustainable economic level of leakage (SELL) which includes the costs to society and the environment. The social costs consider the impact on society of the additional traffic and other disruption associated with finding and fixing leaks. The environmental costs consider the cost of the carbon of fixing and finding leaks versus the cost of the operational carbon from an additional water source. It also includes the environmental benefit of reduced abstraction.

The level of background leakage is an important component of the calculation of the sustainable economic level of leakage. Our assessment included detailed analysis of background leakage levels.

We have a relatively young pipe network; however some of our pipes are over 100 years old. New leaks are continually breaking out and so a sustained leak detection and repair effort is needed to maintain the current levels. Higher costs are involved to reduce leakage further. As leakage gets lower, leaks are getting increasingly smaller and more difficult to locate and fix. Figure 13 below shows how costs increase rapidly as leakage levels reduce. The government have recently consulted on transferring ownership of supply pipes to water companies. We support this proposal, as it will have a benefit for lead reduction as well as a benefit, although smaller, in leakage. As many supply pipes were installed pre-1974, they will continue to deteriorate over time seeing increases in leakage. Transfer of ownership would allow us to adopt a policy of replacing more supply pipes. Continuing the current repair policy will lead to the wider-customer base paying more than if we owned the pipe and undertook to replace rather than repair the pipe at first visit.

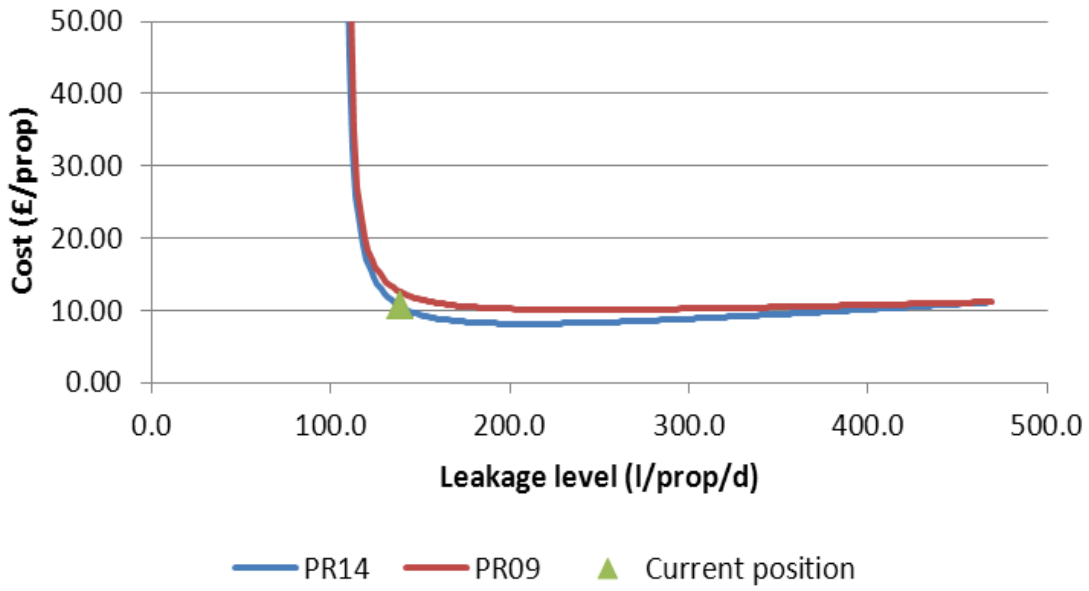


Figure 13: Cost Curve for Integrated Zone

We are already significantly below our sustainable economic level of leakage in all of our water resource zones, which has been calculated at 606 Ml/d. This means that further leakage reduction in itself is not self-financing through reduced water production costs. However, future leakage reduction may be sustainable and economic in the long run as part of the least-cost plan to balance supply and demand.

5.3 WATER EFFICIENCY

The quantities of water directly saved by individual water efficiency measures may be relatively small compared with other options. However, the cumulative effects of behaviour change can be very significant. Household consumption has decreased by 8% over the last decade. We believe it is important to promote awareness of the need to use water efficiently to save our customers' money and protect the wider environment. We have carried out a large number of activities since the last Water Resources Management Plan was published in 2009.

5.3.1 Customer Attitudes to Saving Water

As part of the Customer Preference Study 2012, we asked a number of questions about water efficiency.

79% of customers believe they make a conscious effort to save water. However, this result must be balanced against the 59% of customers who at the same time "don't think much about saving water and take it for granted" and the 53% of customers who believe that we do enough to encourage water efficiency.

When presented with a suite of options for addressing any future supply-demand balance, reducing leakage and increasing water efficiency in the home are customers' first and second choices, both with and without considering the costs. Our commitment to reducing demand through water efficiency initiatives and a sustainable economic level of leakage continues with our strategy outlined in Section 11.

5.3.2 Activities Up to 2015

Ofwat introduced mandatory water efficiency targets for water companies from 2010/11 – 2014/15. To date we have exceeded the annual target set of 2.95Ml/d and the strategy for the remainder of the period to 2015 will be to continue to as a minimum meet the statutory targets.

5.3.3 Customer education

We believe that educating customers begins with children. The water cycle and the knowledge of how to be water efficient cannot start early enough and we firmly believe in “pester power”. We have played a key role in getting the water efficiency message to over 5.5 million children.

From September 2011, we have promoted and offered primary schools in the North West region the opportunity to take part in a water efficiency education programme. To date over 7,500 Key Stage 2 pupils have taken part in the programme, which is delivered by an education provider. The programme includes topics such as the water cycle, water safety, what not to flush and water efficiency. As well as the expert teaching, which is spread over two visits to the classroom, each child is provided with a booklet reiterating the important messages, a set of water efficiency “trump cards” and a “toothy timer” to encourage them to turn off the tap when brushing their teeth.

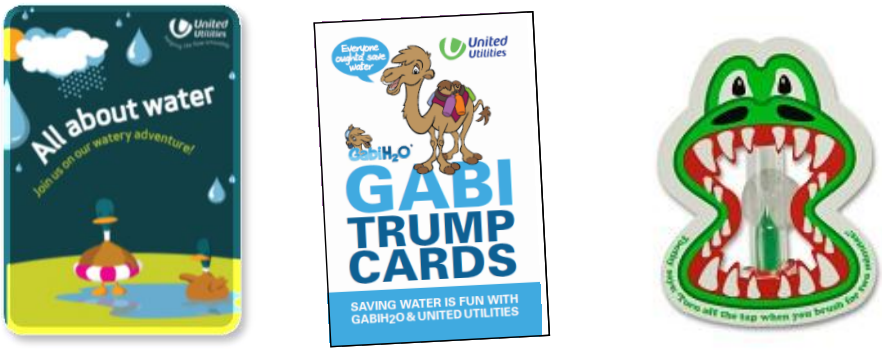


Figure 14: Examples of water efficiency products for school children

Since May 2012, we have been sponsoring the children’s TV character Gabi H20, shown on the Nickelodeon channel. It is the UK’s first on-air animated character dedicated to educating children about water efficiency.

Since its launch, an estimated 5.5 million children and 1.6 million parents have tuned in to Nickelodeon, where the Gabi message has been played three times a day. The accompanying website has had over 174,700 visits suggesting a high level of engagement with Gabi and his message. Gabi has featured in classroom sessions delivered in primary schools by us.

The campaign has picked up both a UK Water Efficiency Award for Campaigns and Education and a prestigious international gold award in the Green Apple Environment Awards.

5.3.4 Water efficient products and advice

We offer all our customers the opportunity to see if they would be financially better off by moving to a water meter. Our water meter calculator calculates how much water the household uses and confirms if the customer would be better off moving to a measured account.

The calculator also allows the customers to think about their current water usage and discover what would happen if they change their behaviour slightly by, for example taking one less bath a week or using the economy setting on their washing machine.

If the customer already has a water meter fitted in their home, our calculator will give them some hints and tips on how to make further water savings in a usage report.

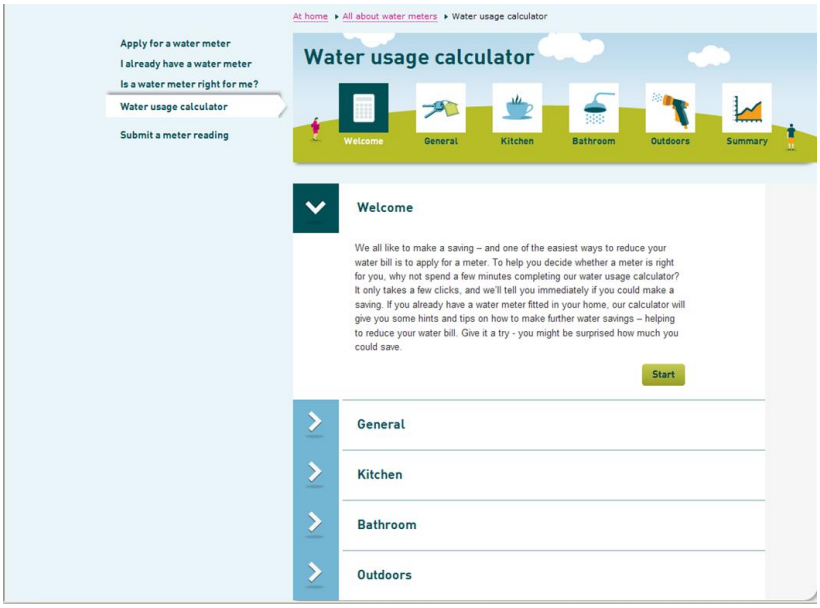


Figure 15: Screen shot of our customer water meter calculator

We believe that cistern displacement devices offer excellent water saving opportunities at an affordable cost. As such, we ensure that all domestic customers have access to free cistern water saving devices. We advertise them at unitedutilities.com, in our "Guide to using water wisely" and hand them out at events.

We have distributed over 350,000 cistern devices free of charge to household and non-household properties since 2010. We distribute the "Save-a-flush" water saving cistern device as a "customer-fit" option, so simple-to-follow instructions are included on the front of each device.

We also promote and distribute shower regulators and water efficient showerheads to our customers. Since 2010/11 there have been an estimated 166,000 shower devices installed.

Products such as tap inserts, shower timers and toothy timers are also promoted via our billing leaflet, our website, advertisements in local council magazines, local press, at community events and through road show activities.

These devices are provided alongside a household water audit and guide to using water wisely in the home to reinforce water saving behaviour.

Our water efficiency leaflets are available by phone or through our website. Our website also carries a wide range of water efficiency hints, tips, and educational resources. Customers can also estimate their future water consumption and likely bills on the website, and order a "Save-a-flush" device. There are also links to other water efficiency focussed organisations including Waterwise, Water in the School, and the Water Family websites.

We have also trialled "visit and fit" home audits where representatives from partner organisations, who are already visiting a customer's home for an annual maintenance or emergency repair appointment, offer water savings tips, fits water saving devices, and provide the customer with a "Water Savers" pack. During the visit, the representative fits and records relevant water efficient retrofit products. We have tested this approach in over 800 homes across the region.

We have offered subsidised water butts to all domestic customers in our region. The water butts are promoted on our website, in the "Water Savers Pack", and in "A Simple Guide to Your Water Meter" leaflets. We have also organised recycling road shows with Local Authorities across the region where water butts and composters were sold at

a discounted price. Since April 2010, over 1,800 water butts have been sold through these promotions.

5.3.5 Commercial customers

Our Key Customer Managers regularly visit major industrial, commercial and institutional customers, and have contact with many smaller customers. As part of these visits, they promote water conservation and the related services provided by us.

We provide water savings advice and self-audit packs, free of charge, to institutional customers on request. Over 280 self-audit packs have been distributed to non-household customers since April 2010.

For commercial customers we provide seminars on water conservation measures. We use a large model toilet for display at local authority and commercial premises to promote cistern devices and water efficiency information. This has also been used at major venues and environmental-themed events across the region.

5.3.6 Customer awareness

We have worked closely with local groups such as 'Faiths 4 Change' in the Burnley area, empowering members of the community to learn about the benefits of water saving and spreading those messages further.

We provide continued communications campaigns via our annual billing leaflets, local press releases and other company literature to encourage customers to use water wisely. We also maintain stands annually at the Southport Flower Show and the Cheshire Show to promote water efficiency to visitors.

Winter pipe protection roadshows and media campaigns are undertaken annually, reaching thousands of customers. We have also taken the opportunity to sponsor the ITV weather in the Granada and Border television regions as this gives us an ideal way of communicating to a large numbers of our customers, daily (Figure 16). The sponsorship allows us to deliver messages such as saving water, by turning the tap off when brushing your teeth, in a creative way. Our weather sponsorship also includes the online communication channel and is used to support the many campaigns we run to raise customer awareness, educate and change their behaviour.

We maintain partnerships with external bodies to promote water conservation. Bodies we collaborate with include local councils, local environmental groups, the Environment Agency, and water efficient product manufacturers.

Figure 16: Branding used for our sponsorship of ITV weather

5.3.7 Commitment to research and development

One significant barrier to the wider use of water efficiency options by water companies is a lack of clarity around the costs and benefits of water efficiency projects. We have made a continuing commitment to researching the benefits and costs of new ways of promoting water efficiency, with active participation on the Evidence Base Steering Group, the Collaborative Fund Steering Group and numerous UKWIR projects

including “Customer Behaviour and Water Use” and “Links and Benefits of Joint Water and Energy Efficiency”.

Over the last few years, we have undertaken a number of studies and investigations into water efficiency. We have investigated a range of different water saving approaches, considering a wide range of factors that can influence the effectiveness of such projects.

Notable studies include:

- Rainwater harvesting trial on a domestic property: Usage was monitored and analysed for periods before and after the kit was installed;
- Sponsorship of Bolton at Home Eco Home Research project, in partnership with University of Salford: This project will be monitoring the energy and water use within properties over a two year period to ascertain the extent to which retrofitting reduces consumption;
- Testing people’s likes and dislikes of water efficient shower heads;
- Car washing research with Liverpool John Moore's University: The research is trying to find out how much water is used during car washing, how many people actually wash their own cars and how many people would be interested in using a waterless car washing product;
- A customer opinion survey: Included in the survey were a number of questions on customers’ awareness and opinion towards water efficiency. The results of this study will be used to help target future water efficiency messages and promotions; and
- Low consumption washing machine: The basis of the project is to develop a low energy and low water consumption washing machine.

5.3.8 West Cumbria Green Zone

The 2009 Water Resources Management Plan identified that West Cumbria would face a deficit in 2014. The plan identified a suite of options to address the deficit in the region and water efficiency would contribute to meeting that deficit. It would do this in two ways: Economic water efficiency and water efficiency research. This will achieve a water saving of 0.327 Ml/d.

These two targets form part of our annual Sustainable Economic Level of Water Efficiency (SELWE). The annual SELWE target of 0.066 Ml/d has been achieved through a number of activities. These included attendance at local events such as the farmers market in Cockermouth, Paint The Town Red and HMRC learn at work days where water efficiency advice and retrofit products were distributed.

We have also organised our own water efficiency give away days through local supermarkets, where water efficient showerheads were distributed with advice and other key messages for saving water.

West Cumbria Research

The West Cumbria Water Efficiency Research project started in 2010/11 and will be complete by 2014/15. Its purpose is to reduce customer water demand in West Cumbria, and thereby help us to maintain an adequate supply-demand balance. Its secondary purpose is to inform future approaches to water efficiency.

The project has been split into three separate trials:

- Cistern displacement devices: these are quick and easy to fit and have a wide appeal;

- Free meter options: these look at different ways to encourage customers to opt for a meter and then to encourage them to reduce water consumption after opting; and
- Fuel and water affordability initiatives: these work with customers who struggle to afford their fuel bills to find simple and easy ways to reduce these by focusing on bathing and clothes washing as these use both energy and water.

Some early results from the research are:

- Two thirds of meter optants have tried to use less water. The most common changes were adapting devices or making repairs to reduce the water use, particularly for toilet flushing; and behavioural changes, such as using showers instead of baths, reducing the amount of water in their bath or turning off the tap while brushing their teeth or shaving;
- Almost all optants were happy that they had decided to get a water meter fitted;
- The likelihood of saving increased with age from around a quarter of those aged 35-44 to over three quarters of those aged 65 and over; and
- Female customers are more likely to accept a cistern displacement device, but men are more likely to fit them.

We have used these early results to design our demand management options for this plan. We will continue to refine our water efficiency offering as further research findings emerge.

5.4 CUSTOMER METERING

5.4.1 Introduction

It is widely accepted that customers with a meter use less water than those without one. Metering is an opportunity for customer engagement, which if sustained, can be useful for promoting water efficiency. Metered customers are able to review the impact of their behaviour on their bills, and metering also gives us the opportunity to use flexible tariffs based on consumption patterns. “Paying for what you use” is a well-supported principle.

Our metering aims are to:

- Maximise the economic utilisation of customer metering and tariffs to assist in achieving and maintaining adequate supply-demand balances, in accordance with the UKWIR / Environment Agency national best practice methodology “Economics of Balancing Supply and Demand”;
- Carry out action plans that are consistent with national best practice; and
- Target demand management activities in those water resource zones where supply-demand deficits exist or are anticipated to occur in the near future where it can be identified that customers will realise the benefits of taking up metering opportunities.

5.4.2 The requirement for metering

In our 2009 Water Resources Management Plan, we assumed that metering reduces water consumption by households in our region by 8.3% in a normal weather year, based on a detailed study of our customers (National Economic Research Associates,

2003). This is slightly below the expectations reported by Professor Herrington[6], which were based mainly on studies in southern England where discretionary water use, for example on garden watering, is much higher than in North West England.

Results from the different studies into savings associated with metering are varied. The long-term effects must be considered, as savings may not be sustainable over a long period. Experts previously thought that there was a “bounce back” associated with metering, i.e. the benefit of metering being reduced over time. However, analysis of optant properties by us has found no evidence of “bounce back”.

We focus on metering customers because:

- Reducing demand can help to improve security of supply and reduce the impact on the environment through lower abstraction;
- Metering and reducing water use can help cut greenhouse gas emissions associated with abstracting, supplying water, treating water and wastewater, and heating water in homes and businesses;
- Metering gives us better information about customer water use and can help plan and operate our networks more efficiently, whilst reducing losses and leaks;
- Metering provides customers with accurate information about their water use and allows them to be billed on the amount used. This can be a key element in behaviour change as rateable value or assessed charges do not encourage water efficient behaviour;
- Metering programmes can consider both current and future opportunities for variable tariffs; and ensure that people who are unable to afford their bills are protected through appropriate tariffs;
- Where we install meters we can ensure a range of water efficiency measures are put in place to enhance the benefits of metering;
- Opportunities to link smart metering for water and energy could be applied to all large scale metering programmes. Our position is to continue with automatic meter reading (AMR) in its current form, using walk / drive by technology, until such time as energy smart metering is rolled out nationally. At the end of AMP6 we will have an understanding of how successful this roll-out has been and likely costs of entry, and be better informed as to whether we wish to migrate to using the same smart grid for AMP7 /8 business plans; and
- Customers save not only on their water bills, but also on their energy usage. It is therefore an overall financially attractive option for many customers.

There are however additional factors which we have to take into consideration when reviewing our approach to metering.

- Not all customers will benefit financially from being on a meter, those with a large household who are currently on a low rateable value may not benefit; and
- The cost of maintaining a measured customer is higher than that of an unmeasured customer.

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[6] **Herrington 1996:** *Climate change and the demand for water*, written by Professor Herrington for Department of the Environment (now part of Defra).

5.4.3 United Utilities current metering policy

Our metering policy is to:

- Meter all new household properties. Our current policy for new build is to install meters in an above ground location (internally, or in a wall mounted meter box that allows easy access to read the meters for both the customer and the company). All new meter installations have automated meter reading (AMR) technology in them, which allows them to be read remotely; all 454,068 new homes from 1989 to 2012 have been metered. An estimated further 640,000 new homes are expected to be built by 2040, in line with the projections described in Section 6, Demand Forecasting. As a result the number of houses metered when built is expected to increase to over 1 million by 2040;
- Provide a free meter option scheme for household customers. Since April 2000, we have actively promoted this scheme to customers. Our preferred meter location position is internally and all new meters since 2010 are AMR enabled;
- Meter all new non-households;
- Proactively replace household and non-household water meters that are beyond their practical operational life;
- Offer unmeasured household customers an alternative choice of tariff in the small number of instances where metering is not practically possible;
- Accurately read all household and non-household water meters in a timely and cost efficient manner, with the use of AMR, where AMR meters are installed;
- Meter existing unmeasured non-households where possible. All industrial premises and the majority of commercial and public service premises are already metered following a programme in recent years to compulsorily meter all non-households where practical. Those that remain unmetered tend to be relatively small water users and where it would be disproportionately costly to install meters;
- Have all industrial and commercial customers who consume over 20 Ml per annum on enhanced AMR to enable remote automated meter readings and updated data every 15 minutes to monitor usage via a web portal service; and
- Have all other industrial and commercial customers on AMR to enable walk-by automated meter readings and migration to monthly billing.

5.4.4 Free Meter Option Scheme

By the end of 2012, 508,000 household customers that were previously unmetered have opted to be metered.

The number of customers opting to be metered has increased significantly since we introduced the free meter option scheme for households in April 2000. Before this, customers had to pay to have a meter installed. There have been further significant increases in take up during the last ten years due, particularly, to customer responses to rising water prices, but also due to increased awareness of other benefits of the free meter option scheme such as the ability to monitor use. We continue to advertise the free meter option scheme to all our customers via our website.

There was a particularly high take-up of the free meter option scheme during 2008/09 with well over 58,000 installations. We consider this to be in response to the economic climate and customers being even more keen than usual to find ways of saving money. Household meter penetration has increased from 13% in 2002/03 to 32% in 2012 and we anticipate meter penetration through those opting and new properties being metered to reach 76% by 2040. Options for further metering have been considered as

part of the plan and are outlined in Appendix 10. No options to increase the level of metering above the baseline forecast have been included in our preferred plan.

5.4.5 Further targeted promotion of the free meter option

In their consultation responses, several stakeholders suggested that we could do more to reduce demand, We have considered this carefully. The supply-demand surplus in most of our region means that further demand management is in general not economic and therefore would require an unjustifiable increase in customers' bills. Recognising that further demand management may result in an increase in bills, the Water Resources Planning Guidance and the Water White Paper say that companies should be "reducing the demand for water by managing leakage and providing services to help customers use water efficiently where there is a reasonable prospect that the benefits of doing so will outweigh the costs".

We have identified some cost-effective ways of increasing the uptake of the free meter option. We are focusing on the 15,000 customers whom we would expect would apply for a meter but are unable to have a meter fitted, due to pipe work restrictions or other complexities. We are already reviewing our operating policies and contractor practices with a view to reducing meter rejections from a rate of 15% to 10%, allowing an additional 13,000 customers to benefit from a water meter. We continue to look at the options to help remaining customers who cannot have a meter installed.

We are also planning to run a targeted marketing campaign to reach those 5,000 customers who already have an unused underground meter box installed and where we might install a meter as part of service renewal or stop tap replacement work.

As part of our plans to help customers who face affordability and subsequent debt issues, we are planning to promote the free meter option scheme to 100,000 customers who are in debt. This will help reduce their on-going charges.

In aggregate, these measures will allow us to install an additional 82,510 meters between 2015 and 2025, saving a further 12.7 Ml/d of water across the North West.

5.4.6 Automated Meter Reading

With the continual growth of metering there is the opportunity to engage with customers to help them monitor their consumption.

We will pilot a new way of reading meters following a small scale trial carried out in 2012. The pilot will be based on data already collated from AMR metered properties in the Warrington Borough Council area, and will provide a more robust analysis of the data collated so far. It will also extend the trial from 7,000 to 8,500 properties by using accelerated proactive meter exchanges.

The pilot will install 30 data collection units on refuse collection vehicles. Data will then be collected during weekly refuse collections and displayed in a web portal format. It is anticipated that this will ultimately be available for customers to use dependant on the success of the pilot. Customers will be able to use the web portal to access their water consumption history, meter readings and other related data, see Figure 17. We will use the data to support proactive customer management, for example to inform customers that they may have a leak on their property.

The pilot will be complete by December 2013 and if it proves successful, we will use the results to identify appropriate areas for full deployment of the technology.

We anticipate the data will help us identify when customers' consumption changes or "leak alarms" are triggered so we can proactively notify customers of the changes. Automatic meter reading will also help to reduce the number of estimated bills customers receive. They will also play a key role in leakage detection as the availability

of frequent data and alarms allows leaks to be detected earlier than when a bill is generated.

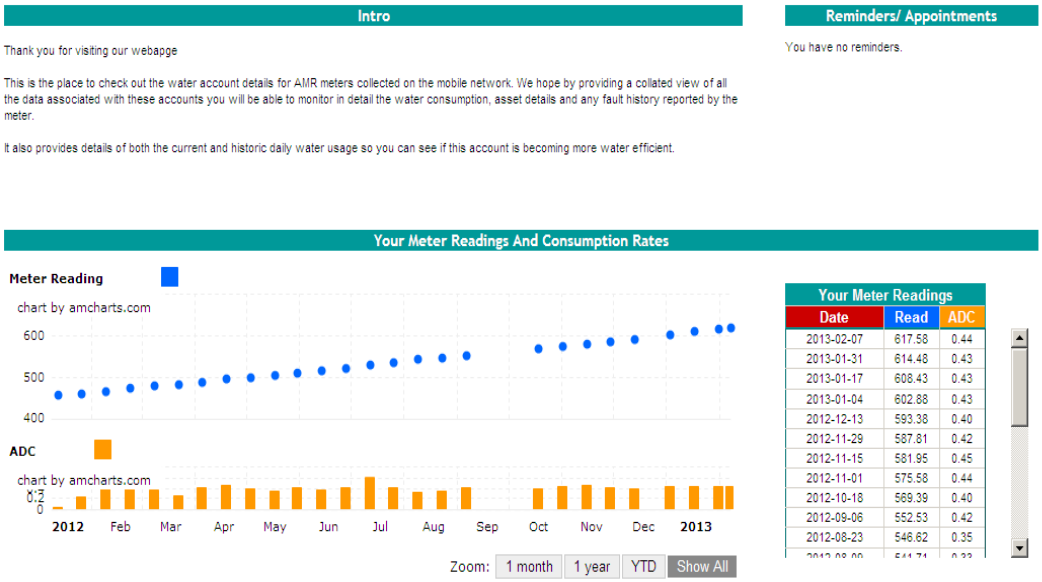


Figure 17: Concept web portal

5.4.7 Future tariff developments

Our current tariff policy is to set tariff structures that are easily understood by customers, are broadly cost reflective and comply with the regulatory licence conditions.

We recognise advantages in being able to start installing “smart meters” that take automated readings, for example using radio technology. They record water use more easily and more frequently. The key elements of our plan are to:

- Install automated meter reading technology in all newly metered properties and where meters are being replaced; and
- Consult with customers in line with the Defra requirement to investigate the support for a social tariff.

We continue to review the opportunities for more complex tariff structures. We annually review all our charging policies and continue to monitor the developments of tariffs in the industry, and other industries where applicable, and we will continue to review the effectiveness of alternative tariffs for different customer types.

6 CUSTOMERS' FUTURE DEMAND FOR WATER

Key Messages

- Demand for water from both business and household customers continues to decline
- Customer metering and water efficiency play a key role in helping reduce demand
- The latest available Office for National Statistics data has been used to predict population growth

This section describes how we forecast the future demand for water, before the benefit of any additional water efficiency or leakage programmes. We call this the "baseline" demand forecast. There is no way to forecast demand with complete accuracy, however following the application of Environment Agency guidelines and industry best practice we aim to be as accurate as possible. The policies and aspirations of the guiding principles of Water Resources Planning Guideline (set out in section 1.3) have been incorporated into the demand forecast. It is important that we do not overestimate demand, which would increase customer bills by requiring additional supply-demand schemes, and it is equally important that we do not underestimate demands increasing the risk that we are unable to meet customer demand or our Level of Service during periods of dry weather.

The primary measure of water demand is "distribution input", which is the total volume of water put into the water supply network from water treatment works. It includes customer use, leakage and operational water use within the water network. Distribution input is related to the weather and can be significantly higher during hot, dry periods. In this plan, we express distribution input in million litres per day (Ml/d), and typically quote annual averages.

6.1 HISTORIC DEMANDS

Previous Water Resources Management Plans have followed guidance and national best practice such as Demand Forecasting Methodology (UKWIR/NRA, 1995).

The 2009 Water Resources Management Plan forecast of distribution input for 2007-2015 is shown in Figure 18. In this forecast, we can see that actual measured demand has shown a consistent decline over the last five years faster than was anticipated in 2009. This is due to a number of factors such as the slowdown in the economy, affecting commercial water users, more customers moving to a measured tariff and increased general awareness of water efficiency.

6.2 WATER DEMANDS

Our demand forecast shows a number of different types of demand. We forecast annual average distribution input for:

- Each year assuming weather conditions are normal in that year;
- Each year assuming weather conditions are similar to 1995/96 in that year (a dry year);
- A weighted average of normal and dry years; and
- Each of these three forecasts before and after any additional demand management options (a "baseline" and "final planning" forecast).

In the Carlisle and West Cumbria resource zones, reservoirs and lake sources can go from full to their lowest level in a few months. The time taken for this to happen is called the critical period, and the demand for water over this period determines the supply-demand balance of these zones. Therefore, for these two zones, we also produce a critical period forecast, both "baseline" and "final planning", and because the critical period can coincide with the hottest, driest months the critical period demand is higher than the dry year demand.

This is consistent with requirements of the Water Resources Planning Guideline (EA, 2013).

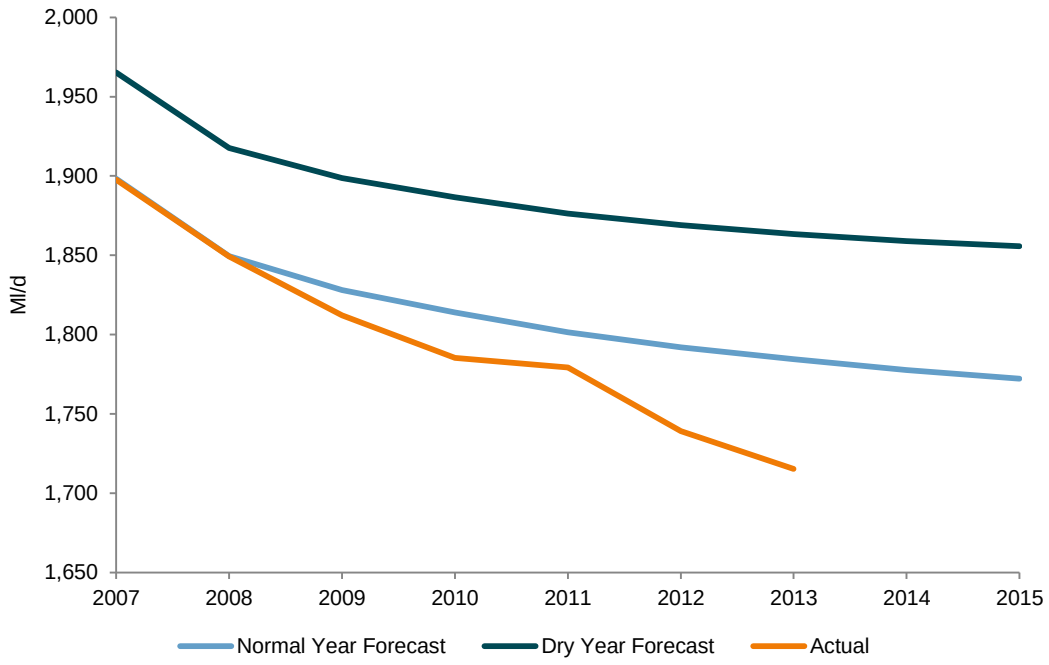


Figure 18: Forecast Distribution Input from 2009 Water Resources Management Plan against observed data

6.2.1 Baseline demand definition

We have carried out detailed studies to determine the "baseline" water demand forecast for each of our four water resource zones for each year from 2012 to 2040.

Baseline demand forecasts include our current demand management policies, but exclude the effects of any additional demand management measures identified by the option appraisal. The effects of these measures are included in the "final planning" demand forecasts discussed in Section 10.6.

We use the baseline forecast to derive further forecasts by applying factors to the forecast such as applying a "Dry Year Factor".

6.3 DEMAND FORECASTING METHODOLOGY

The total demand forecast is built up from separate forecasts of the various components of water use, as shown in Figure 19.

National best practice methods and current guidance have been used by us in the preparation of the population and water demand component values, including application of the following methodologies and guidance documents:

- Demand Forecasting Methodology (UKWIR/NRA, 1995);
- Best Practice for Unmeasured Per Capita Consumption Monitors (UKWIR, 1999);
- Future Approaches to Leakage Target Setting for Water Companies in England and Wales ("The Tripartite report") (Defra/EA/Ofwat, 2002);
- Impact of Climate Change on Water Demand (UKWIR, 2013);
- A Framework Methodology for Estimating the Impact of Household Metering on Consumption (UKWIR, 2003);

- Towards Best Practice for the Assessment of Supply Pipe Leakage (UKWIR, 2005);
- Peak Water Demand Forecasting Methodology (UKWIR, 2006);
- June Return Reporting Requirements (Ofwat, 2011);
- Water Resources Planning Guideline (EA, 2013);
- Environment Agency's Methods of Estimating Population and Household Projections (EA, 2012);
- A Framework Methodology for Estimating The Impact of Household Metering on Consumption - Supplementary Information". (page 74), (UKWIR 2003); and
- Market Transformation Programme (MTP), Developing evidence for Government and business on energy using products (Defra March 2011).

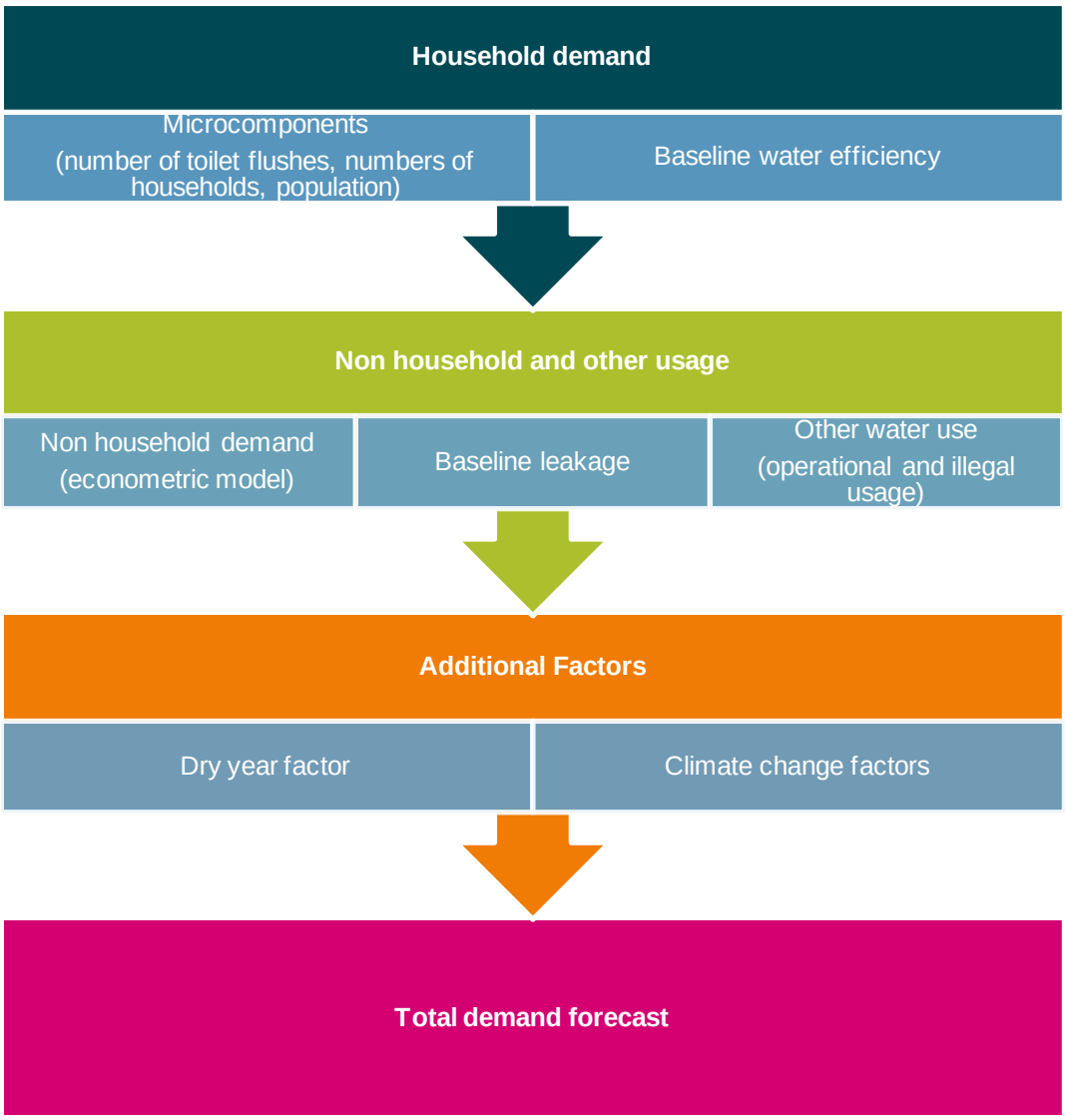


Figure 19: Building blocks of the total demand forecast

6.4 KEY DATA

A number of assumptions have been made in preparing the baseline demand forecasts in line with national methodologies and discussions with the Environment Agency. In each case, the best sources of available data have been used to ensure a reliable and robust assessment.

The key data used for derivation of the baseline demand forecasts is set out in the following sub-sections. The demand in 2012/13 was lower than forecast. Thereforewe have now used 2012/13 as our base-year to derive forecasts for future years. All data used for 2012/13 is consistent with the data reported to Ofwat and Environment Agency in our 2012/13 regulatory reporting.

6.4.1 Baseline demand management

Our baseline demand forecasts assume continued achievement of the baseline leakage levels in Table 14. Further leakage reduction actions needed as part of our water resources and demand strategy are set out in Section 11.

Table 14: Baseline leakage

	Actual total leakage 2012/13 (Ml/d)	Baseline total leakage from 2014/15 onwards (Ml/d)
Integrated Resource Zone	434.82	441.90
Carlisle Resource Zone	4.81	4.80
North Eden Resource Zone	2.14	2.00
West Cumbria Resource Zone	15.60	13.95
Region	457.37	462.65
Ofwat target for UU region	464.20	462.65

The “base service” component of the mandatory water efficiency target specifies, “each water company should have an annual target of saving one litre of water per billed property per day through approved water efficiency activity” (Ofwat, 2008). In our case, this equates to a target saving of 2.95 Ml/d each year, and we are required to carry out activities that should achieve these savings until 2015. We plan to maintain at least this level of water efficiency promotion until 2040 even if it no longer remains a mandatory target.

Our forecasts assume implementation of our current metering policies, which include metering of all new households and non-households, continued provision of a free meter option scheme for households and following consultation on our draft plan, further targeted promotion of the free meter option. For the draft plan, we used an econometric opting model developed for the water industry (UKWIR, 2008) to estimate that there would be 427 thousand free meter options installed between 2015 and 2025. Following consultation, we have identified a cost-effective way of increasing meter uptake, and committed to delivering a total of 510,000 free meter options between 2015 and 2025. We have continued to use the opting model to predict uptake beyond 2025 and expect a further 527,000 free meter options between 2025 and 2040. See Section 5 for further details of our metering programme.

The figure below shows how we expect our customer base to change as more customers move to being metered.

The effect of metering on household demand has been based on an assessment of actual historic data from long-term optant customers.

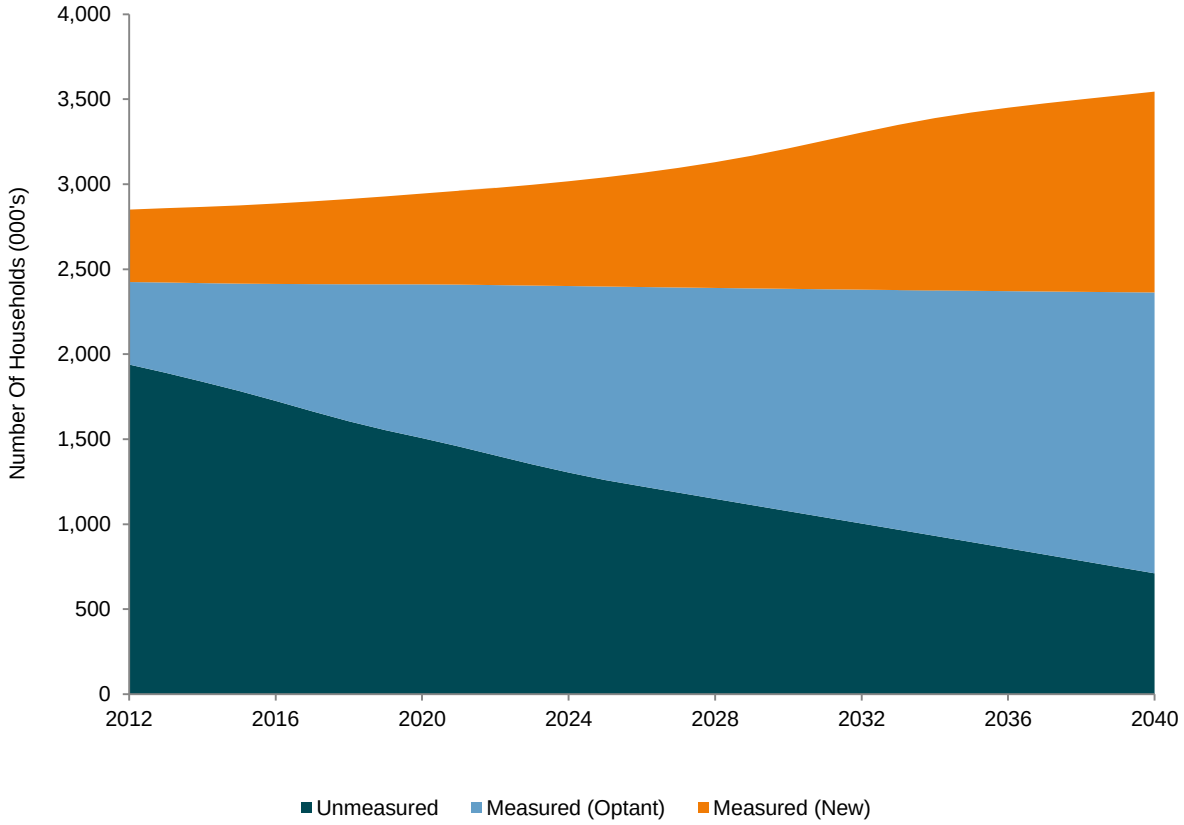


Figure 20: Forecast changes in household types

6.4.2 Population and Households

The population supplied with water by us is expected to increase by 12.6% from the 2013 level of 7.0 million to 7.9 million by 2040. This is in accordance with the latest information published by the Office for National Statistics (ONS) provided by census agent CACI. The number of properties served by us is expected to increase by 22.9% from the 2013 level of 3.0 million to 3.7 million by 2040. The forecasts are summarised in Table 15 below.

