DRAFT WATER RESOURCES MANAGEMENT PLAN 2024

MAIN REPORT - DRAFT FOR CONSULTATION

November 2022

DOCUMENT CONTROL SHEET

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Reviewer	Keith Haslett Andrew Beaver	30/09/22	Water Director Regulation & Assurance Director
Approver	Heidi Mottram Mike Porter	30/09/22	On behalf of Northumbrian Water Board

Northumbrian Water is a trading division of Northumbrian Water Limited which is a group company of Northumbrian Water Group Limited

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BOARD ASSURANCE STATEMENT

Having reviewed the draft final WRMPs, the Northumbrian Water Limited Board made the following statement:

- The Board is satisfied the plan represents the most cost effective and sustainable long-term solution;
- The Board believes it has sufficiently collaborated with customers, partners and regulators to develop a strong understanding of future needs, explore every option, and build consensus on delivery plans;
- The Board confirms the integrity of the risk assessment process put in place for all of our water supplies;
- The Board confirms our plan reflects Water Resources North's regional plan which has been developed in accordance with the national framework and relevant guidance and policy; and
- The Board is satisfied that the WRMPs take account of all statutory drinking water quality obligations, and plans to meet all drinking water quality legislation in full including the Drinking Water Directive.

The Board confirms that Northumbrian Water complies with its duties on drinking water quality matters in its broader resilience and resource planning arrangements.

Date: 30 September 2022

Signed for and on Behalf of the Board:

Heidi Mottram
Chief Executive Officer

Mike Porter
Chief Financial Officer

EXCLUSIONS ON THE GROUNDS OF NATIONAL SECURITY

Northumbrian Water Limited has not excluded any information from this plan on the grounds that the information would be contrary to the interests of national security.

Under Section 37B(10)(b) of the Water Industry Act 1991, as amended by the Water Act 2003 ("the Act"), the Secretary of State can direct the Company to exclude any information from the published Plan on the grounds that it appears to him that its publication would be contrary to the interests of national security.

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GLOSSARY

Term / Acronym	Definition
AMP7	Asset Management Period 7 (April 2020 – March 2025)
AMP8	Asset Management Period 8 (April 2025 – March 2030)
ANZP	Average Zonal Night Pressure
APR	Annual Performance Reporting
ASB	Abstraction Sensitivity Band (ASB)
BH	Borehole
BL	Baseline
CACI	Leading specialists in location planning- CACI Ltd
CBA	Cost benefit analysis
CC&B	Our customer billing database
CMOS	Central Market Operating System
CSMG	Common Standards Monitoring Guidance
DEFRA	Department of Environment, Food and Rural Affairs
DI	Distribution Input
DMA/DA	District metering areas / Drainage areas
DMO	Demand Management Option
DO	Deployable Output
DWI	Drinking Water Inspectorate. DWI has responsibilities under the Water Industry Act 1991 relating to the sufficiency and quality of water supplies.
dWRMP	Draft Water Resource Management Plan
DYAA	Dry Year Annual Average
DYCP	Dry Year Critical Period
EA	Environment Agency. The Environment Agency is a statutory consultee for WRMPs. It leads on producing guidance for water companies to use in compiling their WRMP. It has a statutory duty to secure the proper use of water resources in England. The Environment Agency works with water companies as they prepare WRMPs and provide a representation as part of water companies' WRMP consultation. At the statement of response stage, its role changes and it becomes a technical advisor to the Department for Environment, Food & Rural Affairs (Defra) and the Secretary of State.
EBSD	Economic balance of supply and demand
ED	Environmental Destination
EFI	Environmental Flow Indicator
EST	Energy Saving Trust
ESW	Essex & Suffolk Water
FL	Full licence
GVA	Gross Value Added
GW	Groundwater
HH	Household (Domestic use customers)
HMWB	Heavily modified waterbody
HOF	Hands off Flow
IROPI	Imperative Reasons of Overriding Public Interest

l/hd/d	Litres per head per day (litres per person per day)
l/min / l/hr / l/yr	Litre per minute / litre per hour / litre per year
l/p/d	Litres per property per day (litres per premise per day)
LA	Local Authority
LHN/OAHN	Local Housing Need / Output Area Housing Need
LPA/DPA	Local Planning Authority / District Planning Authority
Max Peak or MP	Maximum Peak abstraction is the maximum volume of water abstracted in any one year during the representative abstraction period. For the Norfolk, Suffolk & Essex EA area the representative period is taken to be calendar years 2005-2015 (Iain Page pers comm. March 2022). The definition of Max Peak (Operational) was updated in July 2022, so that the capped licence would receive conditions of: a six-year rolling annual average of 6 x the annual RA quantity to keep average use to the RA average over a 6-year period (Iain Page pers comm. July 2022). Licences capped to Max Peak (Original) allow some growth of abstraction towards the new Max Peak level.
MCA	Multi Criteria Analysis
MHCLG	Ministry for Housing, Communities and Local Government's
Ml/d	Megalitres per day
MLE	Maximum likelihood estimation
MOSL	Market Operator Service Ltd
MTP	Market Transformation Programme
MUR	Meter under- registration
NAV's	New Appointments and Variations
NE	Natural England
NHH	Non-Household (Business customers who primary use of water is non-domestic)
NPP	National Population projections
NSERV/SERV1/SERV2	Non service non-household industries / Service industry group 1 / Service industry group 2
NW	Northumbrian Water
NWG	Northumbrian Water Group
NWL	Northumbrian Water Limited
NYAA/ DYAA/ DYCP	Normal Year Annual Average / Dry Year Annual Average / Dry Year Critical Period
OBR	Office for Budget Responsibility
Ofwat	Ofwat is the economic regulator of the water industry. It is a statutory consultee for WRMPs, has been key stakeholder during the development of our plan and will provide a representation as part of our consultation. Our WRMP will primarily inform the supply demand balance part of our business plans which we will submit to Ofwat. Ofwat determines the extent to, and conditions under which, we can recover the costs of investment through our charges to customers.
p.a.	Per annum (per year)
PCC	Per capita consumption
PHC	Per household consumption
Planning Horizon	Refers to the forecasted years from 2024/25 until 2079/80.

PR19	Periodic Review 2019 – Business Plan 2020-2025
Price Review	Ofwat is the economic regulator of the water industry and every five years it sets the investment and service package that customers receive including the price water companies charge their customers. Ofwat carry out a review of these price limits known as a Price Review (PR) every five years. The current Price Review will be completed in 2024 and so is known as PR24 and will set customer bills for the period 2025 to 2030. As part of the Price review process, water companies submit a business plan which sets out the investment and outcomes for customers and the environment that they are required to deliver and how this would impact customer bills. The Business Plan will include the investment needed to deliver the WRMP24 Best Value Plan.
RAA	Recent Actual Average abstraction. Defined by the EA as the total volume of water abstracted during the representative recent actual period divided by the number of years in that period. Defined in 'Water resources planning guideline supplementary guidance – actions required to prevent deterioration' (April 2022). For the Norfolk, Suffolk & Essex EA area the representative period is taken to be calendar years 2010-2015 (Iain Page pers comm. March 2022). This definition was updated in July 2022, so that the capped licence would receive conditions of: A 6-year rolling annual average of 6 x the annual RA quantity to keep average use to the RA average over a 6-year period; An annual peak set as the max annual actual peak used within the RA period (2010-15) (Iain Page pers comm. July 2022)
RAPID	Regulators' Alliance for Progressing Infrastructure Development (RAPID) RAPID will help accelerate the development of new strategic water infrastructure and inform future regulatory frameworks. It is made up of the 3 water regulators in England: Ofwat, Environment Agency and DWI. It also works closely with Welsh Government and Natural Resources Wales. Find further information on RAPID's website. Some water companies received additional funding to investigate and develop strategic regional water resource options in the 2019 price review (PR19) final determination. These companies should account for progress made on these options through a gated process. RAPID will then make recommendations on the solutions and Ofwat will make decisions on funding. You must present the need for these schemes, their timings, and the justification for your decisions in your regional plan and WRMP.
RBMP	River Basin Management Plan
SAM	Small Area Monitor (unmeasured consumption monitor in NW)
SIC	Standard Industry Classification
SPL	Supply Pipe Leakage
SSSI	Site of Special Scientific Interest
SWU	Study of Water Use (individual unmeasured consumption monitor in ESW)
UKCP09	UK Climate Change projections 2009
UKWIR	UK Water Industry Research
Void households	Empty (unoccupied) households
WAM	Whole Area Metering
Water Industry National Environment Programme (WINEP)	A programme of actions (Investigations, options appraisal and implementation schemes) water companies are required to take to meet the environmental legislative requirements that apply to water companies in England.
WFD	Water Framework Directive
WFH	Working from home
WRc	Water Research Commission

WRE	Water Resources East
WReN	Water Resources North regional group
WRMP19	Water Resource Management Plan 2019
WRMP24	Water Resource Management Plan 2024
WRPG	Water Resources Planning Guideline
WRZ	Water Resource Zone

NON-TECHNICAL AND TECHNICAL SUMMARY DOCUMENTS

This document is a technical document written primarily for our regulators and technical stakeholders. We have prepared two separate documents including a:

- Executive Technical Summary; and
- Non-Technical Summary

Both summary documents can be found on our WRMP24 webpage - **www.nwg.co.uk/wrmp**.

NORTHUMBRIAN WATER – OUR STORY

Welcome

We are pleased to present our draft Water Resources Management Plan 2024 (dWRMP24), which sets out how we intend to maintain a secure supply of water for our customers and businesses while protecting and enhancing the environment.

The climate is changing and the latest projections indicate that while the winters may well be wetter, the summers will be drier and we can expect summer river flows to be lower. This is particularly concerning for water stressed regions in the South and East of England.