In compiling the forecasts for properties, we have followed the guidance set out in the steps outlined in the Water Resources Planning Guideline and the Environment Agency report “Methods of Estimating Population and Household Projections: Update 2012”.

The guidance suggests looking at a range of property forecasts and applying the most appropriate for the Water Resources Management Plan. Having completed this and having reviewed recent connection rates our preferred approach has been to adopt the projections supplied by the Office for National Statistics for population only and to use a forecast based on our current levels for properties going forward.

Table 15: Population and property forecasts by resource zone

Resource Zone	Population (000s)		Properties (000s)	
	2013	2040	2013	2040
Integrated Resource Zone	6,760	7,639	2,908	3,595
Carlisle Resource Zone	109	117	51	56
North Eden Resource Zone	14	14	7	8
West Cumbria Resource Zone	149	155	69	72
Regional Total	7,031	7,925	3,036	3,731

ONS data for properties is currently suggesting that we should be connecting circa 22,000 properties per annum. This level of connection has not been experienced since 2007/08 when connections stood at 25,000. The average from 2010 to 2012 has been circa 10,500. Figure 21 below shows the actual household connections from 2008 to 2012. This demonstrates the impact of the economic recession on house building.

The household projections that we use impacts not just on water demand forecasts, but also forecasts for income from customers, water supply-demand expenditure, new development expenditure, and wastewater supply-demand expenditure. Following unrealistically high levels of projected connections by ONS in the short term, could mean planning unnecessary investment, which customers would pay for.

We have therefore decided to adopt the following approach:

- 2014-15 – current best estimate of household growth based on economic research;
- 2016-20 – we will assume that the number of new households will increase by an additional 6.5% year on year;
- 2021-25 – we will assume that the number of new households will increase by an additional 10% year on year; and
- 2025-2040 – we will assume gradual increase back to absolute level forecast by ONS, with additional higher growth rate to allow for alignment to overall ONS figures.

Data from the 2011 census was not available for the draft plan, but has been included in this revised plan.

Average household occupancy has been steadily declining in recent decades, and we expect it to reduce from the 2012 level of 2.27 to 2.09 by 2040, in accordance with the projections used for population and households. Based on our recent survey of 1,287 customers, the average occupancy rates of new homes and meter optant properties are lower than those of unmeasured houses. These effects are also included in the demand forecast.

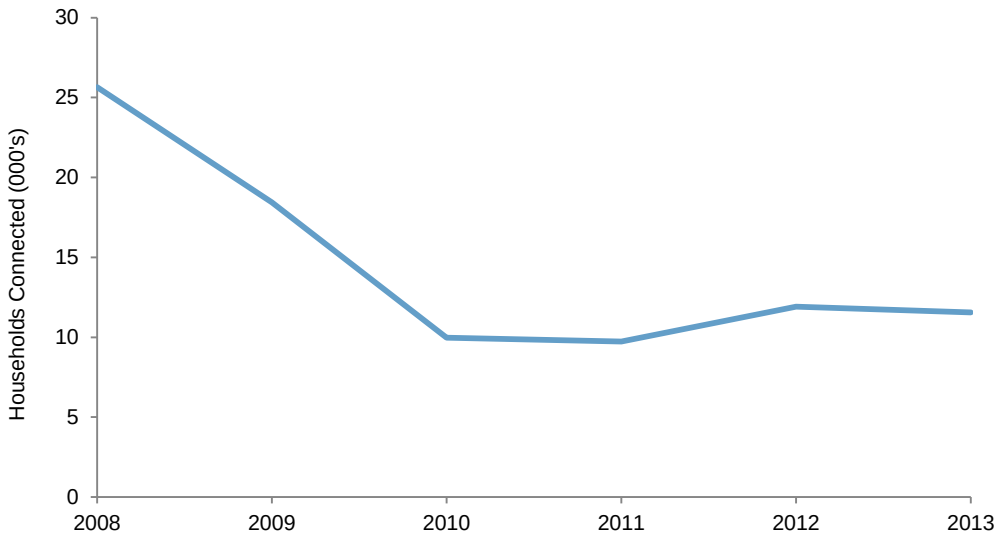


Figure 21: Number of actual household connections 2008-2013

6.4.3 Household demand

Forecast per capita consumption rates for metered and unmetered household customers is derived from detailed micro-component analysis. Current ownership of water-using appliances is derived from our detailed survey of 1,287 customers. The volume per use and frequency of use of such appliances has been derived from the Defra Market Transformation Programme. The change in appliance ownership over time has also been derived from the Market Transformation Programme. The results are summarised in Table 16.

We have included the effects of our base service water efficiency programme in these forecasts.

Our forecast average per capita consumption rate in a normal year at 2030 is 113 l/hd/d, which is lower than the Government's Future Water aspirational ambition of achieving an average of 130 l/hd/d by 2030 (Defra, 2008). At 2040, we forecast an average of 107 l/hd/d.

Since Spring 2009 Part G of the Building Regulations came into force, as specified in *Homes for the Future* (DCLG, 2007), all new homes built after this date have been and will be required to comply with a water use standard of no more than 125 l/hd/d. Our forecasts are fully consistent with these new requirements as the average water consumption rate for new homes is currently about 107 l/hd/d, and is forecast to remain close to that level.

6.4.4 Non-household demand

Non-household consumption of potable water across our region has reduced substantially in recent decades. This reduction is expected to continue, as shown in Figure 22.

We forecast that non-household water demand will fall by a further 18% between 2013 and 2040. This is based on the results from detailed econometric modelling of water consumption in North West England. Separate forecasts have been prepared for different industrial sectors.

Table 16: Summary of dry year household water demand

Ml/d	2013	2020	2030	2040
Water consumption by measured households	248	352	501	639
Water consumption by unmeasured households	692	567	403	261
Water consumption by measured non-households	360	327	309	295
Water consumption by unmeasured non-households	13	12	11	11
Other water use	26	26	26	26
Total leakage	457	463	463	463
Dry Year Distribution Input	1,797	1,747	1,712	1,695

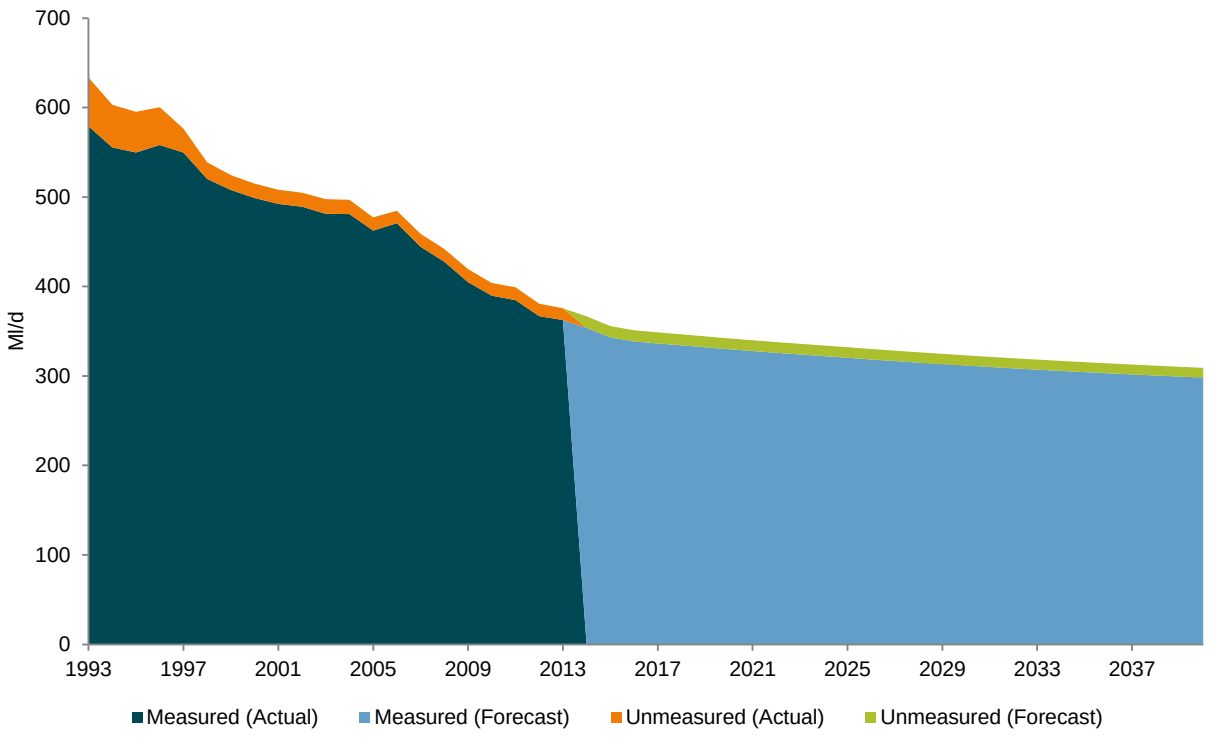


Figure 22: Trend in non-household water demand (Ml/d)

Water use by non-households has consistently reduced over the last thirty years. Our econometric model assumes continued economic growth in the region (after the next few years) but that the strong trend for reducing water use will also continue. The continuing decline in non-household water demand results from continuing water efficiency measures and reduction in water-intensive industry in North West England. While there will be some local variations, the overall trend is clear.

Table 17 below outlines our forecast for non-household demand.

We will continue to ensure that adequate water supplies will be available to meet customer requirements, and that our plan presents no barrier to the region's economic growth or housing development.

Table 17: Forecast non-household demand

Ml/d	2013	2040
Unmeasured non-households	13	11
Measured non-households	360	295
All non-households	373	306

6.4.5 Weather effects on demand

The balance of supply and demand is most critical in years that have a prolonged hot and dry summer. In these conditions, water availability is reduced and higher than usual demands occur. In accordance with the Water Resources Planning Guideline (EA, 2013) an assessment has been made of the dry year annual average unrestricted daily demand for each resource zone for comparison with reliable water supply availability.

During the consultation period, the Environment Agency questioned our approach to planning for a dry year. We have worked with the Met Office to improve our approach and this better understanding has reduced the dry year uplift. This work has shown that 1995/96 was the year where we would expect the most weather related demand within the period that good data was available (1961/62 to 2012/13).

The Met Office developed a model of weather and demand for the United Utilities region. Using representative weather observations of air temperature, rainfall and sunshine from 1961 to present, the model predicts total demand, weather related usage and leakage. Approximately 10 years of weekly, and 3 years of daily demand, leakage and non-domestic data were used for model configuration.

The weighted average demand is designed to more accurately estimate weather induced demand over the planning horizon compared with using the normal or dry years alone. Over the planning horizon there will be some combination of wet, dry and normal years, and the weighted average demand is designed to reflect these conditions more accurately. The “average year” (which the guidelines refer to as the “weighted average”) is the arithmetic mean of all the years in the distribution.

We retain our definition of the dry year by reference to the weather conditions experienced in 1995/96. This is the year in which the model predicts the highest demand in the observed weather record from 1961. We assume that the base year 2012/13 represents a normal year and have calculated our dry year uplift in relation to the 2012/13 year.

The model predicts that household consumption in a dry year will be 9.4% higher than the base year. It predicts that the weighted average household consumption will be 1.9% higher than the base year. No weather signal was detected in the non-household consumption and therefore it is concluded that there is more variability in non-household consumption due to other factors than weather. No uplift has been applied to non-household consumption.

The model has also identified the uncertainty in the dry year factor and this has been included in headroom (Section 7).

The Environment Agency asked us to consider using a year with less extreme demand, a year when we wouldn’t need to introduce water use restrictions. Another stakeholder asked us to plan for more extreme dry weather demand. We do not think it appropriate

to plan for a less severe drought than 1995/96, because this would make us more reliant on drought permits than is currently the case and there is a strong customer preference to avoid these (see Section 2.1.2). Equally we do not consider it appropriate to plan for more extreme events in our baseline demand forecast because it could require further investment that is difficult to justify based on historical evidence. Furthermore, an allowance for uncertainty in the demand forecast is included in the headroom allowance. Therefore, we will continue to use 1995/96 to define our dry year.

The Carlisle and West Cumbria Resource Zones are vulnerable to short period drought events because of the lower volumes of storage available. In these cases, the "critical periods" of our water sources are between 2 and 3 months. Forecasts of "critical period average daily demand" have been prepared for these zones in accordance with the Water Resources Planning Guideline (EA, 2013) and using the Peak Water Demand Forecasting Methodology (UKWIR, 2005).

6.4.6 Climate change effects on demand

In the draft plan, we have used the report Climate Change and the Demand for Water (Defra, 2003) to estimate the potential effects of climate change on water demand. Although this is nearly a decade old, it remained the authoritative source for assessing the impact of climate change on demand. Since the publication of our draft plan, new research has become available and we have used it in this revised plan. The data from the Impact of Climate Change on Water Demand (UKWIR, 2013) report results in a lower increase in demand than we included in the draft plan. The estimated impacts are summarised in Table 18.

Table 18: Estimated impact of climate change on dry weather demand

Ml/d	2012	2020	2030	2040
Draft plan – Defra 2003 method	0	6.6	14.0	15.9
Revised draft plan – UKWIR 2013 method	0	2.0	4.2	6.7
Difference	0	-4.6	-9.8	-9.2

6.5 BASELINE DEMAND FORECASTS

The methods and assumptions described above have been used to prepare baseline demand forecasts for each water resource zone, as summarised in Tables 19 and 20. The components of the regional dry year demand forecast through the planning period to 2040 are illustrated in Table 19. This shows the way in which we expect household demand and non-household demand to reduce, and the anticipated transfer of a large number of households from unmeasured to metered.

Overall, we forecast that demand will generally reduce due primarily to the expected effects of:

- Growth in customer metering;
- The growing use of low-flush-volume toilets and other water efficient appliances;
- The continuation of our base service water efficiency programme; and
- Forecast reductions in measured non-household demand resulting from macroeconomic factors and water efficiency.

Table 19: Baseline dry year average demand forecast for all resource zones including climate change

Ml/d	Integrated Resource Zone		Carlisle Resource Zone		North Eden Resource Zone		West Cumbria Resource Zone	
	2013	2040	2013	2040	2013	2040	2013	2040
Measured household demand	240.2	621.0	3.5	8.6	0.5	1.1	3.7	8.2
Unmeasured household demand	659.3	242.6	11.8	5.3	1.5	0.6	19.8	12.7
Measured non-household demand	342.2	281.0	6.8	5.6	1.4	1.1	9.6	7.7
Unmeasured non-household demand	11.9	9.9	0.3	0.2	0.1	0.1	0.5	0.4
Other water use	24.0	24.0	0.4	0.4	0.1	0.1	1.3	1.3
Total baseline leakage	434.8	441.9	4.8	4.8	2.1	2.0	15.6	14.0
Total dry year demand	1,712.5	1,620.4	27.7	24.9	5.8	5.1	50.6	44.3

Table 20: Baseline dry year critical period demand forecast for Carlisle and West Cumbria Resource Zones

Ml/d	Carlisle Resource Zone		West Cumbria Resource Zone	
	2013	2040	2013	2040
Measured household demand	3.8	9.2	4.1	9.0
Unmeasured household demand	12.7	5.7	21.7	14.0
Measured non-household demand	7.3	5.9	10.5	8.5
Unmeasured non-household demand	0.3	0.2	0.6	0.5
Other water use	0.4	0.4	1.3	1.3
Total baseline leakage	4.8	4.8	15.6	14.0
Total dry year demand	29.3	26.4	53.8	47.3

Table 21: Comparison to draft Water Resources Management Plan

Ml/d	Integrated Resource Zone 2040	Carlisle Resource Zone 2040	North Eden Resource Zone 2040	West Cumbria Resource Zone 2040
Dry Year				
Total demand – draft plan	1,668	27	5	46
Change of base year to 2012/13	(17)	0	0	(0)
Changes to weather & climate change effects	(31)	(1)	(0)	(1)
More metering	(7)	0	(0)	0
Total demand – revised draft plan	1,620	25	5	44
Critical Period				
Total demand – draft plan	N/A	29	N/A	50
Change of base year to 2012/13	N/A	0	N/A	(0)
Changes to weather & climate change effects	N/A	(1)	N/A	(1)
Property & population changes	N/A	(2)	N/A	(2)
More metering	N/A	0	N/A	0
Total demand – revised draft plan	N/A	26	N/A	47

7 TARGET HEADROOM

Key Messages

- Long term forecasts by their nature are uncertain
- We have made allowance for uncertainties by including headroom in the supply-demand balance
- We have adopted the same approach to risk in our 2009 Water Resources Management Plan

7.1 ROLE OF TARGET HEADROOM

It is difficult to forecast demand for water or water availability with complete accuracy, especially over a 25-year period. Uncertainty exists in all the components of the supply-demand balance. These include political, social, environmental, climate change and technical factors outside of our control. To make sure we always have sufficient water to supply our customers there must be a "buffer" to make sure water availability is greater than demand. This buffer is called target headroom.

Government Ministers (Defra, 2004) recognise the need for sufficient headroom. They require water companies "to plan to have sufficient headroom and use appropriate methodologies and guidance to achieve this".

7.2 TARGET HEADROOM METHODOLOGY

We have applied the most recent national best practice methodology to determine target headroom values for each of our four resource zones for the planning period to 2039/40. The methodology involves identifying and quantifying the potential effects on the supply-demand balance of the following issues[7]:

Supply-side issues

- S4. Bulk transfers;
- S5. Gradual pollution causing a reduction in abstraction;
- S6. Accuracy of supply-side data;
- S8. Uncertainty of climate change on yield; and
- S9. Uncertainty in deployable output of supply-side solutions.

Demand-side issues

- D1. Accuracy of sub-component data;
- D2. Demand forecast variation;
- D3. Uncertainty of climate change on demand; and
- D4. Uncertainty in benefit of demand-side solutions.

The elements of uncertainty associated with each of the above components have been considered for each of our resource zones. Demand-side issues have also been assessed for the critical periods of the Carlisle and West Cumbria Resource Zones.

7.3 LEVEL OF CONFIDENCE

The headroom methodology determines "Headroom Uncertainty" as a probability distribution that represents a likely range of values for headroom over selected years

[7] Further supply side issues, numbered S1, S2, S3 and S7 were included in Water Resources Management Plans prior to the 2009 plan. In accordance with the Water Resources Planning Guideline (Environment Agency, 2012) we have made no allowance for S1, S2, S3 or S7 type uncertainties – mainly because abstraction licences changes can be planned in advance through the Water Resources Management Plan process.

within the planning period. This is illustrated in Figure 23, which plots illustrative percentile values through time.

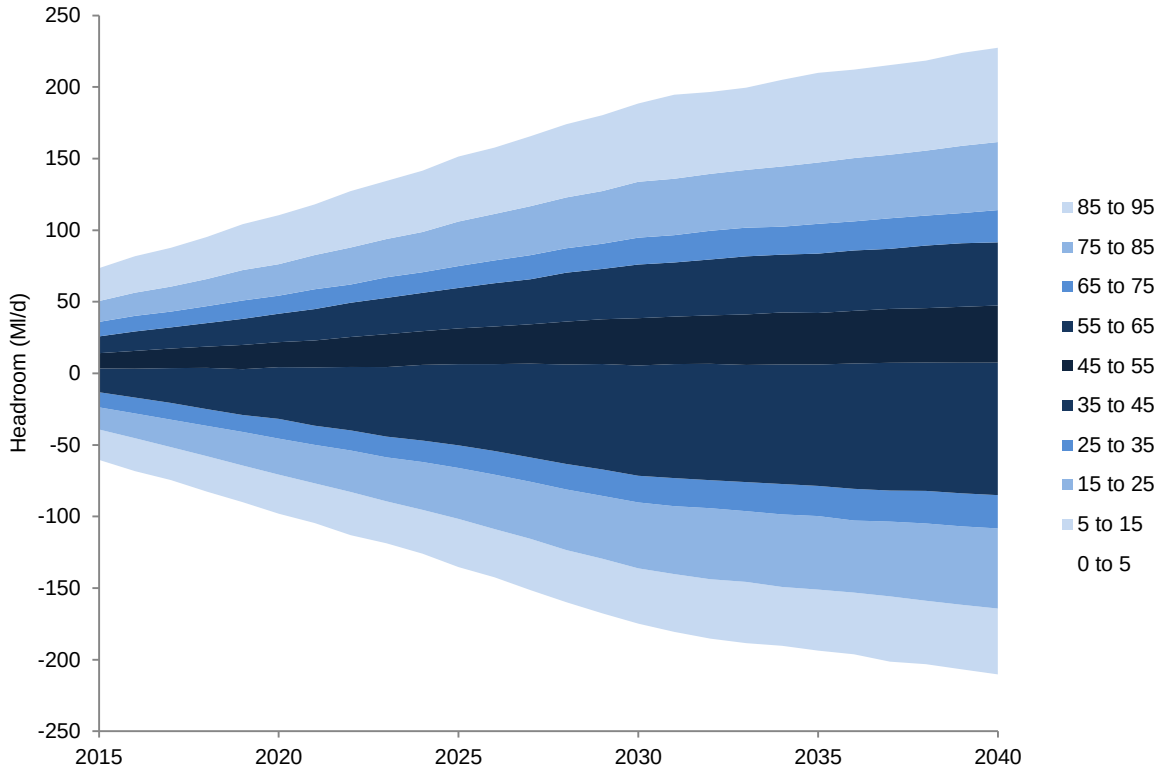


Figure 23: Illustrative results for headroom uncertainty for the Integrated Resource Zone

The amount of headroom to include in the plan is determined by a choice of percentile. The percentile measures how confident we are that there is an adequate supply-demand balance. For example, the 95th percentile is a very high level of confidence in the supply-demand balance.

In accordance with the Water Resources Planning Guideline, we have applied a varying percentile over the planning horizon, with a lower level of confidence in future years than at present. The percentile through the planning horizon adopted by us has been chosen to ensure an appropriate balance between taking adequate measures to safeguard the reliability of supply to customers and the avoidance of unnecessary costs.

In our 2008 draft Water Resources Management Plan, the climate change uncertainty components (S8 and D3) had a very large impact on the target headroom values for the Integrated Resource Zone. We had carefully followed best practice in the assessment; it was the wide range of predictions from the different global climate models we were required to use that led to the large uncertainty. Ofwat suggested in their consultation response that United Utilities consider reducing the effect in order to avoid major expenditure (and impact on customer bills) arising directly from the large uncertainty in the climate change predictions. In discussion with the Environment Agency, we decided to apply a different percentile for climate change to that applied for other uncertainty components for our 2009 Final Water Resources Management Plan.

The adopted percentiles for this Water Resources Management Plan are summarised in Table 22. As 2014/15 is very near to the present time, we have used the 95th percentile headroom values representing a high degree of confidence. In the case of 2039/40, which is much more distant in the planning horizon, we have the opportunity, over the coming years, to modify our plans to adapt to changing circumstances. It is,

therefore, appropriate that a smaller allowance is made in the supply-demand balance, representing less confidence in the longer term. We have therefore selected a profile that reduces to the 70th percentile by 2039/40.

Table 22: Summary of profile used to derive target headroom values

Headroom uncertainty percentile	2014/15	2019/20	2024/25	2029/30	2039/40
Non-climate change uncertainties	95th percentile	85th percentile	75th percentile	70th percentile	70th percentile
Climate change uncertainties	50th percentile	50th percentile	50th percentile	50th percentile	50th percentile

The percentile through the planning horizon adopted by us for non-climate change uncertainties has been chosen to ensure an appropriate balance between taking adequate measures to safeguard the reliability of supply to customers, and the avoidance of unnecessary costs. The factors that influence the choice of percentile include customer requirement for reliable, continuous supply of water and the need for affordable water prices. This requirement has been consistently expressed by customers, for example in customer surveys undertaken for the current and previous Periodic Reviews. The views of customers have been used to define our target level of service, which includes a hosepipe ban frequency of once in 20 years. However, customers prioritise sufficient water to meet demand higher than hosepipe ban frequency (see Figure 24).

In the consultation no respondents raised issues with our approach to headroom, so we have made no changes to our approach and retained the choice of percentile in Table 22. Because demand and supply forecasts have been updated following consultation, these changes have a minor effect on the total headroom in the plan.

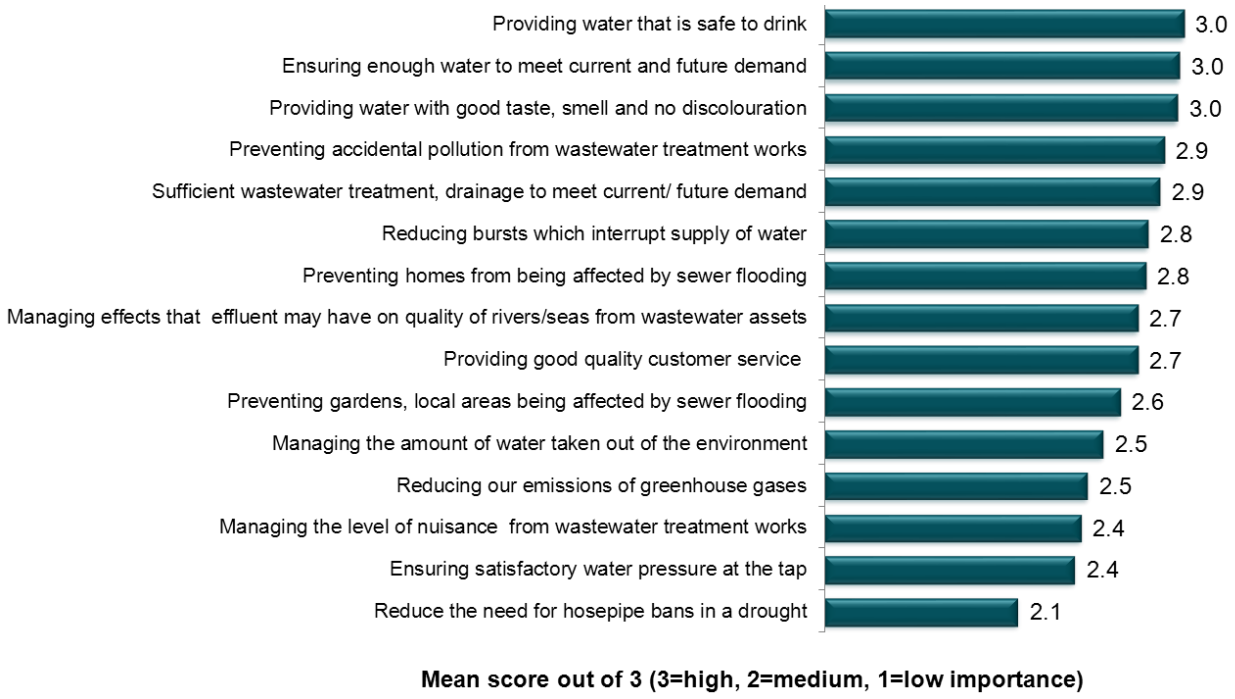


Figure 24: United Utilities and DJS customer priorities research (May 2012)

7.4 TARGET HEADROOM VALUES

The calculated target headroom values required between water available for use and demand are summarised in Table 23. The headroom values tend to fluctuate through time, with upward pressures due to increasing uncertainties, and downward pressures in line with the increasing percentile profile.

The contribution to target headroom values due to uncertainty of climate change impact on water source yields and water demand is shown in Table 24. It is significant only in the case of the Integrated Resource Zone, because of the large number of reservoirs that are part of the supply system for that resource zone.

Table 23: Target headroom values (with climate change)

	2014/15	2019/20	2024/25	2029/30	2039/40
Integrated Resource Zone					
Target Headroom (Ml/d)	63.5	53.5	52.4	55.9	68.0
% of water for available use	3.4	2.9	2.9	3.1	3.8
Carlisle Resource Zone (Critical Period)					
Target Headroom (Ml/d)	2.5	1.9	1.6	1.5	1.6
% of water for available use	7.7	6.1	5.3	5.0	5.4
North Eden Resource Zone					
Target Headroom (Ml/d)	0.2	0.2	0.2	0.2	0.2
% of water for available use	2.7	2.0	1.9	1.9	2.5
West Cumbria Resource Zone (Critical Period)					
Target Headroom (Ml/d)	3.0	2.2	1.7	1.7	1.8
% of water for available use	5.4	3.8	9.5	10.2	11.9

Table 24: Contribution of climate change to the target headroom values (M/d)

Water Resource Zone	Contribution of climate change to target headroom (Ml/d)				
	2014/15	2019/20	2024/25	2029/30	2039/40
Integrated Resource Zone	2.2	7.6	13.0	18.4	21.9
Carlisle Resource Zone (Critical Period)	0.0	0.1	0.1	0.2	0.2
North Eden Resource Zone	0.0	0.0	0.0	0.0	0.0
West Cumbria Resource Zone (Critical Period)	0.1	0.3	0.5	0.7	0.8

7.5 SENSITIVITY ANALYSIS

The uncertainty factors which generally have greatest impact on the calculated values for target headroom are:

- Uncertainty in accuracy of supply side data (S6);
- Climate change impact on water source yields (S8), which is the dominant component for the Integrated Resource Zone and a significant component in the Carlisle and West Cumbria Resource Zones for much of the planning horizon; and
- Uncertainty in demand forecast (D2).

The sensitivity of the headroom values for each resource zone to the inclusion of climate change uncertainties (components S8 and D3) at the 50 percentile is indicated in Table 25. In addition, this table shows the target headroom values if a different climate change percentile was adopted for comparison reasons.

Table 25: Effect of climate change on target headroom values

Ml/d	2014/15	2019/20	2024/25	2029/30	2039/40
Integrated Resource Zone					
Climate change impact using 50th percentile	2.2	7.6	13.0	18.4	21.9
Climate change impact using 95th to 70th percentile	2.0	12.0	21.8	29.0	34.0
Carlisle Resource Zone (Critical Period)					
Climate change impact at 50th percentile	0.0	0.1	0.1	0.2	0.2
Climate change impact using 95th to 70th percentile	0.0	0.2	0.4	0.5	0.7
North Eden Resource Zone					
Climate change impact at 50th percentile	0.0	0.0	0.0	0.0	0.0
Climate change impact using 95th to 70th percentile	0.0	0.0	0.0	0.0	0.0
West Cumbria Resource Zone (Critical Period)					
Climate change impact at 50th percentile	0.1	0.3	0.5	0.7	0.8
Climate change impact using 95th to 70th percentile	0.3	1.8	2.7	3.6	4.6

7.6 COMPARISON WITH DRAFT PLAN AND THE 2009 PLAN

Table 26 summarises the target headroom derived for use in our 2009 Water Resources Management Plan, while Table 27 summarises the target headroom values calculated by the assessment undertaken for this draft plan using the same percentile choice as for the 2009 plan.

Table 26: Target headroom values derived for 2009 Water Resources Management Plan

Water Resource Zone	Target Headroom (Ml/d)				
	2009/10	2014/15	2019/20	2024/25	2034/35
Integrated Resource Zone	53.4	79.3	99.0	106.0	129.5
Carlisle Resource Zone	0.6	0.8	0.6	0.5	0.7
North Eden Resource Zone	0.4	0.2	0.1	0.2	0.2
West Cumbria Resource Zone	1.9	1.8	1.6	1.4	1.5

Table 27: Target headroom values derived for the draft plan

Water Resource Zone	Target Headroom (Ml/d)				
	2014/15	2019/20	2024/25	2029/30	2039/40
Integrated Resource Zone	57.6	62.3	50.8	52.7	59.8
Carlisle Resource Zone (Critical Period)	2.4	1.8	1.5	1.4	1.4
North Eden Resource Zone	0.2	0.2	0.2	0.2	0.2
West Cumbria Resource Zone (Critical Period)	2.7	1.6	0.9	0.5	0.4

Table 28: Target headroom values derived for this plan

Water Resource Zone	Target Headroom (Ml/d)				
	2014/15	2019/20	2024/25	2029/30	2039/40
Integrated Resource Zone	63.5	53.5	52.4	55.9	68.0
Carlisle Resource Zone (Critical Period)	2.5	1.9	1.6	1.5	1.6
North Eden Resource Zone	0.2	0.2	0.2	0.2	0.2
West Cumbria Resource Zone (Critical Period)	3.0	2.2	1.7	1.7	1.8

There are a wide range of factors that have contributed to the changes in target headroom profiles from the 2009 Water Resources Management Plan to this plan, with the largest effects due to the reasons described below.

Accuracy of supply-side data (S6)

An improved assessment of the different uncertainties of supply-side data has been carried out. Depending on the resource zone in question, the following categories have been included in component S6:

- Hydrological data uncertainty: This accounts for uncertainty associated with inflow derivation methods and is linked to sensitivity testing in Aquator™ models (see Section 4.3) where possible;
- Modelling and operational uncertainty: This accounts for the uncertainty associated with real-life operational decision-making;
- Process and raw water losses: This accounts for the uncertainty in the calculations of losses from raw water assets and treatment works;
- Groundwater data uncertainty: This accounts for the uncertainty in hydrogeological data;
- Compensation over-releases: This reflects the fact that compensation releases cannot be controlled exactly; and
- Demand saving uncertainty: This is associated with demand saving restrictions as this impacts on the deployable output result (included for the Integrated Resource Zone only).

Uncertainty of climate change on yield (S8)

For the 2009 Water Resources Management Plan, we carried out detailed hydrological modelling to estimate the effect of the “low”, “medium” and “high” climate change scenarios on deployable output during the 2020’s for each resource zone. The central estimated impacts were included in our water supply forecasts. The uncertainty in potential impacts on water availability, as represented by the lower and upper impacts derived from applying the UKWIR methodology, were included in our target headroom analysis.

As explained in Section 4.5, we used new methodologies to assess the likely impact of climate change on source yields. Following the completion of vulnerability assessments, our approach has ultimately resulted in the assessment of climate change for 20 UK Climate Projections 2009 (UKCP09) scenarios for each resource zone. These cover the full range of UKCP09 scenarios (from a 100 sub-sample of the 10,000 scenarios available), with a greater number of samples towards the drier end of the population. For this reason, results are weighted for the Integrated and Carlisle Resource Zones. We treat all 20 scenarios in the West Cumbria Resource Zone with an equal weighting because sub-sampling of UKCP09 based on aridity did not work well. This method does not bias overall deployable output calculation, but allows for a fuller understanding of resilience of a resource zone to climate change impacts. The 20 UKCP09 scenarios have been used to inform uncertainty in our headroom assessment. This improved understanding has resulted in lower values for component S8, particularly for the Integrated Resource Zone.

The changes from the draft to current plan are relatively small. The biggest impact is from a change in the analysis of the demand-side issues. Analysis of uncertainty around the increase in demand in dry years has been included, which increases the headroom allowance. However, the overall reduction in the dry year demand is greater than the increase in headroom.

8 OPTIONS

Key Messages

- We have considered a wide range of supply-demand options for all four of our water resource zones
- These options include new water sources, reducing leakage from water mains and working with our customers to reduce their demand for water through water efficiency promotions and fitting more water meters
- For each feasible option, we have assessed the amount of water it would provide, the cost and the positive/negative effects of building and operating it, including any effects on the environment and people

8.1 NEED FOR SUPPLY-DEMAND OPTIONS

We have completed detailed studies to identify the expected future changes in the availability of water for supply and to predict demand changes, described in Sections 4, 5 and 6. Where supply is not sufficient to meet demand, in order to maintain our preferred level of service to customers (see Section 2.4), we need to carry out actions to increase supply and/or reduce demand in this zone. If we do not carry out such actions, the frequency of water restrictions and of environmental drought powers will increase. This would be contrary to the expectations of our customers (as reflected in the outcomes of our customer surveys, see Section 2 of this document), the Environment Agency, Defra, Ofwat and the Consumer Council for Water.

8.2 OPTION APPRAISAL METHODOLOGY

We have followed the Water Resources Planning Guidelines to identify and appraise potential supply-demand options (Environment Agency, 2013). Within the guideline is a detailed process called the Economics of Balancing Supply and Demand methodology (EBSD). The Environment Agency and United Kingdom Water Industry Research (UKWIR) together wrote the methodology. This provides a structured, consistent approach that all water companies can follow to identify, assess and compare a range of options to balance supply and demand (Environment Agency / UKWIR, 2002). An amended version of the EBSD decision framework is also presented in a 2012 UKWIR report (UKWIR/Environment Agency, 2012). We have used both of these reports for the options appraisal process. A full description of the EBSD methodology and its components is provided in Appendix 9. There is also a requirement for us to carry out two separate environmental impact assessments as part of the water resources planning process. The strategic environmental assessment (SEA) and habitats regulations assessment (HRA) are described in detail in Section 8.5.

As well as the EBSD, there are several other important supporting methodologies which describe specific aspects of the option appraisal process:

- Benefits Assessment Guidance (eftec, 2012) gives guidance on the assessment of the environmental and social costs, benefits and impacts associated with each option;
- Involving customers in price setting (Ofwat, 2011), describes how companies will engage with their customers to help them shape their plans for PR14;
- Carrying out willingness-to-pay surveys (UKWIR, 2012), provides guidance of how a water company undertakes willingness to pay surveys and engages with customers to determine their views; and
- A review of the calculation of sustainable economic level of leakage and its integration with water resource management planning (Environment Agency, Ofwat and Defra, 2012), describes how to value the environmental and social costs or benefits of leakage reduction options.

We have completed customer preference surveys, willingness to pay and willingness to accept surveys and commissioned focus group research in order to gather our customers' views (see section 2 for further details). These surveys helped us to explore the views of customers about what supply-demand solutions they preferred. These demonstrated strong support for leakage reduction, or a mixed programme of

leakage reduction, water efficiency promotion and some additional water supplies. These options were preferred to solely implementing new water supplies.

- Our approach for the options appraisal process, in accordance with the various methodologies, is set out in this report as follows:
- Identification of "unconstrained" options – Section 8.3;
- Identification of "feasible" options and their costs and benefits – Sections 8.4 and 8.5;
- Environmental appraisal (SEA/HRA) – Section 8.5;
- Derivation of the supply-demand balances – Section 9; and
- Derivation of a water resources and demand strategy, taking account of the environmental appraisal, customer preferences and costs – Section 10.

Our approach is explained further in Appendix 9, and an outline description of each feasible option is provided in Appendix 10.

For our revised plan, we have provided further details on how components of the cost of options has been derived. This supplementary information is also detailed in Appendix 9.

8.3 UNCONSTRAINED OPTIONS

The EBSD methodologies and Water Resources Planning Guidelines provide details of a wide range of different types of option that need to be considered when constructing a supply-demand strategy. Some of these options have been requested by Government, such as water trading and demand management activities and we have included these option types in the appraisal process. The option types are grouped into four main categories. Detailed in Table 29 are the various option descriptions that we have considered with specific examples of each type and whether we have included the option in the appraisal process. These options are referenced from the Water Resources Planning Guidelines and UKWIR/Environment Agency (2013).

Table 29. Types of supply and demand options suggested in the water resources planning guidance

Production Management Options	Examples
Diagnostic studies	Verification of metered flows on major water supply pipes. This is considered a business as usual activity and no specific options have been developed.
Improved leakage detection and reduction on raw water mains	Leakage on raw water pipes that feed water treatment works.
Reduce treatment works losses	Changes that make our water treatment works more efficient. We have not considered this option specifically as this is a business as usual activity.
Customer Management Options	**Examples**
Water use audit and inspection/identification of household and non-household water efficiency opportunities	Checks of water usage and fitting of water saving devices, such as retro-fit dual flush toilets.

Targeted water conservation information	Working with our customers so that they can become more water efficient. We will continue to implement extensive water conservation and education programmes and therefore no specific options have been developed.
Promotion of water saving devices	Showerheads, save-a-flushes, waterless car washing kits given away at customer events.
Water recycling	Rainwater harvesting systems in domestic properties.
Water efficiency enabling activities	Offering free and subsidised water butts to customers.
Advice and information on direct abstraction and irrigation techniques	There is negligible use of drinking water for irrigation in our region. No specific options have been developed.
Advice and information on leakage detection and fixing techniques	We already provide such advice and information and will continue to provide such information. No specific options have been developed.
Change in level of service to enhance water available for use	Reducing the level of service to impose more frequent water use restrictions (e.g. hose pipe ban).
Compulsory metering	Household and non-household compulsory metering has not been considered as a specific option as this is not considered appropriate.
Enhanced/smart metering	We have considered promotion to all customers who would benefit financially from having a meter.
Meter installation policy	This has not been considered as a specific option.
Metering of sewerage flow	This has not been considered as a specific option.
Introduction of special fees	We do not charge special fees to customers, e.g. those that use swimming pools and we have no plans to implement. No specific options have been developed.
Changes to existing measured tariffs	Changes to existing measured tariffs have been considered and are either not feasible or are already implemented as fully as practicable at the present time. No specific options have been developed.
Introduction of special tariffs for specific users	We already consider such tariffs and will continue to consider them for some of our commercial customers to better service their requirements. No specific options have been developed.
Other options (e.g. use of non-potable water, improving the enforcement of water regulations)	We have included extra options for: • metering on change of occupier • blanket promotion to all customers about metered supply benefits • water efficiency visits to customers with free meter options being promoted • each time a customer contacts us we will inform them that a new meter will be installed.
Distribution Management Options	**Examples**
Customer supply pipe leakage reduction	Identification and fixing of water supply pipe leaks. This is an on-going activity and so no specific options have been developed.
Leakage reduction	Fixing of reported leaks on water mains and pipes to customers. This is an on-going activity and so no specific options have been developed.
Leak detection	Data collection and analysis of metered flows in water mains to detect leaks.
Pressure reduction programmes	Understanding whether reducing the pressure in water mains can reduce leakage

Advanced replacement of infrastructure for leakage reasons	Understanding the condition of our water mains and whether these should be replaced proactively.
Distribution capacity expansion	The increase of the capacity of the water mains does not provide any benefit and therefore no specific options have been developed.
Resource Management Options	**Examples**
Direct river abstraction	New abstraction sites on rivers
New reservoir storage	New impounding reservoirs or pumped-storage reservoirs
Reservoir raising	Increasing the height of dams to provide more water storage
Groundwater wells (boreholes)	New abstraction sites or utilising existing sources
Infiltration galleries	These systems have no additional benefit above and beyond direct river abstractions and groundwater wells and so no specific options have been developed.
Artificial storage and recovery wells	Pumping water into aquifers during the winter for re-abstraction in the summer. No specific options have been developed.
Aquifer recharge	Pumping water into aquifers during the winter for re-abstraction in the summer. No specific options have been developed.
Desalination	Removal of sea water and treating to supply to customers
Reclaimed water	Effluent reuse from waste water treatment works
Bulk transfers	Transfers from sources both inside and outside the United Utilities supply area.
Tankering of water	No specific options have been developed as this would not satisfy operational requirements and customers' expectations.
Improved/sophisticated conjunctive management	Consideration of further improvements in the connectivity within our supply system

An important resource management option that has been considered in this plan relates to the bulk transfer of water into, out of and within our supply area. Options to improve the connectivity between water companies and to better share existing abstraction licences are a fundamental requirement of Defra and Ofwat in the preparation of the PR14 Water Resource Management Plans. Therefore, we have considered the following types of option:

- Water trading – through bulk supplies between water companies (neighbouring or not). Imports and exports between eight companies were identified;
- Abstraction licence trading within catchments – this provides a company with an option to purchase or sell abstraction licences to help meet its supply needs or to sell surplus water to other abstractors. Potential trading opportunities with 10 abstraction licence holders were identified; and
- Supply/demand options provided by other water companies or by third parties – allowing others to provide demand and/or supply options in the plan increases the scope for lower costs and innovative solutions. No options from third parties were received following our advertisements.[8]

[8] corporate.unitedutilities.com/Water-Resources-Management-Plan

Options proposed or provided by other water companies or third parties have been included in the options appraisal process alongside the feasible options from within our own water supply area, see Appendix 8 for more details. These options have been evaluated in the same way to ensure a consistent approach. Since the publication of our draft plan, we have sought confirmation from other water companies on the requirement for sharing of water resources options. No companies have indicated that there is a requirement for trading in the 2015-2020 period.

We have considered a wide range of possibilities for each of the four option types detailed in Table 26 above. This list, described as the "unconstrained" options, has been screened based on how feasible the option would be to implement. The criteria used to carry out this screening process are detailed in the EBSD methodology and in Environment Agency (2012):

- Does the option address the problem?
- Does the option breach unalterable planning constraints?
- Is the option promotable?
- Does the option have a high risk of failure?

This screening resulted in the identification of a smaller list of feasible options. The options appraisal process has been carried out simultaneously with the supply-demand balance assessment, and so options for all four water resource zones have been considered.

All of the water trading options passed the screening process. However, none of the abstraction licence trading options passed the screening process and were not considered further in the feasible options list. This is because the options were either non-consumptive licences (i.e. there is no water to trade for public water supply), have water quality issues or a lack of a nearby suitable water treatment works in our supply area.

For those options that passed the screening criteria and that formed the feasible list, option scopes were constructed to provide an indication of the potential water savings each option could deliver. At this stage, assumptions were made about the scheme outputs considering what could realistically be achieved(customer/production/distribution management options) or what water was available for abstraction (resource management options). Interdependencies with other options were also considered at this stage where applicable.

Since we published our draft plan, we have considered the outputs from the Habitats Regulation Assessment of our Drought Plan(Stage 3)[9]. This report details possible options for our West Cumbria resource zone that could be implemented during a drought and highlighted that a redundant impounding reservoir and a large scale effluent reuse scheme could be supplementary resource side options pending a review of infrastructure requirements.

The impounding reservoir was an unconstrained option in the draft plan but did not pass the screening assessment. Effluent reuse was considered as a feasible option in the draft plan (option reference WC23) to non-household customers but on a much

[9] Habitats Regulation Assessment Stage 3 – Alternative Option Assessment report (Grontmij, 2013).

smaller scale than the proposed “treatment and transfer” from the large coastal sewage works.

For our revised plan, we have provided a new scope for the treatment of final effluent from Workington and Whitehaven wastewater treatment works and the transfer to our West Cumbria water supply system. Therefore, option WC25 has been included in the feasible options list alongside the other options already assessed.

We have also provided additional scopes for variations to some of the existing groundwater source options for West Cumbria. Details of these changes are provided in Appendix 10.

8.4 FEASIBLE OPTIONS

The feasible options have been analysed to assess:

- Potential benefit to water available for use or savings in demand;
- The cost to construct/implement the option and the associated operational costs;
- Any savings in operational costs associated with demand reduction;
- Environmental and social costs/benefits;
- Sustainability of benefits. For example, the water savings from many water efficiency options reduce as customers replace or remove devices over time; and
- The Average Incremental Social Costs (AISC). The AISC is a measure of the overall unit cost of an option, and is usually expressed in terms of pence per cubic metre of water (p/m^3). It provides a simple, initial ranking of supply-demand options of different types, and includes monetised environmental and social costs and benefits as well as financial costs.

The list of the feasible options and a description of each are presented in full in Appendix 10.

The environmental and social costs and benefits of each feasible option have been calculated from a detailed study using best available cost-benefit valuations. The valuations were carried out following the detailed methods in the Environment Agency’s Benefits Assessment Guidance (EA, 2012).

The environmental and social issues evaluated include a wide range of issues, as appropriate for each particular option, such as:

- Environmental impacts of water supply schemes, during construction and/or during scheme operation. Examples of impacts considered include those on aquatic flora and fauna, informal recreation activities such as walking, cycling or birdwatching, in-stream recreational activities such as boating, canoeing or rowing, other water abstractors, heritage, archaeology and landscape;
- Social impacts of water supply schemes, during construction and/or during scheme operation. Examples of impacts considered include those of noise, dust, odour, or time delays to people’s journeys as a result of work in highways to lay or repair pipelines; and
- Increases or reductions in carbon emissions that could result from the abstraction, treatment and distribution of water. Examples of impacts considered include: fuel consumption of vehicles used in construction, leakage management, installation of water meters or water efficiency devices, energy use at work sites, emissions from road traffic as a result of diversions or

disruptions, embodied carbon in materials used, changes in water use (and thus changes in energy use) within the home.

The environmental and social costs and benefits were combined with the whole life financial costs of each option to derive the AISC value for each option in accordance with the EBSD methodology.

Figures 25, 26, 27 and 28 show the AISC values and the amount of water each option would deliver for each water resource zone. The options have been ranked based on the AISC value.

AISC's have been calculated in accordance with the Water Resources Planning Guideline and take into account the whole life cost of an option (its operating, construction and replacement costs) and its social and environmental costs. We have calculated the AISC based on using the option at its maximum capacity. AISC's are quoted in 2011/12 prices.

The AISC values indicate the relative unit costs of the various options, but the least-cost solution depends on the optimal schedule of options over time that best satisfy the profile of any supply-demand deficits. Consequently, the most economic plan may not necessarily directly reflect the AISC ranking. In accordance with guidance, a least-cost planning approach using mathematical programming has been applied to derive an optimal schedule of solutions, to achieve a supply-demand balance in each water resource zone with a deficit.

In accordance with guidance the least-cost planning approach used the concept of "utilisation" to assess the operating costs, and operational environmental and social costs of each option. This was used for both the draft and revised draft plans. It is important to do this because it recognises that on average over a long period of time the option will only be used to meet the weighted average demand in the zone. The contribution of each option to meeting the weighted average demand, was assessed using Aquator™ simulations.

In assessing options, we have included the operating cost savings and capital maintenance saving from changes to existing supply arrangements. The AISC's and NPV's reported in this plan are net of any savings. This is particularly relevant for some of our West Cumbria options where there are considerable on-going cost savings.

The total number of options considered for each of the four water resource zones is shown in Table 30 along with the total cumulative water available for use figure.

Table 30: Total number of options and Water Available for Use for each of United Utilities resource zones

Water Resource Zone	Total number of supply-demand options	Total additional Water Available for Use if all options are implemented (Ml/d)
Integrated Resource Zone	71	571
Carlisle Resource Zone	41	31
North Eden Resource Zone	22	2
West Cumbria Resource Zone	44	256

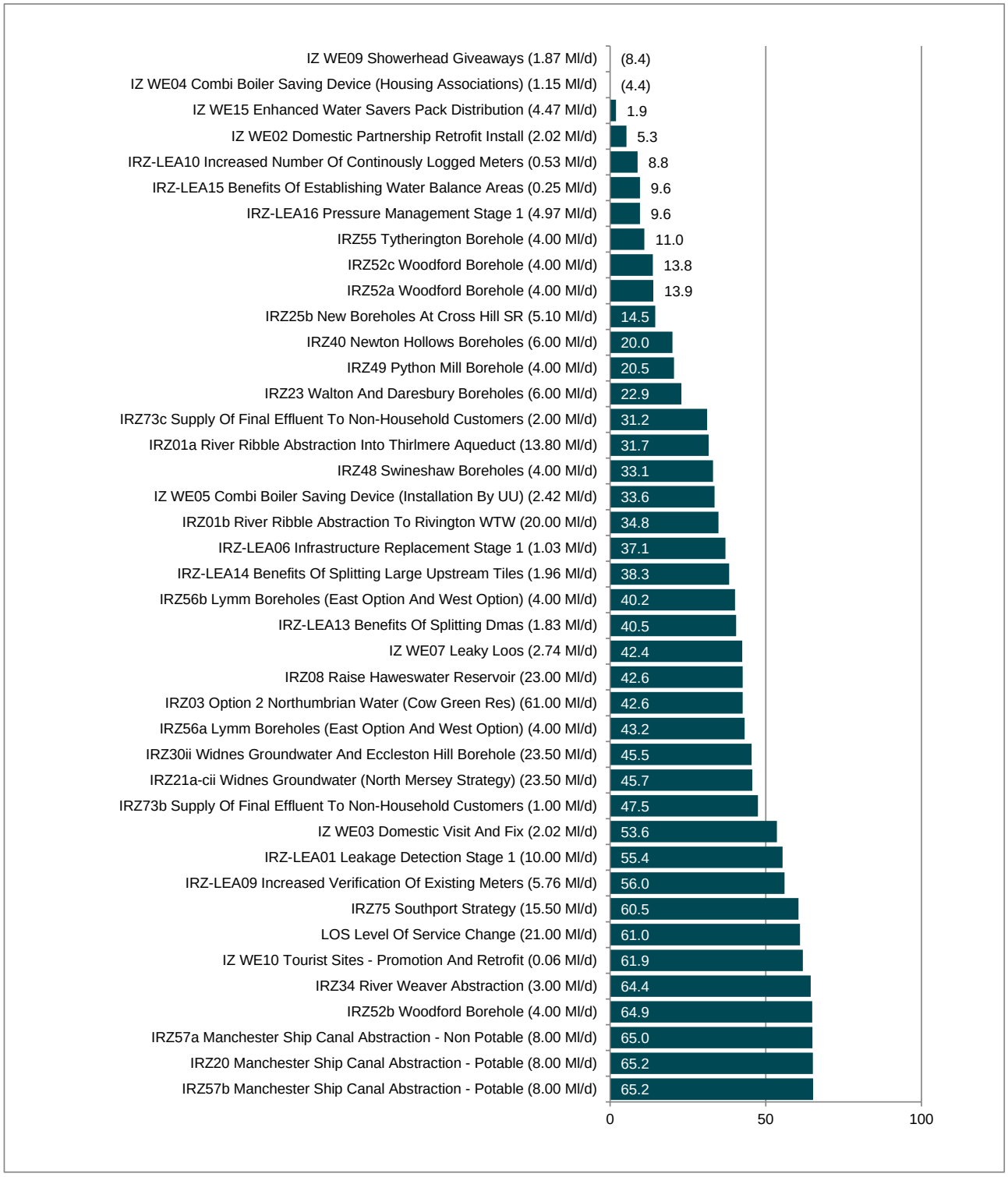


Figure 25: Ranking of options for the Integrated Resource Zone based on AISC (p/m3)

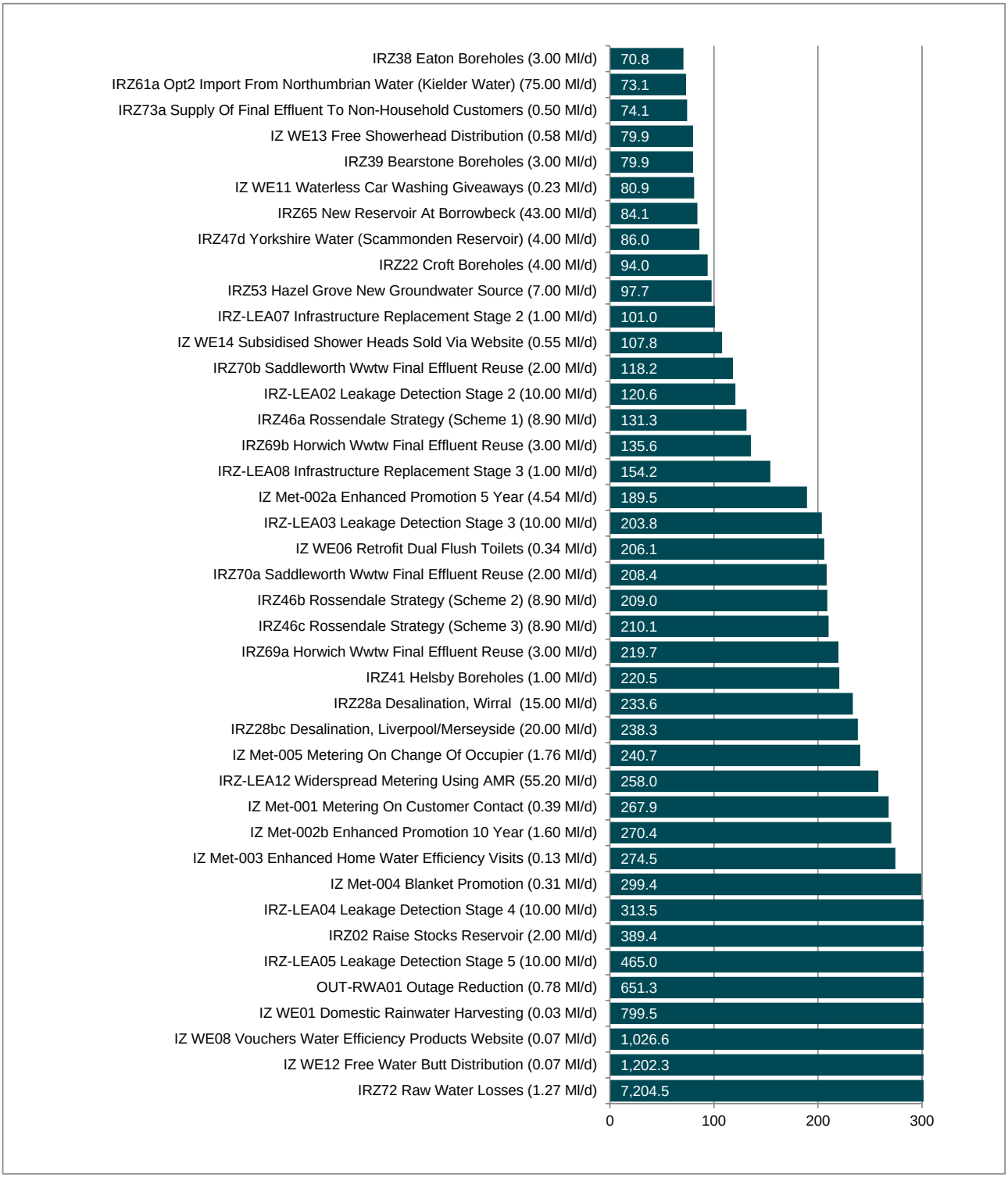


Figure 26: Ranking of options for the Integrated Resource Zone based on AISC (p/m^3) continued

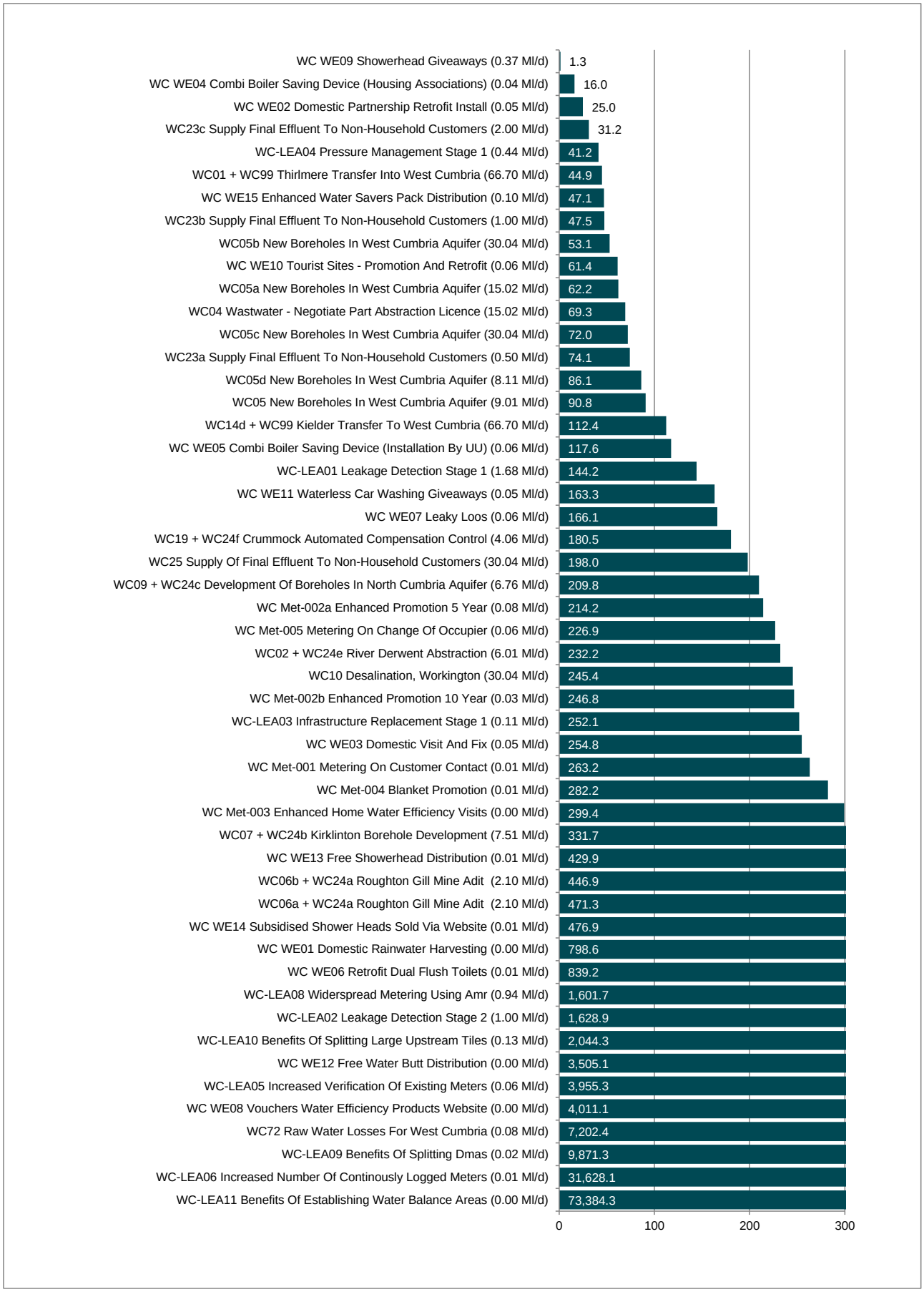


Figure 27: Ranking of options for the West Cumbria Resource Zone based on AISC (p/m^3)

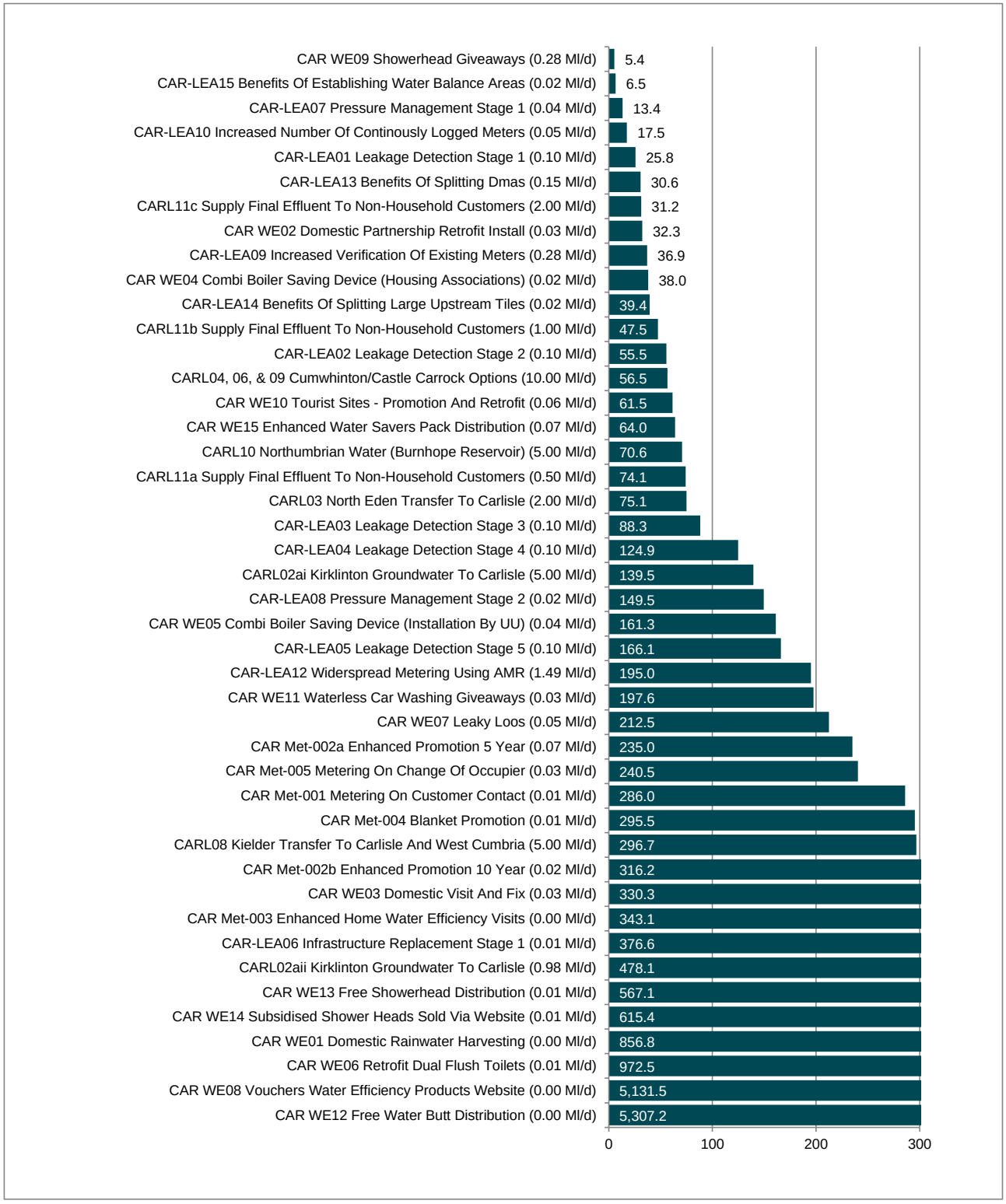


Figure 28: Ranking of options for the Carlisle Resource Zone based on AISC (p/m^3)

8.5 ENVIRONMENTAL APPRAISAL OF OPTIONS

8.5.1 The process we have followed

This section presents the approach that we have taken in complying with the requirements to carry out a Strategic Environmental Assessment (SEA) and Habitats Regulation Assessment of the draft Water Resources Management Plan. AMEC Environment & Infrastructure UK Ltd has completed the assessment of our options on our behalf.

The SEA and Habitats Regulations Assessment has assessed the likely economic, social and environmental effects of proposed water management options and has identified ways in which adverse effects can be minimised and positive effects enhanced. In carrying out the Assessments, we have followed the process shown in Figure 29.

As a consequence of following this process we have screened out a number of options which were considered to be unacceptable in terms of value to customers and their impact on the environment.

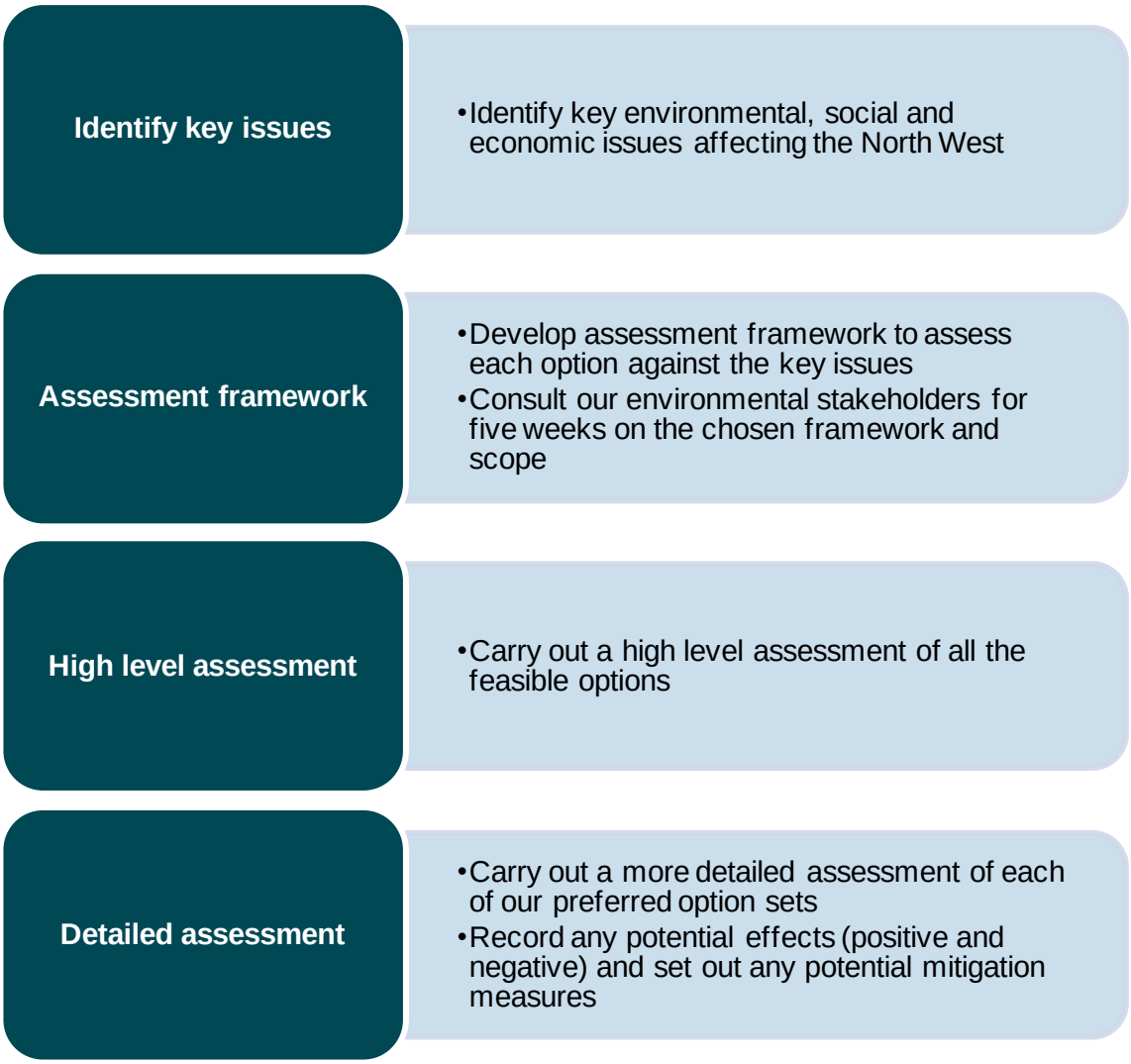


Figure 29: Strategic environmental assessment process

8.5.2 Habitats Regulations Assessment

The Conservation of Habitats and Species Regulations 2010 (as amended) (the 'Habitats Regulations') require that competent authorities assess the potential impacts of plans and programmes on the Natura 2000 network of European protected sites to determine whether there will be any 'likely significant effects' on any European site. This process is known as a Habitats Regulations Assessment. It looks at potential impacts resulting from implementation of this Water Resource Management Plan either on its own or 'in combination' with other plans or projects. Where potential impacts are identified, it assesses whether these effects will result in any adverse effects on the site's integrity. The Habitats Regulations require every Competent Authority, in the exercise of any of its functions, to have regard to the requirements of the Habitats Directive. Water Companies have a statutory duty to prepare water resource management plans and are therefore the Competent Authority for a Habitats Regulations Assessment.

Alongside the SEA, AMEC has undertaken a Habitats Regulations Assessment of the draft Water Resources Management Plan. The findings of the Habitats Regulations Assessment have been used to inform the assessment of options as part of the SEA process, and in particular the assessment of options against SEA Objective 1: To protect and enhance biodiversity, key habitats and species, working within environmental capacities and limits.

8.5.3 The potential effects of the feasible options

Each feasible option was assessed against the SEA objectives (and for supply side options, through the Habitats Regulations Assessment) to identify its potential effects during both construction/implementation and operation. The feasible options were assessed based on the nature of the effect, its timing and geographic scale, the sensitivity of the human or environmental receptor that could be affected, and how long any effect might last.

Section 11 sets out the results of the detailed assessment for the Habitats Regulations Assessment and SEA of the combinations of options that we are considering to address the forecast supply-demand deficit.

9 INITIAL SUPPLY-DEMAND BALANCE

Key Messages

- We have calculated the initial supply-demand balance for each of our four water resource zones
- The Integrated, Carlisle and North Eden Resource Zones are all in surplus
- The West Cumbria Resource Zone has a supply-demand deficit. This is due to the anticipated revocation of our abstraction licence at Ennerdale Water

9.1 SUPPLY-DEMAND BALANCE CONCEPT

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

Where:

- Water available for use is the amount of water that can be reliably supplied from our water sources during prolonged dry weather (see Section 4 for details);
- Dry weather demand is the total customer demand for water with leakage during prolonged dry weather (see Section 6 for details); and
- Target headroom is the calculated allowance for uncertainties that are outside the control of the water company (see Section 7 for details).

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, described in Section 8. Otherwise water use restrictions or other drought powers are likely to be required more frequently than desired by our customers and other stakeholders.

9.2 INITIAL SUPPLY-DEMAND BALANCES

Initial “baseline” supply-demand balances are summarised in Table 31. Each balance indicates the difference between water available for use and baseline demand forecasts including target headroom.

Our baseline demand forecasts include the effects of the following (as described in Section 5):

- Continuation of existing leakage control policies to maintain regional total leakage at 463 Ml/d from 2015/16;
- Continuation of existing water efficiency activities;
- Continue to meter all new properties;
- Continuation of the free meter option scheme, with targeted further promotion. We plan for 510,000 households to opt between 2015/16 and 2024/25; and
- Continue with existing tariff structures for water bills.

Figures 30 to 33 show the initial supply-demand balance for each water resource zone.

The surplus in the Integrated Zone and Carlisle Zone has increased since the draft plan because of lower demand and a smaller effect from sustainability changes. There is

little change in the North Eden Zone. The deficit in West Cumbria is larger due to our improved water resources modelling, but it should also be noted that this improved modelling results in an increase in the water available for use benefit of some of the options. Therefore, the overall change in the plan is not significant.

Following our further work on estimates of delivery timescales for the West Cumbria options, we now assume that the sustainability changes this zone will not occur until 2025. This is to allow time for planning, environmental assessments and construction of the significant new infrastructure required to maintain public water supply in this zone.

Table 31: Initial supply-demand balances 2015/16 to 2039/40

Ml/d	2015/16	2020/21	2025/26	2030/31	2035/36	2039/40
Integrated Resource Zone						
Water available for use	1,885.1	1,863.4	1,831.2	1,802.7	1,792.5	1,784.3
Dry weather demand	1,687.8	1,662.3	1,641.8	1,635.5	1,630.3	1,620.4
Target Headroom	60.7	53.6	53.2	57.1	63.0	68.0
Supply-Demand Balance	136.5	147.6	136.2	110.0	99.2	96.0
Carlisle Resource Zone (Critical Period)						
Water available for use	32.1	31.6	31.0	30.6	30.4	30.2
Dry weather demand	28.6	27.9	27.3	26.9	26.6	26.4
Target Headroom	2.3	1.8	1.6	1.5	1.6	1.6
Supply-Demand Balance	1.2	1.8	2.1	2.1	2.2	2.2
North Eden Resource Zone						
Water available for use	9.7	9.7	9.7	9.7	9.7	9.7
Dry weather demand	5.4	5.3	5.2	5.1	5.1	5.1
Target Headroom	0.2	0.2	0.2	0.2	0.2	0.2
Supply-Demand Balance	4.0	4.1	4.3	4.3	4.3	4.3
West Cumbria Resource Zone (Critical Period)						
Water available for use	58.9	57.2	17.9	16.4	15.8	15.4
Dry weather demand	51.4	50.5	49.5	48.6	47.8	47.3
Target Headroom	2.8	2.1	1.7	1.7	1.8	1.8
Supply-Demand Balance	4.8	4.6	(33.3)	(33.9)	(33.7)	(33.7)

Notes:

The Integrated Resource Zone supply-demand balance takes in to account completion of the planned PR09 Southport investment (new groundwater sources for Royal Oak WTW) which adds 15.5 Ml/d to Water Available for Use from 2020.

Values may not sum exactly due to rounding.

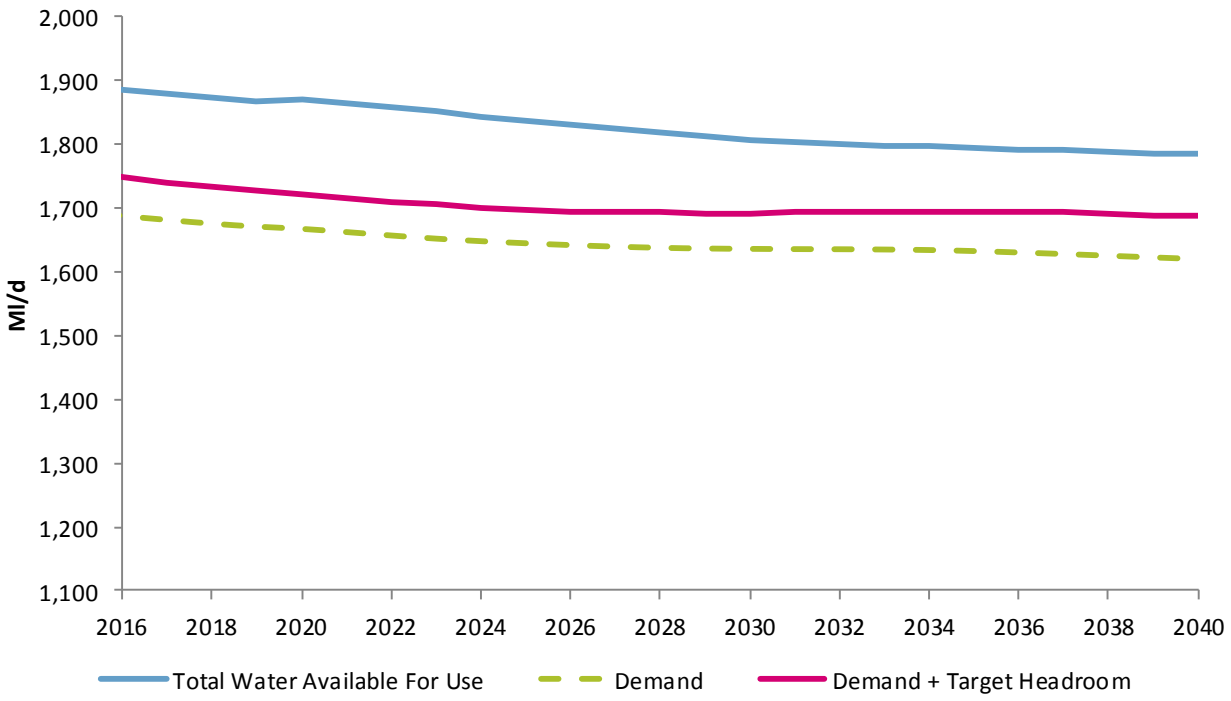


Figure 30: Initial supply-demand balance for Integrated Resource Zone

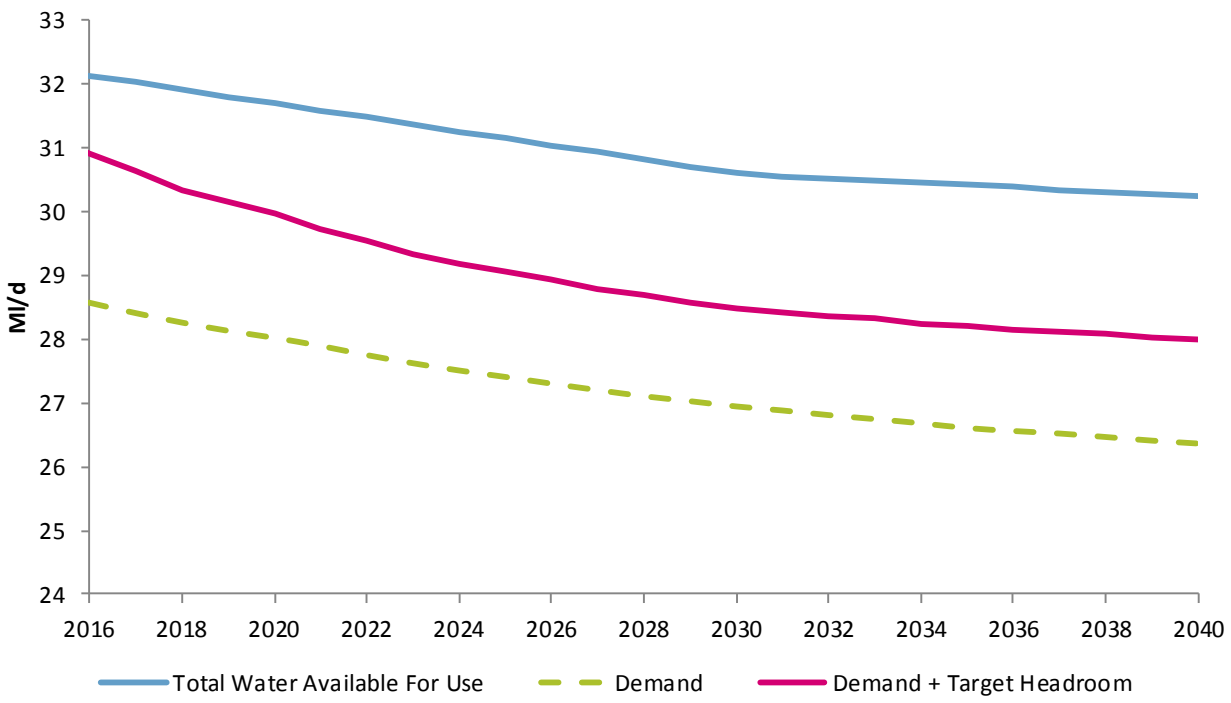


Figure 31: Initial supply-demand balance for Carlisle Resource Zone

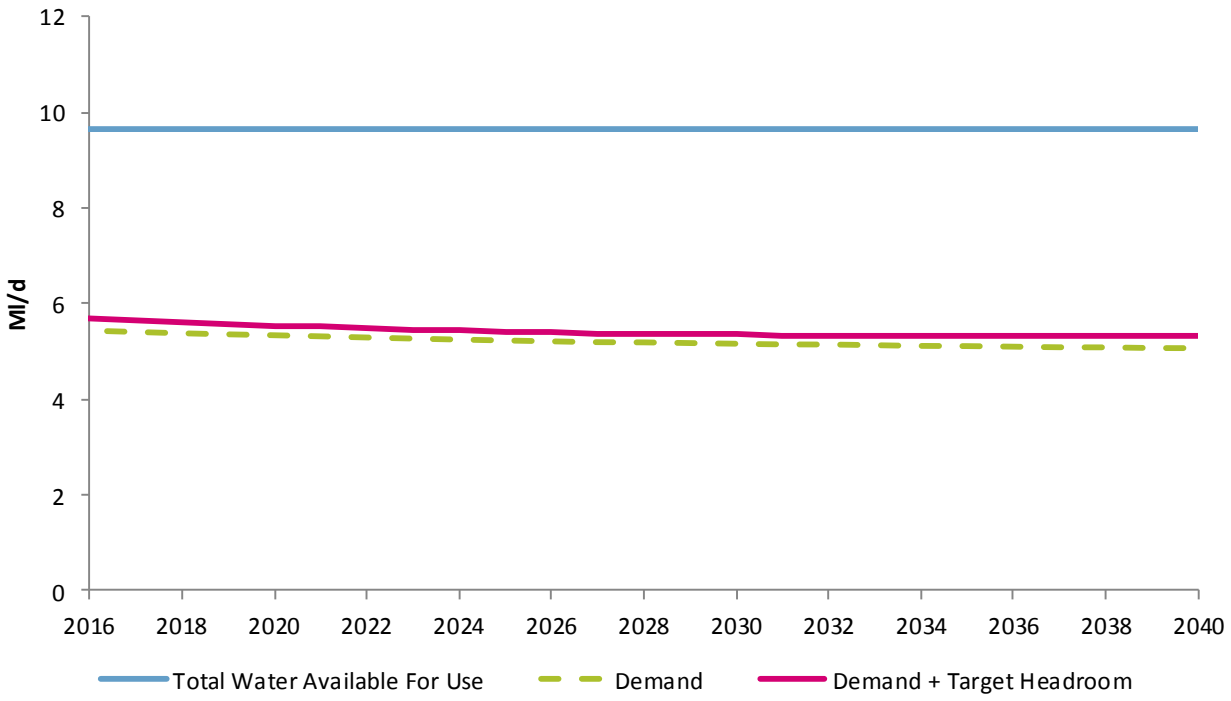


Figure 32: Initial supply-demand balance for North Eden Resource Zone

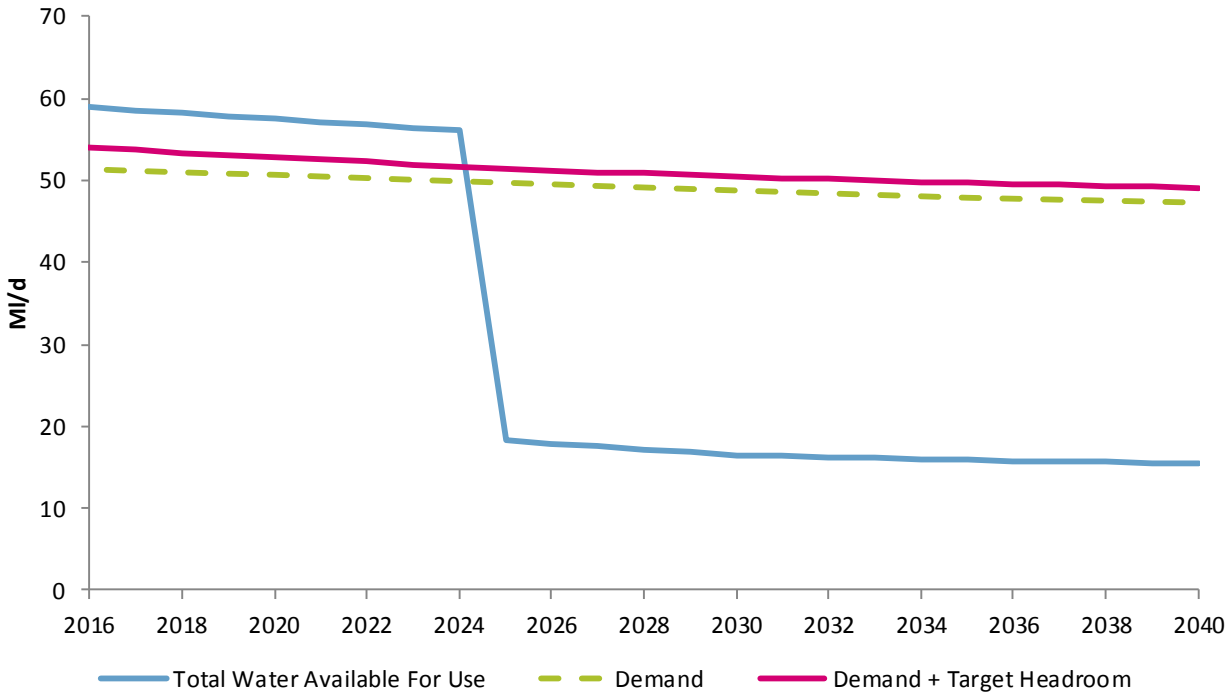


Figure 33: Initial supply-demand balance for West Cumbria Resource Zone

9.3 IMPLICATIONS

The Environment Agency's water resource planning guideline describes three possible results for a water resource zone's supply-demand forecast:

- **No further action:** There is enough water to meet demand (including target headroom), the water company does not need to take any further action;
- **Do the right thing:** There is enough water to meet demand (including target headroom), however the company wishes to consider investment in order to achieve Government aspirations; and
- **Remove the deficit:** There is not enough supply to meet demand, the company should investigate all options, decide on the best option (for customers and the environment).