In the North East, we've always had an eye on the future, recognising that we are a long-term business and must make sure we provide resilient water supplies and look after the environment for our current customers, but that we must also do the same for future generations. We enjoy resilient water supplies in the North East thanks to our 25 upland impounding reservoirs, including Kielder Reservoir. Kielder is the largest man-made reservoir in Europe and due to the Tyne Tees Transfer scheme, which enables us to move water around the region, supports river flows and our water abstractions on the rivers Tyne, Wear and Tees.

We have updated our supply and demand forecasts for this dWRMP24 and confirm that we have sufficient water resources to meet forecast customer demand, even during the most extreme of droughts. This is good news for customers and our region, and provides great opportunities for businesses wanting to operate or expand in our region as well as for economic growth and jobs.

Nevertheless, we are not complacent. Fresh water is still a finite and precious resource which we mustn't take for granted. It is still going to be really important for us all to play our part in saving water. Reducing leakage from our networks and reducing customer demand (known as per capita consumption, or PCC) will mean that we:

- Abstract less water from the environment. This will leave more water in our rivers allowing them to function more naturally.
- Treat less water meaning we will use less energy and chemicals at our treatment works and use less energy pumping water around our network.

Reducing water use at home can save money for customers who are on a water meter. Being efficient with hot water use, for example with filling baths, can also help to save on gas or electricity bills, which has never been more important. Consequently, we are proposing in our dWRMP24 the following programme of demand management measures.

Reducing leakage and customer water use

Leakage levels from our network and from our customers' homes are at an average level for the water industry but still higher, for example, than our sister company Essex & Suffolk Water, which has one of the lowest leakage levels in the industry. Consequently, we recognise that there is a lot more to do and so our preferred plan, in line with Government expectations, is to reduce leakage by a further 50% by 2049/50. Innovation is key and we will use latest technology to make our network smart to help us identify leaks more quickly.

When customers pay by the volume of water they use, it is the fairest way of charging them for their water use and we have promoted the benefits of this widely. 40% of our customers now have a water meter and are charged by how much they use.

While we are not proposing to compulsory meter our customers, going forward, we will work with our customers to help them understand whether moving to a smart water meter, similar to the ones used for electricity and gas, is right for them. We also propose to replace customer's existing water meters with a smart meter. They have many benefits and will provide information to customers so that they can make more informed choices about how they use water. They will also help customers identify when they might have a leaking pipe or toilet and will help us support high water use customers become more water efficient.

We are proud of our award-winning water efficiency programmes. These have included our 'Water's Worth Saving' home visits to the highest users, The Ripple Effect educational resources for children, and our Leaky Loos programme repairing leaking toilets of customers for free. We plan to upscale this important work from 2025 to help our customers use less water.

Increasing supplies

The forecast demand savings from our demand management options means that we will have sufficient water supplies to meet forecast demand for water and so we are not proposing to develop any new water resource schemes.

Water transfers to other water companies

Thanks to Kielder Reservoir, we have more water than we need, even in the most extreme of droughts. Consequently, we've been working with our regulators, regional water resources planning groups and neighbouring water companies to identify whether some of our surplus water could be transferred by new pipelines to other water company areas where there is a shortage. We've worked closely with both United Utilities to investigate the viability of a transfer out of Kielder reservoir into United Utilities supply area and with Yorkshire Water to investigate a transfer from the River Tees (supported by our Cow Green and Kielder Reservoirs). The transfer to United Utilities is not included in United Utilities' preferred plan. However, a transfer is included in Yorkshire Water's plan from 2040 and so this is also included in our preferred plan.

Protecting and enhancing the environment

We want the best outcome for the environment and we know that if it is not protected, not only will important habitats and species be lost but the water quality in our rivers and reservoirs will deteriorate. This would mean we have to use more energy and chemicals to treat the water before we can distribute it to our customers.

We have always monitored the effects of our abstractions on the environment and taken timely action to make sure they remain sustainable. As our understanding of the environment improves, so does our understanding of how much water needs to be left in it. Recent investigations in our Berwick supply area have concluded that while the maximum amount of water we are currently abstracting each year is sustainable, the maximum amount we could take out of each abstraction point would not be. Consequently, we are now planning on the basis that the maximum licensed quantity stated in our abstraction licences (the permits that allow us to legally abstract water), will be reduced to sustainable levels. We also closely monitor the effects of water releases from our upland reservoirs and amend these when needed.

As part of our current Water Industry National Environment Programme (WINEP) (2020-25), we have also implemented measures to reduce the transfer of Invasive Non-native Species (INNS) both into and out of our rivers and reservoirs. We've continued with our programme to install eel screen on abstraction intakes and fish passes on weir structures. We are currently developing our part of the 2025-30 WINEP with regulators and stakeholders including the Rivers Trust. We continue to put forward partnership schemes, that if supported by our regulators, will deliver multiple benefits including improved water quality, biodiversity net gain and flood risk reduction.

Consultation

We're really keen to hear your thoughts on our dWRMP24. We're particularly keen to hear your views on our preferred plans for reducing leakage and for smart metering. Your responses will shape our revised dWRMP24 which we expect to submit to Defra in May 2023.

We look forward to hearing from you.

Heidi Mottram

Chief Executive Officer

CONSULTATION

This document is the Main Report of our Northumbrian Water draft Water Resources Management Plan 2024 (dWRMP24). An Executive Summary and a Non-technical Summary can be found on our WRMP24 webpage - **www.nwg.co.uk/wrmp**).

Our dWRMP24 sets out how we will maintain an efficient, sustainable and secure supply of water to our customers over the next 60 years from 2025 to 2085, with a focus on the next 25 years from 2025 to 2050.

Our dWRMP24 has been prepared for the purposes of consultation and will form the basis of the final Water Resources Management Plan, which is likely to be published in 2024.

We would like to hear your views on our dWRMP24 including those on:

- our projections of future water needs including those of our customers, businesses and the environment; and
- our preferred plan including:
    - our demand management options to reduce leakage by 50% by 2049/50; smart metering; and water efficiency programmes; and
    - in the long term, potential raw water transfers to other water companies.

The consultation period for this dWRMP24 consultation starts on Friday 18 November 2022 and closes on Friday 24 February 2023. During this time we will publish this dWRMP24 on our website(www.nwg.co.uk/wrmp).

The Statutory Consultees are the Secretary of State, Defra; Ofwat; Environment Agency; Consumer Council for Water; Natural England; Local Authorities within the company's supply area; National Park Authority; Historic England and Navigation Authorities.

Please email your comments (written representation) on this dWRMP24 to the Secretary of State for the Department for Environment Food and Rural Affairs (Defra) at water.resources@defra.gov.uk and to waterresources@nwl.co.uk including the words "Northumbrian Water draft Water Resources Management Plan 2024 Consultation" in the email subject header.

Alternatively, you can send your comments to:

Water Resources Management Plan Consultation
Department for Environment Food and Rural Affairs (Defra),
Water Resources,
Seacole 3rd Floor,
2 Marsham Street
London, SW1P 4DF

We will publish on our website a statement of response to any representations we receive. This will confirm how we have taken account of each response in our final Water Resources Management Plan 2024.

1. INTRODUCTION

1.1 PLANNING FOR A SECURE SUSTAINABLE SUPPLY OF WATER

Under sections 37A to 37D of the Water Industry Act 1991, we are required to prepare and maintain a Water Resources Management Plan (WRMP) every five years (reviewed annually) which sets out how we intend to achieve a secure, resilient and sustainable supply of water for our customers and a protected and enhanced environment, both now and in the long term.

This document is our draft WRMP and has been developed as part of the Price Review 2024 process (PR24) and so is known as WRMP24.

What is Price Review 2024?
Ofwat is the economic regulator of the water industry and every five years it sets the investment and service package that customers receive including the price water companies charge their customers. Ofwat carry out a review of these price limits known as a Price Review (PR) every five years. The current Price Review will be completed in 2024 and so is known as PR24 and will set customer bills for the period 2025 to 2030.

As part of the Price review process, water companies submit a business plan which sets out the investment and outcomes for customers and the environment that they are required to deliver and how this would impact customer bills. The Business Plan will include the investment needed to deliver the WRMP24 Best Value Plan.

It forecasts supply and demand from 2025 to 2100 to identify appropriate solutions to meet future pressures albeit with a focus on the statutory minimum 25-year planning period (2025 to 2050). The statutory minimum 25-year planning period aligns to the long-term planning period that Ofwat uses when appraising water company business plans into which WRMPs feed into.

Our current WRMP 2019 is the starting point for our new draft WRMP24. For example, our supply and demand forecasts take account of investment in new water supply schemes and customer demand reduction programmes up to 31 March 2025.

We are required to produce a final plan with no supply deficits in any of our water resource zones over the final planning period. Consequently, where we have forecast a supply deficit, we have considered a twin track approach including:

- supply-side options to increase the amount of water available to us; and
- demand-side options which reduce the amount of water our customers require.

To determine our preferred programme, we have identified and appraised a range of options and justified the selection of the options included in our preferred Best Value Plan.

Our preferred Best Value Plan also covers our Water Resource Zones (WRZ) where a supply surplus is forecast as in line with government expectations, we will still need to reduce leakage from our network (and support customers in reducing leaks from their water pipes and fittings) and support customers in reducing their water demand.

In producing our Best Value Plan, we have considered government policy as set out in the Water Resources Management Plan Direction 2022 and in a regulatory document called Government Expectations for Water Resources Planning (Defra, 2022) including the requirement to:

- provide a secure and clean water supply as expected by customers in a way that provides value for customers, society and the environment over the long term;

- improve supply resilience by planning to raise customer levels of service for a Level 4 drought plan restrictions (stand pipes and rota cuts) from 1 in 200 years to 1 in 500 years by 2040;
- reduce household Per Capita Consumption (PPC) to 110l/head/day by 2049/50 as well as working with retailers to implement actions to assist non-household users to sustainably reduce their water use;
- reduce leakage by 50% from 2017/18 levels by 2049/50 with water companies helping customers reduce water demand and water lost through leaks by adopting consistent approaches to support repair and replacement of supply pipes;
- install smart meters as a standard;
- consider compulsory metering in regions assessed by the Environment Agency (EA) to be a Serious Water Stressed Area.
- adapt to climate change;
- demonstrate a step change in rectifying overreliance on unsustainable water sources.