We have used these to classify each resource zone below:

9.3.1 Integrated Resource Zone

The water available for use in this resource zone is expected to reduce by about 22 Ml/d between 2015/16 and 2019/20. This is due to the anticipated 5 Ml/d sustainability reductions arising from the proposed abstraction licence changes described in section 4.4 and the impact of climate change. The reduction is lower than anticipated because we will have delivered additional groundwater sources to Royal Oak WTW in Southport by 2019/20, which will increase water available for use by 15.5 Ml/d. No supply deficit is forecast for the Integrated Resource Zone, a surplus of over 90 Ml/d is maintained throughout the planning period.

No further action / Do the right thing: There is enough water to meet demand and United Utilities does not need to take any further action. However, following Water Resource Planning Guidelines and Government Aspirations, we will consider using this forecast surplus, with possible new source or demand management investment, to enable transfers between our own water resource zones or enable water trading with other water companies, see Appendix 8 for more details. Following consultation, we will provide more free meters to those customers who will benefit most.

9.3.2 Carlisle Resource Zone

There are no anticipated changes to our abstraction licences in the Carlisle Resource Zone; therefore, water available for use is expected to reduce as a result of climate change alone, from around 32 Ml/d to 30 Ml/d. Despite this, water available for use is expected to be adequate to meet forecast demands.

No further action / Do the right thing: There is enough water to meet demand and we do not need to take any further action. Following consultation, we will provide more free meters to those customers who will benefit most.

9.3.3 North Eden Resource Zone

No supply deficits are forecast in the North Eden Zone throughout the planning period.

No further action / Do the right thing: There is enough water to meet demand and we do not need to take any further action. Following consultation, we will provide more free meters to those customers who will benefit most.

9.3.4 West Cumbria Resource Zone

A significant reduction in water available for use is expected to occur as a result of the estimated 37.5 Ml/d sustainability reductions, due to the anticipated loss of our abstraction licence for Ennerdale Water and changes to our Overwater and River Ellen licences. Supply-demand solutions will be required as soon as they can be delivered

(subject to agreement with the Environment Agency) to maintain adequate water supply reliability in West Cumbria.

Remove the deficit: There is not enough supply to meet demand. We have investigated all options and present the best option for customers and the environment in the next section.

10 WATER RESOURCES AND DEMAND STRATEGY

Key Messages

- Managing demand remains a priority with our water efficiency and metering programmes
- Our plan addresses the forecast deficit in West Cumbria
- Moving water from Thirlmere reservoir in the Integrated Resource Zone to West Cumbria is our preferred plan
- The preferred plan is supported by consultation responses and our customer research

10.1 STRATEGIC PRINCIPLES

Our water resources and demand strategy is to undertake the best plan for our customers, including climate change, and ensure sustainable water abstraction. Therefore, it reflects our customers' priorities and complies with statutory requirements. The plan will contribute to meeting our long-term priorities (revised following consultation on our strategic direction in summer 2013):

- Your drinking water is safe and clean
- You have a reliable supply of water now and in the future
- The natural environment is protected and improved in the way we deliver our services
- Our services and assets are fit for a changing climate and our carbon footprint is reduced
- You're highly satisfied with our service and find it easy to do business with us
- Bills for you and future customers are fair
- You have support if you struggle to pay
- The North West's economy is supported by our activities and investment

Importantly, our proposed plan is flexible and robust. It will allow us to continue to meet the changing needs of households and businesses in the North West for the next 25 years.

10.2 MAINTAINING THE SUPPLY-DEMAND BALANCE

There are no baseline supply-demand deficits forecast for the Integrated, Carlisle and North Eden Resource Zones until at least 2040. This means there is enough water to maintain customer supplies in droughts as bad as the worst experienced in the last 80 years, and even worse droughts than we would expect with climate change.

In the **West Cumbria Resource Zone** the picture is very different. Abstraction licence changes are needed to protect the environment and prevent rare species from becoming extinct in England. Once these changes are implemented, there will be insufficient water available to maintain public water supply, unless new sources are developed and demand reduced. The Environment Agency have now confirmed that the abstraction licence at Ennerdale will be revoked. We recognise that this needs to happen as soon as possible and will work to deliver this. We made a working assumption for the draft plan that this could happen in 2020. Further, more detailed, engineering work has shown that to allow sufficient time for detailed design, the planning process and construction of the new abstraction facility, treatment works and pipes, the most likely completion date is 2024/25. If any of these are able to happen earlier than these estimates, we will stop abstracting from Ennerdale before 2024/25.

In our draft plan, we considered three different ways of maintaining an adequate public water supply for the West Cumbria Zone:

- Lowest cost plan – this would offer less resilience and environmental improvement, by relying on local sources and water abstracted from special areas of conservation, but would result in lower impacts on customer bills;

- Preferred plan – a resilient and cost effective plan involving abstraction from Thirlmere, offering significant environmental benefits to West Cumbria; and
- Alternative plan – a more expensive plan, providing resilience and environmental improvement by transferring water from Kielder reservoir in Northumberland. This could provide potentially longer-term benefits in supporting future water trading in the Integrated Resource Zone and supporting any future deficits in the Carlisle Resource Zone (beyond 2040).

In developing this final plan, we considered customer and stakeholder views about the three alternative plans very carefully. We also completed more detailed engineering assessments of the cost and delivery time of the options and updated our environmental assessments of the options. The time schedule and costs of the local and Thirlmere options were then scrutinised by the Environment Agency, We have also considered the risks associated with the alternative plans. We have applied a comprehensive decision making process, which is summarised in Figure 34. This process is consistent with the Water Resources Planning Guidelines.

Based on all of this, we consider that the Thirlmere option is the only way we can confidently plan to meet demand in the zone and comply with our regulatory and environmental obligations. It also comprises the most flexible solution for the zone which will be able to meet the requirements of the people, the economy and the environment over the next 25 years.

10.2.1 Lowest-cost set of options – no longer considered a viable alternative plan:

The potential solution that we consulted on in our draft plan consists of developing a number of new sources of water:

- Using Wastwater for public water supply, by trading water with the holder of an existing third-party abstraction licence; and
- Developing new boreholes in the West Cumbria aquifer and the North Cumbria aquifer.

In response to representations, we have continued to work on the lowest cost option. We have carried out further engineering estimates of project costs and delivery timescales. We have carried out further water resources modelling and economic appraisal. As a result of the water resources modelling we have identified that the compensation flow control at Crummock and the transfer pipeline to take this water to the areas currently served by Ennerdale are not required. This results in a small reduction in cost of this options set.

The lowest cost solution has been derived by using a mathematical optimisation. The costs also include environment and social costs as well as financial costs. The Net Present Value of the total financial, environmental and social costs to implement these options is £116 million.

This set of options had the following benefits identified in the draft plan:

- Having these local solutions can be one of the most environmentally friendly solutions in the short term due to the lower levels of construction required;
- The surface water components are within existing licences and would not need new licences; and
- It is the lowest cost set of options, resulting in the smallest relative increase in customer bills.

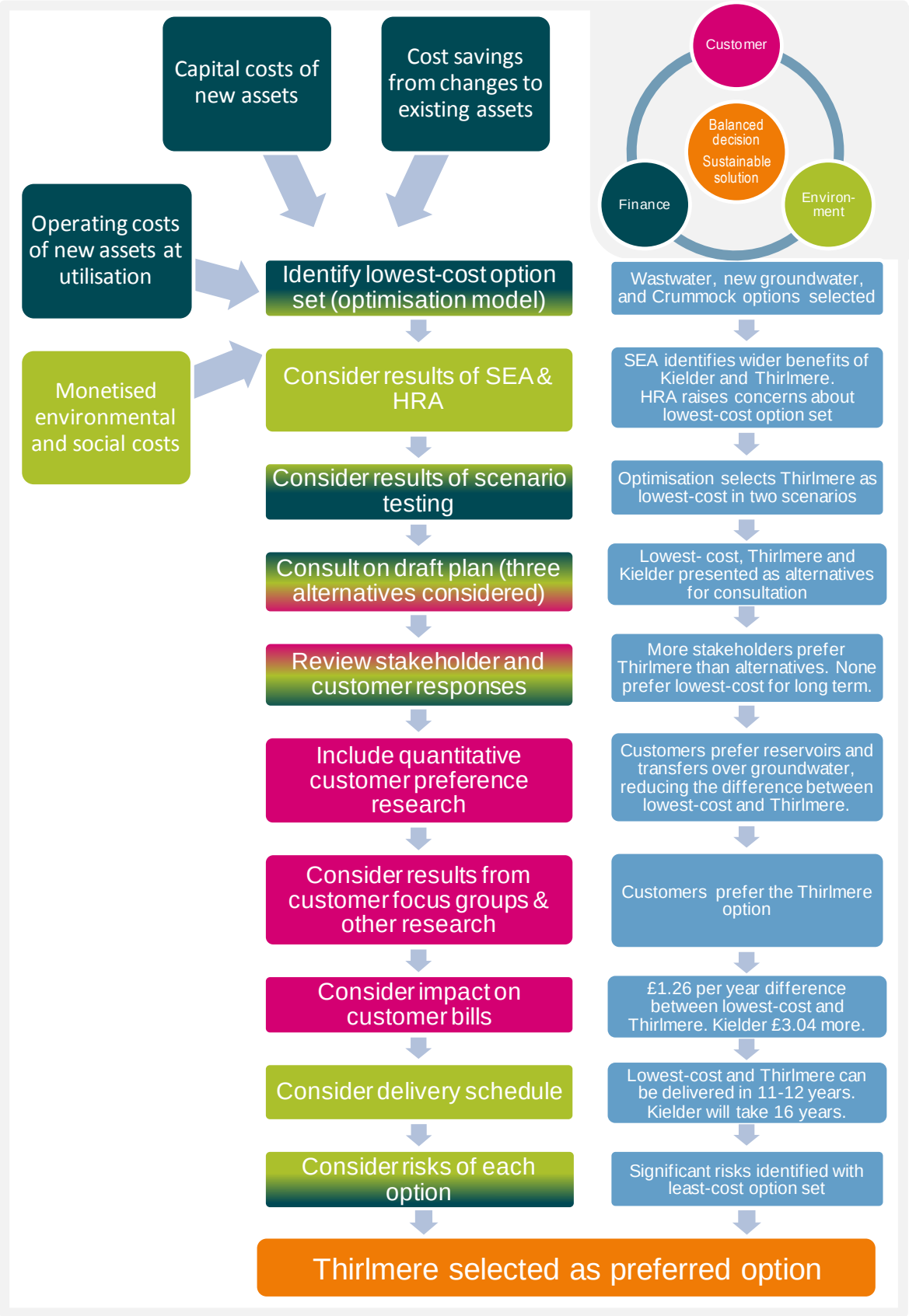


Figure 34 A robust and balanced decision-making process has been used to select the preferred option

It also raises a number of concerns:

- It is reliant on the agreement of a third party abstraction licence holder. In their consultation response the licence holder said their future water needs were uncertain and that it would not be sensible for us to assume that this could be a preferred option. This leaves significant uncertainty about the viability of a major component of this options set.
- The Habitats Regulation Assessment identified that the operation of both the Wastwater and groundwater components had the potential for adverse effects on protected sites. This creates uncertainty as to the viability of the lowest cost alternative, which cannot be resolved without significant further investigation. In their representation on the draft plan Natural England said that the current uncertainty regarding impacts of the groundwater option could have excluded this option from the plan. These abstractions would require Habitats Regulation appropriate assessments, which introduces considerable uncertainty and potential delays to delivery of the least cost alternative.
- If there are further sustainability changes in West Cumbria these options will no longer meet future demand; one more sustainability change has been confirmed by the Environment Agency following publication of the draft plan. Following further discussion with the Environment Agency, we estimate that the likelihood of, as yet unknown, future sustainability reductions in West Cumbria is around 25%.
- This plan will not solve West Cumbria's reliance on abstraction from Special Areas of Conservation.
- This option set will not solve West Cumbria's vulnerability to short duration droughts and limited drought options remain. This vulnerability has caused United Utilities to start revising its drought plan for West Cumbria only three months after publishing a final plan. Under this alternative, drought orders from Crummock Water would be the only supply side drought option available. Crummock Water is part of a Special Area of Conservation.
- No consultation respondents said they preferred this as a long-term solution to meeting water supply needs in West Cumbria.
- In our customer focus group research, once the relative costs and benefits of the alternatives were explained, fewer customers favoured this alternative.

On the basis of these concerns we cannot select this option set as the preferred plan. We have considered whether it would be in customers' and the environment's best interest to continue working on this option set in parallel with the Thirlmere option. There are high levels of uncertainty as to whether the solution could be delivered, because of the third party licence holder's concerns, the potential for new licences not becoming available due to Habitats Directive concerns and lack of stakeholder support. The long-term viability of the option is also uncertain, as shown by our scenario testing. There is also a significant probability of inefficiently using customer's money to pursue an ultimately unviable option. For these reasons we do not consider that this would be in the interests of our customers or the environment.

10.2.2 Kielder alternative – no longer considered a viable alternative plan

In identifying alternative options for the draft plan we considered the potential for importing water from neighbouring water companies. Our discussions with Northumbrian Water led to the identification of an option to take water from Kielder Reservoir in the north Pennines. There would be a new raw water pipeline from Kielder to a new water treatment works near Carlisle, and then a new potable water pipeline to

West Cumbria. This has the same benefits to the preferred plan, but avoids construction in the Lake District National Park.

In response to representations we have continued to work on this option. We have carried out further engineering estimates of project costs and delivery timescale. Our central estimate is that it will take 16 years to complete this option. It is a higher cost option because of the requirement for pumping. The net present value of the total financial, environmental and social costs to implement this option is £371 million.

Four respondents to our consultation preferred this option on the grounds that it provides a long term solution, Kielder reservoir is already developed, and the option is seen as having less landscape impact. While respondents recognised that the Kielder alternative was a more expensive solution, they thought it represented genuine long-term thinking in so far as it would become a key element in a national water grid. These respondents were also concerned about the impact of the Thirlmere option on parts of the Lake District. In our customer focus groups, Kielder was the least favoured option.

All of this has been taken into account in our decision making process. We have concluded that despite there being some advantages to the Kielder alternative it cannot remain in the plan because it would take an estimated 16 years to construct and this would not allow us to comply with our legal obligations under the Conservation of Habitats and Species Regulations as fast as practicable. Also, the considerable additional cost of this option cannot be justified given the lack of widespread customer and stakeholder support.

10.2.3 Preferred plan

Our preferred solution is to dedicate a greater proportion of the water available in Thirlmere reservoir to meet the needs of Cumbria. This would require a new water treatment works and a pipeline to transfer the water into West Cumbria. The population of West Cumbria would then benefit from being part of the UK's largest interconnected water resource zone. This transfer would be of sufficient size to meet all the demand for West Cumbria and brings a number of benefits for the region, such as:

- Increased confidence in long term supplies in meeting changing demands;
- Support for the developing Britain's Energy Coast economic strategy as it would allow for more water to be available than is currently forecast;
- Allows abstraction from existing sources in West Cumbria to cease and return the habitats to more natural conditions;
- Protects internationally important Special Areas of Conservation;
- Future climate change resilience;
- Removes the vulnerability to short duration droughts;
- Longer-term cost savings as the existing treatment works can be closed; and
- Removes the vulnerability of West Cumbria to future sustainability reductions.

This would result in a reduction in deployable output in the Integrated Resource Zone of 33 Ml/d. In the baseline scenario supply-demand balance, the Integrated Resource Zone is currently forecast to be in surplus throughout the planning period; this will remain the case even with the transfer to West Cumbria Resource Zone, see Figure 35.

The net present value of the total financial, environmental and social costs to implement this plan is £176 million. The costs of this and all the other options are based on the expected utilisation of the sources and where relevant this will form part of our business plan submission to Ofwat in 2014.

Table 32 sets out the costs for the three options.

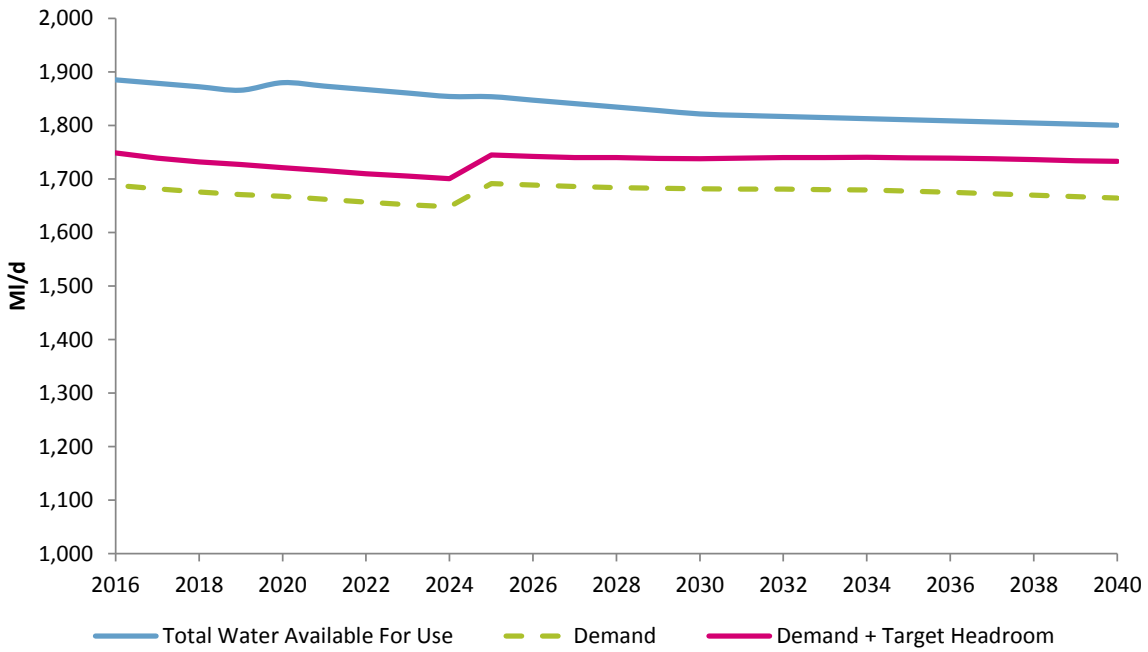


Figure 35: Baseline supply-demand balance for the Integrated Resource Zone including the impact of a Thirlmere transfer to West Cumbria

Table 32: Net Present Value (NPV) and customer bill comparison of solutions for the West Cumbria Zone

	Lowest-cost alternative	Preferred plan	Kielder Alternative
NPV of capital costs (£m)	79	182	297
NPV of operational costs (£m)	19	3	16
NPV of social and environmental costs (£m)	18	(9)	58
Total NPV (£m)	116	176	371
NPV of customer willingness to pay (£m)	(74)	(143)	(72)
Total NPV including willingness to pay (£m)	42	34	300
Maximum change to average household customer annual water bill	£1.67	£2.93	£4.71

10.3 ENVIRONMENTAL APPRAISAL OF PREFERRED AND ALTERNATIVE PLANS

These three alternative plans to address the deficit in the West Cumbria Resource Zone were taken forward for more detailed assessment as part of the SEA and HRA preferred plans. These options were:

- Lowest-cost plan, comprising: Wastwater (negotiate part abstraction licence) (WC04); Development of new boreholes in West Cumbria aquifer (10 Ml/d) (WC05a); Development of Boreholes in North Cumbria aquifer (WC09);
- Preferred plan, WC01: Thirlmere Transfer into West Cumbria;
- Alternative plan, WC14d: Kielder Water Transfer to West Cumbria (Treated near Carlisle);

A summary of the assessment is presented in Table 33 below. Chapter 9 detailed the approach in assessing the options against the screening criteria. The results in Table 33 were assessed based on the following scale:

Key to the Symbols to be used in the Relationship Column:	
++	Significant positive effect of the Water Resources Management Plan option on this objective
+	Positive effect of the Water Resources Management Plan option on this objective
0	Overall neutral or insignificant effect of the Water Resources Management Plan option on this objective
-	Negative effect of the Water Resources Management Plan option on this objective
--	Significant negative effect of the Water Resources Management Plan option on this objective
?	Uncertain effect of the Water Resources Management Plan option on this objective
++/-	Combination of positive and negative effects of the Water Resources Management Plan option on this objective

Table 33: Summary of the preferred plan and alternatives assessment

Option Name	Design Capacity (Ml/d)	Construction (C) or Operation (O)	Biodiversity	Land Use/Soils	Water Quantity and Quality	Flooding	Air Quality	Climate Change	Human Health	Economic and Social Well-being	Water Resource Use	Use of Resources	Heritage	Landscape
Lowest Cost Plan	25	C	-	-	0	-	-	--	-	++/-	0	--	-	-
		O	?	0	-	-	0	--	++	++	0	--	0	-
Preferred Plan	80	C	-	-	0	-	-	--	-	++/-	0	--	-	--
		O	++	0	++	-	0	--	++	++	0	0	0	-/?
Alternative Plan	80	C	-	-	0	-	-	--	-	++/-	0	--	-	--
		O	++	0	++	-	0	--	++	++	0	-	0	-/?

10.4 PREFERRED PLAN: THIRLMERE TRANSFER INTO WEST CUMBRIA

The results of the preferred plan were as follows:

10.4.1 Construction effects

Reflecting the scale of construction activity associated with this plan, significant negative effects were identified in respect of climate change (as a result of associated greenhouse gas emissions from heavy goods vehicle movements, construction plant and embodied carbon in raw materials) and resource use. The majority of development sites and approximately half of the new pipeline would be within the Lake District National Park and therefore there was considered to be potential for significant negative landscape effects associated with construction activity.

The construction of this plan would represent a large capital investment which is likely to generate a number of employment opportunities and supply chain benefits as well as increased spend in the local economy by contractors and construction workers. However, heavy goods vehicle movements and pipeline works of the proposed scale may cause traffic disruption. The plan was therefore assessed as having a mixed significant positive and minor negative effect on economic and social well-being.

The assessment did not identify any further significant negative or significant positive effects. The Habitats Regulations Assessment identifies that there is potential for significant construction effects on the following Special Areas of Conservation (SACs): River Derwent and Bassenthwaite Lake SAC, Clints Quarry SAC, Lake District High Fells SAC and River Ehen SAC. These potential effects are primarily due to pipeline works. However, taking into account scheme specific mitigation, and a commitment for pipeline works to be within existing roads (or suitable alternatives identified in discussion with Natural England and the Environment Agency), no significant construction-related effects would be anticipated. Notwithstanding, this plan would result in the loss of greenfield land at several development sites and in consequence there is potential for localised loss of habitat and, in conjunction with decommissioning works, disturbance which has been assessed as having a minor negative effect on biodiversity. The plan may also generate minor negative effects in respect of land use/soils (due to additional land take required under this option), flood risk (as some sites and sections of pipeline are situated within Flood Zones 2/3) and cultural heritage (due to potential effects on the settings of listed buildings and scheduled monuments). Emissions to air from heavy goods vehicle movements and construction plant may also have a minor negative effect on air quality and, together with noise/vibration, human health.

10.4.2 Operational effects

The scheme is designed to relieve pressure on the River Ehen SAC. Abstraction from Ennerdale Water, which discharges into the Ehen, has been identified for amendments under the Review of Consents programme due to the impact of abstraction on interest features in the SAC (primarily fresh water mussels). The decommissioning of Ennerdale water treatment works and associated abstraction from Ennerdale Water under this plan may therefore generate benefits in respect of these features due to increased flows. Additionally, the decommissioning of Quarry Hill water treatment works would result in a reduction in abstraction from Dash Beck and Hause Gill, sources that have been investigated under the Review of Consents programme due to impacts on salmon which are interest features of the River Derwent and Tributaries Site of Special Scientific Interest (SSSI) and River Derwent and Bassenthwaite Lake SAC. Taking into account the potential operational benefits in respect of the River Ehen SAC and River Derwent and Bassenthwaite Lake SAC in particular, this plan was assessed as having a significant positive effect on biodiversity. The decommissioning of the five water treatment works has also been assessed as having a significant

positive effect on water quantity and quality due to increases in flows in the catchments in which associated abstractions are located (Dash Beck, Bassenthwaite/Derwent, Ellen, Ehen and Cocker).

The option has a design capacity of 80 Ml/d, serving to address deficit within the West Cumbrian WRZ. Further, the decommissioning of existing sources may benefit downstream abstractors (where hands off flow constraints are in place) or present opportunities for new abstractions (subject to licensing). This option has been assessed as having a significant positive effect on health (in helping to ensure the continuity of a safe and secure drinking water supply) and economic and social well-being (given the potential for additional supply to support economic/population growth).

Similar to the construction phase, the plan is likely to have significant negative effects on climate change. This principally reflects net additional energy requirements (and related greenhouse gas emissions) associated with the treatment and pumping of water.

No further significant negative or significant positive operational effects were identified during the assessment although the option is expected to have minor negative effects on flood risk (owing to the location of assets within Flood Zones 2/3).

The new water treatment works, in the vicinity of the existing facility near Thirlmere, would constitute a relatively large scale development in the Lake District National Park and a substantial increase in building footprint. In consequence, there is the potential for significant negative effects on landscape and the visual amenity of local receptors during operation. However, it is anticipated that mitigation would be implemented to lessen landscape and visual impacts. Overall, assuming that mitigation measures are implemented to reduce landscape and visual impacts, it is not expected that these would be significant in this instance and the effects have been considered as minor negative. Further discussion on this issue can be found in section 3.2.1 of the SEA addendum.

We have also considered the landscape effects due to increased abstraction from Thirlmere to supply West Cumbria. Operation of the option would result in additional drawdown of Thirlmere, which may be perceptible to recreational users. Given the national importance of the Lake District National Park, there is potential for effect on landscape and the visual amenity of recreational users due to changes in reservoir levels. However, we have calculated that the difference in the mean operating level of the reservoir between this option and the current operation would be fairly limited. Although the minimum level in a dry year would be lower, it is considered the difference between reservoir levels under current operation and under this option would not substantially affect landscape character or visual amenity. Further information and data relating to this issue can be found in the addendum to the SEA.

10.5 ALTERNATIVE PLANS: KIELDER AND LOWEST COST

10.5.1 Construction effects

Construction related effects across all the alternatives were considered broadly similar to those identified in respect of the preferred plan with significant negative effects assessed against climate change and resource use and a combination of positive and negative effects identified in respect of economic and social well-being. As with the preferred plan, it was assumed that pipeline works would be within existing roads (or suitable alternatives identified in discussion with Natural England and the Environment Agency) such that no significant construction-related effects on designated European sites would be anticipated.

10.5.2 Operational effects

Similar to the preferred plan, significant negative operational effects were identified in respect of climate change and resource use objectives for all alternative options, due to additional energy requirements (and related greenhouse gas emissions) associated with the treatment and pumping of water. All of the options were also assessed as having a significant positive effect on health and economic and social well-being, reflecting the substantial additional capacity each would deliver. However, there was a marked difference in effects against the biodiversity SEA objective across the three alternatives.

Like the preferred plan, the Kielder Water transfer to West Cumbria would involve the decommissioning of Ennerdale, Corn How, Quarry Hill and Buttermere water treatment works. As with the preferred Thirlmere option, this was assessed as having a significant positive effect on biodiversity, water quantity and water quality objectives.

The operational effects of the lowest-cost plan on biodiversity were considered to be more uncertain as it is not clear at this stage how abstraction from the West Cumbria aquifer, which would also take place under the lowest-cost plan, may affect the River Ehen SAC.

10.5.3 Conclusion and reasons for selection of the preferred plan

Following the more detailed assessment, the Thirlmere transfer into West Cumbria remains the preferred plan for this draft Water Resources Management Plan.

10.6 DEMAND MANAGEMENT STRATEGY

Demand management has an important role to play in securing reliable water supply in the light of future challenges. Overall demand for water has reduced significantly over the past 20 years. With our baseline demand management strategy, further demand reductions are expected over the next 25 years. This means that for three out of our four water resource zones, there will be enough water available to meet the challenges of population growth, new housing, climate change and environmental protection without any need for enhanced demand management or new water sources.

In West Cumbria, the scale of the water supply deficit compared to the total demand for water means that demand management can only ever be a relatively small part of the solution. The development of new water sources or large scale interconnection is inevitable. Demand management in West Cumbria forms part of the least-cost combination of options, however much wider benefits are gained by investing in the interconnection. This also means that future demand management can be more effective by targeting across a wider area and sharing the benefits across an enlarged Integrated Resource Zone.

We are committed to reducing demand by increasing levels of household metering, continuing to offer water efficient devices, advice and education and maintaining a sustainable economic level of leakage.

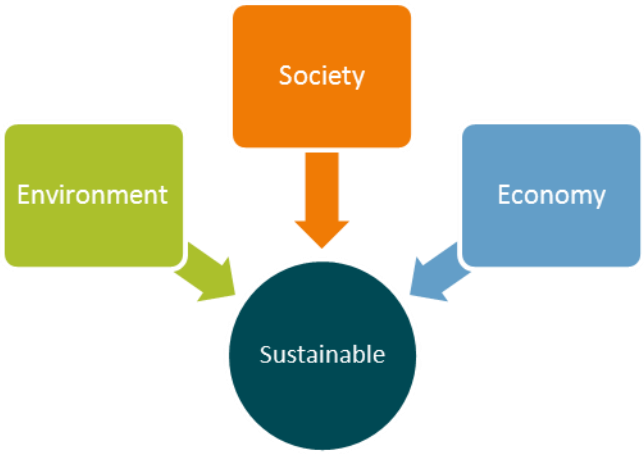
Given the fact that our preferred plan does not include additional demand management above the baseline assumed, our “final planning” demand forecast is the same as our baseline forecast.

10.6.1 Leakage reduction

United Utilities is committed to maintaining a sustainable economic level of leakage. This looks at all the costs to society of losing water through leaking pipes and the costs to society of finding and fixing those leaks. By applying the principle of the three pillars

of sustainability[10] in this way (Figure 36), we ensure we are operating at the optimum level for everyone in North West England.

Figure 36: Three pillars of sustainability



We have some old pipe network, new leaks are continually breaking out and so a continuous leak detection and repair effort is needed to maintain the current levels. To reduce leakage further, below the sustainable level, would mean that customer bills would be higher. By not doing this, society as a whole has more resources to spend elsewhere, for example on other environmental or social improvements which would give better benefits.

It already costs much more to find and fix leaks than the simple costs of abstracting and treating the water. This “short-run” sustainable economic level of leakage is 605.7 Ml/d. This means that further leakage reduction in itself is not self-financing through reduced water production costs.

Our full assessment of the sustainable economic level of leakage compares the full cost leakage reduction against the cost of developing other supply demand options. This can be seen in Figures 25, 26, 27 and 28, which compares the Average Incremental Social Cost of all our options.

The sustainable economic level of leakage assessment has shown that no reductions are required to maintain the supply-demand balance. Planning to reduce leakage lower than these levels cannot be justified at the present time. It would require additional cost above the cost required to maintain our current level of service and these costs would result in higher water bills. The final plan leakage targets are therefore to continue meeting the 2015 targets from the 2009 Final Water Resources Management Plan for each year of this plan. Because these are volumetric targets and the network is growing due to new connections, the level of leakage per kilometre of water main will reduce over the 25-year period and the leakage per property will reduce as there are more properties.

10.6.2 Water efficiency

There are two key components of our water efficiency programme for the future:

- Continuation of our baseline water efficiency activities; and

[10] For a good discussion of the three pillars of sustainability see www.forestry.gov.uk/forestry/edik-59fmzf

- Continuing research programme to investigate innovative water efficiency measures.

The measures adopted by us will continue to be targeted on those activities that are most beneficial.

Key elements of our baseline level of water efficiency programme (described in more detail in Section 6.3) include:

- Providing free “Save-a-flush” devices and “Water Savers” packs on request;
- Offering supply pipe repair and replacement schemes;
- Providing educational material through schools and on the company website, and promoting the benefits of water efficiency at large public events;
- Promoting the free meter option to domestic customers on our website and through the billing leaflet; and
- Working with key stakeholders to raise the public awareness of water efficiency.

The benefits of this activity are included in our baseline demand forecasts, and our supply demand forecasts show that no enhanced promotion is economically justified.

10.6.3 Customer metering

We will continue to meter all new properties and those households who opt to be metered under our free meter option scheme. As a result of the increasing uptake in Free Meter Options and the compulsory metering of all new houses, we forecast that the number of metered households will increase from 0.97 million at 2013 to 2.8 million at 2040; at that point meter penetration will be at 80% in the North West.

10.6.4 Benefits of our demand management strategy

We have assessed the benefits of our baseline demand management strategy. Without the reductions in demand from our free meter option programme and water efficiency programmes there would be a supply demand deficit in the Integrated Resource Zone of 107 Ml/d by 2040. This means that we avoid having to develop a large number of new water sources because of our demand management programme. These supply side schemes would include many new groundwater sources, a new abstraction from the River Ribble and raising Haweswater reservoir.

Without our demand management programme there would also be a deficit of 0.7 Ml/d in the Carlisle Resource Zone, which would necessitate new groundwater sources.

The total net present value of the avoided new water source development is over £300 million. This demonstrates the value of our baseline demand management programme, which contributes towards helping us adapt to climate change.

11 TESTING OUR PLAN

Key Messages

- We have undertaken analysis to ensure our plan can react to changes in the assumptions we have made
- We have investigated different Levels of Service and undertaken scenario testing
- This shows that our plan allows for changes to supply and demand forecasts and demonstrates that we have sufficient options to enable us to adapt to larger changes

Our water supply and demand strategy is based on detailed studies, calculations and judgements about future outcomes. A number of factors can influence the supply-demand balance (Figure 37). It is therefore important to check whether the plan can react to changes in the assumptions we have made.

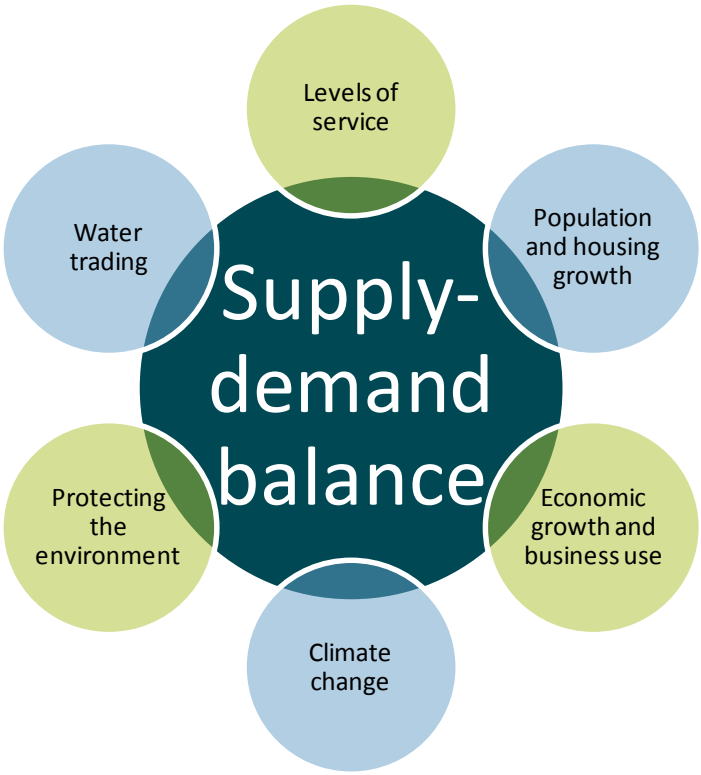


Figure 37: Factors influencing the supply-demand balance

11.1 LEVELS OF SERVICE

The level of service we have chosen for this plan includes water use restrictions (hosepipe ban) frequency of no more than once in 20 years; this is outlined in Section 2.4. However, we have investigated a range of potential alternative service levels and associated deployable output values. Table 34 summarises the results. It demonstrates the large scale of water supply enhancement and/or demand reduction actions that would be required to achieve less frequent hosepipe bans. For example, enhancements totalling 111 Ml/d would be required to improve the hosepipe ban frequency to no more than once in 40 years.

Table 34: Water supply-demand requirements to achieve alternative levels of service for Integrated Resource Zone

Level of Service Scenario	Hosepipe ban frequency	Change in deployable output for the zone (Ml/d)	Supply-demand balance at 2040 (Ml/d surplus or deficit)
Current level of service Our preferred minimum level of service	1 in 20 years	-	-
Reduction alternative Water supply-demand reductions (by ceasing use of water sources) that would be required to deteriorate the level of service	1 in 10 years	+21	88 (surplus)
Enhancement alternatives Water supply-demand enhancements (by increasing supply or reducing demand) that would be required to improve the level of service to:	1 in 40 years	-168	-101 (enhancement required)
	1 in 80 years	-211	-144 (enhancement required)

During 2012/13 we carried out further research of customer views in preparation for the 2014 Price Review. Our detailed willingness-to-pay studies asked our customers to express the extent to which they would be willing (or otherwise) to see their water bills increase in order that increases in level of service could be obtained. We obtained the views of 800 household customers and 376 non-household customers. This demonstrated that customers do not value fewer water use restrictions but they do not want to see deterioration in our level of service i.e. more frequent water use restrictions.