We have prepared baseline supply and demand forecasts which forecast what water resources we will have over the planning period as well as how customer demand will change without any additional water company interventions. The final plan adjusts our baseline forecasts to take account of the demand management and supply-side measures that are included in our preferred Best Value Plan to reduce customer demand and to increase water resources. There are uncertainties associated with preparing both baseline and final plan supply and demand forecasts and therefore with our Best Value Plan. For example, there are uncertainties around:

- how water company and government measures to reduce customer demand, known as per capita consumption (PCC), will reduce over time;
- how quickly the climate will change and as it does, how this will effect rainfall patterns and totals, river flows, reservoir refill and groundwater recharge;
- how resilient the environment will be to climate change and whether water company abstraction licences will need to be reduced further in the future to ensure enough water is left in the environment so that it is able to be resilient to future climate change.

Consequently, our Best Value Plan is an adaptive plan and includes:

- a central pathway and preferred programme representing the most likely future (based on the uncertainties); and
- alternative pathways and programmes should our forecasts (e.g. customer demand forecast) out-turn differently.

1.2 OUR PREVIOUS WATER RESOURCES MANAGEMENT PLAN

Our current WRMP19 was published in 2019 and forecast a final plan supply surplus across the full planning period. As such, no supply schemes were required. However, it does include demand management options including reducing leakage by 15% by 31 March 2025 as well an optant metering and water efficiency programmes to reduce per capita consumption to 118l/head/day by 2040. The Covid-19 pandemic and associated lockdown restrictions initially hindered the delivery of these programmes although we have worked hard to catchup and are forecasting to meet our 2025 targets.

Our baseline draft WRMP24 supply and demand forecasts for our Kielder WRZ result in a small supply deficit when planning to provide a 1 in 500-year level of resilience. This return period is the level of service for Level 4 restrictions on customer demand and specifically relate to the use of stand pipes and rota cuts. The supply deficits are caused by:

- **Climate change:** We have used the latest CP18 projections which have had a more significant impact on summer river flows, and therefore our Kielder water resource zone deployable output, than the previous CP09 projections did;
- **Non-household demand:** Our latest non-household demand forecast includes new demand;
- **New abstraction sustainability reductions:** These are applied where a Water Industry National Environment Programme (WINEP) environmental investigation has concluded that an abstraction is not sustainable (i.e. it could have an adverse impact on the environment). Our baseline WRMP24 supply and demand forecasts have taken account of the conclusions of our AMP7 Water Industry National Environment Programme (WINEP) abstraction sustainability investigations.
- **1 in 500 supply resilience:** We are required to plan for 1 in 500-year supply resilience from 2040; and
- **New methods:** We have used new statistical methods for forecasting supply and demand, specifically the use of stochastics for supply forecasts.

It's important to note that while there is a baseline supply deficit in the Kielder WRZ, there is still sufficient water in Kielder reservoir and a surplus could be restored by increasing pumping and pipeline transfer capacity. However, this will not be needed as the supply deficits are eliminated through our new preferred demand management options.

Our baseline draft WRMP24 supply and demand forecasts for our Berwick & Fowberry WRZ confirms a small supply surplus when planning to provide a 1 in 500-year level of resilience.

1.3 REGULATORY FRAMEWORK

The PR24 water resources planning process is significantly different to that in previous Price Reviews, with both national and regional tiers as illustrated in Figure 1 to consider.

1.3.1 NATIONAL FRAMEWORK

FIGURE 1: PR24 WATER RESOURCES PLANNING FRAMEWORK

The Environment Agency published the Water Resources National Framework (WRNF) in March 2020 following publication of reports from WaterUK in 2016 , and the National Infrastructure Commission in 2018 .

The WRNF sets out the long-term needs of all sectors in England that depend on a secure supply of water. This includes public water supplies to homes and businesses, direct abstraction for agriculture, electricity generation and the water needs of the environment.

The WRNF identifies that with climate change and growth in customer demand, if no action is taken between 2025 and 2050, around 3,435 million extra litres of water per day will be needed for public water supply to address future pressures.

Traditionally, water company WRMPs have focussed primarily on the supply needs of public water supply within their supply areas. However, given long-term water resources pressures, particularly in the South and East of the country, the WRNF confirmed the need for consideration of regional and inter-regional solutions to support national water resources resilience. Consequently, the WRNF set out the EA's expectations for the 5 regional water resources planning groups (Figure 2) with respect to solving regional supply deficits and increasing abstraction sustainability.

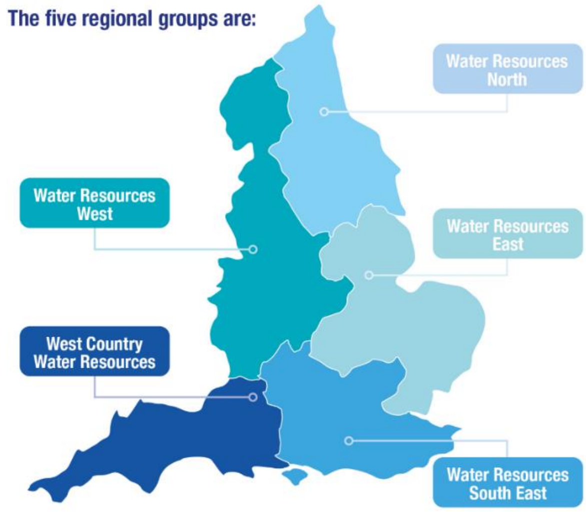


FIGURE 2: REGIONAL GROUPS

The WRNF defined expectations for regional water resources planning, and specifically defined a set of "must, should and could" requirements for the plans (see Figure 3)

MUST

- take account of the National Framework and set out its potential contribution to the national need
- be reflected in Water Resource Management Plans
- forecast supply and demand over at least 25 years and set out solutions to any deficits
- be a single strategic plan with a preferred adaptive solution
- take a multi-sector approach
- look beyond regional boundaries and use technical approaches compatible with other regions
- include enhanced environmental improvements and demand management
- take a catchment-based approach
- consider wider resilience benefits, including reducing flood risk, when developing options
- be open to market mechanisms
- take into account growth ambition
- comply with Strategic Environmental Assessment (SEA) and Habitats Regulations Assessment (HRA) legislation

SHOULD

- engage widely with interested groups
- set out how the region will respond to drought and agree common scenarios for drought actions
- join up with drainage and wastewater management plans
- seek to improve resilience to events other than drought, particularly floods
- look ahead 50 years or more

COULD

- contain all the detailed information required for Water Resource Management Plans
- contain all the detailed information required for Drought Plans

FIGURE 3 : WRNF REQUIREMENTS OF REGIONAL WATER RESOURCES GROUPS

A key requirement for each regional group is to set out how they will contribute to the national need. For example, some regions are under serious water stress and have difficulty sourcing sufficient supplies within their own region to meet demand for water. Consequently, those regions with a surplus of water may be able to support those regions with a supply deficit through new inter regional transfers of water.

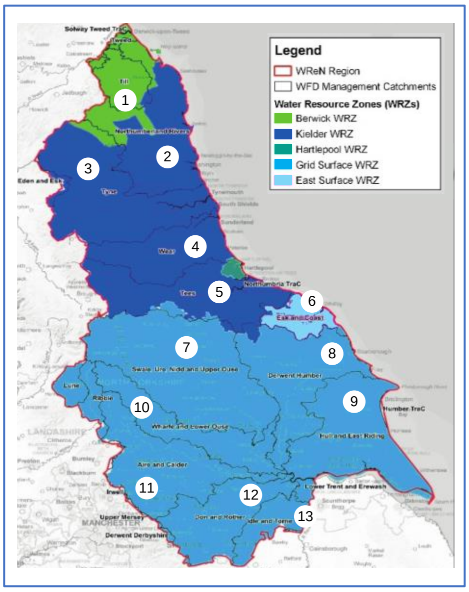
This requirement presents opportunities for collaboration between regions and other water sectors to develop sustainable solutions, especially in the early stages, in advance of preparing water company dWRMP24s.

The Environment Agency intends to update the WRNF in early 2023 following the current round of regional and water resources planning.

1.3.2 REGIONAL PLANNING

Overview

Our operating and supply area is covered by Water Resources North (WReN) (www.waterresourcesnorth.org/) which has used the WRNF expectations summarised above to help shape its approach to regional planning and its draft regional plan.



WReN's core water company members include Northumbrian Water, Yorkshire Water and Hartlepool Water as well as environmental, energy and agricultural sector representatives.

WReN, along with all other regional groups, has developed a regional plan, to be consulted on at the same time as the water company WRMP24s, which supports the Government's 25-year environment plan which has an objective to '…leave the environment in a better condition than we found it'. It has:

- undertaken a resource assessment informing the needs of the region including that from public water supply, other sectors (including energy and agriculture) and the environment; and
- Prepared a preferred Best Value Plan with an agreed level of environmental ambition that identifies the best value strategic options to meet multi-sector water demands

It has explored water resource resilience at a national, regional and water company level and has considered water transfers within and between different regions including Water Resources West (WRW) and Water Resources East (WRE). To ensure that regional groups have iteratively appraised solutions and to ensure their plans are aligned with each other as far as is feasible, national reconciliation workshops have been held through 2021 and 2022.

Importantly, WReN's regional plan informs the water companies' draft WRMP24s although has allowed them to refine smaller, local level solutions that are not strategically significant at a regional level. An overview of how WReN's plan has informed our dWRMP24 is presented below.

Baseline and Final Plan Supply Demand Balance

The corner stone of WReN's regional plan is its baseline supply demand balance which covers a planning period from 2025 to 2085. This compares the baseline supply and demand forecasts to determine when there is a supply deficit or a supply surplus at any point across the planning period. In all cases, the individual water companies have prepared their own baseline forecasts and then shared them with the WReN workstream lead who has amalgamated all forecasts to prepare an overall one for the WReN region. For consistency, the same baseline forecasts have been used for both the region and water company plans.

Leakage and Per Capita Consumption (PCC)

A national target has been set to for water companies to reduce leakage by 50% from 2017/18 levels by 2049/50 and to reduce PCC to 110/litres/head/day by 2049/50. WReN has adopted both targets and so our Northumbrian Water dWRMP24 planning is to meet these targets too. The WReN water companies have developed demand management strategies to meet these targets and have confirmed the demand reductions that will be achieved in each year of the planning period. These demand savings have then been applied to baseline demand forecasts.

Environmental Destination

The Government's 25 Year Environment Plan aims to improve the environment for the next generation with specific targets for sustainable abstraction. The WRNF builds on this, setting clear expectations for achieving and maintaining sustainable abstraction to 2050 and beyond. Some abstraction licences have annual licensed quantities which are already considered unsustainable and so will be reduced through the application of "sustainability reductions" either on renewal of time limited abstraction licences else by 2030. Other abstraction licence annual licensed quantities are considered unsustainable in the longer term (e.g. 2040 to 2050) and may need to have sustainability reductions applied then in order to leave more water in the environment to ensure it is resilient to the effects of climate change. The sustainable level of abstraction in the longer term is known as Environmental Destination (ED).

The Environment Agency provided regional groups with an initial assessment of long-term abstraction sustainability under a number of scenarios including:

- Business As Usual
- Business As Usual Plus
- Enhanced
- Adapt

For our Northumbrian water abstraction licences, in all cases, it has been assumed for both the WReN and NW plans that there will be no further long-term sustainability reductions required under any of the scenarios. For our Berwick WRZ, this is because all our groundwater abstractions have recently been investigated through our AMP6 and AMP7 WINEP with abstraction sustainability reductions being applied in 2030. For our Kielder WRZ, no further sustainability reductions are required either because we are not the cause of any adverse environmental effect or because we can mitigate any impact on the rivers Tyne, Wear and Tees through the use of the Tyne Tees Transfer.

Intra and Inter-regional Water Transfer Options

Yorkshire Water

Our Northumbrian Water Kielder Water Resource Zone (WRZ) has a supply surplus, due to the historical investment in Kielder reservoir and the Tyne Tees Transfer (TTT). Yorkshire Water's Grid WRZ has a forecast supply deficit and so both the WReN and our dWRMP24 have considered the following intra-region options to export:

- 15Ml/d of treated water from one of our River Tees Water Treatment Works to Yorkshire Water's strategic network; and
- 140Ml/d of raw water from the River Tees in our Kielder WRZ to York in Yorkshire Water's Grid WRZ.

Our Best Value Plan in Section 0 includes the 140Ml/d raw water export. The raw water would be abstracted from the River Tees from an existing intake albeit Yorkshire Water would need to install an additional pump. The Rivers Tees is a regulated river with flows maintained by releases from Cow Green reservoir. When Cow Green reservoir storage falls below an agreed level, Cow Green releases are reduced and River Tees flows are supported with additional transfers from Kielder reservoir via the TTT system. However, the capacity of a key TTT Pumping Station will need to be increased to deliver the full 140Ml/d export to Yorkshire Water in some drought years. This would involve installing an additional pump and may require a new incoming electricity supply although this cannot be confirmed until an application for the new connection has been made and granted.

Our modelling has confirmed that the full 140Ml/d of raw water is available with the TTT pumping station upgrade. However, this assumes that another raw water export from Kielder Reservoir to United Utilities described below does not proceed. This is currently the case with the option not featuring in either United Utilities or Water Resources West's Best Value Plans.

We have allowed for all known new household and non-household demand in our Kielder WRZ demand forecast including an additional 25Ml/d for future unknown industrial demand on Teesside. However, if new, currently unknown industrial demand exceeds 25Ml/d over the next 5 to 10 years, then this could reduce the size of the export to YW.

We will continue to work with Yorkshire Water who intend to undertake further detailed design, possibly as a Strategic Resource Options (SRO) via the RAPID gated process.

United Utilities

We have also considered inter-region options including the export of raw water directly from Kielder reservoir to Unities Utilities reservoirs in the north west of England. This option was investigated by Water Resources West and United Utilities both as an option to increase resilience in United Utilities own supply area as well as a national resilience scheme to facilitate the transfer of water down to serious water stressed regions such as that covered by WRSE. However, given the need to construct long large diameter pipelines across difficult terrain and the high pumping costs, the cost of the scheme was higher than other WRW options and so was not chosen for inclusion in its Best Value Plan. As such, the export is not included in either WReN's plan or our dWRMP24.

1.3.3 LOCAL PLANNING

In compiling this draft WRMP24, we have actively engaged with customers and stakeholders at a local / catchment level and specifically with a wide range of stakeholders through pre-consultation webinars held in January 2022.

We engaged with 44 individuals representing a wide range of organisations, including:

- Regulators – OFWAT, Environment Agency, SEPA, and Natural England.
- Councils – Northumberland, South Tyneside, Sheffield City, and Hull City.
- Environmental stakeholders – The Rivers Trust, Tyne Rivers Trust, Canal & River Trust, and East Yorkshire Rivers Trust.
- Landowner groups – Historic England, National Farmers Union (NFU), and Country Land and Business Association (CLA)
- Other Water Companies – Yorkshire Water, Anglian Water Services, Wessex Water, and Scottish Water.
- Wholesale Water retailer - Wave Utilities
- Infrastructure – Port of Blyth, and Uniper.
- Academia - Newcastle University, and University of Leeds.

A significant amount of engagement with regard to supply, demand and environmental ambition has been undertaken at a regional level through Water Resources North (WReN) and its Stakeholder Steering Group. Representatives include those from Energy UK, Canal & Rivers Trust, Natural Farmers Union, Catchment Groups, the Environment Agency, and Water Companies. The Stakeholder Steering Group meets bi-monthly and has an advisory role to:

- provide direction and input into the development of methodologies, options and scenarios;
- inform and contribute to the development of WReN's environmental destination; and
- facilitate spin off discussions where needed into specific sector or catchment issues.

At a water company level, we have agreed with the Environment Agency planning assumptions with regards to abstraction sustainability and the future need for further long-term abstraction sustainability reductions.

We have engaged with local planning authorities to:

- inform our household property and population forecasts and household demand forecasts; and
- understand future non-household growth to inform our non-household demand forecast.

We have engaged directly with non-household retailers, businesses and specifically with large users to inform our non-household demand forecast.

We are currently developing our AMP8 Water Industry National Environment Programme (WINEP) including new integrated catchment schemes that will support the delivery of outcomes both for the Government's 25 Year Environment Plan and also Local Nature Recovery Strategies. This process will conclude in March 2023 allowing us to update progress in this area in our revised draft WRMP24 which we expect to submit to Defra in May 2023.

1.4 CONSULTATION

We recognise the importance of pre-consultation in the development of our draft WRMP24. Stakeholder consultation has been undertaken at the regional level through WReN as well as by ourselves.

WReN of undertook deliberative research across 16 representative customer groups, each meeting twice over a period of a week. These groups comprised a mix of existing household customers, future customers and citizens, as well as a range of non-household customers. The non-household sessions were held with a mixture of water dependent businesses (e.g., farmers) and non-water dependent businesses. Whilst this type of approach typically engages a lower number of customers than quantitative survey approaches, it benefits from a much greater dialogue and opportunity for those involved to really understand the nuances of water resources management. This allows for more informed feedback on customer priorities for future plans, especially where topics are relatively complex or multi-faceted.

The key focus areas for the research were:

- Objectives and metrics for developing a Best Value Plan
- Environmental destination
- Water trading
- Opinions on option types

Additionally, we held draft WRMP24 pre-consultation stakeholder webinars in January 2022 to share our initial baseline supply demand balance position, the planning assumptions used in developing the forecasts and our ambition to reduce leakage and customer demand (Per Capita Consumption or PCC).

In addition to our regular liaison meetings with the Environment Agency, we have also held formal pre-consultation meetings with the Environment Agency and Ofwat in January and July respectively.

1.5 ASSURANCE

Our draft WRMP24 has been audited by Jacobs consultants to confirm that:

- We have met obligations in developing our plan;
- Our plan reflects Water Resources North's regional plan;
- We have developed a best value plan for managing and developing our water resources so we can continue to meet our obligations to supply water and protect the environment; and
- We have developed a plan that is based on sound and robust evidence including relating to costs.

Our Board Assurance Statement is presented on page 3 of this document and provides further detail on how the Board has engaged, overseen and scrutinised all stages of development of your plan and the evidence it has considered in giving its assurance statement. In summary, we have involved our Board in the development of our draft Water Resources Management Plan and have kept them appraised of our baseline supply and demand forecasts, assumptions regarding Environmental Destination, our baseline supply demand balance, the development of our preferred demand management options and how we have considered utilising our surplus resource for intra and inter-regional exports of water.

1.6 LINKS WITH OTHER PLANS

In preparing this draft WRMP24, we have considered a number of other plans as summarised in the tables below.

1.6.1 GOVERNMENT'S 25 YEAR ENVIRONMENT PLAN AS FOLLOWS

The Table below summarises how we have considered the Government's 25 Year Environment Plan.