Customers are not willing to pay an increase in water bills to improve the frequency of water use restrictions from once in 20 years. The results from our "willingness-to-pay" study for water supply level of service are summarised in Table 35. This table shows that:

- We could save £1m by relaxing the security of supply level of service to a 1 in 10 year water use restrictions level. Customers have said that they would need to be compensated by £99m to return to a 1 in 10 years level of service. In other words customers would need to see savings of £4.5m each year on their bills before they would tolerate a reduction in their security of supply.
- Customers are not willing to pay to improve their security of supply level of service to a 1 in 40 year hosepipe ban level.

Table 35: Total customer willingness to pay and costs of implementation for water use restrictions level of service

Service level (hosepipe ban frequency in years)	1 in 10	1 in 40	1 in 80
Required WAFU (Ml/d) at 2040	-21	+101	+144
Total willingness to pay (£'m)	-72	+19	+28
Estimated additional NPV of achieving new service level (£'m)	-1	+147	+235

These findings strongly support maintaining the existing hosepipe ban frequency of no more than once in 20 years. Therefore, we consider that our preferred minimum level of service represents the best balance between customer expectations for supply reliability and the scale of water resource enhancements that would be necessary to provide a higher standard of service.

We have also investigated the deficit that would result should we improve our level of service for implementing drought permits and or orders i.e. less frequent implementation. The volume of water that would be required to meet the level of service and the cost of providing this are presented in Table 36 below. The willingness to pay from our further surveys is also included in this table.

The results show that there is an economically advantageous way of improving the level of service to 1 in 40 years. This is possible because of the size of the predicted surplus in the integrated zone. The improvement can be delivered largely by water efficiency promotion starting in 2020/21, which through saving domestic hot water use gives economic and social benefits. Some leakage reduction (2 Ml/d) would also be required in the mid 2030's. Because this improvement does not require us to take action until 2020/21, because it has not been consulted on specifically and because of the mixed views on levels of service in the representations we received, we will not formally adopt this as our plan. Customers will benefit in the period 2015-2020 because the surplus we report will mean that effectively this level of service will be achieved anyway. However we commit to doing further work to understand how these improvements can be delivered beyond 2020 and carrying our further customer research and consultation on specific proposals for our 2019 Water Resources Management Plan.

The results also suggest that improvement to 1 in 80 years may be supported by customer willingness to pay. This is less certain because the costs are closer to the willingness to pay value. Because of the mixed views on levels of service and the results of our acceptability testing research, we are not confident that this improvement would be supported by the majority of our customers and stakeholders. However we will consider it further as we develop our 2019 Water Resources Management Plan.

Table 36: Total customer willingness to pay and costs of implementation for drought permit or orders level of service

Service level (drought permit frequency in years)	1 in 10	1 in 40	1 in 80
Required WAFU (Ml/d) at 2040	Not considered	+6	+126
Total willingness to pay (£'m)		+132	+198
Estimated additional NPV of achieving new service level (£'m)		-5	+163

11.2 SCENARIO AND SENSITIVITY TESTING

It is recognised that the future is uncertain and affected by many variables. The inclusion of headroom (see Section 7) provides a buffer for uncertainties within the supply and demand forecasts. We have undertaken analysis of headroom to explore the sensitivity of our plan to variations in the risk percentile adopted (see 11.2.1).

In addition, to ensure our plan is robust we have undertaken scenario testing. This shows that:

- Our plan will allow for minor changes to supply and demand forecasts in the near future and moderate changes as the plan progresses; and
- It considers the main risks, as perceived by us, indicating the scale and timing of the impacts.

11.2.1 Headroom sensitivity testing

For our Water Resources Management Plan, the percentile profile we have used to derive our headroom values reduces from the 95th percentile from the beginning of the planning horizon to the 70th percentile by the end of the planning horizon i.e. less confidence in our supply-demand balance in the longer term. However, for climate change uncertainty components we have used the 50th percentile value across the planning horizon. This is consistent with how headroom was calculated for our 2009 Water Resources Management Plan.

We have investigated the impact on the supply-demand balance, of varying the risk percentile profile used for climate change and non-climate change uncertainty components. This sensitivity analysis has been undertaken for the Integrated and West Cumbria Resource Zones.

For the Integrated Resource Zone, we assessed the impact of using a risk profile ranging from the 95th to the 70th percentile for all uncertainty components, including climate change. This results in a reduction in the current baseline surplus at 2040 from 96.0 Ml/d to 83.9 Ml/d. However, the resource zone still remains in surplus throughout the planning horizon. We also investigated the impact of maintaining greater confidence in the first part of the planning period, than in our baseline target headroom profile i.e. a slower decline in percentile from 95th to 70th. However, the resource zone remains in surplus under these assumptions.

We undertook a similar assessment for the West Cumbria Resource Zone. This indicates that using a risk profile ranging from the 95th to the 70th percentile for all uncertainty components, including climate change, results in an increase in the forecast deficit from 33.7 Ml/d to 37.5 Ml/d by 2040.

This analysis indicates that adopting a more risk averse target headroom profile would not result in a deficit (or investment to maintain supply-demand balance) for the Integrated Resource Zone. Increasing the allowance for certainty in the West Cumbria Resource Zone results in an increase in the forecast deficit, but this is small and would not result in a change to the preferred plan.

As mentioned in Section 11.1, we would need to find an additional 101 Ml/d of water in the Integrated Resource Zone to be able to deliver an improved Level of Service, water use restrictions no more than once in 40 years. This improved Level of Service could not be delivered by taking a more flexible approach and reducing headroom because headroom is only 68 Ml/d by the end of the planning period, 2040.

11.3 SCENARIOS

We have identified the key factors that could affect our plan. They are abstraction licence changes, climate change, uncertain future demand and water trading. Testing the plan enables us to demonstrate which supply-demand options may be needed if these four factors are larger than forecast.

11.3.1 Sustainability changes

Abstraction licence changes to allow more water for the environment, also known as sustainability changes, have been agreed with the Environment Agency for the baseline supply forecasts. This included all ‘confirmed’ and some ‘unknown’ sustainability changes. We have also investigated low impact scenarios (only the

‘confirmed’ abstraction licence changes) and high impact scenarios (all abstraction licence changes, ‘confirmed’ and ‘unknown’). These scenarios are only applicable for the Integrated Resource Zone. The North Eden Resource Zone does not have any proposed abstraction licence changes, and the abstraction licence change for the River Gelt, in the Carlisle Resource Zone, does not affect the forecast deployable output for the resource zone.

For the West Cumbria Resource Zone, we are planning for the loss of Ennerdale Water abstraction licence in our baseline scenario. There are no further ‘unknown’ abstraction licence changes that can be included in a high impact scenario. If we retain abstraction from Crummock Water (which, like Ennerdale Water, is designated as a Special Area of Conservation under the Habitats Directive) it would become a more important water source for West Cumbria during extreme droughts. We have identified a requirement in our latest Drought Plan (2012) to obtain a drought permit or drought order to enable abstraction to continue beyond the current licenced conditions to maintain customer water supply.

As mentioned in section 4.3.2 we have included an allowance of emergency storage for our reservoirs, this is currently 30 days in the West Cumbria Resource Zone. Given the flashy nature of Crummock Water and the environmental sensitivity, we consider it appropriate to develop a scenario allowing for more emergency storage at Crummock. This will increase the resilience of the resource zone to drought conditions; allow more time to for the Environment Agency to determine drought permits and more time to consider application for drought orders. Correspondence relating to our Drought Plan from Defra and the Environment Agency has indicated that determination of a drought permit would take a minimum of 35-40 working days. The Water Resources Planning Guideline indicates an upper allowance of 45 days emergency storage; we have investigated this as a scenario for West Cumbria.

In line with the Water Resource Planning Guidelines (EA 2013), uncertainty relating to sustainability changes has not been included in headroom. However, we use these scenarios to vary the forecast water supply presented in the supply-demand balance, and investigate the impact of this risk on our plan in isolation and in combination with demand uncertainty, climate change scenarios and water trading (where applicable).

11.3.2 Climate change

Our plans include our best current estimates of the effects of climate change on water supply. This has been developed using the UK Climate Predictions 2009 and the latest national methodology. The climate change impact demonstrated in the supply-demand balance for each resource zone is based on the mean deployable output from 20 UK Climate Predictions (2009) climate scenarios (see Section 4.5 for more details). Following Water Resource Planning Guidelines, uncertainty around the central estimate of climate change impact has been included in target headroom (see Section 7).

We considered alternative climate change outcomes on the forecast water supply presented in the supply-demand balance. We generated low and high climate change impact scenarios based on the 20 climate scenarios. We investigated the impact of this risk on our plan in isolation and in combination with sustainability reductions, demand uncertainty and water trading (where applicable).

The scenarios are only applicable for the Integrated, Carlisle and West Cumbria Resource Zones. The groundwater sources in the North Eden Resource Zone are not vulnerable to climate change.

11.3.3 Uncertainty in future demand

Our baseline demand forecasts present the dry year scenario demand for the next 25 years based on forecast population change, customer behaviour and industrial requirements, see Section 6 for more details on this. Demand could differ from what is forecast due to changes in population growth and growth in the number of properties built. We have looked at the implications of 25% more new properties each year, together with the annual population growth being 25% higher. We also considered a scenario with both the population growth of the North West and the number of new properties being 25% less than the baseline forecast. In our high and low scenarios, we also included different levels of non-household consumption. We have prepared these high and low demand scenarios for all resource zones.

Following Water Resource Planning Guidelines, uncertainty around the central estimate for dry year scenario demand has been included in target headroom using these high and low demand scenarios, see Section 7.

We also used these scenarios to vary the forecast demand presented in the supply-demand balance, and investigated the impact of this risk in isolation and in combination with sustainability reduction, climate change and water trading scenarios (where applicable).

11.3.4 Water trading

An important resource management option that is considered in this plan relates to the bulk transfer of water in to and out of our supply area. Options to improve the connectivity between water companies and to better share existing abstraction licences are a fundamental requirement of Defra and Ofwat in the preparation of this Water Resources Management Plan. Section 8 provides details of the potential imports that could be utilised in the preparation of our plan to meet deficits forecast in our supply area.

Throughout the process of developing the potential imports, we also proposed and developed potential exports to other water companies through a process of bi-lateral engagement. Potential exports were identified with eight water companies. We and the recipient water companies agreed that these export options were technically feasible and could provide a potential benefit to water supply within their supply area. Options identified through this process are presented in Appendix 8.

In the baseline planning scenario there is enough water to meet demand in the Integrated Resource Zone. Therefore, in line with guidance and government aspiration, we will consider using the forecast surplus to enable exports to any of the seven water companies identified. We will also consider possible new source development or demand management to facilitate larger scale exports. Any export considered further by us must:

- provide a benefit to the customers of the importing company, by being an economic option;
- result in financial benefits to our customers and shareholders, through full cost recovery from the importing company;
- result in no deterioration in service to our customers; and
- have the potential to increase resilience within our supply area.

Whilst developing this plan it is difficult for us to predict what the exact requirements for potential exports to other water companies will be. We consider 180 Ml/d to be a likely maximum export.

11.4 SCENARIO SELECTION TO TEST THE PLAN

We used the key risk factors to develop alternative supply and demand scenarios. These are presented in comparison with the baseline in Table 37 below.

Five scenarios are shown for the Integrated Resource Zone, see Table 38. Increased sustainability reductions (Scenario 1) and the drier climate scenario (Scenario 3) do not result in a supply-demand deficit. The high demand scenario (Scenario 2) results in a supply-demand deficit of 2.1 Ml/d in 2040. Scenario 4, water trading of 180 Ml/d, results in a deficit from the start of trading; by 2040 the deficit is 84.0 Ml/d. Scenario 5 shows that the combined impact of increased sustainability reductions, high demand, drier climate and maximum water trading results in a deficit of 257.3 Ml/d by 2040. We also tested these scenarios for the combined Integrated and West Cumbria Zone, which will be formed in 2025 following completion of the Thirlmere transfer.

Three scenarios have been investigated for the Carlisle Resource Zone, see Table 38. The high demand and drier climate scenarios result in a surplus. However, the combined impact of these results in a small supply-demand deficit of 0.6 Ml/d at 2040.

We have generated four scenarios for the West Cumbria Resource Zone, see Table 38. The baseline scenario includes the revocation of the Ennerdale abstraction licence, therefore our sustainability reductions scenario investigates an increase in emergency storage at Crummock Water from 30 days to 45 days, for drought resilience and as a proxy for further unknown sustainability changes. We also considered high demand and drier climate scenarios and Scenario 4 includes the combined impact of these, see Table 38. The increase in emergency storage at Crummock is infeasible with the current supply arrangement in West Cumbria and cannot be achieved. Therefore, the deficit for this scenario and the combined impacts scenario is demand plus headroom (49.1 Ml/d and 51.3 Ml/d respectively), assuming Water Available For Use is 0 Ml/d.

We have also investigated a high demand scenario for the North Eden Resource Zone. However, given the current surplus, this does not result in a deficit during the 25 year planning horizon and will not be considered further.

The scenarios that have resulted in supply-demand deficits during the planning horizon have been tested using our optimisation model to demonstrate which options could be used. We should not invest for an unlikely, worst case scenario. However, we should be reassured that sufficient options are available in these circumstances that could be implemented in a timely manner. The results of this scenario testing are presented in the Table 39 below.

Table 37: Four main water resource planning uncertainties

	Resource Zone	Low Impact Scenario (L)	Baseline (B)	High Impact Scenario (H)
Sustainability Reductions	Integrated Resource Zone	'Confirmed' licence changes only (River Calder new Hands Off Flow 9 Ml/d	'Confirmed' and some 'Unknown' licence changes (considered likely). See section 4 for details	All 'Confirmed' and all 'Unknown' licence changes. See section 4 for details
	West Cumbria Resource Zone	'Confirmed' licence change at Overwater. Compensation flow variation at Ennerdale (between 70 Ml/d and 50 Ml/d)	'Confirmed' licence change at Overwater. No Ennerdale licence.	'Confirmed' licence change at Overwater. No Ennerdale licence. Increased Emergency Storage at Crummock from 30 days to 45 days.
Demand Forecast	All resource zones	Low demand forecast	Dry year scenario demand	High demand forecast
Climate Change	Integrated, Carlisle and West Cumbria Resource Zones	Low percentile (25th percentile)	Weighted average of 20 climate change runs	High percentile (85th percentile)
Water Trading	Integrated Resource Zone	Existing exports decline	Retain existing exports	Significant new exports up to 180 Ml/d

Table 38: Scenarios used to test the plan

Scenario	Uncertainty				Surplus Or Deficit In 2040 Under The Scenario
	Sustainability Reductions	Demand Forecast	Climate Change	Water Trading	
Integrated Resource Zone					
IRZS1. Further Sustainability Reductions	H	B	B	B	80.1 (surplus)
IRZS2. High Demand	B	H	B	B	-2.1 (deficit)
IRZS3. Drier Climate	B	B	H	B	36.7 (surplus)
IRZS4. Large Scale Water Trading	B	B	B	H	-84.0 (deficit)
IRZS5. Overall Worst Case	H	H	H	H	-257.3 (deficit)
Carlisle Resource Zone					
CRZS1. High Demand	N/A	H	B	N/A	0.6 (surplus)
CRZS2. Drier Climate	N/A	B	H	N/A	1.1 (surplus)
CRZS3. Overall Worst Case	N/A	H	H	N/A	-0.6 (deficit)
West Cumbria Resource Zone					
WCRZS1. Further Sustainability Reductions	H	B	B	N/A	-49.1 (deficit)*
WCRZS2. High Demand	B	H	B	N/A	-35.9 (deficit)
WCRZS3. Drier Climate	B	B	H	N/A	-41.1 (deficit)
WCRZS4. Overall Worst Case	H	H	H	N/A	-51.3 (deficit)*
Combined Integrated and West Cumbria Zone					
FPS1. Further Sustainability Reductions	H	B	B	B	51.0 (surplus)
FPS2. High Demand	B	H	B	B	-36.3 (deficit)
FPS3. Drier Climate	B	B	H	B	7.6 (surplus)
FPS4. Large Scale Water Trading	B	B	B	H	-113.1 (deficit)
FPS5. Overall Worst Case	H	H	H	H	-291.5 (deficit)

* Resource zone deployable output is 0 Ml/d therefore deficit is demand plus headroom in 2040

Table 39: Selected schemes for scenarios tested

Scenario	Deficit in 2040 under the scenario (Ml/d)	Total NPV Of Schemes Selected (£m)	Schemes Selected
Integrated Resource Zone			
3. High Demand (25% increase in population growth and new development)	2.1	(1.0)	Water efficiency promotion
4. Large Scale Water Trading (Up to 180Ml/d)	8.4	142.6	Water efficiency promotion, leakage reduction, network enhancement, new groundwater sources, effluent re-use, river abstraction and raise an existing reservoir
5. Overall Worst Case (Combination of scenarios 1, 2, 3 and 4)	257.3	492.6	Water efficiency promotion, leakage reduction, network enhancement, new groundwater sources, effluent re-use, raise an existing reservoir, bulk transfer from Northumbrian Water and surface water abstractions
Carlisle Resource Zone			
3. Overall Worst Case (Combination of scenarios 1 and 2)	0.6	0.1	Water efficiency promotion and leakage reduction
West Cumbria Resource Zone			
1. Increase in emergency storage at Crummock	49.1*	176.3	Transfer from Thirlmere in Integrated Resource Zone
2. High Demand (25% increase in population growth and new development)	35.9	111	New groundwater sources and third-party abstraction licence
3. Drier Climate (Larger climate change impact)	41.1	176.3	Transfer from Thirlmere in Integrated Resource Zone
4. Overall Worst Case (Combination of scenarios 1, 2 and 3)	51.3*	188.9	Transfer from Thirlmere in Integrated Resource Zone
Combined Integrated and West Cumbria Zone			
3. High Demand (25% increase in population growth and new development)	36.3	29.0	Water efficiency promotion, leakage reduction, network enhancement, new groundwater sources and effluent re-use
4. Large Scale Water Trading (Up to 180Ml/d)	113.1	204.2	Water efficiency promotion, leakage reduction, network enhancement, new groundwater sources, effluent re-use, river abstraction and raise an existing reservoir
5. Overall Worst Case (Combination of scenarios 1, 2, 3 and 4)	291.5	668.6	Water efficiency promotion, leakage reduction, network enhancement, new groundwater sources, effluent re-use, raise an existing reservoir, bulk transfer from Northumbrian Water and surface water abstractions

* Resource zone deployable output is 0 Ml/d therefore deficit is demand plus headroom in 2040

11.4.1 Scenario testing: Integrated Resource Zone

From the scenario testing, it is evident that the Integrated Resource Zone will only have a supply-demand deficit if the North West experiences higher demand than that assumed in our baseline assessment or we undertake large scale water trading.

A commitment to large scale water trading is within our control therefore the requirement for investment prior to this can be factored in to any trading agreement we may make.

The high demand scenario we have investigated only drives a deficit by 2040 and can be managed with small demand management schemes. It is therefore appropriate that an update of the assessment is undertaken for our Water Resources Management Plan 2019 to determine whether our strategy should be reviewed at this point.

11.4.2 Scenario testing: Carlisle Resource Zone

The worst case scenario has driven a small deficit in the Carlisle Resource Zone, up to 0.6 Ml/d. As the combined deficit involves small quantities of water, it can be managed easily with small demand management schemes. Therefore, it is appropriate that this is revisited for our Water Resources Management Plan 2019 to determine whether our strategy should be reviewed.

11.4.3 Scenario testing: West Cumbria Resource Zone

The scenario testing undertaken for the West Cumbria Resource Zone indicates possible deficits of between 35.9 Ml/d and 51.3 Ml/d, compared to the baseline deficit of 33.7 Ml/d by 2040. Our preferred plan, the Thirlmere transfer, would resolve the deficits identified for all scenarios, therefore the preferred solution will not change. This is one of the reasons for selecting the Thirlmere transfer as the preferred plan. This is also the case for the alternative plan of a transfer to West Cumbria from Northumbrian Water's Kielder reservoir.

The least cost plan (a number of local schemes) would meet the baseline forecast deficit and the high demand scenario. However, should we experience a drier climate or if greater environmental protection of our local water sources was required, the Thirlmere transfer is the least cost plan to resolve the deficit.

11.4.4 Scenario testing: Combined Integrated and West Cumbria Zone

For the larger zone that will exist from 2025 under the preferred plan, the situation is similar to the Integrated Resource Zone. Only higher demand and large scale water trading result in a deficit. As discussed, large scale water trading is within our control.

The high demand scenario we have investigated drives a small deficit after 2030. This could be resolved with demand management, new groundwater sources in Cheshire and Lancashire and effluent re-use. The demand assessment will be reviewed for our Water Resources Management Plan 2019 to determine whether our strategy should be revised at this point.

11.4.5 Scenario testing summary

The timing and impacts of the scenarios tested indicates that our preferred plan will not require modification before the next plan is published in 2019.

11.5 BEYOND THE 25 YEAR PLANNING HORIZON

We used a 25-year planning horizon in this Water Resources Management Plan. However, we have considered whether a longer-term view would have been appropriate.

We have undertaken some high level analysis to assess the vulnerability of our resources to climate change beyond the 25-year planning period, to determine how supply in our resource zones might be affected. It is extremely difficult to predict what might happen this far into the future but the UKCP09 climate change projections have allowed us to investigate available supplies by providing estimates of climatic conditions in each decade until the 2080s.

We used the output from our climate change modelling scenario runs (Section 4.5) to determine the relationship between deployable output and change in precipitation for each resource zone (excluding North Eden Resource Zone which is supplied by groundwater and not affected by climate change: see Section 4.5). We then used these relationships, along with UKCP09 climate change projections of precipitation from 2040 to 2080, to estimate the potential impact of climate change on deployable output and hence water available for use in each resource zone.

In North West England, the UKCP09 projections show an overall reduction in precipitation of around 20% by 2080, compared to 13% at the end of the planning period in 2040. We expect this to cause a further estimated reduction of only 2.0-2.5% in water available for use from 2040 to 2080. This is less than 1 Ml/d in the Carlisle and West Cumbria Resource Zones. In the much larger Integrated Resource Zone it is around 40 Ml/d. If demand follows the current decreasing trend then the Integrated Resource Zone would remain in surplus to 2080. Demand is very hard to predict over this much longer period as it depends on demographic changes[11].

The preferred solution to address the significant supply-demand deficit identified for the West Cumbria Resource Zone is sufficient to meet any future reductions in supply availability due to climate change, beyond 2040.

In light of this high-level assessment, we conclude that there is no merit in undertaking a more detailed assessment over a planning period longer than 25 years.

[11] Walker, G “A critical examination of models and projections of demand in water utility resource planning in England and Wales” International Journal of Water Resources Development (2012)

12 CONCLUSIONS

Key Messages

- We have a supply-demand surplus in three of our four water resource zones
- The West Cumbria Resource Zone has a supply-demand deficit, due to the anticipated revocation of our abstraction licence at Ennerdale Water
- Moving water from Thirlmere reservoir in the Integrated Resource Zone to West Cumbria is our preferred plan
- We have taken account of stakeholder and customer views in selecting our preferred plan
- The plan is flexible and will meet the future needs of our customers
- Our level of service to our customers remains unchanged
- We will continue to look at the potential for exporting water to other parts of the country

We have carried out detailed analysis to determine the supply demand balance and required investment in this draft Water Resources Management Plan. Our water resources and demand strategies ensure that our water supply reliability will continue to be achieved across the region over the 2040 planning horizon. It also ensures sustainable water abstraction and meets the challenges of climate change.

We have produced a plan that is not only compliant with the Environment Agency's guidelines and incorporates current best practice, but is a plan that is robust, flexible and helps the North West to be ready for the future.

12.1 OUR PROPOSAL

We propose to resolve the forecast shortfall in supply in West Cumbria by connecting the area to the Integrated Resource Zone. This will allow long-term environmental protection for this environmentally important area, make it resilient to changes in the climate and support economic growth.

No deficits of supply are forecast elsewhere in the North West region.

We will continue to operate the most economically sustainable level of leakage, finding and fixing repairs where it is of economic benefit to our customers to do so.

We will continue to encourage our customers to take up the Free Meter Option available to them and we will look into new and engaging ways of helping customers to monitor and manage their own water demand.

We will continue to be leaders in the area of water efficiency, to deliver a continued reduction in the total demand for water.

Over the medium-term, we will consider the potential for exporting water to other parts of the UK, where it is economic to do so and will result in benefits for our customers.

12.2 NEXT STEPS

Water resources planning is a dynamic process and we are committed to on-going review of the key elements of the plan. The final plan will be reviewed annually, with the annual review published at unitedutilities.com/waterresourcesplan.

Our next statutory Water Resources Management Plan is expected to be completed in 2019.

UNITED UTILITIES WATER PLC

Revised Draft Water Resources Management Plan 2013

APPENDICES

APPENDIX 1. REFERENCES

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APPENDIX 2. GLOSSARY

AMP	Asset Management Plan: AMP5 covers the period April 2010 to March 2015, AMP6 covers the period April 2015 to March 2020, etc.
AMR	Automated Meter Reading
Aquator™	The name of a water resources computer modelling system used by United Utilities.
Average Incremental Social Cost (AISC)	The ratio of present Social Costs over Present Net Value of additional water delivered or reduced demand.
Baseline Demand Forecast	A demand forecast which reflects a company's current demand management policy but which assumes the achievement of the current agreed target for leakage during the forecast duration, as well as the implementation of the current company Water Efficiency Plan, irrespective of any surplus.
Consumer Council for Water	The Consumer Council for Water (Northern), which represents the interests of water customers
Countryside Council Wales	Countryside Council for Wales. To be replaced by Natural Resources Wales 1 April 2013
Compensation flow	Stored water released from a reservoir to ensure a continuous flow in the downstream watercourse
Critical Period	The length of time between a reservoir being full and the reservoir reaching minimum storage during the worst drought on record.
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs.
Demand Management	The implementation of policies or measures which serve to control or influence the consumption or waste of water. (This definition can be applied at any point along the chain of supply).
Deployable Output	The output of a commissioned source or group of sources or of a bulk supply as constrained by: the environment; abstraction licences; water quality; existing water treatment and supply system capacities.
DETR	Department of the Environment, Transport and the Regions (which no longer exists and many of its functions are now undertaken by the new department Defra).
Distribution Input	The amount of water entering the distribution system at the point of treated water production.
Distribution Losses	Comprises water lost from trunk mains, service reservoirs, distribution mains and communication pipes. Distribution losses = distribution input less water taken.
DMA	District Meter Area – an area (of up to 3000 properties) where the supply to it is continuously monitored.
Dry Year Annual Daily Demand	The level of demand, which is just equal to the maximum annual average, which can be met without the introduction of demand restrictions at any time during the year. This should be based on a continuation of current policies regarding demand management. The dry year demand should be expressed as the total demand in the year divided by the number of days in the year.
Drought Order	The Water Resources Act 1991 gives the Secretary of State or the National Assembly for Wales the power to grant ordinary and emergency drought orders to water undertakers or the EA

	Ordinary drought orders can include the same powers to abstract water as drought permits, but they can also authorise water undertakers to take other actions. In this plan the term “drought permit/order” is used to differentiate these from drought orders for non-essential use
	An emergency drought order gives water companies complete discretion on the uses of water that may be prohibited or limited, and they can authorise supply of water by standpipes or water tanks, or impose rota cuts
Drought Permit	Schedule 22 of the Environment Act 1995 amended the Water Resources Act 1991 to give the EA the power to grant drought permits. Drought permits can only authorise a water undertaker to “take water” from specified sources or modify or suspend restrictions or obligations relating to a water undertaker’s existing powers to “take water” from a source. In this plan the term “drought permit/order” is used to differentiate these from drought orders for non-essential use
EA	The Environment Agency
EBSD	*Economics of Balancing Supply and Demand* – a key methodology document published by UKWIR in 2002.
ELL	Economic level of leakage, which is being superseded by the concept of “sustainable economic level of leakage” (SELL).
Final Planning Demand Forecast	A demand forecast that reflects a company’s preferred policy for managing demand and resources through the planning period, after taking account of all options through economic analysis.
Habitats Directive	The European Union Habitats Directive (92/43/EC) is the instrument through which Member States must identify and protect as “Special Areas of Conservation” (SAC) certain sites that are representative of specified habitats for specific species which are of European importance. It also covers “Special Protection Areas” (SPA) but none are identified as being affected by United Utilities abstractions.
Habitats Regulation Assessment (HRA)	Habitats Regulations Assessment is a process for identifying the implications of the drought plan options for European designated sites (SAC, SPA, Ramsar). If likely significant adverse impacts are predicted, then a detailed Appropriate Assessment of the option is required
Hands-off flow	A hands-off flow (also known as a prescribed flow) is normally associated with a river abstraction and is the flow above which abstraction can occur. The purpose of a hands-off flow is to ensure a given flow of water continues in the river prior to abstraction
Headroom	Available headroom is the difference (in Ml/d or %) between WAFU (including imported water) and demand at any given point in time. See below for Target Headroom.
Hosepipe Ban	Section 36 of The Flood and Water Management Act 2010 replaced the original Section 76 of the Water Industry Act 1991. The original legislation only allowed water undertakers to prohibit or restrict the use of hosepipes (or similar apparatus) for the purposes of watering private gardens and the washing of private motor cars, commonly known as a hosepipe ban. The new legislation gives water companies further powers to restrict water use by customers. Therefore this plan refers to “water use restrictions” rather than hosepipe bans
Household	A property used as a single domestic dwelling as defined by Ofwat.
Initial Supply-Demand Balance	The difference between WAFU and baseline demand forecast (including target headroom) before any additional demand management measures or source enhancements.

Inset Appointee	The inset appointment process is the route by which one company replaces the incumbent (i.e. United Utilities for the North West) as the appointed water and/or sewerage company for a specified area. As such the replacement appointed water company will have all of the same duties and responsibilities as the previous statutory water company for the specified area. UNITED UTILITIES's only inset appointment is for Peel Water Networks Ltd. who supply water to Media City, Salford. Peel are not a licensed supplier as they do not hold a Water Supply Licence
l/hd/d	Litres per person per day
LeakLine	A free telephone number for the public to report leaks to United Utilities.
Level of Service	Reliability of water supply to our customers expressed as the frequency of the imposition of water use restrictions.
Ml/d	Megalitres per day (million litres per day).
Micro-component analysis	The process of deriving estimates of future consumption based on expected changes in the individual components of customer use.
Natural Resources Wales	New single environmental body from 1 April 2013. Replacing Countryside Council for Wales, the Forestry Commission in Wales and the Environment Agency in Wales.
NE	Natural England
NERA	National Economic Research Associates.
Non-essential Use Ban	Also known as a prescribed uses order. The Drought Direction 2011 sets out the "non-essential" uses of water that can be prohibited or limited by an ordinary drought order. It is more restrictive than Section 76 of the Water Industry Act 1991 (as replaced by Section 36 of The Flood and Water Management Act 2010) and can impact particularly on car washing businesses, building cleaning businesses and those businesses with private swimming pools
Non-household	Properties receiving potable supplies but which are not occupied as domestic premises, i.e. factories, offices, commercial properties, and cattle troughs. They also include properties containing multiple households, which receive a single bill (e.g. block of flats).
Normal Year Annual Daily Demand	The total demand in a year with normal or average weather patterns, divided by the number of days in the year.
Net Present Value (NPV)	Net Present Value of a schedule of costs for a programme. NPV is a very widely used method to combine various costs occurring over a period of time into a single value for comparison with the NPV of an alternative programme.
NRA	National Rivers Authority, which was replaced by the Environment Agency (EA) in 1996.
ODPM	Office of the Deputy Prime Minister
Ofwat	The public name of the Water Services Regulatory Authority, previously called Office of Water Services (the economic regulator of the water industry in England and Wales).
ONS	Office for National Statistics.
Outage	A temporary loss of deployable output due to planned or unplanned events. An outage is temporary in the sense that it is retrievable, and therefore deployable output can be recovered.
PCC	Per capita consumption (in litres per person per day)

Price Review or Periodic Review	A review (normally every 5 years) conducted by Ofwat of water tariffs, price limits, water company investment plans and service levels to customers.
PR14	Price review at 2014 to determine water prices, water company investment plans and service levels for the period 2015-20.
Point of Production	The point where treated water enters the distribution system. Defined as raw water into treatment less treatment works operational use and treatment works losses.
Ramsar	Ramsar sites are wetlands of international importance designated under the Ramsar Convention. More formally known as "The Convention on Wetlands of International Importance especially as Waterfowl Habitat" it is an intergovernmental treaty signed in Ramsar, Iran, in 1971
Resource Zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall.
Review of Consents	The EA process by which abstraction licences (and other consents such as discharge consents) that have the potential to adversely affect SAC and SPA sites are being reviewed by the EA to determine if they need to be altered. This process will result in changes such as increases to compensation or prescribed flow requirements and reductions to the volume of water that can be abstracted
SAC	Special Area of Conservation designated under the EU Habitats Directive
SEA	Strategic environmental assessment – see Section 8.5.
SELL	Sustainable economic level of leakage, a concept introduced by Ofwat in 2007.
SELWE	Sustainable economic level of water efficiency, a concept introduced by Ofwat in 2010.
Secretary of State	The Secretary of State for Defra (Department for Environment, Food and Rural Affairs)
SPA	Special Protection Area, as designated under the EU Directive on the conservation of wild birds (also known as the Birds Directive). Together with SAC's these form the Natura 2000 network of protected sites
SSSI	Site of Special Scientific Interest
Statutory Water Use Restrictions	Statutory Water Use Restrictions would be implemented approximately 28 days following the introduction of Voluntary Water Use Restrictions. The Statutory Water Use Restrictions are as set out in Section 76 of the Water Industry Act 1991 (as replaced by Section 36 of The Flood and Water Management Act 2010)
Supply Pipe Losses	Losses that occur from pipes which are the responsibility of the customer.
Sustainability Reduction	Reduction in deployable output of a water source, or group of water sources, due to change in abstraction licence conditions imposed by the Environment Agency to ensure more environmentally sustainable water abstraction.
Target Headroom	Target headroom is the threshold of minimum acceptable headroom, which would trigger the need for total water management options to increase WAFU or decrease demand.
Total Leakage	The sum of distribution losses and customer supply pipe losses.

Total Water Management	All water management activities from source to end use (i.e. resource management, production management, distribution management and customer-side management)
Tripartite Report	The short name often given to the Ofwat, EA and Defra (2002) report: *Future Approaches to Leakage Target Setting for Water Companies in England and Wales*
UKCIP	United Kingdom Climate Impacts Programme.
UKCP	United Kingdom Climate Projections
UKWIR	United Kingdom Water Industry Research Limited .
United Utilities	United Utilities Water PLC, the licensed water company for North West England.
Water Available For Use (WAFU)	The value of Ml/d calculated by the deduction from deployable output of allowable outages and planning allowances in a resource zone.
Water Framework Directive	The European Union Water Framework Directive (2000/60/EC) establishes a strategic “river basin planning” approach to managing the water environment, including achievement of good ecological status in water bodies by 2015. It provides a consistent approach for ensuring compliance with standards and objectives set for protected areas, and implementation of programmes of measures to meet those objectives.
Water Resource Zone	See Resource Zone above.
Water Taken Unbilled	Water supplied to customers for legitimate purposes which is unbilled and water taken illegally.
WRc	Water Research Centre
Yield	A general term for the reliable supply of water from a source. More specific, defined terms are used in this document – see Water Available For Use and Deployable Output.

APPENDIX 3. USEFUL WEBSITES

Organisation	Website
Chartered Institute of Water and Environmental Management (CIWEM)	ciwem.org
Consumer Council for Water	ccwater.org.uk
Department for Communities and Local Government (DCLG)	communities.gov.uk
Department for the Environment, Food and Rural Affairs (Defra)	defra.gov.uk
Environment Agency (EA)	environment-agency.gov.uk
Natural England (NE)	naturalengland.org.uk
Ofwat	ofwat.gov.uk
Office for National Statistics (ONS)	statistics.gov.uk
UK Climate Impacts Programme (UKCIP)	ukcip.org.uk
UK Water Industry Research Limited (UKWIR)	ukwir.org
United Utilities (United Utilities)	unitedutilities.com
Water Research Centre (WRc)	wrcplc.co.uk
Water UK	water.org.uk
Waterwise	waterwise.org.uk

APPENDIX 4. LIST OF CONSULTEES

The following table lists the organisations we are required to consult on the plan, in accordance with the Water Resources Management Plan Regulations (Defra, 2007).

Environment Agency	South Lakeland District Council
Water Services Regulation Authority (Ofwat)	South Ribble Borough Council
Secretary of State for Environment, Food & Rural Affairs	St Helens Metropolitan Borough Council
National Assembley for Wales	Stockport Metropolitan Borough Council
Allerdale Borough Council	Stoke on Trent City Council
Barrow in Furness Borough Council	Tameside Metropolitan Borough Council
Blackburn with Darwen Borough Council	Trafford Metropolitan Borough Council
Blackpool Council	Warrington Borough Council
Bolton Metropolitan Borough Council	West Lancashire Borough Council
Burnley Borough Council	Wigan Metropolitan Borough Council
Bury Metropolitan Borough Council	Wirral Metropolitan Borough Council
Carlisle City Council	Wyre Borough Council
Cheshire East Council	Greater Manchester Combined Authority
Chester West and Chester Council	The Lake District National Park Authority
Chorley Borough Council	The Peak District National Park Authority
Copeland Borough Council	The Snowdonia National Park Authority
Cumbria County Council	Natural England
Eden District Council	Historic Buildings and Monuments Commission for England (English Heritage)
Fylde Borough Council	Canal & River Trust
Halton Borough Council	Mersey Docks and Harbour Company (Liverpool & Birkenhead)
High Peak Borough Council	Manchester Ship Canal Company (Manchester and Bridgewater Canals)
Hyndburn Borough Council	Associated British Ports (Barrow, Silloth, Fleetwood & Garston)
Knowsley Metropolitan Borough Council	Heysham Port Ltd
Lancashire County Council	Lancaster Port Commissioners
Lancaster City Council	Cumbria County Council (Workington Harbour)
Liverpool City Council	Whitehaven Harbour Commissioners
Manchester City Council	Consumer Council for Water - Northern
Oldham Metropolitan Borough Council	Countryside Council for Wales
Pendle Borough Council	Peel Water Network Ltd.
Preston City Council	Yorkshire Water
Ribble Valley Borough Council	Dee Valley Water
Rochdale Metropolitan Borough Council	Northumbrian Water
Rossendale Borough Council	Severn Trent Water
Salford City Council	Welsh Water
Sefton Council	

APPENDIX 5. FREQUENTLY ASKED QUESTIONS

Why don't you take more water when it is plentiful rather than in a drought?

During wet weather our reservoirs refill, however we are limited by their maximum capacity and cannot store more water. We would need new reservoirs to allow us to store more water. We have abstraction licences that limit our abstractions from rivers and lakes (e.g. Lake Windermere, Lake Ullswater). We also have operating rules in relation to abstractions that mean that we wouldn't abstract from some sources when there is no benefit, e.g. if the storage in the receiving reservoir is already very high. These rules are included in our assessments of water availability in this plan.

Why is leakage so high?

The amount of water we lose through leakage is now at the lowest ever levels. We operate a network of nearly 43,000 km of pipes, operating under pressure (typically 3 bars). Leakage on our pipes can occur as a result of:

- Bursts which are relatively easy to find and fix;
- Background weeps and seeps which are difficult to find.

It becomes increasingly difficult and costly to drive leakage down as we have to find more and more of the small leaks, faster and earlier.

Our investment in reducing leakage means that the amount of water lost has reduced by more than half since 1995.

Why don't we build more reservoirs?

As part of the Water Resources Management Plan we consider all options which include new reservoirs. However, the options to build new reservoirs are not preferred. This is due to a combination of factors including the environmental impact, loss of visual amenity and high cost of building a new reservoir. In addition, new reservoirs require a very long time to plan compared to other supply options. There are many other, more preferable options (e.g. new borehole sources, leakage reduction etc.)

Why should I have a water meter?

If you don't already have a water meter fitted, your current bills are based on the rateable value of your property, not on the amount of water you use – so how much you pay won't relate to how much water you use.

If you live on your own, if you have a small family or if you live in a house with a high rateable value, chances are you're probably paying too much for your water services, so a water meter could be right for you. Take a look at our water meter pack to help work out much money you could potentially save each year if you have a water meter: unitedutilities.com/is-a-meter-right-for-me

With a water meter, you can work out how much water you're using on a regular basis – which can help you understand how to save water and money. Environmentally, it makes sense too! A meter can also help to reduce your energy bills and carbon footprint, as around 30% of a household's energy bills come from using hot water.

If you find after having it fitted that a meter isn't right for you, you can revert back to being charged by your home's rateable value as long as you ask us within 13 months of having your meter fitted. There is no charge for this. All home owners can apply for a free water meter. If you are a tenant and have a fixed term agreement, you can apply too. If you have an agreement that is less than 6 months, you must obtain your landlord's permission first before applying.

Why should I save water?

A lot of the water we use in the home is heated by gas or electricity (such as baths, showers and washing up) so any water savings you make should reduce your energy bills too. Simple changes to your daily routine can really help to drive down your bill if you are on a meter. Visit unitedutilities.com/usewaterwisely for lots of hints and tips. You can also order free stuff from us at our website to help you get started!

We need to use water wisely to make sure that there is plenty for everybody who needs it - households, businesses and wildlife. Our water treatment works have to use lots of energy to collect, clean and pump drinking water to homes and businesses every day. Using water wisely will reduce wastage and reduce your energy bill (and your carbon footprint). The water that leaves your home needs to be cleaned before being returned to the environment. Our wastewater treatment works use lots of energy to do this, so you reducing your water wastage can reduce our carbon footprint too.

Why don't I get compensation when we have a hosepipe ban?

Hosepipe bans (now known as water use restrictions) are part of our planned level of service. We plan for water use restrictions to be enforced no more than once in 20 years on average, therefore water use restrictions experienced at this frequency are part of the service our customers pay for and therefore we would not compensate customers when water use restrictions are enforced.