REQUIREMENT	CONSIDERATION	SECTION IN THIS DRAFT WRMP24
Set out your destination for environmental sustainability and resilience	Our dWRMP24 supply forecasts are based on an agreed position for abstraction licence sustainability reductions under both WINEP and Environmental Destination.	3.3 and 3.4
Support Nature Recovery	Our Best Value Plan contains demand management options to meet ambitious targets for leakage reduction and customer demand (per capita consumption or PCC). These options will reduce the amount of water we need to abstract from the environment in order to meet customer demand. We are developing our PR24 Water Industry National Environment Programme which will bring environmental benefits supporting nature recovery. As well as including statutory schemes, it is likely to include non-statutory schemes under the 25 Year Environment Plan driver.	8.3.2
Use natural capital in decision making	We have used a multi-criteria assessment approach that uses natural capital in decision making	10.1

REQUIREMENT	CONSIDERATION	SECTION IN THIS DRAFT WRMP24
Use a catchment approach	We are taking a catchment approach to developing our Water Industry National Environment Programme. We have held catchment workshops in the first instance with the EA and Natural England and then with wider stakeholders. We are developing catchment schemes under the 25 Year Environment Plan Driver that if supported by our customers and regulators, will deliver multiple environmental benefits through collaborative working. We will continue to with our catchment-based drinking water catchment management work which is not business as usual as well as putting forward a new capital grant scheme to support land managers in improving water quality, flow and the wider environmental.	10.2
Deliver net gain for the environment	Over and above 10% Biodiversity Net Gain requirements, net gain for the environment is an important consideration in our best value planning process. Additionally, subject to customer support and regulatory approval, we expect WINEP schemes with a NERC driver and a 25 Year Environment Plan driver to deliver gain for the environment.	10.1

TABLE 1: CONSIDERATIONS OF GOVERNMENT'S 25 YEAR PLAN

1.6.2 WATER COMPANY BUSINESS PLANS

Business plans set out the investment plans for the next asset management period and are the mechanism to achieve the planned outcomes set in this draft WRMP24 as well as delivering wider water system resilience.

The Table below summarises how we have considered Ofwat's guidance 'PR24 and Beyond: Final Guidance on Long-term delivery strategies'.

REQUIREMENTS	CONSIDERATION IN THIS DWRMP24	SECTION IN THIS DRAFT WRMP24
Clear links between WRMPs and business plans	Our draft WRMP24 sets out our demand management strategies and action plan that we intend to deliver to achieve leakage and PCC targets. These schemes have been costed and will be transferred to our draft Business Plan along with a robust business case.	8.3
Use of long-term adaptive planning	We have considered adaptive planning although as a supply surplus is forecast in each of our water resource zones and this remained the case under each of the Ofwat Common reference Scenarios, an adaptive plan is not required.	8.6
Planning for common reference scenarios	We have undertaken sensitivity analysis using the Ofwat common reference scenarios. As summarised above, a supply surplus is maintained in all cases.	8.5
Linking new plans to delivery of previous ones	Our previous WRMP19 forecast a supply surplus in both our water resource zones across the full planning period and so our final plan included demand management options only. Our draft WRMP24 baseline demand forecasts assume we will have met our WRMP19 targets for leakage and PCC by 31 March 2025.	1.2
Using robust and consistent cost estimates	We have used a consistent process for costing our demand management options (no supply options required). The costs of the WRMP24 demand management options will be the same as those used for our Business Plan.	8.3.2

TABLE 2: CONSIDERATIONS OF OFWAT LONG-TERM STRATEGIES

1.6.3 DROUGHT PLANS

This draft WRMP24 is complemented by our Drought Plan (**www.nwg.co.uk/droughtplan**) which sets out the short-term operational steps we will take if our region faces a drought in the next five years. It describes how we would enhance available supplies, manage customer demand and minimise environmental impacts as the drought progresses.

We are forecasting to maintain a supply surplus in both water resources zones across the planning period with only demand management options. Consequently, we do not need to change the levels of service for Drought Plan drought actions.

Our Levels of Service are reconfirmed in see Section 2.5.

1.6.4 RIVER BASIN MANAGEMENT PLANS

The Environment Agency's River Basin Management Plans include environmental objectives (classifications) for each water body. Table 3 below summarises how this draft WRMP24 supports meeting river basin management plan objectives.

REQUIREMENT	CONSIDERATION IN THIS DWRMP24	SECTION IN THIS DRAFT WRMP24
Prevent deterioration and support achievement of protected area and water body status objectives	We have prepared this draft WRMP24 having confirmed through our WINEP investigations that: ▪ recent actual utilisation of our abstraction licence annual licensed quantities is sustainable; and ▪ that where abstraction is forecast to increase in the future, that it will not result in a deterioration of the environment (or in the RBMP water body classification)	3.3 and 3.4
Have a secure and sustainable set of options to supply your customers	We have taken account of all known abstraction licence sustainability reductions in our baseline supply forecasts. Our draft WRMP24 confirms that only demand management options are required to maintain a supply surplus.	8.3
Are contributing to sustainable catchments by ensuring supplies are managed well in a drought	Our Drought Plan (www.nwg.co.uk/droughtplan) has recently been approved by Defra. It sets out the demand management options that we will take to minimise demand. It also sets out the supply side options we will take in order to maintain target river flows (Minimum Maintained Flows) through river regulation, either directly using impounding reservoir releases and / or through the Tyne Tees Transfer.	1.6.3
Are demonstrating how you will help your customers to use water wisely	This draft WRMP24 sets out how we will support our customers to reduce their water use.	8.3
You should identify integrated catchment-based solutions in your plan. These should deliver multiple benefits, for example reducing flood risk and improving resilience of the environment to droughts.	We are working closely with our regulators and stakeholders to identify what needs to be included in our part of the WINEP for delivery in 2025 to 2030. Our latest thinking is included in this plan. We will confirm any further integrated catchment management solution in our revised draft WRMP24 which we expect to submit to Defra in May 2023 following agreement of our PR24 WINEP with the Environment Agency in March 2023.	10.2

TABLE 3: MEETING RIVER BASIN MANAGEMENT PLAN OBJECTIVES

1.6.5 DRAINAGE AND WASTEWATER MANAGEMENT PLANS

Our first draft drainage and wastewater management plan was submitted to Defra earlier in the year. We have ensured our long-term planning for water supply and wastewater is aligned by aligning our methodologies for growth and climate change assumptions.

1.6.6 DRINKING WATER SAFETY PLANS (OR RISK ASSESSMENTS)

Drinking Water Safety Plans and the risk assessments which inform them provide a means of identifying hazards and hazardous events that could arise in the catchment area, from the source up to the customer's tap. We have drinking water safety plans for all of our existing supplies of water from source to tap. However, as we are forecasting a supply surplus in both water resource zones across the planning period, no further supply schemes are required. Consequently, no additional drinking water safety plan risk assessment are required either.

1.6.7 LOCAL AUTHORITY PLANS

Local authority plans set out future development, such as housing. This draft WRMP24 reflects local growth ambitions and plans to meet the additional needs of new businesses and households (Section 4.3.2)

1.6.8 LOCAL NATURE RECOVERY STRATEGIES (ENGLAND)

The Environment Act 2021 introduced Local Nature Recovery Strategies for areas in England. Section 3.3 of this draft WRMP24 sets out how our PR24 WINEP will support recovery and enhancement of biodiversity.

2. DEVELOPING OUR PLAN

2.1 OVERVIEW

This section of our draft WRMP24 covers the process we have followed in preparing our draft WRMP24 preferred plan.

2.2 DEFINING OUR WATER RESOURCE ZONES (WRZ)

2.2.1 WATER RESOURCE ZONE INTEGRITY ASSESSMENT

A Water Resource Zone (WRZ) is the basic building block of a Water Resource Management Plan (WRMP). A WRZ is the largest area of a company's supply area where supply infrastructure and demand centres are generally integrated, to the extent that customers in the WRZ should experience the same risk of supply failure due to climatic conditions.

FIGURE 4: MAP OF NORTHUMBRIAN WATER WATER RESOURCE ZONES

In our WRMP19, we had three water resource zones including:

- Kielder Potable WRZ;
- Berwick & Fowberry Potable WRZ; and
- Kielder Industrial WRZ

The boundaries of our potable WRZs have not changed since our WRMP19 was published in 2019. However, as part of our Water Resources Zone Integrity Assessment, we have agreed with the Environment Agency's that the Industrial WRZ can be integrated into the existing Kielder WRZ. This is because we can demonstrate how the Industrial Supply Zone can be supported by Kielder reservoir and the Tyne–Tees Transfer system and is therefore subject to the same risk to supply as the rest of the Kielder WRZ.

2.2.2 KIELDER WRZ

There are three supply zones within the Kielder WRZ as follows:

- Northern Zone comprising of the North Tyne and Northumberland resources which supply the major urban conurbations of Tyneside;
- Central Zone comprising River Wear and Mid Durham resources which supply the major urban conurbations of Wearside;
- Southern Zone comprising of the River Tees and Teesdale Resources which supply the major urban conurbations of Teesside.

Additionally, there is the 'Industrial Zone' which abstracts water from the River Tees and supplies the non-potable demand on Teesside. An overview of our WRZ's is presented below

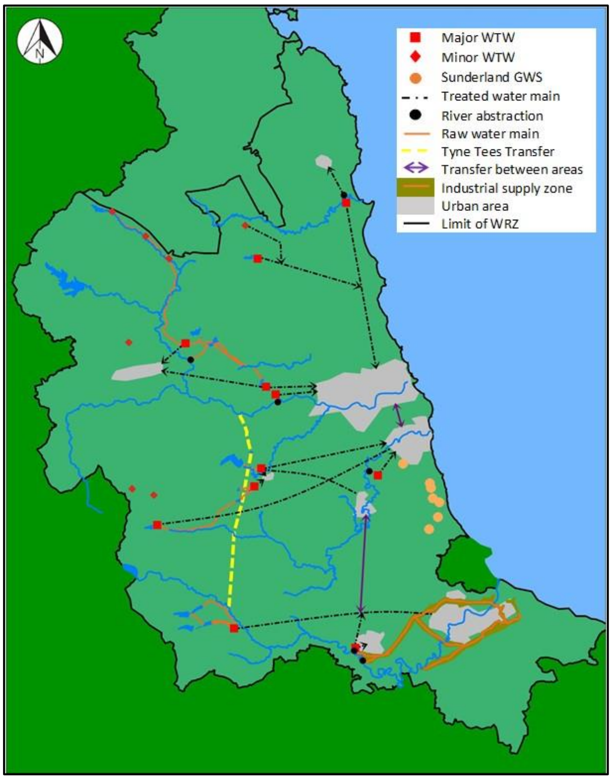


FIGURE 5: MAP OF THE KIELDER WRZ

These supply zones are operated in effectively a discrete manner in terms of treatment capacity, but they can all be supported from Kielder Reservoir. As such they all have the same theoretical risk of restrictions on use and are considered as a single water resource zone.

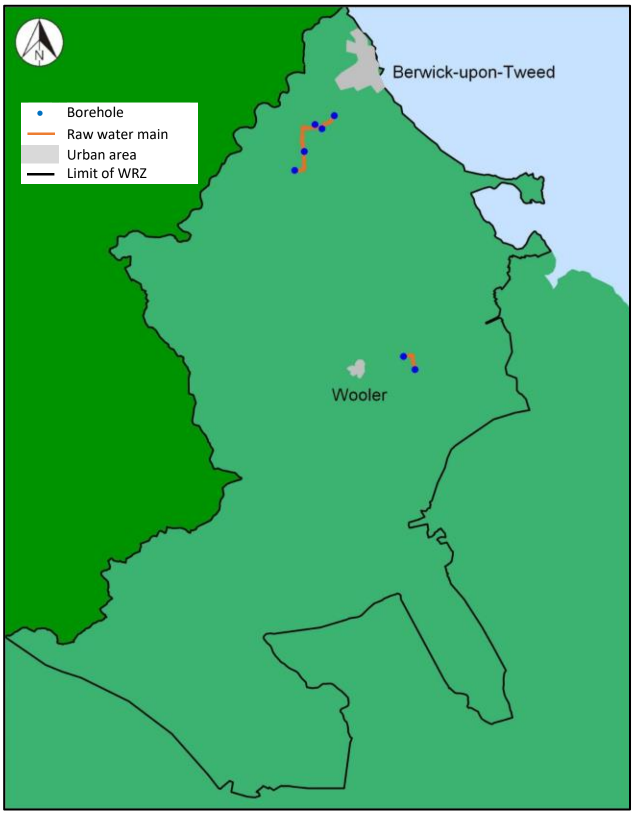


FIGURE 6: MAP OF BERWICK & FOWBERRY WRZ

2.2.3 BERWICK & FOWBERRY WRZ

The Berwick and Fowberry WRZ is located in the northeast of Northumberland encompassing the towns of Berwick-upon-Tweed and Wooler. It is a small rural zone with a resident population of about 25,000 people (just 1% of our customers) but is a popular tourist area. It is a discrete zone in terms of both water resources and treatment capacity and cannot be supported by Kielder reservoir or the Tyne Tees Transfer. The resources comprise a series of Fell Sandstone boreholes, five of which supply Murton WTW and two supply Fowberry WTW.

2.3 PROBLEM CHARACTERISATION

2.3.1 OVERVIEW

Problem Characterisation is the process used by water companies to assess the vulnerability of each of their WRZs to various strategic issues, uncertainties, and risks. We undertook a problem characterisation assessment and submitted our report to the Environment Agency in 2020. The assessment was completed following the method outlined in the 2016 UKWIR report entitled WRMP 2019 Methods – Risk Based Planning.

The first stage of the problem characterisation assessment was an assessment of 'strategic needs'. This entailed three simple 'headline' questions that explored the size of any potential supply demand deficit, and if required, the cost of any supply and demand management options. Both of our WRZs had a supply surplus in all years of the planning horizon under the PR19 Baseline scenario. At the time of the assessment, it was reasonable to assume that all WRZs would continue to have a supply surplus in this draft WRMP24 and so no investment would be sought to fund supply and / or demand management measures.

The second stage of the problem characterisation was an assessment of the 'complexity factors'. This stage asked whether there was concern regarding understanding of near-term supply system performance, either because of:

- recent LoS failures; or
- poor understanding of system reliability/resilience under different or more severe droughts than those contained in the historic record.

Given the forecast supply surplus in both of our WRZs, we continue to meet levels of service and so there were no significant concerns about understanding of near-term supply system performance.

A similar question was asked regarding demand and whether the nature of current or near-term demand had recently changed or was likely to change (e.g. because of large scale metering programmes or sudden changes in economics/demographics). At the time of the assessment, the nature of current and near-term demand had not recently changed. Industrial demand was generally falling and domestic demand was fairly constant.

The problem characterisation assessment concluded that both of our WRZs had a "low vulnerability" score. The results of this assessment were then carried forward to the risk composition stage detailed below.

2.3.2 RISK COMPOSITION

Risk composition requires water companies to select and justify one of the following three approaches in developing their WRMPs:

- Conventional;
- Resilience Tested; or
- Fully risk based.

The Water Resources Planning Guideline (WRPG) provides a summary description of the approaches and techniques for each approach for developing supply and demand forecasts and is re-produced in table 2.1 below.

RISK COMPOSITION	WHAT IS IT?	SPECIFICS OF WHAT IS INVOLVED (SUPPLY, DEMAND, INVESTMENT)
1 – The ‘Conventional’ Plan	Estimates of supply capability are based on the historic record, perturbed for climate change. Any testing of droughts outside of the historic record is done using a simple ‘top down’ method and is only done to examine supply / demand risk under more extreme conditions (i.e. sensitivity analysis only). Uses a simple representation of dry year/normal year demand.	*Supply* – conventional ‘Deployable Output’ (DO) or historically based time series. *Demand* – dry year/normal year estimates. *Investment* – inputs to the Decision Making Tool (DMT) are based on analysis of the historic record and the investment programme therefore represents the ‘best value’ response to maintaining Levels of Service and resilience against the historic record.
2 – The ‘Resilience Tested’ Plan	Companies use ‘Drought Events’ to test the Plan and look at the implications of alternative/more severe droughts on the ‘best value’ investment programme. These ‘Drought Events’ can be derived using a variety of top-down methods, but their ‘plausibility’ (approximate level of severity) is checked using *metrics* of rainfall, aridity or hydrology. More complex representation of demand *variability* can be tested.	*Supply* – conventional plus ‘event based’ DO or time series. *Demand* - conventional, or can use demand/weather models to create equivalent demands for generated events. *Investment* – Events are used to test the programme; either by comparing the resilience of similar NPV programmes, or to look at the cost implications of achieving LoS commitments and resilience to droughts outside of the historic record.
3 – The ‘Fully Risk Based’ Plan	Companies use modelling methods to evaluate a full range of drought risks to their supply system, supported by more sophisticated approaches to matching this with demand *variability*. This is used to generate a ‘best value’ WRMP at a level of resilience that is linked to Levels of Service and the Drought Plan.	*Supply* – companies use generated data sets to explore the yield response to drought severity and patterns. Inputs to system-simulation DMTs are based on probabilistic sampling of the drought response. *Demand* - demand variability to drought is incorporated, although methods/complexity can vary. *Investment* the Plan is developed to represent the ‘best value’ response to overall drought risk, according to our stated LoS and drought resilience.

TABLE 4: RISK COMPOSITION GUIDANCE

The WRPG states that the over-riding concept when choosing which approach to follow is that non-conventional methods (i.e. risk composition 2 and 3) for forecasting supply and demand should only be used where they are warranted and should be proportionate to the supply demand problem as defined in the problem characterisation stage. Methods beyond the ‘conventional’ baseline can be chosen, but only need to be followed where there are specific concerns with the supply/demand components that mean a risk-based approach is needed to better understand the supply/demand problem that they face.

Our early (2016) supply and demand forecasts indicated that both of our WRZs would have a supply surplus across the full planning period. As such, the problem characterisation assessment concluded that the WRZs had a low vulnerability to supply deficits.

However, in line with the WRPG, we have applied some Risk Composition 3 approaches in that each water resource zone has been tested against a theoretical drought event which could occur one year in every 500 years on average.

2.4 DROUGHT VULNERABILITY ASSESSMENT

We carried out a partial assessment which uses the principles of the UKWIR ‘Drought Vulnerability Framework’ (17/WR/02/12), for our 2022 Drought Plan.

The Drought Vulnerability Framework assessed the resilience of the Kielder System to droughts ending in October and to a range of durations (6, 12, 18, 24 and 36 months) and return periods (100, 200, 500 and 1000 years). The demand placed upon the system during the drought modelling was the PR19 deployable output of 836Ml/d.

The number of days of failure of the system were recorded for each drought, with failure occurring either when the demand could not be met, or when the emergency storage level of a reservoir was reached. Only the 1 in 500 and 1 in 1,000 droughts for the six-month duration had any failure days, as shown in the table below.

RAINFALL RETURN PERIOD	DURATION (MONTHS)				
	6	12	18	24	36
50	0	0	0	0	0
100	0	0	0	0	0
200	0	0	0	0	0
500	20	0	0	0	0
1000	114	0	0	0	0

TABLE 5: FAILURE DAYS FOR VARIOUS DROUGHT DURATIONS AND RETURN PERIODS

2.5 OUR LEVELS OF SERVICE / RESILIENCE

During long or very intense droughts we may need to place some restrictions on customer water use to ensure we are always able to maintain reliable supplies should the dry weather turn into an extreme drought. Without these levels of service, we would need to develop new or larger water supply schemes than otherwise would be the case.

Levels of service are expressed in terms of expectations about the frequency of restrictions on use during dry years and set out the standard of service that customers can expect to receive from their water company.