As part of this plan we have investigated the possibility of decreasing the frequency of water use restrictions through our customer research. We asked our customers to express the extent to which they would be willing (or otherwise) to see their water bills increase in order that increases in level of service could be obtained. We obtained the views of 800 household customers and 376 business customers. This demonstrated that customers do not value fewer water use restrictions and were not willing to pay higher bills for the frequency of water use restrictions to be reduced.

Why can't we stop flooding?

The issue of flooding is not directly related to the Water Resources Management Plan process, which is primarily concerned with maintaining adequate water supplies to customers over the coming 25 years. The Environment Agency are responsible for flooding (e.g. river and coastal) and have a programme of measures in place to protect communities from flooding. To minimise the impact of flooding it is possible to construct purpose built flood storage basins or to implement controlled flooding measures (e.g. where lowlands are allowed to flood). United Utilities water supply reservoirs are built for the purpose of water supply however they do provide some attenuation of floods, although this is often a minimal impact due to the comparative volume of water arriving in a flood and the available storage in a reservoir.

Are you going to cause droughts in the North West by selling water elsewhere?

In line with government aspirations outlined in the Water White Paper and Draft Water Bill, we have investigated options to improve the connectivity between water companies and to better share existing abstraction licences.

We have identified a number of potential opportunities for United Utilities to sell water to other water companies that have a large supply-demand deficit in the future. However, in order to ensure the trade does not adversely affect the service we provide to our customers in the North West, as part of the trade we have identified new water sources and demand management activities that would be developed in the North West in support of the trade. Therefore, if we were to enter in to water trading agreements with other companies, these would be implemented as part of the trade and there would be no impact on drought frequency in the North West; we would maintain our current level of service for our customers. There would also be

advantages to having the new water sources in the North West, because this would provide a more resilient supply system.

Why can't we have a national grid for water?

It is government's aspiration that connectivity between water companies should be improved to allow water to be passed from areas where it is plentiful and areas where there is a shortage. For this Water Resources Management Plan companies have been asked to investigate the possibility of connectivity but it is very early days. Large scale water transfer between areas of the country is not currently practical because connecting pipelines do not exist. We think that such pipelines should only be built if they make economic sense and will benefit our customers.

It always rains, why are we worried about a lack of water?

The amount of rain we get in the North West is important to support the environments we have here, especially those designated for European protection in the Lake District. The ecology and environment of the Lake District thrives due to the amount of rain it receives. We are only able to capture rain for public water supply within our reservoirs, and these have a limited capacity. Once our reservoirs are full we are unable to store more rain.

Why not use sea water by building desalination plants?

Desalination was considered, along with many other options as part of our Water Resources Management Plan. Desalination does not form part of the preferred strategy, since the costs – including environmental and social costs – are about four times higher than alternatives such as groundwater schemes or leakage control. Desalination has a high carbon cost as it is very energy intensive, and also generates high concentration saline waste which can have environmental impacts. Interconnecting pipelines and new groundwater sources formed part of the plans that we included in the consultation, because they have lower impacts on the environment and customer bills.

Why did United Utilities sell off or abandon reservoirs?

United Utilities only sell or abandon reservoirs after a full investigation. We consider issues such as the volume of water available, the benefit to the resource zone, the connectivity to the rest of the water supply network and the water treatment required. In all cases, the reservoirs sold off or abandoned are very small, and often in remote locations, have poor water quality and do not have operational water treatment works. In many cases these reservoirs were built to supply an individual village or small town, and over time these areas have been connected to our larger integrated water supply network meaning that the small local reservoirs are no longer used. Customers ultimately get better quality water at lower cost.

Why don't you just replace all the water mains with new ones?

Research has shown that large-scale replacement of old water mains is not necessarily the most cost effective means of reducing the rate of leakage.

In future, replacement of mains will be confined to small areas and where it is needed to enable other work like pressure management. We will also replace mains in poor condition, or those that burst frequently, as part of a small investment programme.

Instead of mains replacement, we know that managing pressures according to when customers need the water is a proven method of reducing leakage. Controlling pressures reduces background leakage and limits the water lost from existing leaks. During the 1990s the introduction of widespread pressure management helped us reduce leakage levels by 50%. Pressure reduction stabilises the network and is a proven way to control leakage.

We monitor pressures in the water network to make sure that everyone is getting the same standard of service, whenever they need it, day or night.

Is my bill going to go up?

This depends on a wide range of factors. Every five years we are required to undertake a detailed review of service and expenditure needs for all our water and wastewater services, known as the “Price Review”. This review determines the water prices that we will charge over the following five-year period (2015 - 2020). This is then assessed by Ofwat, the economic regulator for the water industry. The outcome of this review will be provided by November 2014.

Why isn’t everybody metered?

Since 1989 all newly built properties are fitted with a water meter. Compulsory metering of new business premises was introduced in 1990 and we fit all business customers with a meter where it is practical to do so. The Water Industry Act 1999 gives household customers the right to opt to have a water meter fitted for free. Water companies do not have the power to compulsorily meter all their household customers unless their area is designated as “seriously water stressed”. United Utilities area is not seriously water stressed. Overall, 32% of households have a water meter and this number is expected to increase to over 70% by 2040 by offering the free meter option and installing meters on all new properties.

Why are you taking water from Wales?

We own abstraction rights to a number of sources of water in Wales, the River Dee and Lake Vyrnwy. Infrastructure is in place that enables us to bring this water to Cheshire, Merseyside and Manchester to supply our customers. Using water from Wales enables us to balance the risk of local weather patterns resulting in dry spells and reduced water availability. If water supplies become low in the North of our region we can use Welsh sources to meet demand and if water supplies become low in Wales we can use other sources in the North West to supply our customers.

Why don’t we dig more boreholes?

The Environment Agency is responsible for licensing how much water can be taken from rivers, lakes or groundwater. They will only permit new borehole abstractions where it can be proven that there will not be any impacts on the environment or other existing licensed abstractors. We work closely with the Environment Agency to only abstract the water that we need to supply our customers and in the majority of cases, we do not need to construct new boreholes as we have sufficient sources of water available.

Why can’t we have more frequent / less frequent hosepipe bans?

Hosepipe bans (now known as water use restrictions) are part of our planned level of service. As presented in this document we plan for water use restrictions to be enforced no more than once in 20 years on average.

As part of this plan we have investigated the possibility of decreasing the frequency of water use restrictions through our customer research. We asked our customers to express the extent to which they would be willing (or otherwise) to see their water bills increase in order that increases in level of service could be obtained. We obtained the views of 800 household customers and 376 business customers. This demonstrated that customers do not value fewer water use restrictions and were not willing to pay higher bills for the frequency of water use restrictions to be reduced. However, they do not want to see deterioration in level of service i.e. more frequent water use restrictions.

The willingness-to-pay studies support maintaining the existing water use restrictions frequency of no more than once in 20 years on average and demonstrate there would be opposition to adopting more or less frequent restrictions.

Why can't you just do more water efficiency?

We encourage all our customers to use water wisely but there is still a need to use water for washing, drinking, cleaning etc. We are always looking at new products and advice that will help to reduce the amount of water these activities need. Our extensive water efficiency programme is discussed in Section 5.

Why don't you promote metering?

We promote the free meter option on our website and in customer billing information.

unitedutilities.com/is-a-meter-right-for-me

Why not have rainwater harvesting?

We are trialling a domestic rainwater harvesting system to understand how much it costs and how much water it saves. Some homes and businesses have been installing their own rainwater harvesting systems and we have to make sure that the water fittings are up to standard for drinking water.

Why not recycle greywater?

It takes a lot of energy to collect and recycle greywater. When we have assessed the overall impact on the environment of this option we have found that there are many alternative ways of saving water that do not use as much energy and are cheaper to build too.

Why have you got reservoirs that you don't use?

We have a number of reservoirs across the region that we use to maintain flows to downstream rivers to support the ecology of the rivers. We also maintain and operate reservoirs that support flows to canals to enable their recreational and commercial use. A number of our reservoirs are maintained for recreational purposes such as sailing and fishing.

There are a few small reservoirs in the North West that we used to use for public water supply. However, due to poor water quality we have stopped using them in favour of much larger, more reliable water supplies we have available across the region. These old reservoirs are not included in our assessments of water availability in this plan.

Why don't you use all your abstraction licence?

We still retain some licences for sources that are no longer used on a day-to-day basis. This can be for a variety of reasons, for example, use in a drought or as an emergency backup source. The majority of our licences are historic and were granted in the 1960s for abstractions that were used at that time when licensing came in to force. Since that time the volume of water abstracted has fluctuated, for example current abstraction volumes are significantly lower than those of the 1990s due mainly to a reduction in the amount of water lost through leakage and reductions in the volumes of water used by industry. Due to lower current levels of abstraction we have some abstraction licences that we no longer use or use to a lesser extent than in the past.

Why don't you raise the levels of your existing reservoirs or the weirs on some lake sources?

As part of our option appraisal process, we have considered raising the levels on some of our impounding reservoirs in order to provide more water storage. Whilst in theory raising the levels on any reservoir is possible, we need to carefully consider the

potential impacts of such an activity and what actual benefit the extra water stored gives to our public water supply system.

How do you future-proof population growth in the plan?

We use population growth figures issued by the Office for National Statistics. This means that we make our plans using data which government also uses. We then test the plan under a number of different scenarios one of which is an increase in population above what we have already considered. Additionally we also have a buffer called headroom, which means that we can accommodate fluctuations in demand.

Given all the uncertainty how do you know you have considered climate change enough in your forecasts?

When we determine the future available supplies in our resource zones we incorporate the latest Met Office UKCP09 projections of climate change. In addition to estimating the most likely impact of climate change on supplies we also make an allowance for uncertainty in this estimate as part of our calculation of target headroom.

Why is there so much uncertainty in the plan?

In preparing our Water Resources Management Plan it is necessary for us to make predictions of water availability and customer demand for water a number of years in to the future (25 years). No one has a crystal ball and so these predictions are necessarily uncertain. It's therefore vital that we look at the risks associated with this and ensure that we have made adequate allowance of uncertainties in our plans.

Why aren't you doing more to reduce environmentally damaging abstractions?

United Utilities have implemented many projects over the last decade to protect the environment from our abstractions. For example: a new fish pass at Heltondale on the Haweswater catchment; new fish screens at New Water on the River Gelt and the River Derwent; increased flow releases to downstream rivers at Holdenwood reservoir and Dubbs reservoir; new fish screens on all our River Dee abstractions.

We have recently implemented the provision of a new flow release to St John's Beck at Thirlmere to provide a flow of water to a previously dry river. We are also currently implementing new flow releases to the Brennand and Whitendale rivers in the Forest of Bowland.

In the next few years we plan to install a new fish pass and provide increased flows to the River Ehen at Ennerdale; a new fish pass on the River Derwent; a new fish pass and fish screens at Swindale (Haweswater catchment); abandon a river intake on Ben Gill (Ennerdale) and return the stream to its natural state; increased flow releases to downstream rivers at Dash Beck (Quarry Hill), Heltondale and Cawdale (Haweswater catchment) and New Water (River Gelt).

The Environment Agency has reviewed all of United Utilities' abstraction licences that potentially affect Special Areas of Conservation and we are working with them to implement changes to address any concerns. Many of the projects listed above result from this review. In addition the Environment Agency identify sites where they have concerns over the environmental impact of our abstraction and these are included in our programme of works/investigations. For the 2015-20 period we expect to be implementing the following schemes to further protect the environment: eel passes/screens at approx. 30 sites; provision of a new flow release downstream of our River Calder, Tarnwood Wyre and Afon Cownwy (Lake Vyrmwy) abstractions; provision of a new fish pass and downstream flow release on Old Water (River Gelt); implementation of a hands-off lake level at Overwater (Quarry Hill). The yield impacts of all these changes are considered within this Water Resources Management Plan.

United Utilities is also heavily involved in assessing all our reservoirs to ensure they meet the Good Ecological Potential requirements of the Water Framework Directive and this will also result in increases to river flow releases and structural improvements (e.g. fish screens and passage) for the benefit of the environment.

Why don't you focus on business water efficiency?

We offer advice, products and services to our business customers through the website, bills and customer contact.

unitedutilities.com/business-save-water-reduce-bill

How does this plan compare to the drought plan?

Our Drought Plan sets out the short-term operational steps we will take as a drought progresses. This water resources management plan sets out our strategy to minimise the effects of drought or prolonged dry weather conditions, and ensure that water use restrictions and other drought powers are required no more frequently than our customers would expect. The key assumptions including how often we will enforce water use restrictions and implement drought permits/orders are the same in both the Drought Plan and Water Resources Management Plan.

Do you have enough water for shale gas exploration?

We expect that the water requirements for the shale gas industry will be small in relation to our total volume supplied.

However, if we are approached to supply treated water for shale gas operations we would consider the supply arrangements for each individual site including any local network constraints. We will never compromise our existing customers' water supplies either in the short or long term.

What has changed since the draft plan / previous plan?

Since our last Water Resources Management Plan (published in 2009) we have updated our forecasts for supply availability and customer demand for water for the next 25 years. This was undertaken using updated guidance and techniques; in particular the method for including the impact of climate change on supply availability has improved, as this is now based on UK climate projections data released in 2009.

In our 2009 Plan, the Environment Agency identified that changes were required to our abstraction licence from Ennerdale Water, in West Cumbria, in order to protect the fresh water mussels in the river downstream. Following this, the environmental sensitivity of this species has been further understood and it is now proposed that the abstraction licence from Ennerdale should be revoked to protect this internationally important species. This has had a significant impact on the supply-demand balance for West Cumbria.

Since publication of the last plan, the Water White Paper and draft Water Bill have been published by government. These have highlighted the requirement to consider water trading options, abstraction licence trading and third party options in line with our own options to resolve any supply-demand deficits we have identified. Our Plan demonstrates we have done this. These government publications also promote water companies to consider demand side measures to address any supply-demand deficit and flexible planning approaches so plans are more adaptable to future change.

The Water White Paper also supports increased environmental responsibility with a commitment that all abstractions will be sustainable by 2027. We have a number of sustainability reductions in our Integrated Resource Zone and many more sites that are still under investigation. These may require sustainability reductions in the future.

APPENDIX 6. WATER RESOURCES MANAGEMENT PLAN DIRECTIONS

This Appendix describes how we have complied with the Government's requirements for the information that should be included in a water resources management plan.

The Water Industry Act 1991 as amended by the Water Act 2003

The Water Act 2003 introduced the requirement for statutory water undertakers to prepare water resource management plans, which are to include the information as shown in the following text box.

Section 37A(3) of The Water Act 2003:

A water resources management plan shall address in particular:

(a) the water undertaker's estimate of the quantities of water required to meet those obligations;

(b) the measures which the water undertaker intends to take or continue for the purpose set out in subsection (2) above (also taking into account for that purpose the introduction of water into the undertaker's supply system by or on behalf of licensed water suppliers);

(c) the likely sequence and timing for implementing those measures; and

(d) such other matters as the Secretary of State may specify in directions.

We have complied with these requirements as described below.

(a) Quantities of water required

The current and future volumes of water required to meet our obligations to maintain water supplies to our customers are described in Chapter 6 of this Water Resources Management Plan.

(b) Measures required and (c) Timing of measures in a potential drought

The activities undertaken by United Utilities to supply water for use by customers and the timing of actions required in the event of a potential drought are described in Section 3.1 of this Water Resources Management Plan and United Utilities Statutory Drought Plan corporate.unitedutilities.com/waterresourcesplan.

(d) Matters specified in directions

The additional requirements in the WRMP directions are discussed below.

Water Resources Management Plan Direction 2012

The Water Resources Management Plan Direction 2012 came into force on 20th June 2012. It sets out the steps a statutory water undertaker must follow with respect to publication and consultation of a draft water resources management plan, and the publication of its final plan.

Below we have provided a clear list of these Directions and evidence that we have complied with each one.

Direction paragraph	Direction text	Evidence United Utilities have complied with this requirement in our Water Resources Management Plan
2	A water undertaker shall prepare a water resources management plan, for a period of 25 years commencing on 1st April 2015	This plan covers a time period from 1 April 2015 to 31 March 2040.
3(a)	how frequently it expects it may need to impose prohibitions or restrictions on its customers in relation to the use of water under each of the following— (i) section 76(a); (ii) section 74(2)(b) of the Water Resources Act 1991(b); and (iii) section 75 of the Water Resources Act 1991;	The minimum level of service for water supply reliability that we plan to provide is set out in Section 2.4 of this Water Resources Management Plan. In Section 5.7 we have provided details of how the views of customers and the needs of the environment have been used to determine the preferred level of service, and how we have made improvements in recent years to achieve it.
3(b)	the appraisal methodologies which it used in choosing the measures it intends to take or continue for the purpose set out in section 37A(2), and its reasons for choosing those measures	The appraisal methodologies used in this Plan to derive the solutions (measures) to maintain adequate water supplies are set out in Sections 8, 9 and 11, with additional information in Appendix 9.
3(c)	the emissions of greenhouse gases which are likely to arise as a result of each measure which the water undertaker has identified in accordance with section 37A(3)(b)	See below
3(d)	how the supply and demand forecasts contained in the water resources management plan have taken into account the implications of climate change;	The implications of climate change on water supply availability and water demand are detailed in Sections 4 and 6 of this Plan, with further information presented in Chapters 8 and 12.
3(e)	how it has estimated future household demand in its area over the planning period, including the assumptions it has made in relation to population and housing numbers, except where it does not supply, and will continue not to supply, water to domestic premises;	Our forecasts of population, housing numbers and household demand are presented in Chapter 6 of this Plan, together with details of the methodologies and the assumptions that have been used.
3(f)	its estimate of the increase in the number of domestic premises in its area, over the planning period, in respect of which it will be required to fix charges by reference to volume of water supplied to those premises under section 144A	Our customer metering plan is presented in Section 5.4 and details of the estimated numbers of households that will be metered in the future, is described in Section 6.

Direction paragraph	Direction text	Evidence United Utilities have complied with this requirement in our Water Resources Management Plan
3(g)	where the whole or part of its area has been determined by the Secretary of State to be an area of serious water stress under regulation 4(1) of the Regulations, its estimate of the number of domestic premises which are in the area of serious water stress and in respect of which it will fix charges by reference to volume of water supplied to those premises over the planning period	There are no areas of serious water stress in the United Utilities region and so this does not apply to this Plan.
3(h)	its estimate of the increase in the number of domestic premises in its area (excluding any domestic premises which are included in the estimate referred to in sub-paragraph (g)), over the planning period, in respect of which section 144B(2) will not apply because the conditions referred to in section 144B(1)(c) are not satisfied and in respect of which it will fix charges by reference to volume of water supplied to those premises	Our customer metering plan is set out in Section 5.4, forecast numbers of households that will be metered are provided in Section 6. This excludes compulsory metering as there are no areas of serious water stress in the United Utilities region
3(i)	full details of the likely effect of what is forecast pursuant to sub-paragraphs (f) to (h) on demand for water in its area	See below
3(j)	the estimated cost to it in relation to the installation and operation of water meters to meet what is forecasted pursuant to sub-paragraphs (f) to (h) and a comparison of that cost with the other measures which it might take to manage demand for water, or increase supplies of water, in its area to meet its obligations under Part III of the Water Industry Act 1991	See below
3(k)	a programme for the implementation of what is forecasted pursuant to sub-paragraphs (g) and (h)	Our customer metering plan is set out in Section 5.4, forecast numbers of households that will be metered are provided in Section 6. This excludes compulsory metering as there are no areas of serious water stress in the United Utilities region
4	except where the Secretary of State or the Welsh Ministers otherwise permit, a water undertaker must send its draft water resources management plan to the secretary of State or the Welsh Ministers in accordance with section 37B(1) before 31 March 2013	We have submitted our draft plan to Defra by the 31st March 2013

Direction paragraph	Direction text	Evidence United Utilities have complied with this requirement in our Water Resources Management Plan
5	except where the Secretary of State or the Welsh Ministers otherwise permit, a water undertaker must send its draft water resources management plan to the secretary of State or the Welsh Ministers in accordance with section 37B(3)(a) within 30 days of the later of the date on which the Secretary of State or Welsh Ministers-….	Following the direction of the Secretary of State we will ensure that information that is commercially confidential or contrary to the interests of national security will be removed and the plan submitted within the timescales specified.
6	except where the Secretary of State or the Welsh Ministers otherwise permit, a water undertaker must publish the statement required by regulation 4(2)(a) of the Water Resources Management Plan Regulations 2007(a), and send a copy of the statement to the persons specified in regulation 4(2)(b), within 26 weeks of the date of publication of the draft water resources management plan	We have published our statement of response by 12 November 2013, which is within 26 weeks of publication of the draft Water Resources Management Plan. We have also sent our statement of response to any person that has made a representation.

3(c) Emission of greenhouse gases

The emissions that could arise from our preferred and alternative plans are summarised as follows. We have included the carbon figures for the decommissioning of the WTW in West Cumbria that are included in the Preferred and Alternative Plans.

Table A. Greenhouse gas emissions from preferred and alternative plans

Scheme	Construction including embedded carbon (CO_2e) (total tonnes CO_2)	Operation (tonnes CO_2e per year)
Preferred Plan WC01 (Abstraction from Lake Thirlmere)	331,473	1,501
Alternative Plan WC14d (Kielder transfer)	884,256	10,411
Lowest-cost plan		
WC04 (Wastwater, negotiate part abstraction licence)	34,370	1,442
WC09 (Development of new BH's in North Cumbria aquifer) includes treated water link (WC24C)	49,554	1,873
WC05a (Development of new BH's in West Cumbria aquifer)	17,504	2,177
Lowest-cost plan total	101,435	5,496

The annual greenhouse gas emissions associated with operating our water supply system are shown in Figure A below, with the impact of the West Cumbria scheme included from 2024/25.

We have forecast that there will be a significant reduction in the greenhouse gas emissions from our water services, predominantly resulting from changes to the carbon intensity of energy use determined by our supplies from the UK electricity network. The rate of decarbonisation is based on predictions by the Department of Energy and Climate Change (DECC), which utilises modelling of the impacts of various energy policy decisions and implementation as set out in the Energy White Paper. Our forecasts utilise the latest DECC guidance for policy appraisal on energy and greenhouse gases[12].

Using these projections, the impacts of the West Cumbria scheme are small in the context of the overall water service.

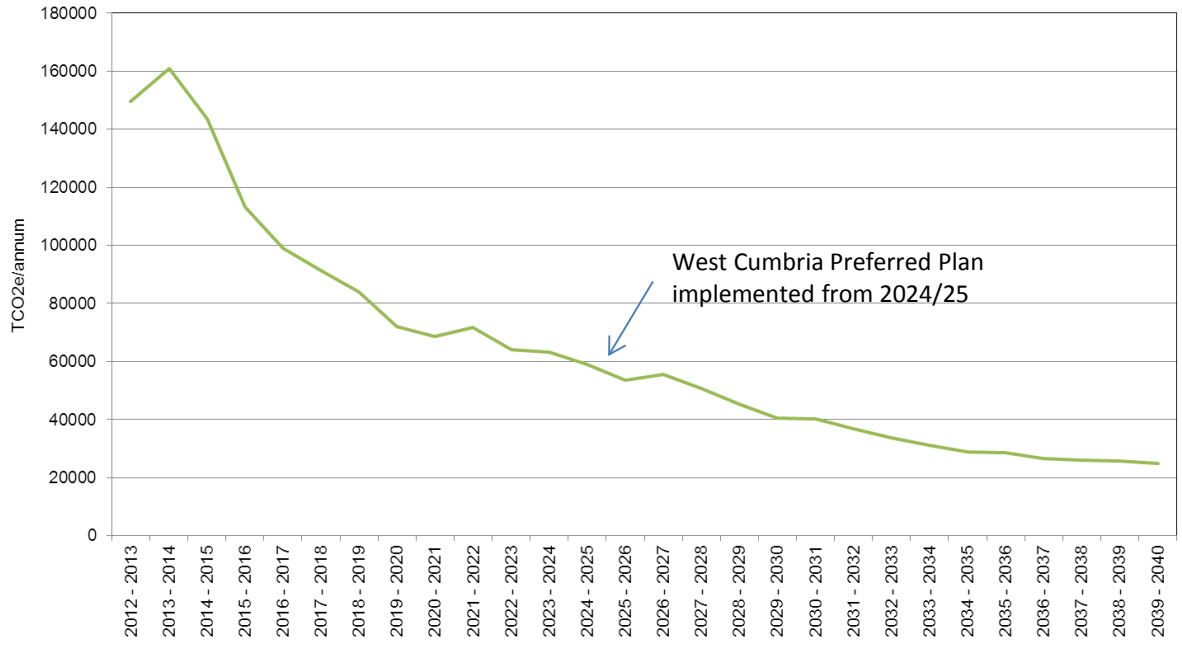

Figure A. Greenhouse gas emission forecast for our water service to 2039/40

3 (i) effect of customer metering on demand

The table below provides a summary forecast of demand across the planning horizon for each of the metered categories as required by section 3(i).

The figure below demonstrates how the makeup of United Utilities' customer base will change the demand over the planning horizon.

[12] Department of Energy and Climate Change (2013) – "Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal" - https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Table B: Effect of customer metering on demand

	New houses (metered) (000's cum.)	Free meter optants (000's cum.)	Total number of properties to be metered 000's	Total metered demand Ml/d	Total unmeasured customers 000's	Unmeasured demand Ml/d	Total demand Ml/d
2012	426.11	485.49	915.72	241.25	1,938.99	726.57	967.82
2013	437.28	531.37	972.75	248.02	1,890.42	692.49	940.51
2014	448.41	579.99	1,032.51	261.08	1,838.02	676.57	937.65
2015	460.11	631.06	1,095.28	275.11	1,783.99	661.30	936.41
2016	473.00	688.14	1,165.23	290.26	1,725.29	641.49	931.75
2017	486.81	748.19	1,239.09	306.44	1,663.95	620.78	927.22
2018	501.54	806.11	1,311.74	322.56	1,605.21	600.71	923.27
2019	517.29	858.13	1,379.51	337.74	1,552.92	582.73	920.47
2020	534.14	904.53	1,442.75	352.18	1,506.28	566.84	919.02
2021	552.03	952.25	1,508.36	366.59	1,457.04	549.19	915.78
2022	571.40	1,001.95	1,577.42	381.80	1,404.53	530.29	912.09
2023	592.77	1,051.62	1,648.45	397.51	1,352.09	511.27	908.78
2024	616.41	1,097.13	1,717.60	412.82	1,303.75	493.53	906.36
2025	642.54	1,138.50	1,785.08	427.71	1,259.51	477.04	904.74
2026	671.50	1,172.86	1,848.39	441.13	1,222.31	462.43	903.55
2027	703.76	1,206.90	1,914.69	455.02	1,185.49	447.72	902.73
2028	739.86	1,240.90	1,984.77	469.59	1,148.80	432.90	902.48
2029	780.42	1,274.66	2,059.08	484.84	1,112.41	417.97	902.81
2030	826.19	1,308.33	2,138.51	500.85	1,076.20	402.83	903.68
2031	875.14	1,342.09	2,221.22	517.19	1,039.97	387.53	904.72
2032	924.62	1,375.96	2,304.55	533.49	1,003.70	372.37	905.86
2033	971.72	1,409.79	2,385.48	549.17	967.54	357.53	906.70
2034	1,013.80	1,443.81	2,461.56	563.97	931.28	343.11	907.09
2035	1,048.90	1,478.17	2,531.01	577.59	894.75	329.08	906.67
2036	1,079.32	1,512.80	2,596.05	590.45	858.01	315.29	905.74
2037	1,106.68	1,547.47	2,658.07	602.85	821.32	301.73	904.57
2038	1,132.19	1,582.30	2,718.41	614.89	784.53	288.21	903.10
2039	1,156.85	1,617.37	2,778.12	626.89	747.59	274.72	901.62
2040	1,181.50	1,652.44	2,837.84	638.89	710.70	261.26	900.14

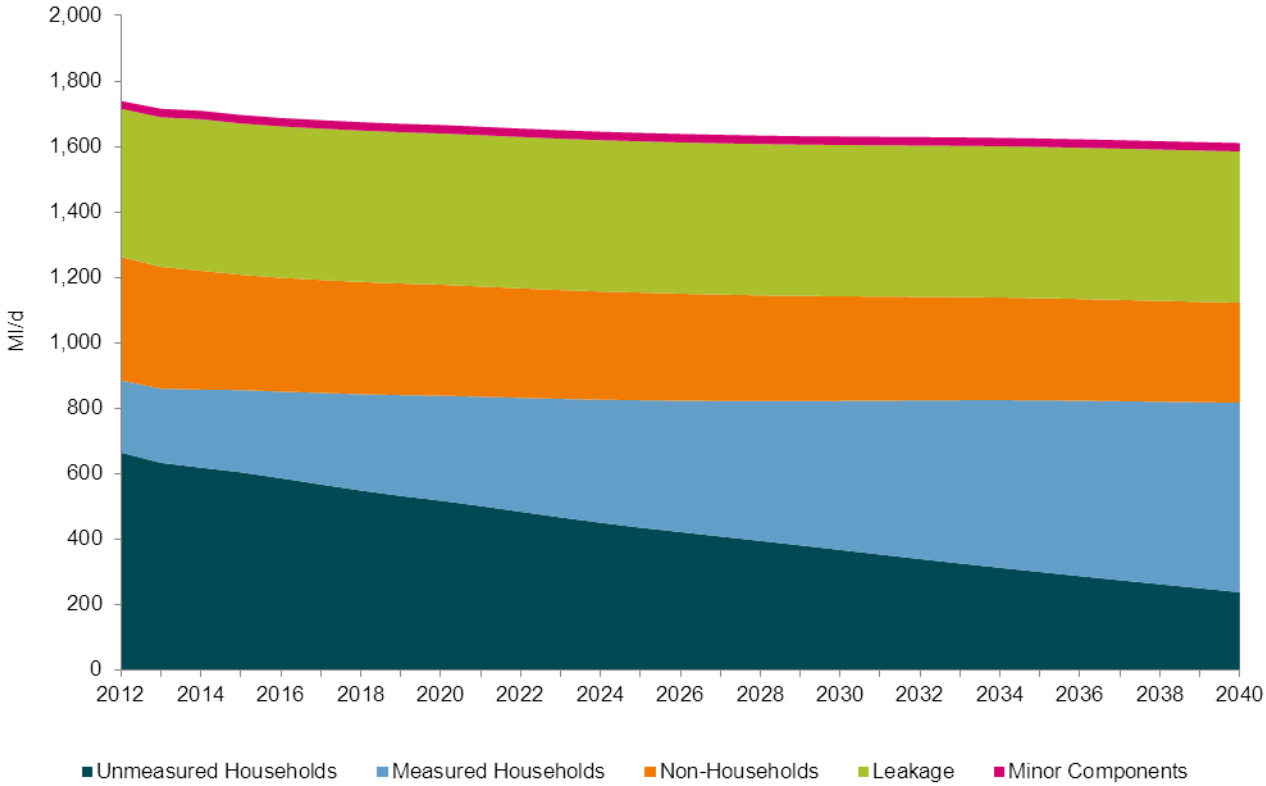

Figure B: Effect of customer metering on demand

3(j)

Six options for increasing the take up of the free meter option across each water resource zone were reviewed. They included:

- Metering on customer contact: when a customer contacts United Utilities, we would offer them a free water meter;
- Enhanced promotion over five and over ten years: we would launch a campaign to those customers who would benefit financially from a meter to take up the option
- Enhanced home water efficiency: in conjunction with our partner visits to install water efficiency devices, we would offer customers a free water meter
- Blanket promotion: we would launch a high profile communications campaign to customers to encourage take up
- Metering on change of occupier: when we are informed of a change of occupier we would attempt to install a free water meter.

The AISC values are summarised in the table below.

Table C: The costs of metering

Option ID	Option title and summary description	WAFU benefit (Ml/d)	AIC (p/m3)	Env & social cost (p/ m3)	AISC (p/m3)
IZ Met-001	Metering On Customer Contact	0.39	186	82	268
IZ Met-002a	Enhanced Promotion 5 Year	4.54	191	-1	190
IZ Met-002b	Enhanced Promotion 10 Year	1.60	215	56	270
IZ Met-003	Enhanced Home Water Efficiency Visits	0.13	174	101	274
IZ Met-004	Blanket Promotion	0.31	198	101	299
IZ Met-005	Metering On Change Of Occupier	1.76	182	58	241
WC Met-001	Metering On Customer Contact	0.01	182	81	263
WC Met-002a	Enhanced Promotion 5 Year	0.08	193	21	214
WC Met-002b	Enhanced Promotion 10 Year	0.03	230	17	247
WC Met-003	Enhanced Home Water Efficiency Visits	0.00	209	90	299
WC Met-004	Blanket Promotion	0.01	192	90	282
WC Met-005	Metering On Change Of Occupier	0.06	168	59	227
NE Met-001	Metering On Customer Contact	0.00	381	78	459
NE Met-002a	Enhanced Promotion 5 Year	0.01	390	23	413
NE Met-002b	Enhanced Promotion 10 Year	0.00	818	58	876
NE Met-003	Enhanced Home Water Efficiency Visits	0.00	753	96	848
NE Met-004	Blanket Promotion	0.01	203	96	299
NE Met-005	Metering On Change Of Occupier	0.00	220	55	275
CAR Met-001	Metering On Customer Contact	0.01	205	81	286
CAR Met-002a	Enhanced Promotion 5 Year	0.07	209	26	235
CAR Met-002b	Enhanced Promotion 10 Year	0.02	256	60	316
CAR Met-003	Enhanced Home Water Efficiency Visits	0.00	245	99	343
CAR Met-004	Blanket Promotion	0.01	197	99	295
CAR Met-005	Metering On Change Of Occupier	0.03	182	58	240

APPENDIX 7. DROUGHT PLAN CONSULTATION RESPONSES RELEVANT TO THE WATER RESOURCES MANAGEMENT PLAN

Drought Plan consultation respondent	Issue	United Utilities Response
Individual respondent	Work with the Government Dept dealing with finding new renewable energy sources as The Lake District has a number of lakes which already store large amounts of water. Consider damming outlet of these lakes and also install hydroelectric schemes to provide more power and at the same time raise the level of the lakes to provide more water.	As part of our Water Resources Management Plan review we are considering all options for dealing with forecast supply-demand deficits including the development of new water sources. However the Lake District is a highly protected area, particularly environmentally, and so any such schemes are unlikely to have support.
Friends of the Lake District	Need further leakage control to avoid need for new water sources.	The leakage targets for United Utilities are set by Ofwat and are the sustainable level of leakage based on a combination of environmental, social and cost considerations. As part of the Water Resource Management Plan process we consider the investment in leakage compared to our supply-demand options such as new water sources, metering, water efficiency etc. However in time of drought we would take action to minimise leakage as far as practicable.
Friends of the Lake District	United Utilities needs to take a strategic long term view of the overall water resources situation in West Cumbria (next 50y) and plan accordingly so that actions are joined up and integrated. The forthcoming Water Resource Management Plan will be key to this and the drought plans will have to fit with this longer term view. Again far more demand management, and stronger input into planning framework for new developments, would be favoured over new supplies.	The issue of long term water supplies for West Cumbria will be dealt with as part of the Water Resource Management Plan. However if the solution constituted a material change for the drought plan then this would initiate a review of that plan.
Friends of the Lake District	More longer term strategic planning by United Utilities which will have knock on effects on drought planning including education of public and stronger planning policies for water efficiency requirements of new buildings.	The Water Resource Management Plan is the vehicle for United Utilities to review the long term strategic approach to water resources.
Friends of the Lake District	How is the mis-match in drought plan and Water Resources Management Plan cycles dealt with e.g. if levels of service change.	Defra sets the cycles for the Water Resource Management Plan and the Drought Plan and currently the cycles are at 5 year and 3.5 year intervals respectively. However we understand that Defra are considering extending the drought plan cycle to 5 years which would give a better alignment with Water Resource Management Plans. In the event that the Water Resource Management Plan alters the level of service, which results in the implementation of supply-demand schemes and hence significantly alters the position of drought triggers, then we would consider this to be a material change and under the Water Act 2003 this would trigger the need to review the drought plan.

Drought Plan consultation respondent	Issue	United Utilities Response
Windermere Lake User Forum	Include information of how proposal to use Thirlmere to supply West Cumbria will affect water levels in Windermere and Haweswater.	As part of developing our Water Resource Management Plan we will be undertaking hydrological modelling which will consider the impact of a link between Thirlmere and West Cumbria on the Integrated Resource Zone (including the impact on pumping from Windermere and Haweswater reservoir level).
Windermere Lake User Forum	The medium and long term shortfall in water resources identified in the Water Resource Management Plan 2009 show a forecast deficit in supply - this is not specifically referred to in this drought plan.	The drought plan is a short-term plan to deal with a drought event within the next 3.5 years (currently drought plans have to be reviewed every 3.5 years). The triggers within the drought plan are based on up to date flow and demand data, and as such reflect any changes in these which have occurred. In contrast, the Water Resources Management plan is a long-term plan covering a 25 year period and it is through this process that deficits in the supply-demand balance are identified and addressed.
Windermere Lake User Forum	Consultation and recommendations contained in water resource management PR14 need to be taken into account with this drought consultation.	United Utilities is currently working on a review of its Water Resources Management Plan and will consult on this in 2013. The drought plan is consistent with our current Water Resources Management Plan 2009.
Windermere Lake User Forum	Leakage accounts for 20% of water, what is the cost benefit analysis behind the lack of investment in this area. 33% of this waste is on private land, what initiatives are being considered to reduce this. The annual investment of only £25million into leakage does not appear to represent a balance of cost and benefit to those who live in Windermere and would have to carry the economic impact of these drought plans.	The leakage targets for United Utilities are set by Ofwat and are the sustainable level of leakage based on a combination of environmental, social and cost considerations. As part of the Water Resource Management Plan process we consider the investment in leakage compared to our supply-demand options such as new water sources, metering, water efficiency etc. However in time of drought we would take action to minimise leakage as far as practicable.
Windermere Lake User Forum	The use of water meters reduces usage by 7%, significantly more effective than hosepipe bans.	The issue of determining our metering strategy falls within the remit of the Water Resource Management Plan.
Windermere Lake User Forum	What is being done to promote and support the conservation and reuse of rain water to reduce demand on processed potable water?	We are part of Water UK who are key to lobbying government on issues common to all water companies and are also involved in discussions with the building industry regarding water efficiency standards. United Utilities as an individual company also respond to relevant consultations such as the recent EA consultation on water stress designation (Nov 2012).
Windermere Lake User Forum	Today's society are benefiting from the investment made by the Victorians, solid build with minimum running costs. What work is underway to emulate this and protect future generations?	The issue of long-term water resource options to address a forecast supply-demand deficit is dealt with within the Water Resources Management Plan. In 2011/12 United Utilities constructed a West to East pipeline to allow more water to be transferred from the west (e.g. North Wales) to Manchester and hence reduce the need to abstract water from the Lake District. This pipeline provides increased drought resilience in United Utilities Integrated Resource Zone. As part of the Water Resources Management Plan, we will be looking at long-term solutions to address the forecast supply deficit in West Cumbria.

Drought Plan consultation respondent	Issue	United Utilities Response
Holker Estates	We believe additional resources should be directed towards leakage prevention and the fitting of water meters.	The leakage targets for United Utilities are set by Ofwat and are the sustainable level of leakage based on a combination of environmental, social and cost considerations. As part of the Water Resources Management Plan process we consider the investment in leakage compared to our supply-demand options such as new water sources, metering, water efficiency etc. However in time of drought we would take action to minimise leakage as far as practicable. The issue of determining our metering strategy falls within the remit of the Water Resources Management Plan.
Holker Estates	Many of the assumptions made in the Draft Drought Plan would require remodelling if West Cumbria were to be connected into the Integrated Zone.	The issue of long term water supplies for West Cumbria will be dealt with as part of the Water Resource Management Plan review, the draft of which is due to be consulted on in 2013. However if the solution constituted a material change for the drought plan then this would initiate a review of that plan.
Natural England	Continue efforts to better manage demand for water.	United Utilities undertakes extensive demand management as part of its normal operations, for example, water efficiency campaigns and education. The level of demand management needed to secure a supply-demand balance is considered as part of the Water Resource Management Plan process and United Utilities will be consulting on its revised plan in 2013.
Natural England	Give further consideration to improving leakage in West Cumbria at all times.	United Utilities is committed to tackling leakage in West Cumbria and has several initiatives to address this issue. The level of leakage needed in West Cumbria to maintain a supply-demand balance will be reviewed as part of the Water Resource Management Plan, which will be consulted on in 2013.
Natural England	As part of WRMP, review levels of service particularly in West Cumbria.	The levels of service will be reviewed as part of the Water Resources Management Plan process - the draft plan will be consulted on in 2013.
Natural England	Ennerdale: urgent need to minimise impacts in the short term and identify and deliver a sustainable solution to drought events in the medium to long term.	United Utilities has implemented the compensation flow requirements of the Environmental Damage notice to release flows of up to 95 Ml/d to the River Ehen. Information on the notice has been included in Section 8.8 of the plan. United Utilities' Water Resources Management Plan will consider the medium and long term water supply requirements for West Cumbria.
Windermere Lake Cruises	We do not feel that sufficient financial resource is allocated to leakage reduction. Leakage in 2006/7 was 468 Ml/day, more than double the daily abstraction limit from Windermere of 205 Ml/day. We feel that it is not unreasonable to have some highway disruption considering the impact on businesses and tourism of a Windermere drought permit.	The leakage targets for United Utilities are set by Ofwat and are the sustainable level of leakage based on a combination of environmental, social and cost considerations. As part of the Water Resources Management Plan process we consider the investment in leakage compared to our supply-demand options such as new water sources, metering, water efficiency etc. However in time of drought we would take action to minimise leakage as far as practicable.