Levels of service are generally grouped into the following categories:

RESTRICTION LEVEL	RESTRICTION DESCRIPTION
Level 1: Appeal for restraint	Ask customers to use water wisely. For example, watering plants at night and not watering the lawn because grass is resilient to drought.
Level 2: Temporary Use Ban	Applies mainly to the domestic use of water and stops the use of a hosepipe or sprinkler for any garden watering or cleaning.
Level 3: Drought Order Ban	Bans what has been applicable to the domestic customer under the Temporary Use Ban, to non-domestic or commercial customers. These bans have economic consequences for businesses and must be used as sparingly as possible.
Level 4: Reduced supply at customer tap	A temporary reduction or nil supply of water at the customer tap. For example; ▪ Reduced pressure at the customer tap (and therefore reduced flow), ▪ Rota cuts (e.g., 12 hours normal supply, 12 hours no supply); or, ▪ Standpipes where supplies to customer's taps are turned off leaving customers to fill containers from an in-pavement standpipe tap.

TABLE 6: LEVELS OF SERVICE

It is important to note that, in line with government expectations to be resilient to a 1–500-year drought event, our DO is such that a level 4 event is classed as a failure and therefore a level 4 restriction would only be applied for droughts with a return period greater than 500 years.

We are forecasting to maintain a 1 in 500-year supply surplus in both water resource zones across the planning period. Consequently, as summarised in the table below, our Level 1 to 3 'planned' levels of service for our customers remain the same for this draft WRMP24.

Restriction	Frequency of restriction	Annual chance of rest
Level 1: Appeal for restraint	1 in 20 years	5% probability in any one year
Level 2: Temporary Use Ban	1 in 150 years	0.66% probability in any one year
Level 3: Non-Essential Use Ban	1 in 200 years	0.5% probability in any one year
Level 4: Pressure Reduction	1 in 500 years	0.2% probability in any one year

However, our Level 4 levels of service improve from 1 in 250 years on average to 1 in 500 years on average.

2.6 PLANNING ASSUMPTIONS

Our plan is based on:

- a baseline design scenario which is our estimate of supplies which are available in a drought-caused failure with a likelihood of once in 500 years or 0.2% in any one year.
- forecast dry year annual average demand, when demand for water is at its highest before temporary use bans are imposed.

We have also considered a ‘dry year critical period’ scenario to show how we will plan for a period of peak strain on our system (e.g. high seasonal demand such as during a heatwave).

Other baseline water resources planning assumptions are as follows:

- Assumes leakage remains static from 2025/26 throughout the whole planning period;
- Includes our forecast of customer consumption without any further water company intervention. We have assumed we end our water efficiency programmes and metering programmes after what we have been funded to deliver in AMP7;
- Includes existing transfers to the extent of the agreed bulk supply agreements;
- Includes abstraction licence sustainability reductions;
- Includes the benefits of capital maintenance
- Includes risks to groundwater and surface water sources due to declining water quality.
- Excludes contributions from any demand or supply drought measures;
- Includes benefits of schemes that will be delivered by 2025 including the abandonment of Thronton Bog 1 & 2 and construction of Felkington 2.
- Forecasts for non-potable water demand and supply have been included as additional lines in the water resources planning tables.
- Includes an assessment of the demand we would expect during a 1 in 500-year drought event.

Data has been reported at a water resource zone level using the water resources planning tables. Our preferred plan addresses deficits in our dry year annual average scenario.

2.7 TECHNICAL REPORTS

Technical reports have been prepared for the following areas when developing our plan and are available on request by emailing waterresources@nwl.co.uk

TECHNICAL REPORTS
Allowing for Uncertainty
Demand Forecasting
Groundwater Deployable Output and Climate Change
Leakage *
Metering *
Options Appraisal
Outage Allowance
Raw Water and Process Losses
Stakeholder and Customer Engagement
Supply Forecasting
Water Efficiency *

*Detailed costings for each of the demand management options can be found in each of the technical reports.

3. OUR BASELINE SUPPLY FORECAST

3.1 OVERVIEW

The baseline supply forecast confirms the amount of Water Available For Use (WAFU) in Ml/d in each Water Resource Zone (WRZ) across the planning period.

WAFU can then be plotted on a graph against forecast demand (see Section 4) to present a supply demand balance (see Section 6). Where demand is greater than supply in a given year, then a supply deficit is forecast. If demand management options to deliver government targets for leakage reduction and per capita consumption do not restore a supply surplus, then new supply schemes may be required.

The WRPG states that our baseline supply forecast should be based on the response of our raw water system, system response is preferable to rainfall or effective rainfall. This is due to the problems in presenting duration, rainfall patterns and start and finish months when evaluating the return period. Using a system response approach means that the supply forecast will adequately capture our system constraints, conjunctive use capability and operational response.

WAFU is the deployable output of each source (or group of sources) totalled for the WRZ less:

- future changes to deployable output from sustainability changes, including your long-term environmental destination, a changing climate and any other changes you expect
- existing transfers and schemes where planning permission is already in place
- an allowance for short term losses of supply and source vulnerability, known as outage
- any operational use of water or loss of water through the abstraction-treatment process
- a supply forecast that combines all the elements described into WAFU

Each of the above components of WAFU is described below.

For a detailed report on this section please refer to the Supply Forecast technical report.

3.2 DEPLOYABLE OUTPUT ASSESSMENT

3.2.1 OVERVIEW

Deployable Output (DO) is the building block in determining Water Available for Use (WAFU). DO is defined in the ‘Handbook of Source Yield Methodologies’ (UKWIR, 2014) as:

“The output for specified conditions and demands of a commissioned source, group of sources or water resource systems as constrained by:

- hydrological yield;
- licensed quantities;
- environment (represented through licence constraints);
- pumping plant and/or well/aquifer properties;
- raw water mains and/or aqueducts;
- transfer and/or output main;
- treatment;
- water quality;
- levels of service.

3.2.2 SURFACE WATER DEPLOYABLE OUTPUT ASSESSMENT

There is a significant step change in the definition of DO from that of WRMP19 to WRMP24. Previously, DO was based on the worst historic drought on record for the relevant WRZ. The updated guidance states that our baseline DO should be resilient in a drought with a 1 in 500-year return period (i.e. a 0.2% annual chance of failure caused by drought) which is more extreme than any historic drought we have experienced. Additionally, the supply forecast, and therefore the DO of a WRZ, should be based on a system response rather than a single drought event. A system response approach is preferable to historic rainfall events due to the problems of representing various drought durations, rainfall patterns and the start and finish months when evaluating the return period. This method ensures that our supply forecast sufficiently represents our system constraints, conjunctive use capability and operational drought actions.

Our methodology for calculating surface water DO is summarised below:

- Acquisition of a portfolio of stochastic datasets (400 timeseries of 48 years in length) of precipitation and potential evapotranspiration from a regional weather generator that are spatially coherent across the region;
- Stochastic datasets were then imported into our new rainfall-runoff models to produce river flow data which were then imported into our Aquator® water resource models;
- The Aquator model was then used to calculate a system response deployable output using the permitted failure method. This requires the water resources model to be run multiple times using a long hydrological record and incrementally increasing demand;
- The number of years with a failure, or event such as Level of Service implementation, are counted at each demand step and translated into a plot showing deployable output versus return period in years; and
- The 1 in 500-year deployable output is then derived as the DO with a return period of 0.2%.

The baseline and final plan deployable outputs obtained from the Aquator water resource modelling were summarised as follows:

Baseline DO (without Drought Plan Demand Savings)

The Baseline model runs calculated the 1 in 500 years DO (based on combined level of service 4 failures and demand failures) to be 637.52Ml/d for the three main demand centres (Tyneside, Sunderland and Teesside). When combined with the local demand centres, this gives an overall 1 in 500-year surface water DO of 756.85Ml/d.

Final Plan DO (with Drought Plan Demand Savings)

The Baseline model was run again but with the drought plan demand savings from Level 1 (Appeal for Restraint) and Level 2 (Temporary Use Ban or TUB) turned on. This increased the 1 in 500-year surface water DO by approximately 24Ml/d to 661.38Ml/d for the three main demand centres (Tyneside, Sunderland and Teesside) and to 780.79Ml/d when combined with the local demand centres.

3.2.3 GROUNDWATER DEPLOYABLE OUTPUT ASSESSMENT

As with our surface water DO, groundwater DO calculations are now also based on the modelled response of a source to a 1 in 500-year return period drought. The methodology is set out below:

- Acquisition of a portfolio of stochastic datasets (400 timeseries of 48 years in length) of precipitation and potential evapotranspiration that are spatially coherent across the region, from a regional weather generator.

- Statistical analysis of the 400 timeseries to identify five that contain a drought of 1 in 500-hundred-year return period severity.
- These five timeseries were then applied in recharge models to produce recharge data to be used in MODFLOW models.
- The results of the MODFLOW models provided us with relative values of additional drawdown that we'd expect to see in our wells under drought conditions. These values were added to the drawdown we already see under baseline conditions, to give an absolute value of maximum expected drawdown.
- The drought drawdown was evaluated against their depth constraints to see if we would have to reduce the abstraction from a well, in order to remain within those constraints.

For a detailed report on this section please refer to the Groundwater DO and Climate Change technical report.

Baseline DO

In the Kielder WRZ, the expected deployable output from all groundwater sources, after reductions arising from the drought analyses, is 45.22Ml/d. In the Berwick and Fowberry WRZ, the expected deployable output from all groundwater sources is 11.58Ml/d.

3.3 SUSTAINABILITY CHANGES / REDUCTIONS

Sustainable abstraction is essential to support healthy ecology and the natural resilience of our rivers, wetlands and aquifers. In preparing our draft WRMP24 supply forecast, we have considered whether:

- any of our abstraction licences are unsustainable at the full annual licensed quantity; and
- if not, whether we need to implement any sustainability reductions to reduce the annual licensed quantities to a sustainable level of abstraction.

This will prevent deterioration of a water body's condition and supports achievement of water body status and environmental objectives as set out in the Northumbria River Basin Management Plan.