Drought Plan consultation respondent	Issue	United Utilities Response
Lake District National Park	United Utilities need to take a strategic long term view of the overall water resources situation in West Cumbria (next 50y) and plan accordingly so that actions are joined up and integrated. The forthcoming Water Resources Management Plan will be key to this and the drought plans will have to fit with this longer term view.	The issue of long term water supplies for West Cumbria will be dealt with as part of the Water Resources Management Plan review, the draft of which is due to be consulted on in 2013. However if the solution constituted a material change for the drought plan then this would initiate a review of that plan.
River Eden and District Fisheries Association	Reduce leakage.	The leakage targets for United Utilities are set by Ofwat and are the sustainable level of leakage based on a combination of environmental, social and cost considerations. As part of the Water Resources Management Plan process we consider the investment in leakage compared to our supply-demand options such as new water sources, metering, water efficiency etc. However in time of drought we would take action to minimise leakage as far as practicable.
River Eden and District Fisheries Association	Scale up the water efficiency programme and increase metering with a tariff system to promote the economic incentive for efficient water use.	United Utilities is part of Water UK who are key to lobbying government on issues common to all water companies and are also involved in discussions with the building industry regarding water efficiency standards. United Utilities as an individual company also respond to relevant consultations such as the recent EA consultation on water stress designation (Nov 2012). The Water Resources Management Plan is the vehicle for United Utilities to review the long term strategic approach to water resources and this will be consulted on in 2013.
River Eden and District Fisheries Association	REDFA asks that we review what other contingency plans can be put into place to reduce our reliance on existing rivers/lakes/reservoirs that may be at critical levels already.	United Utilities' Water Resources Management Plan considers all available options to deal with forecast supply-demand deficits including water efficiency, metering, leakage control, new water sources etc. As part of our day-to-day operations we continuously monitor the status of the rivers, reservoirs, lakes and boreholes from which we abstract water. If these assessments raise an issue that a source is unhealthy or that the current abstraction rate is unsustainable then we implement actions to try to reduce abstraction and balance the risk across the resource zone.

APPENDIX 8. WATER TRADING AND THIRD PARTY OPTIONS

Background

In order to meet Government's aspirations in relation to the Water White Paper (Defra 2011), the Water Resources Planning Guideline (EA 2013) outlines the requirement for a water company operating wholly or mainly in England, to demonstrate that it has considered the following options fully in developing preferred solutions to address any potential supply-demand deficit identified in their Water Resources Management Plan:

- Water trading – through bulk supplies between water companies (neighbouring or not);
- Abstraction licence trading within catchments – this provides a company with an option to purchase or sell licences to help meet its supply needs or to sell surplus water to other abstractors; and
- Supply/demand options provided by other water companies or by third parties – allowing others to provide demand and/or supply options in the plan increases the scope for lower costs and innovative solutions. Options proposed/provided by other water companies or third parties will need to be included in the options appraisal alongside other feasible options.

Contact Plan

The Environment Agency's guidance stipulates that companies should put together a plan for how they will contact neighbouring water companies to see if they have water available that could be provided by a bulk supply (altering an existing arrangement or new) or develop joint resources. The guidance also stipulates that companies require a third party contact plan to enable third party supply/demand options to be considered alongside its own options. Third parties can bid in options for customer-side, production-side, distribution-side or resource management measures. We developed a Neighbour and third party contact plan. The contact plan was required during the pre-consultation phase. We also published a view of 'need' and 'availability' at the end of September 2012.

http://corporate.unitedutilities.com/Water-Resources-Management-Plan.aspx

Water trading approach

A process of 'Bi-lateral engagement' has been adopted in order to identify potential water trading options, with other water companies (neighbouring and not) for our draft Plan.

We produced a draft list of potential imports and exports into and out of our region to other water companies, including inset appointees. We then held bilateral discussions with these companies. These discussions covered both permanent and temporary trades of water.

During these meetings the following topics were covered: potential 'view of need', development of an unconstrained list of potential trading options and technical feasibility of these options, future screening process for options identified and data sharing. If any of the water trading options were technically feasible they were then taken forward for costing and deployable output benefit assessment. These options were included in the option selection process by the importing and exporting company. If both importer and exporter confirm that the trade is economic, it will be selected in both companies' draft Plans.

Following publication of draft water resources management plans in April 2013, potential importers and exporters had the opportunity to review their costs. Such proposals are considered in final water resources management plans.

A list of the unconstrained options identified during bi-lateral engagement is provided in the Table below.

Assessment of unconstrained options

Options identified during discussions were included in the unconstrained options list for consideration in line with our other supply options. We then assessed the proposed options in our water resource models to consider whether the options provide a benefit to the deployable output of the resource zone. This, alongside an assessment of the criteria set out in the Environment Agency's guidelines (2013), determines whether the option will be included in the feasible options list for option selection.

Where options are not progressed to the feasible list this has been clearly documented and fed back to the donor water company during the information exchange. In summary, all our water trading import options remained feasible with the exception of an import from Dee Valley Water (IRZ61d), which was demonstrated not to provide a deployable output benefit for the area.

We sought confirmation from the relevant water companies that the export options identified are considered feasible. The trades identified with Scottish Water (CARL02b) and Welsh Water (IRZ61e) were confirmed as being no longer required by these companies.

Following our Contact Plan, for all feasible import options an outline of the scheme along with deployable output benefit, potential capital and operating costs, carbon costs and environmental and social costs has been produced. This information feeds into the options appraisal process in ine with our own options list, to identify the preferred option set.

Where the option relates to water being provided by us to another company (i.e. an export) we have carried out a preliminary assessment of the costs of the trade and prices have been provided to the donor company. Prices have been provided for agreements over different timescales (5, 10 and 25 years) to enable trades to be considered over the short term and long term.

Table A Unconstrained options identified for WRMP14 during bilateral engagement with neighbouring and other water companies

Company	Import/ export	Description	Volume (Ml/d)	United Utilities option number
Severn Trent Water	Export	Raw water pipeline transfer from Congleton in United Utilities Integrated Resource Zone to Tittesworth reservoir, Severn Trent Water's North Staffs Resource Zone	10	IRZ42
	Export	Treated water pipeline transfer from Wybersley in United Utilities Integrated Resource Zone to Buxton, Severn Trent Water	20	IRZ74
	Export	Treated Water transfer from Congleton in United Utilities Integrated Resource Zone to Mow Cop, Severn Trent Water's North Staffs Resource Zone.	1	IRZ37
	Export	Treated water transfer from United Utilities Integrated Resource Zone network to Oswestry, Severn Trent Water	20	IRZ44d

Company	Import/ export	Description	Volume (Ml/d)	United Utilities option number
	Export	Treated water transfer from United Utilities Integrated Resource Zone to the network of Severn Trent Water, near Peckforton	10	IRZ44c
	Export	Vyrnwy reservoir raw water releases to River Severn of 30 Ml/d or 80 Ml/d to support Severn Trent Water's Strategic Grid Zone	30, 80 or 180	IRZ44a IRZ44b IRZ44e
Yorkshire Water	Export	Treated water transfer from United Utilities Integrated Resource to Yorkshire Water at Walsden (Todmorden)	1	IRZ47b
	Export	Treated water transfer from United Utilities Integrated Resource to Yorkshire Water at Bentham	1	IRZ47c
	Export	Raw water transfer from United Utilities Whiteholme reservoir, Integrated Resource Zone, to Yorkshire Water	2.8	IRZ47a
	Import	Raw water from Yorkshire Water's Scammonden Reservoir to Buckton Castle, United Utilities Integrated Resource Zone	5	IRZ47d
Dee Valley Water	Export	Treated water transfer from existing main at Vyrnwy to Dee Valley Water at Dymock Arms and/or Bowens Farm	1	IRZ61b
	Export	Treated water transfer from existing main at the River Dee to Dee Valley Water	1	IRZ61c
	Import	Dee Valley Water export to United Utilities at Helsby	3	IRZ61d
Scottish Water	Export	Increased development of new boreholes at Kirklinton. Treated water transfer to border of Scottish Water treated water network	2	CARL02b
Welsh Water	Export	River Dee Licence Trade	8	IRZ61e
Northumbrian Water	Import	Raw water pipeline from Northumbrian Water's Kielder Reservoir to United Utilities' Haweswater system (Integrated Resource Zone) and or West Cumbria Resource Zone	80, 100 or 180	IRZ61a, WC14, WC14b-d
	Import	Raw water pipeline from Northumbrian Water's Cow Green reservoir to United Utilities' Haweswater system (Integrated Resource Zone) and/or River Eden for re-abstraction in Carlisle Resource Zone	25/50	IRZ03 CARL13
Thames	Export	Vyrnwy reservoir raw water releases to River Severn to support Thames Water	30, 70, 180	IRZ44a IRZ44e
Bristol Water	Export	Vyrnwy reservoir raw water releases to River Severn to support Bristol Water	30	IRZ44a

Water trading – next steps

Since publication of our draft plan in March 2013, we have continued the dialogue with water companies and other third parties to understand the immediate need for sharing of water resources in the 2015-2020 planning period. Both Severn Trent Water and Thames Water have indicated that transferring water from Lake Vyrnwy could be viable options in the future. However, no water transfers are required in the finalisation of the current water resources management plans by either these two or any of the other companies listed in the above table.

In order to assess the viability of transferring water from Lake Vyrnwy via the River Severn system, it is acknowledged that there is a great deal of work required over the next few years by water companies, regulators and stakeholders so that informed decisions for the next round of water resources management plans can be made. United Utilities will support this work.

Abstraction licence trading within catchments

Trading can only take place where there is a hydrological or hydrogeological link between the buyer's and seller's abstraction points (i.e. same river or aquifer). The Environment Agency's approach to licence trading is dependent upon the Catchment Abstraction Management Strategy (CAMS) water resource availability status.

We have used the Environment Agency's document 'A Guide to Water Rights Trading' and CAMS documents to screen all licences in the North West and provide an indication of whether a proposed trade is likely to be approved. The key criteria that removed licences from our list of possible trades were those with a maximum or average daily abstraction below 1 Ml/d and licences that fall within 'Water not available for licensing' (red) water bodies.

Following this screening, the top 50 abstraction licence holders were contacted regarding the potential to trade all or part of their licence. We received responses relating to 16 of the abstraction licences; six of these were to confirm the licence holder did not wish to consider abstraction licence trading at this time. Ten expressed an interest in a potential abstraction licence trade with us.

Potential abstraction licence trades identified during this process have been included in the unconstrained options list for consideration in line with our other supply options. We investigated the feasibility of the abstraction licence trade to determine whether the trade would provide a benefit to the deployable output of the resource zone. This, alongside an assessment of the criteria set out in the Environment Agency's guideline (2013) has been used to determine whether the option is included in the feasible options list for option selection.

Following a review of the ten licences, all of the potential abstraction licence trades were discounted from the feasible options list, due to the fact that they wouldn't provide a deployable output benefit to our resource zones.

Supply/demand options provided by third parties

The Environment Agency's guideline (2013) does not indicate how companies should engage third parties for the development of supply/demand options. However, it does require full investigation of third party supply/demand options, including options that have been proposed by third parties and not just those that have been solicited through the company making initial contact. Therefore, in order to enable third parties to contact us with potential options, we advertised for third party options via our external website.

In September 2012 we posted an advert on our external website (see web link below), requesting third parties to contact us with any options or solutions to be considered

alongside our other supply-demand options in the options selection process. This request was published alongside the view of ‘need’ and ‘availability’:

http://corporate.unitedutilities.com/Water-Resources-Management-Plan.aspx

We have received no option proposals from third parties via our advertisement on the external website.

We have discussed two specific options with Peel Utilities Holdings Limited and the Nuclear Decommissioning Authority during the construction of the plan.

Peel Utilities Holdings Limited requested further information on how costs were derived for the options relating to the Manchester Ship Canal. We have provided these details in Appendix 1 of our Statement of Response. We have held discussions with the Nuclear Decommissioning Authority during the development of our Lowest Cost Option for West Cumbria, in relation to the transfer of water from Wastwater.

APPENDIX 9. OPTION APPRAISAL METHODOLOGY

Overview

This Appendix describes the approach adopted for each of the 14 stages set out in the EBSD document. Some of the stages involve key decisions and so these are presented in detail. The information presented here has been submitted to the Environment Agency.

The "Total Water Management" approach has been carried out in accordance with national good practice as detailed in the EBSD methodology (Environment Agency and UKWIR, 2002) and the Water Resources Planning Guidelines to assess and compare the alternative options to balance supply and demand during the period 2014/15 to 2039/40. The EBSD approach to the development of a supply-demand strategy has been applied to each of the four United Utilities resource zones. An amended version of the EBSD decision framework is also presented in a 2012 UKWIR report (UKWIR/Environment Agency, 2012). We have used both of these reports for the options appraisal process and the full descriptions of each of the stages of the EBSD are described here.

Stage 1: Assemble Supply and Demand Forecasts

Detailed water supply, demand and target headroom forecasts have been produced for each of the four water resource zones (see Sections 4-7).

Stage 2: The Planning Problem

Deficits in the supply-demand balance are forecast for the West Cumbria Resource Zone. There is no deficit forecast for the Integrated, Carlisle and North Eden Resource Zones. Further details can be found in Section 9.

Stage 3: Unconstrained Options Set

Unconstrained options sets have been developed for all four Resource Zones. The Environment Agency has been consulted on the scope of these unconstrained lists. All of the generic option types listed in the EBSD report have been considered. For each water resource zone, the options have been screened (in order to remove options that clearly cannot form part of the problem solution) according to the following criteria:

1. Does the option address the problem?
2. Does the option breach unalterable planning constraints?
3. Is the option promotable?
4. Does the option have a high risk of failure?

The results of this screening exercise are shown for each Water Resource Zone in Table A. Those screening questions that were passed are coloured green; those that failed are coloured red. A further column indicates whether the option type has been included for economic and environmental appraisal.

Table A Water Resource Zones Unconstrained Options Set

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Resource Management Options							
Direct River Abstraction	Integrated	✓	✓	✓	✓	✓	Abstractions from rivers in the Integrated Resource Zone requiring new abstraction licences. The Manchester Ship Canal has also been considered for potable and non-potable supplies.
	West Cumbria	✓	✓	✓	✓	✓	Abstractions from rivers considered.
	Carlisle	✓	✓	✓	✓	✓	Abstractions from rivers considered.
	North Eden	✓	×	✓	✓	×	Not considered for North Eden Resource Zone, groundwater options more viable, environmental drivers considered high on rivers.
New Reservoir Storage	Integrated	✓	✓	✓	✓	✓	Construction of a new impounding reservoir has been included.
	West Cumbria	×	×	×	×	×	Construction of a new impounding reservoir would not be acceptable to stakeholders.
	Carlisle	×	×	×	×	×	Not considered for the Carlisle Resource Zone, no suitable locations could be identified.
	North Eden	×	×	×	×	×	Not considered for the North Eden Resource Zone, no suitable locations could be identified.
Reservoir Raising	Integrated	✓	✓	✓	✓	✓	Raising certain reservoir levels has been considered.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
	West Cumbria	✓	×	×	×	×	Increasing the levels of impounding reservoirs not considered due to environmental concerns.
	Carlisle	✓	×	×	×	×	Raising of impounding reservoirs not considered.
	North Eden	×	×	×	×	×	There are no reservoirs in the North Eden Resource Zone.
Groundwater Wells (Boreholes)	Integrated	✓	✓	✓	✓	✓	Numerous existing licensed borehole sites considered. Potential for new abstraction sites also considered.
	West Cumbria	✓	✓	✓	✓	✓	Development of new borehole sites considered in North and West Cumbria.
	Carlisle	✓	✓	✓	✓	✓	Development of new borehole sites in the Carlisle area considered.
	North Eden	✓	✓	✓	✓	✓	Development of an extension to an existing borehole water treatment works considered.
Infiltration Galleries	All resource zones	×	×	×	×	×	This scheme type is considered to offer no significant advantage over direct river abstraction or groundwater abstraction and so was not considered.
Artificial Storage and Recovery Wells (ASR)	All resource zones	×	×	×	×	×	ASR and AR scheme types are considered to offer no significant advantage over development of new boreholes. There is generally adequate water available within the existing aquifer systems and so the need for any artificial recharge in the North West at present is considered unnecessary.
Aquifer Recharge (AR)	All resource zones	×	×	×	×	×	
Desalination	Integrated	✓	✓	✓	✓	✓	Desalination plants considered for the Wirral and Merseyside areas.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
	West Cumbria	✓	✓	✓	✓	✓	Desalination plant considered.
	Carlisle	×	×	×	×	×	Desalination not considered viable as other options available. No suitable coastal boundary.
	North Eden	×	×	×	×	×	No coastal boundary, not viable.
Reclaimed Water	Integrated	✓	✓	✓	✓	✓	Water re-use has been considered in the unconstrained option list either for potable or non-potable supplies. We have considered an additional option for effluent reuse for West Cumbria following the consultation period.
	West Cumbria						
	Carlisle						
	North Eden						
Water trading and third party options	Integrated	✓	✓	✓	✓	✓	Water resource import and export opportunities with adjacent water and sewerage providers have been considered in detail for all resource zones, except the North Eden Resource Zone. Options and solutions proposed by third parties have also been considered.
	West Cumbria	✓	✓	✓	✓	✓	
	Carlisle	✓	✓	✓	✓	✓	
	North Eden	✓	✓	✓	✓	✓	
Abstraction licence trading	All resource zones	×	✓	✓	✓	×	Abstraction licence trading was considered. However, it was determined that none of these trades were viable and provide a yield benefit to United Utilities.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Tankering of Water	All resource zones	×				×	Due to the geographical size of the four resource zones that form the United Utilities supply area, tankering of water would not satisfy operational needs and would involve significant environmental impact from traffic movements. This option has not been considered.
Improved/ Sophisticated Conjunctive Management	All resource zones	✓	✓	✓	✓	✓	Conjunctive management of water resources within the four resource zones is already considered highly optimised. These options further consider improvements in the intra-zone connectivity.
Customer Management Options							
Water use audit and inspection (and identification of household and non-household water efficiency opportunities)	All resource zones	✓	✓	✓	✓	✓	Schemes included: Domestic partnership retrofit install. Domestic visit and fix by United Utilities staff. Combi-boiler saving device installations through Housing Associations. Combi-boiler saving device installations by United Utilities staff. Retrofit of dual flush toilets. Leaky loos identification and fixing service. Audit and product installation of tourist sites across region.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Targeted water conservation information (advice on appliance water usage)	All resource zones	×	✓	✓	✓	×	United Utilities will continue to implement extensive water conservation and education programmes. Further programmes in accordance with the Ofwat good practice register will also continue and so there is no additional benefit of also including them in the economic appraisal.
Promotion of water saving devices	All resource zones	✓	✓	✓	✓	✓	Schemes included: Subsidised water efficiency products sold via website. Showerhead giveaways. Waterless car washing samples given away at events. Water butt giveaways. Enhanced water savers pack distribution.
Water recycling	All resource zones	✓	✓	✓	✓	✓	Installation of rainwater harvesting systems in domestic properties.
Water efficiency enabling activities	All resource zones	✓	✓	✓	✓	✓	Offering free and subsidised water butts to customers. United Utilities participates on numerous industry steering groups, which enhance water efficiency research and implement the outcomes.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Advice and information on direct abstraction and irrigation techniques	All resource zones	×	✓	✓	✓	×	There is negligible use of drinking water for irrigation in the United Utilities region. The use of raw water does not fall within the remit of United Utilities and we continue to actively promote water conservation.
Advice and information on leakage detection and fixing techniques	All resource zones	×	✓	✓	✓	×	United Utilities already provide such advice and information within the free Water Savers Pack, A Simple Guide to Your Water Meter Pack and the free water audit packs for households and non-households. We will continue to provide such information and so there is no additional benefit of including this in the economic appraisal.
Change in Level of Service to enhance water available for use (WAFU)	Integrated	✓	✓	✓	✓	✓	United Utilities Integrated Resource Zone currently has a 1 in 20 year level of service. We have investigated the potential for reducing this level of service to impose more frequent water use restrictions as an option in the water resources management plan. The Carlisle Resource Zone, North Eden Resource Zone and West Cumbria Resource Zones do not have a level of service.
	West Cumbria	×	×	×	×	×	
	Carlisle	×	×	×	×	×	
	North Eden	×	×	×	×	×	
Introduction of special fees	All resource zones	×	✓	×	×	×	United Utilities does not charge special (additional) fees on households who use garden sprinklers, hosepipes, outside taps or swimming pools. If such fees were implemented, it would be difficult to implement and would be seen as a tax on honesty. Customers who did pay may feel they were entitled to “unlimited” supplies. United Utilities has no plans to introduce such tariffs, we do not have information readily available to us that would allow us to introduce such tariffs and therefore would have to rely on customers volunteering the information. Without this information it is difficult to understand the demand saving that would be achieved in levying such a charge.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Changes to existing measured tariffs	All resource zones	×	✓	×	×	×	The percentage of our customers that currently have a meter (approximately 30% households) is still relatively low compared to other companies. Most of the meters in-situ do not have sophisticated technology that would allow us to easily design such tariffs. However, as more sophisticated metering is introduced we will have more information available to us that will allow us to design more sophisticated tariffs and easily identify both the benefits and the incidence effects on our customers. This will ensure that any modifications to tariff structures are managed appropriately with our customers. Therefore, changes to existing measured tariffs have been considered and are either not feasible or are already implemented as fully as practicable at the present time (commercial user tariffs). In the longer term there is potential for rising block volumetric or seasonal tariffs to discourage high consumption patterns, but these require the widespread installation of “smart meters” that can record greater detail of information than current meters.
Introduction of special tariffs for specific users	All resource zones	×	✓	×	×	×	The options considered include: introducing “interruptible” industrial supplies, introducing lower charges for major users with significant storage, introducing higher cost “ban free” sprinkler or hosepipe licences, or introducing spot pricing for selected customers. Although these options do not address the supply-demand balance issues in the region, United Utilities already considers such tariffs and will continue to consider them for some of our commercial customers to better service their requirements.
Customer supply pipe leakage reduction	All resource zones	✓	✓	✓	✓	N/A	Since 1996, United Utilities has provided a free service for the repair of leaking external household supply pipes. This service will continue as normal so it cannot be included in the economic appraisal. We have not considered taking over ownership of supply pipes from customers as this would require new legislation.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Leakage reduction by leak detection and repair	All	✓	✓	✓	✓	✓	United Utilities employs a large leak detection workforce who are trained and equipped with the latest leak detection techniques. An increase in the number of personnel would be required to enhance the current level of leak detection and repair. This scheme is an output from the economic level of leakage analysis. United Utilities has installed a comprehensive network of district meters that are attached to cellular telemetry data loggers that use global positioning technology to continuously monitor water use and leakage in each district. United Utilities maintains a sophisticated leakage information system that analyses 15-minute flow and pressure data from thousands of sites across the region. This identifies the areas where high leakage is occurring and directs our leak detection activities. We have also considered options of reducing leakage on our raw water supply pipes.
Pressure reduction programmes	All	✓	✓	✓	✓	✓	During the 1990s the introduction of widespread pressure management demonstrated a step change in leakage, as described above. Pressure reduction stabilises the network and is a proven way to control leakage. United Utilities has installed pressure management values and implemented other pressure reducing methods to optimise water pressure across the distribution network. United Utilities' focus is to trial further pressure optimisation schemes, including the enabling works. We are moving away from time modulated pressure management and implementing flow modulated devices, which will help to reduce leakage. A scheme in the West Cumbria Resource Zone has recently been completed, which has seen numerous pressure management valves installed in the area. This type of scheme is currently being applied to the Integrated Resource Zone.
Advanced replacement of infrastructure for leakage reasons	All	✓	✓	✓	✓	✓	Research suggests that a focus on large scale mains replacement does not significantly reduce the rate of leakage compared to the effects of pressure management schemes. Infrastructure replacement is very costly compared to other schemes described here. Therefore, it is anticipated that mains replacement is confined to address specific local needs (poor condition mains) and pressure management enabling activities.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Distribution capacity expansion	All	×	✓	✓	✓	×	The expansion of distribution capacity does not directly provide additional deployable output in our water resource zones and so has not been directly considered in the economic analysis. However, some supply options include an element of capacity expansion.
Additional network metering	All	✓	✓	✓	✓	✓	United Utilities has commissioned a high level assessment of the benefits of additional metering to support the options appraisal. Additional metering may be applied at several levels in the water network, form distribution input, trunk mains and intermediate meters, to district and customer meters. We have considered the benefits of metering at all of these locations, the types of meter best suited and the level of accuracy required to assist in robust leakage reporting.
Permanent noise logging	All	×	✓	✓	✓	×	Temporary acoustic or 'noise' loggers are currently used to aid leak detection in city centres where traditional listening techniques are ineffective due to background noise and traffic management restrictions. However, the leakage reduction benefit of acoustic loggers is small when compared to pressure management valves. United Utilities will continue to deploy acoustic loggers where appropriate and this may deliver benefits in terms of increased efficiency of detection activity.
Network modelling	All	✓	✓	✓	×	N/A	Data from the thousands of demand management area loggers can be used to calibrate hydraulic models of our water network. Real-time monitoring of flows and pressures will alert us to potential bursts and allow a quicker response to locating and repairing them. There will be benefits to our customers by reducing the risk of unplanned interruptions to supply, as well as potential leakage benefits by increasing the efficiency of detection activity. This scheme remains an aspiration for United Utilities and until the benefits have been proven, this technology will not form part of the economic analysis. However, United Utilities may implement this scheme as part of mains maintenance in PR14 and beyond.

Scheme Type	Resource Zone	Screening Criteria 1	2	3	4	Option included for Economic Analysis	Example options considered within unconstrained list
Metering on customer contact	All	✓	✓	✓	✓	✓	In order to increase meter penetration, unmeasured customers when contacting United Utilities for any reason will be offered a free meter option.
Enhance Promotion	All	✓	✓	✓	✓	✓	The UKWIR model used in the demand forecasting identifies the number of customers who would benefit financially from having a free meter option. This option will be to actively promote the option to those customers, rather than waiting for a customer to contact UUW.
Enhanced home water efficiency visits	All	✓	✓	✓	✓	✓	This is an additional service we will provide as part of the option for “Water use audit and inspection (and identification of household and non-household water efficiency opportunities)”; at the visits free meter options will be offered and promoted to customers.
Blanket promotion	All	✓	✓	✓	✓	✓	Although the UKWIR opting model generates the number of customers who would benefit financially from the meter, UUW in this option would promote meters to all customers in a blanket promotion, this would entail a large communications campaign across the region.
Metering on change of occupier	All	✓	✓	✓	✓	✓	Upon contacting UUW to inform us of a change of tenancy, a customer would be offered a free meter option.

Stage 4: Feasible Options Set

Feasible options sets have been derived for each of the water resource zones, based on the results of the screening criteria applied in Table A. The options that did not pass one or more of the screening tests were considered to be infeasible options. The feasible options sets are described in more detail in Appendix 10.

In constructing the feasible option list, assumptions were made about the scheme outputs considering what could realistically be achieved (customer/production/distribution management options) or what water was available for abstraction (resource management options). Interdependencies with other options were also considered at this stage. The only interdependencies identified were where resource schemes used similar pipeline routes.

Stage 5: Impacts, Costs and Benefits of Options

Financial Costs

United Utilities has identified the capital and operating costs associated with each option, using current best available information on the likely scope of each scheme.

Supplementary information added for the revised plan:

The way in which we develop the expenditure forecasts for the water resources management plan can be considered as follows:

1. Defining project scopes

For our draft plan. the cost estimates for resource side schemes were detailed to a Level 1 design stage. Our Engineers used the proposed project scopes to construct engineering block diagrams (called Process Block Diagrams) showing the scheme components. During this stage, as much of the base data is confirmed as possible (e.g. pump sizes, pipe diameters, treatment work capacities) so that the Engineering estimate can be as accurate as possible. However, as the option scope is a desk study exercise only, there is an allowance for some uncertainty in the scope and hence the cost estimates. Once the data and information has been collated, the components of the Process Block Diagrams are transferred through to our estimating teams so that the costs of each scheme can be assessed.

2. Use of cost information systems

We use a system called the Investment Programme Estimating System (IPES). IPES is used to capture the tender/estimate and project outturn cost data and unit rates for our capital programme. Cost curves and formulae are derived from these data which are then used to provide estimated solution costs for new projects.

Sometimes where we have limited experience or no cost data, we have utilised external consultants to provide expenditure projections.

We routinely carry out benchmarking in delivery of our capital investment programme using information derived from our capital investment delivery partners and market testing, and we regularly engage cost consultants for cost estimating support and to seek assurance that our programme is being delivered at best value.

Our strategy is for all schemes to reflect the lowest whole life cost solution.

3. How the costs for each scheme are derived

The direct construction costs (mechanical, civil and electrical) are derived using IPES. Project ‘add ons’, (e.g. contingency, risk, fees, overheads) are also included to produce a comprehensive project programme price. Where possible, the project add-ons have been based on the most recent historical data.

Within IPES, there is the ability to override any cost generated by the system as more information becomes available, thereby improving the accuracy of the estimate. The costs produced by the system are intended to reflect the current construction techniques and company design principals, which comply with the regulations in the supply, delivery and construction of equipment.

Derivation of operating costs

Operating costs for each scheme are also derived from IPES and are calculated from formulae associated with each construction component. These formulae comprise an automated series of equations that, given any proposed scope for plant and equipment, calculate: electrical power consumption, manpower resource, maintenance requirements, business rates, cost of waste disposal, chemical usage.

The sources of information used to develop the algorithms are: electrical power consumption figures from process and equipment suppliers, pumping power costs from unit rates, manpower costs, set percentage maintenance rates and data from chemicals based on contract rates.

Derivation of Carbon Costs

We use carbon output models that have been developed by using the quantities of high carbon content items, e.g. concrete, steel, multiplied by the carbon content of each item. The carbon values were obtained from the Bath University Inventory of Carbon and Energy v2.0. Both embedded and operational carbon values are derived in this way. The embedded carbon values relate to carbon output models associated with each code in the database. The operational carbon values are derived from formulae and provides outputs on specific chemical usage and electrical consumption.

Historical cost data have been inflated to 2012/13 prices..

Our costs for leakage options are based on economic modelling to derive costs and associated benefit. Costs for metering options are evidence based from our own experience of previous schemes. Water efficiency options were costed based on previous trials and experience of installing/providing similar devices to our customers.

Environmental and Social Costs/Impacts

The environmental and social costs and impacts have been assessed from a detailed study by specialist environmental consultants AMEC on behalf of United Utilities and have been incorporated in the calculation of AISC values. These have informed the strategic environmental assessment (SEA) methodology for the appraisal of the options. This work is reported in AMEC, on behalf of United Utilities, February 2013.

The water resource planning guidelines detail the approach that water companies should take when preparing their draft plans. For the assessment of the environmental and social costs, the guidelines state that the Benefits Assessment Guidance (BAG) should be used, eftec (2010). The BAG was developed for the use of Environment Agency and water company planners to ensure consistency in approach to the assessment of water resource options for the 2004 Periodic Review. In March 2012 a Benefits Assessment Guidance User Guide and worked example were published by the Environment Agency. The approach used in our plan is consistent with the latest guidance.

The approach within BAG allows an assessment of environmental and social costs and benefits of options using a desk-top approach. This cost-benefit approach requires that the impacts are described qualitatively and, where appropriate, a monetary assessment is made of the potential costs and benefits of implementing a water resource option.

The BAG uses a benefit transfer approach, whereby information on environmental and social costs are taken from published data (for example, from willingness to pay studies) and applied to the option under consideration. The BAG enables the assessment of the environmental and social costs of water resource options as a desk-top study.

Although there are limitations to the approach set out in the BAG, the methodology was subject to a peer review and testing process by relevant policy stakeholders (the Environment Agency, Defra, WAG, Ofwat, Natural England), academics and water company economists at the time of publication, and remains part of the recommended approach to option assessment set out within the water resources planning guidelines.

In October 2008 Ofwat published a revised set of Guidance for the incorporation of environmental and social externalities into water companies' leakage cost assessments, enabling water companies to derive a Sustainable Economic Level of Leakage (SELL), Water Services Regulation Authority (2008). The SELL Guidance builds on existing assessment approaches, drawing heavily on the approaches outlined in the BAG. The SELL Guidance does, however, provide more detailed approaches to assessing leakage related externalities, such as the social cost of delays to pedestrian journeys or temporary losses of water pressure in the distribution system as a result of leakage repairs. The approach taken for the assessment of leakage options draws on information presented in the SELL guidance.

The environmental and social impact issues associated with construction activity that were assessed include:

- Construction Period (years)
- Built Environmental Impact
- HGV Movements (No)
- Energy (Kwh/Ml)
- Noise Impact
- Embodied Energy values (kg)

Odour/dust were also considered and acknowledged that they may be a problem as part of construction-related activities.

An assessment of carbon is included in the BAG. The carbon assessment for each option has been broken down into construction impacts (one-off impacts during the construction period) and operational (i.e. annual, recurring carbon impacts). Carbon emissions have been monetised using the traded carbon price per tonne CO_2e. The price of carbon changes over time, as detailed in the DECC document. Carbon emissions have been assessed over a 105-year accounting period and discounted to a present value at a rate of 4.5% per annum.

The outputs of the environmental and social cost assessments are presented as input data to the EBSD model. The data presented are as follows:

- Operating environmental costs – fixed (£m/yr) – annual environmental and social costs (excludes carbon);
- Operating environmental costs – variable (£/Ml) – annual cost of carbon emissions;
- Construction related environmental costs – initial (£m) – total construction environmental and social costs (excludes carbon); and

- Works related carbon cost (£m) – Total cost of construction related carbon (embodied, vehicle emissions and plant where relevant).

Stage 6: The Modelling Framework

The EBSD report identifies that there are three possible modelling frameworks that can be utilised:

- "Current Framework"
- "Intermediate Framework"
- "Advanced Framework"

The feasibility of collecting the necessary data and applying each of the frameworks has been assessed and is summarised in Table B below.

On the basis of the feasibility assessment and the desire to generate as robust a water resources management plan as possible, the Intermediate Framework has been selected as the most appropriate modelling framework. The Environment Agency has been consulted on the framework selection and is supportive of United Utilities' preference to use the Intermediate Framework.

Table B: Modelling Framework Assessment

Availability of Data	Comment
The Current Framework	Data are available in order to apply the Current Framework.
The Intermediate Framework	Data are available in order to apply the Intermediate Framework.
The Advanced Framework	"Willingness to Pay" data are not currently available in order to be able to apply the Advanced Framework.
Expertise Available to Collect Data	**Comment**
The Current Framework	Expertise is available in order to collect data and apply the Current Framework.
The Intermediate Framework	Expertise is available in order to collect data and apply the Intermediate Framework.
The Advanced Framework	United Utilities has no prior experience of collecting data for the Advanced Framework.
Time and Resources Available to Collect Data	**Comment**
The Current Framework	Time and resources are available in order to collect data and apply the Current Framework.
The Intermediate Framework	Time and resources are available in order to collect data and apply the Intermediate Framework.
The Advanced Framework	Time and resources could be made available if the above two conditions had been met, and UU was seeking to improve its supply reliability standards.

Stage 7: The Selection Routine

The selection routine is central to the planning process. The candidate selection routines available are as follows:

- The AIC/AISC Approach

- Linear / Integer programming-based model formulations
- Stochastic-programming model formulation

Note:

AIC = Average Incremental Cost (pence/m^3), which is calculated based on the NPV capital and operational costs seen by United Utilities and the WAFU value of the option.

AISC = Average Incremental Social Cost (pence/m^3), which is calculated similarly to AIC but includes environmental and social costs.

United Utilities have selected both the AISC approach and the Mathematical (Linear/Integer) Programming approach. The AISC approach provides a simple means of comparing the unit cost of alternative options and is additionally required to be reported to the Environment Agency as part of the water resources management plan process. A mathematical programming model has been selected by United Utilities which will generate an optimal programme of options within the planning horizon that best meets any supply-demand deficit at least cost. Table C summarises the assessment of the candidate selection routines.

Table C: Selection Routine Assessment

Accuracy of Approach	Comment
AISC Approach	The AISC approach is likely to be too simplistic considering the planning horizon and number of potential options available.
Linear/Integer Programming	This approach is likely to deliver an optimal programme of options for each RZ.
Stochastic Programming	This approach takes into account uncertainties in forecasts but model formulation is less likely to be tractable.
Likely Success of Approach	**Comment**
AISC Approach	This approach does not scale well – the larger and more complex the problem, the greater the likelihood of a sub-optimal set of options being selected.
Linear/Integer Programming	With this approach, a global optimum is likely and commercial software is available for this approach. Indivisibilities in scale can be fully taken into account.
Stochastic Programming	This approach has the potential to find a more robust, lower cost solution. However no commercially available software is currently available and has higher data requirements. Likely to be complex and time-consuming to deliver.
Costs of Proposed Approach	**Comment**
AISC Approach	This is the cheapest of the candidate selection routines, requiring least data input and fewest skilled resources.
Linear/Integer Programming	This approach can be run on commonly available commercial software (e.g. Microsoft Excel), it is relatively straightforward to implement and requires less skilled resources than the stochastic approach.
Stochastic Programming	This approach has higher data requirements (i.e.: more costly) and due to the lack of commercial software is likely to have significantly higher skilled resource requirements.

Stage 8: Average Incremental and Social Costs (AISC)

AISC and AIC values have been calculated for each feasible option.

This spreadsheet system has been used to generate all AIC/AISC values for the water resources management plan. The following key assumptions have been used for all calculations:

- A calculation horizon of 105 years has been used to calculate the AIC/AISCs.
- A discount rate of 4.5% has been used for Net Present Value calculations of capital and operational costs.
- A discount rate of 4.5% has been used for Net Present Value calculations of environmental and social costs.

These discount rates are consistent with current Treasury and regulatory guidelines. Alternative values for the discount rate have been considered as part of the sensitivity analysis of the water resources and demand strategy (presented in the water resources management plan).

Summary values of the AIC/AISCs calculated for each feasible option in the four water resource zones are presented in Section 8.

Stage 9: Target Level of Service

The assumed target levels of service for the current and intermediate frameworks are as follows:

- The frequency of hosepipe bans and Drought Permits to augment supplies is 1 in 20 years.
- The frequency of Drought Orders to restrict non-essential water use and further augment supplies is 1 in 35 years.
- No standpipes or rota cuts during worst drought on record (1927-2012)

The justification for this level of service has been based on consultation with customers and regulatory considerations, as described in Section 2 of the water resources management plan.

The Advanced Framework is not being used in this planning process and so customer willingness to pay data is not therefore required. However, United Utilities has carried out willingness to pay surveys to inform the choice of level of service and these are described in Section 2.

Stage 10: Apply the Modelling Framework and Selection Routine

The Intermediate Modelling approach using stochastic Monte Carlo modelling has been applied to the uncertainties in the supply-demand forecasts. The results have been incorporated into our assessments of target headroom.

The economic and environmental appraisal to derive the water resources and demand strategy to maintain the supply-demand balance in United Utilities water resource zones is described in Sections 10 and 11 of the water resources management plan. For each resource zone, the most economic combination of solutions was identified by mathematical programming optimisation.

Stage 11: Indivisibilities (for the AISC Approach)

We have used the AISC values to identify the initial ranking of options according to their overall unit cost. However, in accordance with the EBSD methodology, a mathematical programming approach has been adopted to derive optimal programmes

of options to meet any supply deficits. This avoids “indivisibilities” (i.e. inability to account for part-schemes) in the final solutions that can occur if the AISC approach is used to determine the optimal solutions.

Stage 12: Tariff and Demand Feedbacks

We consider that the feedback effects are likely to be small. This has been confirmed by our econometric modelling of non-household water demand, which demonstrates that the effect of a “real price of water” on non-household demand is very small. We have identified that a price elasticity of -0.1, i.e. a 10% increase in the real price of water would lead to a 1% fall in non-household demand. Herrington (UKWIR, 2005) suggests an elasticity of -0.1 to -0.2 for households. The impact of the proposed supply-demand programme on water prices for United Utilities is small compared with the expenditure requirements of the quality enhancement and maintenance programmes. For these reasons any feedback effects of any tariff impacts on supply-demand deficits and solutions will be negligible and so have not been specifically investigated.

Stage 13: Further allowance for Risk, Environment and Equity

Section 10 of the water resources management plan includes a descriptive appraisal of risks, and environmental and other uncertainties.

Stage 14: EBSD Checklist

The information in this appendix provides a detailed check that all stages of the EBSD have been completed for each water resource zone.

APPENDIX 10. OPTION DESCRIPTIONS

This Appendix provides a summary description of all of the feasible options that were identified from the option screening in Stage 3 and 4 and described in Appendix 9. The options considered for all four water resource zones are presented in Tables B, C and D below. Table E details risks, uncertainties, flexibilities and any interdependency issues for the various option types.

The headings of these tables are as follows:

- Generic Option: These are all of the types of options that have been considered in this plan, as described in Appendix 9.
- Scheme ID: Each option has been given a unique scheme identification number.
- Option Name/Details: A description of each option is provided highlighting the principal components of each scheme and where applicable, some geographic context of where the scheme is located.

Consideration has been given to the risks associated with each feasible option, for example the potential impacts on the environment, visual/amenity risks if the option was implemented. These risks are described in Section 8 of this report with reference to the studies we have completed to assess these risks.

The potential impacts of climate change have also been considered for each generic option type. This analysis has been based on our climate change assessment work that was completed as part of the yield review exercise for all of our existing sources of water. Climate change impacts are only considered of relevance to resource management options and are described in Table A.

Table A: Classification of climate change risk for feasible options

Generic Option Type	Risk	Description
Direct River abstraction	High	In some areas, there could be a significant reduction in river flow at certain times of the year. Therefore, the option may not be viable to implement until a further detailed assessment of river flows has been completed.
New Reservoir Storage/Reservoir Raising	Medium	Our assessments have indicated that at certain times of the year river flow may increase. Therefore, the buffering capacity of reservoir storage would reduce (but not remove) the potential impact of climate change.
Groundwater Wells	Low	Our assessment has concluded that the availability of groundwater in the north-west of England is not susceptible to climate change effects. However, before development of new schemes, an appraisal of the resource availability would be required.
Reclaimed Water	Medium	Suitable flows in rivers are required in order to provide dilution of discharges from wastewater treatment works. Also, the discharges can form in some instances a significant component of the dry weather flow in the river. Therefore, abstraction at certain times of the year may not be viable.
Desalination	Low	The availability of water for abstraction would not be affected by climate change.
Water transfers	Medium	This will depend on where the source of the water comes from. River abstraction sources could be high risk; groundwater sources are likely to be low risk. Therefore, a medium risk classification has been considered appropriate.

Table B: Integrated Resource Zone Feasible Options

Generic Option	Scheme ID	Option Name / Details
Resource Management Options		
Direct River Abstraction	IRZ01a/b	River Ribble Abstraction These options require the construction of a new abstraction point on the lower reaches of the River Ribble and the transfer of water for treatment to an existing United Utilities water treatment works near Bolton.
	IRZ20/57b IRZ57a	New Abstraction from Manchester Ship Canal - Potable and Non-Potable These options require the construction of a new abstraction point on the Manchester Ship Canal and the treatment and transfer of treated water into the Manchester water supply system.
	IRZ34	River Weaver Abstraction This option requires the construction of a new abstraction point on the upper reaches of the River Weaver in Cheshire and the transfer of raw water for treatment to an existing United Utilities water treatment works.
New Reservoir Storage	IRZ65	New Reservoir at Borrowbeck This option requires the construction of a new impounding reservoir in Cumbria and the transfer of raw water to an existing United Utilities water treatment works.
Reservoir Raising	IRZ02	Raise Stocks Reservoir This option raises the level of an existing impounding reservoir in Lancashire, thereby creating additional storage.
	IRZ08	Raise Haweswater Reservoir This option raises the level of an existing impounding reservoir in Cumbria, thereby creating additional storage.
Groundwater Wells	IRZ21a-c	Widnes Groundwater (North Mersey Strategy) This option requires the transfer of groundwater from existing United Utilities boreholes in the Widnes area to a treatment works located in Merseyside.
	IRZ22	Croft boreholes This option requires the transfer of groundwater from existing United Utilities boreholes in the Warrington area to a treatment works located in Wigan.
	IRZ23	Walton and Daresbury boreholes This option requires the transfer of treated groundwater from existing United Utilities boreholes in the north Cheshire area to Warrington.
	IRZ25b	New boreholes at Cross Hill Service Reservoir This option requires the construction of new boreholes on the Wirral.
	IRZ30	Widnes groundwater and Eccleston Hill borehole This option requires the transfer of groundwater from existing United Utilities boreholes in the St Helens area to a treatment works located in Merseyside.
	IRZ38	Eaton boreholes This option requires the treatment of groundwater from existing United Utilities boreholes in the mid Cheshire area.

Generic Option	Scheme ID	Option Name / Details
	IRZ39	Bearstone boreholes This option requires the treatment of groundwater from existing United Utilities boreholes in the south Cheshire area.
	IRZ40	Newton Hollows boreholes This option requires the treatment of groundwater from existing United Utilities boreholes in the mid Cheshire area.
	IRZ41	Helsby boreholes This option requires the treatment of groundwater from existing United Utilities boreholes in the mid Cheshire area.
	IRZ48	Swineshaw boreholes This option requires the transfer of groundwater from existing United Utilities boreholes into impounding reservoirs located to the east of Manchester.
	IRZ49	Python Mill borehole This option requires the transfer of groundwater from an existing borehole in the north Manchester area and its use to replace reservoir compensation water.
	IRZ52	Woodford borehole This option requires the treatment of groundwater from an existing United Utilities borehole in the mid Cheshire area.
	IRZ53	Hazel Grove new groundwater source This option requires the construction of new boreholes in the south Manchester area.
	IRZ55	Tytherington boreholes This option requires the treatment of groundwater from existing boreholes in the east Cheshire area.
	IRZ56	Lymm boreholes (East option and West option) This option requires the transfer of treated groundwater from existing United Utilities boreholes in north Cheshire area to either Manchester or Warrington.
	IRZ75	Southport strategy This option requires the construction of new boreholes in the Southport area.
Reclaimed Water	IRZ69	Horwich WwTW – final effluent re-use This option considers whether final effluent from a wastewater treatment works in the Bolton area can be treated and re-used for public water supply purposes.
	IRZ70	Saddleworth WwTW – final effluent re-use This option considers whether final effluent from a wastewater treatment works in east Manchester area can be treated and re-used for public water supply purposes.
	IRZ73	Supply of final effluent to non-household customers This option considers whether final effluent from wastewater treatment works in the United Utilities supply area can be used as non-potable supplies for industrial customers.

Generic Option	Scheme ID	Option Name / Details
Desalination	IRZ28a	Desalination, Wirral This option requires the construction of a desalination plant on the Wirral.
	IRZ28b/28c	Desalination, Liverpool/Merseyside These options require the construction of desalination plants in the Liverpool and Merseyside areas.
Bulk and Raw Water Transfers – Imports Note: Only import options to the United Utilities supply area have been considered as part of the feasible option list. However, export options have also been assessed for other companies' water resource management plans. These are as follows:	IRZ03	Import from Northumbrian Water (Cow Green reservoir) This option considers the import of water from Northumbrian Water to the United Utilities supply area.
	IRZ47d	Import from Yorkshire Water (Scammonden reservoir) This option considers the import of water from Yorkshire Water to the United Utilities supply area.
	IRZ61a	Import from Northumbrian Water (Kielder Water) This option considers the import of water from Northumbrian Water to the United Utilities supply area.
Bulk and Raw Water Transfers – Exports	IRZ37	Mow Cop borehole (Severn Trent Water export option) This option considers the export of water from the United Utilities supply area to Severn Trent Water.
	IRZ42/42b	Export to Severn Trent Water (Congleton) This option considers the export of water from the United Utilities supply area to Severn Trent Water.
	IRZ44a	Export to Bristol Water (Lake Vyrnwy) This option considers the export of water from the United Utilities supply area to Bristol Water.
	IRZ44b-d	Export to Severn Trent Water (Lake Vyrnwy, Peckforton and Llandforda) These options consider the export of water from the United Utilities supply area to Severn Trent Water.
	IRZ47a-c	Export to Yorkshire Water (Whiteholme reservoir, Walsden and Bentham) These options consider the export of water from the United Utilities supply area to Yorkshire Water.
	IRZ61b-c	Export to Dee Valley Water (Vyrnwy Aqueduct and River Dee) These options consider the export of water from the United Utilities supply area to Dee Valley Water.
	IRZ61e	Export to Welsh Water (River Dee licence trade) This option considers the export of water from the United Utilities supply area to Dŵr Cymru Welsh Water.
	IRZ74	Export to Severn Trent Water (Hazel Grove to Buxton) This option considers the export of water from the United Utilities supply area to Severn Trent Water.
Sophisticated/ conjunctive	IRZ10/13	Barrow Link Main and Paddy End These options require the transfer of treated water into the south Cumbria water supply system from an existing United Utilities water

Generic Option	Scheme ID	Option Name / Details
management		treatment works and improvement of connectivity to the treated water mains system.
	IRZ46	Rossendale Strategy This option requires the construction of new pipelines to transfer river water and treated mine water to an existing United Utilities impounding reservoir and water treatment works in the south Lancashire area.
	IRZ72	Reduction in raw water losses This option considers reductions in leakage from the United Utilities raw water mains, rather than the treated water mains.
	IRZ-LOS1	Reductions in Level of Service This option would involve a reduction in Levels of Service offered to customers from the current 1 in 20 years to a 1 in 10 years for the implementation of hosepipe bans.
	IRZ-OUT1	Outage reduction This option would involve the refurbishment of raw water pipelines to reduce the level of outage due to risk of failure of pipelines.
Customer Management Options		
Water use audit and inspection (and identification of household and non-household water efficiency opportunities)	WE02	**Domestic partnership retrofit install** This option provides our customers with information on how to assess and reduce their water usage. Partners working on behalf of United Utilities would fit water saving devices in customers' properties at the same time as visiting for other reasons, such as an annual gas survey or maintenance visit.
	WE03	**Domestic visit and fix** This option provides our customers with information on how to assess and reduce their water usage and then the installation of water saving devices. This would all be achieved with a single visit to the customer's property.
	WE04	**Combi Boiler saving device** This option provides our customers whose property is managed by a housing association with a thermostatic valve designed to accelerate the heating process by holding back water while the combi boiler heats up to the right temperature. Installation is carried out by housing associations during their routine visits.
	WE05	**Combi Boiler saving device** This option provides our customers with a thermostatic valve designed to accelerate the heating process by holding back water while the combi boiler heats up to the right temperature. Installation is carried out by a United Utilities representative on an appointment basis.
	WE06	**Retrofit dual flush toilets** This option provides our customers with a retrofit dual flush device to reduce water usage. Installation is carried out by a United Utilities representative on an appointment basis.
	WE07	**Leaky Loos** This option assists our customers in identifying if their toilet has a leak. The fixing of the toilet would take place by a United Utilities representative on an appointment basis.
	WE10	**Tourist sites, promotion and retrofit**

Generic Option	Scheme ID	Option Name / Details
		This option allows for the provision of, promotion and retrofit of toilet facilities at tourist sites. The water audit and installation will take place following an agreed appointment with a United Utilities representative.
Promotion of water saving devices	WE08	**Subsidised water efficiency products sold via website** This option consists of our customers receiving a water saving voucher to spend on a water butt via United Utilities website.
	WE09	**Showerhead giveaways** This option consists of customers receiving water saving showerheads and advice at publicity events.
	WE11	**Waterless car washing giveaways** This option consists of customers receiving sample bottles of a waterless car washing product, plus a money off voucher to purchase more with relevant advice at publicity events.
	WE12	**Free water butt distribution** This option consists of customers receiving water butts direct to their properties, after placing an order from United Utilities.
	WE13	**Free showerhead distribution** This option consists of customers receiving water efficient showerheads direct to their properties, after placing an order from United Utilities.
	WE14	**Subsidised water efficiency products sold via website** This option consists of our customers receiving a water saving voucher to spend on water efficient shower heads via United Utilities website.
	WE15	**Enhanced water saving pack distribution through additional promotion of current offering** This option consists of customers receiving promotional material and choosing the items and ordering an enhanced water savers pack from the UU website, call centre or return post.
Water recycling	WE01	**Domestic rainwater harvesting** This option involves installing rainwater harvesting systems in existing domestic properties.
Metering on customer contact	MET01	In order to increase meter penetration, unmeasured customers when contacting United Utilities for any reason will be offered a free meter option.
Enhanced Promotion	MET02	The UKWIR model used in the demand forecasting identifies the number of customers who would benefit financially from having a free meter option. This option will be to actively promote the option to those customers, rather than waiting for a customer to contact UUW.
Enhanced home water efficiency visits	MET03	This is an additional service we will provide as part of the option for "**Water use audit and inspection (and identification of household and non-household water efficiency opportunities)";** at the visits free meter options will be offered and promoted to customers.
Blanket promotion	MET04	Although the UKWIR opting model generates the number of customers who would benefit financially from the meter, UUW in this option would promote meters to all customers in a blanket promotion, this would entail a large communications campaign across the region.
Metering on change of occupier	MET05	Upon contacting UUW to inform us of a change of tenancy, the customer would be offered a free meter option.

Generic Option	Scheme ID	Option Name / Details
Distribution Management Options		
Leak detection	IRZ-LEA01	Leak detection and repair stage 1 from SELL assessment
	IRZ-LEA02	Leak detection and repair stage 2 from SELL assessment
	IRZ-LEA03	Leak detection and repair stage 3 from SELL assessment
	IRZ-LEA04	Leak detection and repair stage 4 from SELL assessment
	IRZ-LEA05	Leak detection and repair stage 5 from SELL assessment
		These five options have been identified through the economic level of leakage assessment. Each stage must be completed in sequence. The options comprise employment of additional trained leak detection personnel, purchase of additional leak detection equipment, and repair of the extra leaks that are detected. Leaks at each stage of detection and repair become harder and more expensive to find and fix because it means looking for smaller leaks and expecting to fix them quicker.
Pressure reduction programmes	IRZ-LEA16	Pressure management stage 1
		This option comprises pressure management to further reduce leakage levels by the fitting of flow modulation to existing pressure management valves or in some cases, new pressure management valves to control pressure within the mains system and thereby reducing leakage from mains, communication pipes and customer supply pipes.
Advanced replacement of infrastructure for leakage reasons	IRZ-LEA06	Infrastructure replacement stages 1
	IRZ-LEA07	Infrastructure replacement stages 2
	IRZ-LEA08	Infrastructure replacement stages 3
		These three options target replacement of those mains where water savings due to reduced bursts and leakage are expected to be the highest. Each stage must be implemented in sequence. The options comprise the replacement of water mains and communication pipes in district areas which show a consistently high level of leakage (particularly background leakage) and a high frequency of bursts.
Additional network metering	IRZ-LEA09	Increased verification of existing meters
	IRZ-LEA10	Increased number of continuously logged meters
	IRZ-LEA12	Widespread metering using AMR
	IRZ-LEA13	Splitting DMAs
	IRZ-LEA14	Splitting large upstream tiles
	IRZ-LEA15	Establishing water balance areas
		The main benefit of these six schemes is to provide better information so that maximum accuracy in flow measurement is gained. By providing more, and more accurate meter readings, a more exact calculation of leakage can be assessed for upstream and district areas. As the leakage calculation improves, areas can be correctly prioritised for detection surveys to locate and repair leaks. This results in leaks being identified more easily and quickly, resulting in a reduction of their run-time.

Table C: West Cumbria Resource Zone Feasible options

Generic Option	Scheme ID	Option Name / Details
Resource Management Options		
Direct River Abstraction	WC02	River Derwent Abstraction This option comprises a new river abstraction in West Cumbria and the transfer to an existing treated water storage reservoir.
Groundwater Wells	WC05/05a	Development of new boreholes in West Cumbria aquifer These options comprise the development of a number of new borehole sources in the West Cumbria area and the transfer of raw water to an existing United Utilities water treatment works
	WC05b/05c/05d	Development of new boreholes in West Cumbria aquifer These supplementary options consider different scheme capacities and borehole locations to those detailed in WC05 and WC05a
	WC06a/06b	Roughton Gill Mine Adit This option comprises the transfer of water from an existing United Utilities minewater source into an existing impounding reservoir. Two pipeline routes have been considered.
	WC07	Kirklinton borehole development This option comprises the development of a number of new borehole sources in the Carlisle area and the transfer of treated water into West Cumbria.
	WC09	Development of boreholes in North Cumbria aquifer This option comprises the development of new boreholes in the northern part of West Cumbria and the transfer to an existing United Utilities water treatment works.
Reclaimed Water	WC23	Supply of final effluent to non-household customers This option considers whether final effluent from wastewater treatment works in the United Utilities supply area can be used as non-potable supplies for industrial customers.
	WC25	Effluent reuse This option considers whether final effluent from two large wastewater treatment works in the United Utilities supply area can be treated and used as potable supplies for our customers.
Desalination	WC10	Desalination, Workington This option comprises the construction of a desalination plant in West Cumbria.
Bulk and Raw Water Transfers	WC04	Wastwater – negotiate part abstraction licence This option comprises the negotiation with an industrial customer to utilise part of existing abstraction licences, the water to be transferred and treated by United Utilities
	WC14	Kielder reservoir transfer to West Cumbria This option considers the import of water from Northumbrian Water to the United Utilities supply area.
Sophisticated/ conjunctive management	WC01	Thirlmere transfer into West Cumbria This option comprises the transfer of treated water from the Integrated Resource Zone into West Cumbria.

Generic Option	Scheme ID	Option Name / Details
	WC19	Crummock automated compensation control This option comprises the improved control (automation) of a compensation flow on an existing United Utilities impounding reservoir.
	WC24 (a-f)	Treated water links (Quarry Hill-Stainburn-Summergrove) This option comprises a treated water link across the West Cumbria Resource Zone. It is considered in conjunction with schemes WC02/WC06/WC07/WC09/WC10 and WC19.
	WC72	Reduction in raw water losses This option considers reductions in leakage from the United Utilities raw water mains, rather than the treated water mains.
	WC99	Decommission sources in West Cumbria This option considers the abandonment of the existing water treatment works in West Cumbria and is considered in conjunction with scheme WC01 and WC14.
Customer Management Options		
Water use audit and inspection (and identification of household and non-household water efficiency opportunities)	WE02	Domestic partnership retrofit install This option provides our customers with information on how to assess and reduce their water usage. Partners working on behalf of United Utilities would fit water saving devices in customers' properties at the same time as visiting for other reasons, such as an annual gas survey or maintenance visit.
	WE03	Domestic visit and fix This option provides our customers with information on how to assess and reduce their water usage and then the installation of water saving devices. This would all be achieved with a single visit to the customer's property.
	WE04	Combi Boiler saving device This option provides our customers whose property is managed by a housing association with a thermostatic valve designed to accelerate the heating process by holding back water while the combi boiler heats up to the right temperature. Installation is carried out by housing associations during their routine visits.
	WE05	Combi Boiler saving device This option provides our customers with a thermostatic valve designed to accelerate the heating process by holding back water while the combi boiler heats up to the right temperature. Installation is carried out by a United Utilities representative on an appointment basis.
	WE06	Retrofit dual flush toilets This option provides our customers with a retrofit dual flush device to reduce water usage. Installation is carried out by a United Utilities representative on an appointment basis.
	WE07	Leaky Loos This option assists our customers in identifying if their toilet has a leak. The fixing of the toilet would take place by a United Utilities representative on an appointment basis.
	WE10	Tourist sites, promotion and retrofit

Generic Option	Scheme ID	Option Name / Details
		This option allows for the provision of, promotion and retrofit of toilet facilities at tourist sites. The water audit and installation will take place following an agreed appointment with a United Utilities representative.
Promotion of water saving devices	WE08	Subsidised water efficiency products sold via website This option consists of our customers receiving a water saving voucher to spend on a water butt via United Utilities website.
	WE09	Showerhead giveaways This option consists of customers receiving water saving showerheads and advice at publicity events.
	WE11	Waterless car washing giveaways This option consists of customers receiving sample bottles of a waterless car washing product, plus a money off voucher to purchase more with relevant advice at publicity events.
	WE12	Free water butt distribution This option consists of customers receiving water butts direct to their properties, after placing an order from United Utilities.
	WE13	Free showerhead distribution This option consists of customers receiving water efficient showerheads direct to their properties, after placing an order from United Utilities.
	WE14	Subsidised water efficiency products sold via website This option consists of our customers receiving a water saving voucher to spend on water efficient shower heads via United Utilities website.
	WE15	Enhanced water saving pack distribution through additional promotion of current offering This option consists of customers receiving promotional material and choosing the items and ordering an enhanced water savers pack from the UU website, call centre or return post.
Water recycling	WE01	Domestic rainwater harvesting This option involves installing rainwater harvesting systems in existing domestic properties.
Metering on customer contact	MET01	In order to increase meter penetration, unmeasured customers when contacting United Utilities for any reason will be offered a free meter option.
Enhance Promotion	MET02	The UKWIR model used in the demand forecasting identifies the number of customers who would benefit financially from having a free meter option. This option will be to actively promote the option to those customers, rather than waiting for a customer to contact UUW.
Enhanced home water efficiency visits	MET03	This is an additional service we will provide as part of the option for “Water use audit and inspection (and identification of household and non-household water efficiency opportunities)”; at the visits free meter options will be offered and promoted to customers.
Blanket promotion	MET04	Although the UKWIR opting model generates the number of customers who would benefit financially from the meter, UUW in this option would promote meters to all customers in a blanket promotion, this would entail a large communications campaign across the

Generic Option	Scheme ID	Option Name / Details
		region.
Metering on change of occupier	MET05	Upon a customer contacting UUW to inform us of a change of tenancy, UUW would install a meter.
Distribution Management Options		
Leak detection	WC-LEA01 WC-LEA 02	Leak detection and repair stages 1 from SELL assessment Leak detection and repair stages 2 from SELL assessment These two options have been identified through the economic level of leakage assessment. Each stage must be completed in sequence. The options comprise employment of additional trained leak detection personnel, purchase of additional leak detection equipment, and repair of the extra leaks that are detected. Leaks at each stage of detection and repair become harder and more expensive to find and fix because it means looking for smaller leaks and expecting to fix them quicker. The economic level of leakage assessment has determined that only two stages of leakage detection and repair are possible in West Cumbria under current operating conditions. This is because the current level of leakage is significantly below the economic level and, as leakage reduces towards the policy minimum, there is little scope for further reduction through active leakage detection methods.
Pressure reduction programmes	WC-LEA04	Pressure management stage 1 This option comprises pressure management to further reduce leakage levels by the fitting of flow modulation to existing pressure management valves or, in some cases, new pressure management valves to control pressure within the mains system and thereby reduce leakage from mains, communication pipes and customer supply pipes.
Advanced replacement of infrastructure for leakage reasons	WC-LEA03	Infrastructure replacement stage 1 This option targets replacement of those mains where water savings due to reduced bursts and leakage are expected to be the highest. Each stage must be implemented in sequence. The options comprise the replacement of water mains and communication pipes in district areas which show a consistently high level of leakage (particularly background leakage) and a high frequency of bursts.
Additional network metering	WC-LEA05 WC-LEA06 WC-LEA08 WC-LEA09 WC-LEA10 WC-LEA11	Increased verification of existing meters Increased number of continuously logged meters Widespread metering using AMR Splitting DMAs Splitting large upstream tiles Establishing water balance areas The main benefit of these six schemes is to provide better information so that maximum accuracy in flow measurement is gained. By providing more, and more accurate meter readings, a more exact calculation of leakage can be assessed for upstream and district areas. As the leakage calculation improves, areas can be correctly prioritised for detection surveys to locate and repair leaks. This results in leaks being identified more easily and quickly, resulting in a reduction of their run-time.

Table D: Carlisle Resource Zone and North Eden Resource Zones Feasible Options

Generic Option	Scheme ID	Option Name / Details
Resource Management Options		
Groundwater Wells	CARL02a	Kirklinton groundwater to Carlisle This option comprises the development of a number of new borehole sources in the Carlisle area.
	CARL03/NE01	North Eden transfer to Carlisle/development of new boreholes These options comprise the transfer of treated water from the North Eden Resource Zone into the Carlisle Resource Zone (CARL03) and the increased output from an existing borehole source to feed into the North Eden Resource Zone (NE01).
Reclaimed Water	CARL11	Supply of final effluent to non-household customers This option considers whether final effluent from wastewater treatment works in the United Utilities supply area can be used as non-potable supplies for industrial customers.
Bulk and Raw Water Transfers	CARL02b	Kirklinton groundwater to Scottish Water This option comprises the development of a number of new borehole sources in the Carlisle area and includes an export to Scottish Water.
	CARL04/06/09	Treated near Carlisle /Castle Carrock options These options comprise the improved operation of existing water treatment works facilities in the Carlisle area and the provision of a new borehole source.
	CARL08 / CARL10 / CARL13	Kielder transfer to Carlisle and West Cumbria/ Import from Northumbrian Water (Burnhope reservoir and Cow Green Reservoir) These three options comprise the import of water from Northumbrian Water into the Carlisle Resource Zone.
Customer Management Options		
Water use audit and inspection (and identification of household and non-household water efficiency opportunities)	WE02	Domestic partnership retrofit install This option provides our customers with information on how to assess and reduce their water usage. Partners working on behalf of United Utilities would fit water saving devices in customers' properties at the same time as visiting for other reasons, such as an annual gas survey or maintenance visit.
	WE03	Domestic visit and fix This option provides our customers with information on how to assess and reduce their water usage and then the installation of water saving devices. This would all be achieved with a single visit to the customer's property.
	WE04	Combi Boiler saving device This option provides our customers whose property is managed by a housing association with a thermostatic valve designed to accelerate the heating process by holding back water while the combi boiler heats up to the right temperature. Installation is carried out by housing associations during their routine visits.
	WE05	Combi Boiler saving device This option provides our customers with a thermostatic valve designed to accelerate the heating process by holding back water while the combi boiler heats up to the right temperature. Installation is carried out by a United Utilities representative on an appointment basis.

Generic Option	Scheme ID	Option Name / Details
	WE06	Retrofit dual flush toilets This option provides our customers with a retrofit dual flush device to reduce water usage. Installation is carried out by a United Utilities representative on an appointment basis.
	WE07	Leaky Loos This option assists our customers in identifying if their toilet has a leak. The fixing of the toilet would take place by a United Utilities representative on an appointment basis.
	WE10	Tourist sites, promotion and retrofit This option allows for the provision of, promotion and retrofit of toilet facilities at tourist sites. The water audit and installation will take place following an agreed appointment with a United Utilities representative.
Promotion of water saving devices	WE08	Subsidised water efficiency products sold via website This option consists of our customers receiving a water saving voucher to spend on a water butt via United Utilities website.
	WE09	Showerhead giveaways This option consists of customers receiving water saving showerheads and advice at publicity events.
	WE11	Waterless car washing giveaways This option consists of customers receiving sample bottles of a waterless car washing product, plus a money off voucher to purchase more with relevant advice at publicity events.
	WE12	Free water butt distribution This option consists of customers receiving water butts direct to their properties, after placing an order from United Utilities.
	WE13	Free showerhead distribution This option consists of customers receiving water efficient showerheads direct to their properties, after placing an order from United Utilities.
	WE14	Subsidised water efficiency products sold via website This option consists of our customers receiving a water saving voucher to spend on water efficient showerheads via United Utilities website.
	WE15	Enhanced water saving pack distribution through additional promotion of current offering This option consists of customers receiving promotional material and choosing the items and ordering an enhanced water savers pack from the UU website, call centre or return post.
Water recycling	WE01	Domestic rainwater harvesting This option involves installing rainwater harvesting systems in existing domestic properties.
Metering on customer contact	MET01	In order to increase meter penetration, unmeasured customers when contacting United Utilities for any reason will be offered a free meter option.
Enhance Promotion	MET02	The UKWIR model used in the demand forecasting identifies the number of customers who would benefit financially from having a free meter option. This option will be to actively promote the option to those customers, rather than waiting for a customer to contact UUW.

Generic Option	Scheme ID	Option Name / Details
Enhanced home water efficiency visits	MET03	This is an additional service we will provide as part of the option for "Water use audit and inspection (and identification of household and non-household water efficiency opportunities)"; at the visits free meter options will be offered and promoted to customers.
Blanket promotion	MET04	Although the UKWIR opting model generates the number of customers who would benefit financially from the meter, UUW in this option would promote meters to all customers in a blanket promotion, this would entail a large communications campaign across the region.
Metering on change of occupier	MET05	Upon a customer contacting UUW to inform us of a change of tenancy, UUW would install a meter.
Distribution Management Options		
Leak detection	CAR-LEA01 CAR-LEA02 CAR-LEA03 CAR-LEA04 CAR-LEA05	Leak detection and repair stage 1 from SELL assessment Leak detection and repair stage 2 from SELL assessment Leak detection and repair stage 3 from SELL assessment Leak detection and repair stage 4 from SELL assessment Leak detection and repair stage 5 from SELL assessment These five options have been identified through the economic level of leakage assessment. Each stage must be completed in sequence. The options comprise employment of additional trained leak detection personnel, purchase of additional leak detection equipment, and repair of the extra leaks that are detected. Leaks at each stage of detection and repair become harder and more expensive to find and fix because it means looking for smaller leaks and expecting to fix them quicker.
Pressure reduction programmes	CAR-LEA07 CAR-LEA08	Pressure management stage 1 Pressure management stage 2 These options comprise pressure management to further reduce leakage levels by the fitting of flow modulation to existing pressure management valves or in some cases, new pressure management valves to control pressure within the mains system and thereby reduce leakage from mains, communication pipes and customer supply pipes.
Advanced replacement of infrastructure for leakage reasons	CAR-LEA06	Infrastructure replacement stage 1 This option targets replacement of those mains where water savings due to reduced bursts and leakage are expected to be the highest. Each stage must be implemented in sequence. The options comprise the replacement of water mains and communication pipes in district areas which show a consistently high level of leakage (particularly background leakage) and a high frequency of bursts.
Additional network metering	CAR-LEA09 CAR-LEA10 CAR-LEA12 CAR-LEA13 CAR-LEA14 CAR-LEA15	Increased verification of existing meters Increased number of continuously logged meters Widespread metering using AMR Splitting DMAs Splitting large upstream tiles Establishing water balance areas The main benefit of these six schemes is to provide better information so that maximum accuracy in flow measurement is gained. By providing more, and more accurate meter readings, a more exact calculation of leakage can be assessed for upstream and district areas. As the leakage calculation improves, areas can be correctly prioritised for detection surveys to locate and repair leaks. This results in leaks being identified more easily and

Generic Option	Scheme ID	Option Name / Details
		quickly, resulting in a reduction of their run-time.

Table E: Risks, uncertainties, flexibility and interdependencies of the generic option types considered

Generic Option Type	Risks and uncertainties	Flexibilities and interdependencies
Direct River abstraction	Further assessment is required on the proposed volumes available for abstraction New abstraction licences will be required for all sites if implemented Water quality may be variable and difficult to treat in certain systems, e.g. the Manchester Ship Canal	It may be possible to increase the proposed scheme capacities. However, this can only be determined once further assessment has been completed. No interdependencies identified between the options. Synergies in scopes for the Manchester Ship Canal options have been described in the scope definition.
New Reservoir Storage/Reservoir Raising	Extensive stakeholder discussions will be required Modifications to existing abstraction licences may not be required Ecological effects uncertain and would need to be understood	It may be possible to increase the proposed scheme capacities. However, this can only be determined once further assessment has been completed. No interdependencies identified.
Groundwater Wells	Low environmental risk of groundwater abstraction in the majority of options For those options which already have abstraction licences, the operation would be within terms of existing licensed volumes	Abstraction above and beyond existing abstraction licences may be possible once detailed appraisal completed. No interdependencies generally identified. Some option schemes have overlap and there would be rationalisation if the option was implemented
Reclaimed Water	The use of final wastewater treatment works effluent for water supply would require extensive public and stakeholder discussions Public acceptability with the solution may be difficult to obtain	Abstraction above and beyond option scope may be possible once a detailed appraisal has been completed. No interdependencies identified.
Desalination	The exact locations for desalination plants would require extensive stakeholder discussions. It may be difficult to locate a suitable site in an urban location New abstraction licences and discharge permits would be required.	Desalination plants can be sized to treat a wide range of volumes. There is flexibility in the option scopes to increase abstraction if required. No interdependencies identified
Water transfers	Water transfers to or from the United Utilities supply region have been presented. There is a risk that some of the options described may be difficult to implement or construct due to large geographical distances and	Pipeline transfer routes have only been estimated to form the basis of this option category within our plan. These routes are flexible and can adapt to ensure that they minimise both disruption to members of the public and risk to the environment. However, such routes can only be established once detailed site surveys are completed.

	environmental factors, for example the potential effects on certain habitats There is uncertainty in some of the volumes of water that are proposed for transfer and these will have to be verified between the water companies and the Environment Agency if implemented.	Interdependencies have been identified where transfer pipelines can provide water to more than one resource zone and these have been examined as part of the option descriptions and scopes.
Sophisticated/conjunctive management	In some cases, uncertainties in the exact volumes of water that this option type can provide do exist and have been described in the scope. Analysis of historical data and statistics has been applied	It may be possible to increase the proposed scheme capacities. However, this can only be determined once further assessment is completed. No interdependencies identified between the options.
Water use audit and inspection	Uncertainty around realised water savings. Take up of retrofits is likely to be influenced by customer metering levels. Uncertainty of resource (UU or partners) to deliver the audits and inspections.	Water savings could be increased with additional resource. No interdependencies identified.
Promotion of water saving devices	Uncertainty around realised water savings. Take up of devices is likely to be influenced by customer metering levels and existing appliance ownership.	Water savings could be increased with additional resource. No interdependencies identified.
Water recycling	Increased public health risk due to system failure, and/or future cross connection with potable supplies. Uncertainty over public willingness to volunteer to have a rainwater harvesting system retrofitted to their property. Uncertainty around realised water savings, principally due to system down times during drought periods. Risk that many volunteers will lack space on their property to install a rainwater harvesting tank.	Water savings could be increased with additional resource. No interdependencies identified.
Metering on customer contact	The number of customer contacts can vary throughout the year. An estimate of customer contact has been used to assess the number of customer contacts which can provide the opportunity to promote a free water	This option is dependent on the number of inbound customer contacts. No interdependencies identified.

	meter.	
Enhanced promotion	This is dependent on the number of customers who are receptive to the promotion of the meters. The costs associated with the enhanced promotion can vary and have been based on recent comparable campaigns.	This option will be in response to the number of customers who take up the option. No interdependencies identified.
Enhanced home water efficiency visits	This includes assumption on the take up rate of the free meter option during the visits	This is dependent on Domestic Visit and Fix and is dependent on the number of visits being carried out. This option is flexible with the number of visits carried out.
Blanket promotion	This is dependent on the number of customers who are receptive to the promotion of the meters. The costs associated with the enhanced promotion can vary and are based on recent comparable campaigns.	This option will be in response to the number of customers who take up the option. No interdependencies identified.
Metering on change of occupier	This has been calculated on historic change of occupier rate that may vary depending on the economic climate.	This is dependent on the number of customers who call in to inform of change of occupancy. No interdependencies identified.
Leak detection	The predicted leakage savings may not be realised. Suitably qualified and leakage detection and repair personnel may not be available when required. Other utilities and buried services are at risk during repair activity.	Further leakage reductions may be possible with increased detection and repair resources at increased cost. No interdependencies identified.
Pressure reduction programmes	Although the predicted leakage savings are based on the results of UU's own models, there is still a risk that the predicted leakage savings will not be achieved. There is a risk that some customers may suffer poor pressure as a result of this scheme. The model assumes that customer supply pipes are in good condition. However, UU experience is that this is not always the case and further enabling works are then required to deliver a successful scheme. Refurbishment is reliant on good quality workmanship, in particular the jointing of	Further leakage reductions may be possible with increased pressure reduction schemes at increased cost. No interdependencies identified.

	polyethylene pipes. There may be a shortage of well-trained pipe layers if other utilities undertake similar programmes of pressure management and mains refurbishment. Other utilities and buried services are at risk during construction activity.	
Advanced replacement of infrastructure	Although the predicted leakage savings are based on the results of national best practice, there is uncertainty over actual savings based on UU's own experience. Refurbishment is reliant on good quality workmanship, in particular the jointing of polyethylene pipes. There may be a shortage of well-trained pipe layers if other utilities undertake similar programmes of mains refurbishment. Other utilities and buried services are at risk during construction activity.	Further leakage reductions may be possible with increased lengths of infrastructure replacement at increased cost. No interdependencies identified.
Additional network metering	The predicted leakage savings may not be realised. There is a risk that there will be insufficient suitably qualified analysts available to undertake the work of the desk-based schemes on a regular basis. There is uncertainty as to the logistical practicalities of meter and logger installation, including compelling unwilling customers and gaining access to their property. There is a risk of negative media and customer reaction to widespread metering	Further leakage reductions may be possible with increased metering and verification at increased cost. No interdependencies identified.

APPENDIX 11. RAW WATER AND PROCESS LOSSES

In order to calculate raw water and process losses for this plan, we improved the method used for the 2009 plan and used the latest available data. The resulting values for the raw water and process losses are comparable with the previous plan.

To calculate the water available for use (WAFU), the raw water and process/operation losses are subtracted from the deployable output. This represents the water that is lost between the initial source and demand from customers. When considering areas of medium or high complexity, the Aquator water resources simulation software (by Oxford Scientific Software) is used, in this instance for assessing deployable output for Carlisle, West Cumbria and Integrated Zones. When using the Aquator models, losses are included on demands in order to represent the 'actual' demand on a source during a dry year.

The process losses have been derived using outputs from questionnaires completed by United Utilities operational staff for each water treatment works (WTW). An average loss factor for each resource zone was derived based on treatment works production. This loss factor was then applied to the dry year uplifted production for each resource zone.

Raw water losses are determined by using standard leakage bursts and background estimates (BABE) methods. To enable calculation of the raw water losses using this method, estimates of raw water asset pressures and average age, obtained from United Utilities PIONEER common framework tool, were used. To determine the raw water mains feeding into each WTW, United Utilities corporate GIS records were used.

The key changes from the 2009 plan have been agreed by the Environment Agency and are summarised below in Table A.

Table A Raw Water and Process Losses: 2009 plan and current methodologies

	2009 final Water Resources Management Plan	This plan (Improved Method)
Process Losses	Questionnaire to operational staff for **top-17 WTW in Integrated Zone** only (full coverage for West Cumbria/Carlisle). **Scaled up to full system using historic average demand** for all other works using **factor** of loss.	Questionnaire to operational staff (Technical Officers) for **all WTW.** Factor of loss derived from base year productions **then adjusted to reflect dry year demand equivalent.** It is more appropriate to plan for forecast dry year demand rather than historic actual.
Raw Water Losses	Using a **factor derived** for treated water trunk main losses per km of pipe, and then **applying this factor to the length of raw water mains and catchwaters**	Derived using BABE analysis, using **raw water mains/catchwater lengths** and estimates of raw water asset **pressures and average age** from Pioneer common framework tool.

The impact of the new analysis is more a change in the proportion of losses between process and raw water. Therefore, looking at process or raw water losses in solitude will show a much greater effect then looking at the overall totals. For example, the overall total for the Integrated Resource Zone has increased by only 13% from 57.2 Ml/d to 64.6 Ml/d. Most of this increase is driven by the change to using dry year uplifted production. In the West Cumbria Resource Zone, the process and raw water losses were 2.56 Ml/d in Regulatory Reporting 2012, but in Regulatory Reporting 2013, the figure is 0.98 Ml/d. These figures are based on actual meter balances. The increase from 0.98 Ml/d to 1.26 Ml/d is explained by the use of dry year uplifted

production and by the increase in process losses at Ennerdale WTW due to the implementation of the South Egremont groundwater scheme.

The resulting losses by resource zone are shown in Table B and the overall change from the 2009 plan is shown in Table C. An uncertainty range on the values has been included in the headroom analysis.

Table B Summary of process and raw water Losses

Resource Zone	Raw Water Losses (Ml/d)	Process Losses (Ml/d)	Total Process and Raw Water Losses (Ml/d)
Integrated	13.74	50.80	64.55
Carlisle	0.20	0.06	0.26
North Eden	0.02	0.01	0.03
West Cumbria	0.60	0.66	1.26
Total	14.56	51.54	66.09

Table C Change in process and raw water losses

Resource Zone	Total Process and Raw Water Losses (Ml/d)		Change (Ml/d)
	2009 plan	This plan	
Integrated	57.21	64.55	7.34
Carlisle	0.49	0.26	-0.23
North Eden	0.13	0.03	-0.1
West Cumbria	2.06	1.26	-0.8
Total	59.89	66.09	6.2

APPENDIX 12. WEIGHTED AVERAGE AND DRY YEAR DEMANDS

In order to calculate a dry year and weighted annual average year demand, analysis is required into the relationship between “dry” and “wet” weather and the resulting demand for water. Weighted average demand is a more accurate way to estimate the expected level of demand averaged over a long period of different weather patterns in comparison to only using normal years. This is because over the planning period, there will be wet, dry and normal years and weighted average incorporates this. To understand and incorporate weather into our forecast of dry and weighted annual average year demand, we commissioned the Met Office to undertake some analysis.

They used an existing model (previously used with other water companies) and calibrated it using weather data and demand data from United Utilities region. Weather data included air temperature, rainfall and sunshine, from 1961 to present. Approximately 10 years of weekly and 3 years of daily leakage and demand data, were used in model calibration together with non-weather related data specific to the region, such as population changes and property numbers. Analysis and processing of the data showed sufficient weather signals to proceed with modelling, but only at a level aggregated to regional total consumption.

The demand profile for the whole region was calculated and a detailed breakdown of usage, demand and leakage for the region was prepared as part of the work. The model was broken into three main components;

- A weather dependent model of summer usage
- A weather dependent model of winter leakage
- A “base” demand component.

The weather dependent models of usage and leakage generate a range of different values for each year dependent on the weather conditions experienced in that particular year. Annual averages were calculated from these range of values and ranked to produce Cumulative Distribution Functions for the aspects of demand whose weather dependent component has been modelled. The weather dependent component of both usage and leakage was estimated and the combined resultant demand figures were calculated.

Using the Cumulative Distribution Functions, the dry and average total demand were calculated in the following way:

- The “dry year” demand is the most extreme of years in the historical record (1995/96).
- The “average year” (which the guidelines refer to as the “weighted average”) is the arithmetic mean of all the years in the distribution.

We retained our definition of the dry year as the weather conditions experienced in 1995/96. This is the year for which the model predicts the highest demand in the observed weather record from 1961. We assume that the base year 2012/13 represents a normal year and have calculated our dry year uplift in relation to the 2012/13 year.

In addition to the household data that were analysed, 10 years of weekly non-household District Metering Area measurements were also analysed. This analysis showed that no weather signal was detected in these data and therefore it is concluded that the majority of non-household use across our region is weather independent.

As non-household use across our region is currently assessed to be weather independent, only uplifts for household consumption were generated for both dry and average conditions as follows:

- Use the actual annual average household consumption from 2012/13 (859 Ml/d)
- Deduct the weather dependent component for 2012/13 (100.7 Ml/d) and add either:
    - The “dry year” weather dependent usage (181.7 Ml/d) to get 940.4 Ml/d (an uplift of 9.42% on household consumption)
    - The average weather dependent usage (117.2 Ml/d) to get 875.9 Ml/d (an uplift of 1.93% on household consumption)

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About us

United Utilities is the North West's water company. We keep the taps flowing and toilets flushing for seven million customers every day. From Crewe to Carlisle, we work hard behind the scenes to help your life flow smoothly.

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