We have considered whether:

- we will need to implement any sustainability reductions on our groundwater licences during AMP8, arising from AMP7 Water Industry National Environment Programme (WINEP) investigations and options appraisals;
- we have any un-used abstraction licences that pose a risk of deterioration under the Water Framework Directive and if we can surrender these; and
- any of our groundwater licences will need to be capped to Max Peak or Recent Actual Average on renewal or by March 2030 to reduce the risk of waterbody deterioration under the Water Framework Directive.

Further AMP7 WINEP investigations in our Berwick & Fowberry WRZ have confirmed a sustainable level of abstraction for each of our sources and these have been used in our baseline groundwater DO assessments.

As part of the development of our PR24 WINEP, the Environment Agency has notified us of two groundwater licences that it considers to be un-used (see Table 7).

We will include investigations in our PR24 WINEP to establish whether they are still needed or can be surrendered. As the two licences are not currently in use, they are not included within our baseline WRMP24 DO or supply demand balance.

LICENCE NAME	ASSOCIATED WATERBODY	REASON FOR INVESTIGATION
Routing Burn, Seal Burn, Black Burn	GB103022076690	These licences have at least 4 years of non-use according to the s201 returns. Where their use would impact a high priority WB EA would expect the licence to be revoked unless there is sufficient justification to retain it or an investigation to show that a return to abstraction would not cause any deterioration. We are aware that some are listed in Drought Plans therefore consideration should be given to Drought plan guidance Section 4.2 Re-commissioning unused sources. Please note returns data is based on the period 2016 - 2019 inclusive.
Halton Lee Gate	GB103023075530	

TABLE 7: NW UN-USED LICENCES

The Environment Agency has confirmed that where an abstraction licence sustainability change is necessary to prevent deterioration in England, groundwater licences will either be capped at a recent actual average utilisation or at the maximum peak abstraction, depending on the risk that deterioration will occur. This capping will occur on licence renewal, for affected time limited licences or licences with a time limited variation, and by 31 March 2030 for all affected permanent groundwater licences.

We have several groundwater abstraction licences with time limited variations which are due for renewal during AMP8. These are listed in the table below.

ABSTRACTION LOCATION	CURRENT DAILY LICENCE VOLUME	CURRENT ANNUAL LICENCE VOLUME	REVOCATION DATE	POST REVOCATION DAILY LICENCE VOLUME	POST REVOCATION ANNUAL LICENCE VOLUME
FOWBERRY	3.64 Ml	1160 Ml	01/04/2027	3.12 Ml	810 Ml
STONEHAUGH	41m3	15 Ml	01/04/2030	25m3	NA
ALLENHEADS	33m3	12 Ml	01/04/2030	23m3	8.4 Ml

TABLE 8: NORTHUMBRIAN WATER TIME LIMITED GROUNDWATER LICENCES

The Environment Agency has confirmed that none of these licences are considered to pose a risk of deterioration and so will not be subject to capping on renewal.
We therefore have not included any sustainability reductions within our NW WRMP24.

3.4 LONG TERM ENVIRONMENTAL DESTINATION

The Environment Agency's policy document 'Meeting our Future Water Needs: a National Framework for Water Resources' (2020) (the 'National Framework') identifies that, nationally, a step change is required in order to improve the water environment and address unsustainable abstractions from it, in order to improve resilience to drought, climate change and increase environmental protection, by 2049/50.

The National Framework sets out a range of environmental destination scenarios that Regional Water Resource Groups and their constituent water companies need to build into their draft WRMP24s to deliver the step change in resilience and environmental protection required.

We have worked with our regional water resources group, WReN, and the Environment Agency, to identify a longer-term environmental destination for our region, to deliver longer term sustainability and environmental resilience. The licence and abstraction reductions proposed under environmental destination are to achieve and maintain sustainable abstraction to 2050 (and beyond), taking into account climate change impacts and future demand.

We have used WReN's Business as Usual Plus (BAU+) Environment Destination (ED) scenario in calculating our DO in our WRMP24 preferred plan. This already includes the sustainability reductions arising from current WINEP and previous National Environment Programme (NEP) investigations, which are already included within our baseline WRMP24 supply forecast.

Under WReN's BAU+ scenario, and their alternative scenarios, there are no further abstraction or licence reductions applicable to our abstraction licences and so we have agreed with the Environment Agency that no environmental destination reductions in deployable output are needed within our WRMP24.

3.5 CLIMATE CHANGE

3.5.1 OVERVIEW

This chapter outlines how we have assessed the risk and possible impact of climate change on the deployable output of current sources of water. Our assessment has been undertaken following guidance set out in the Water Resource Planning Guidelines (WRPG) and takes account of the following:

- Method selection;
- Presentation of climate change assessment results (scenarios);
- Scaling method used to factor in any climate change that has already happened; and
- Allowance for climate change in the headroom assessment (see section 5).

The UKCP18 Regional Climate Model data has been selected as the most appropriate climate change data set as it supersedes the UKCP09 data used for WRMP19 climate change analysis.

However, the datasets are only available for Representative Concentration Pathway (RCP) 8.5, which is a "high" emissions scenario, with warming of around 4 degrees Celsius above the 1981-2000 baseline by the 2070s.

3.5.2 SURFACE WATER CLIMATE CHANGE ANALYSIS

Atkins Consultancy were appointed to develop 12 sets of monthly climate change factors for rainfall and PET based on the UKCP18 RCP8.5 data. Mott MacDonalds then perturbed the stochastic rainfall and PET data using these monthly climate change factors, the GR6j rainfall runoff models were then run with the perturbed climate change rainfall and PET input data, no other changes to the GR6j models were made.

Following completion of the GR6j modelling, Mott MacDonald consultancy provided hydrology data for the 12 RCM climate change scenarios, this included 12 sets of 31 stochastic timeseries of river flows for 19,200 years (plus rainfall and evaporation data for Kielder).

For the climate change analysis, a subset of data was required. For each RCM scenario, 100 scenarios of 48 years were selected to be used in the Aquator® XV modelling work. Hydro-logic consultancy carried out system response deployable output modelling for the 12 sets of RCM scenarios (100 timeseries of 48 years) along with post processing analysis to determine 12 plausible deployable outputs for the various climate change scenarios.

3.5.3 SURFACE WATER CLIMATE CHANGE RESULTS

The results of the modelling using the UKCP18 data showed that the expected impact of climate change was significantly greater than was shown by the UKCP09 data used for WRMP19. This is partly because the RCM data is based on a high emissions scenario (RCP8.5, 4 degrees temperature increase) rather

than a medium emission scenario. In order to assess the climate change impacts under a medium emissions scenario, in the absence of spatially coherent RCM data at medium emissions, we have scaled back the high emissions (RCP8.5) impacts to the medium emission (RCP6) impacts using a method developed by Atkins that uses a temperature-based scaling equation (Atkins - WRSE Climate Data Tools Scaling Report v0.4, 2021)
The outputs of the RCP8.5 modelling along with the results of scaling RCP8.5 to RCP6 are shown in table 2 below, the RCP6 scaled results have been used in our supply-demand balance.

CLIMATE CHANGE SCENARIO	RCP8.5 IMPACT ON DO, ML/D	RCP 6 IMPACT ON DO, ML/D
RCM01	-119.07	-58.34
RCM04	-43.28	-21.21
RCM05	-111.36	-54.57
RCM06	-111.37	-54.57
RCM07	-14.08	-6.90
RCM08	-90.13	-44.16
RCM09	-102.63	-50.29
RCM10	-109.2	-53.51
RCM11	-69.3	-33.96
RCM12	-126.58	-62.02
RCM13	-107.85	-52.85
RCM15	-52.35	-25.65
Min	-14.08	-6.90
Median	-105.24	-51.57
Max	-126.58	-62.02

TABLE 9: CHANGE TO DEPLOYABLE OUTPUT UNDER RCP8.5 AND RCP6.

The WRPG recommends using the following linear scaling equation, to scale the impact of climate from the 2070 modelled impact back through the planning horizon to the present day.

$$Time\ scale\ Factor = \frac{Year - 1990}{2070 - 1990}$$

However, as stated in the Atkins report (WRSE Climate Data Tools Scaling Report v0.4, 2021), rates of warming and temperature related impacts are typically non-linear. Consequently, Atkins proposed the following alternative scaling equation which is based on an assessment of the rates of warming in UKCP18 climate models:

$$Time\ Scale\ Factor = a\,(Year - 1990)^b$$

Where **a** is 0.0056 and **b** is 1.1835.

This has been shown to fit all RCPs well, with the exception of RCP2.6 as the rate of warming levels off at the end of the century. Both these equations assume that warming starts from 1990, therefore there will be some impacts of climate change between 1990 and 2024/25, where 2024/25 is the base year of the water resources plan.

Table 10 below shows the variation in DO due to climate change when scaled to the RCP6 and scaled over the planning horizon.

YEAR	IMPACT ON DO, ML/D
2025-26	-19.41
2030-31	-22.73
2035-36	-26.13
2040-41	-29.60
2045-46	-33.13
2050-51	-36.73
2055-56	-40.38
2060-61	-44.08
2065-66	-47.83
2070-71	-51.63
2075-76	-55.47
2080-81	-59.35

TABLE 10: CHANGE TO DEPLOYABLE OUTPUT SCALED TO RCP6 OVER THE PLANNING HORIZON

3.5.4 GROUNDWATER CLIMATE CHANGE ANALYSIS

Atkins Consultancy were appointed to develop 12 sets of monthly climate change factors for rainfall and PET based on the UKCP18 RCP8.5 data. These climate change factors were used to perturb the five stochastic and PET timeseries that were used for our deployable output assessments, as outlined in section 4.2.3. From these perturbed inputs new recharge data were generated which were then applied in our MODFLOW models. Finally, we applied these new drawdown conditions to our baseline DO curves to see if we could still abstract within our constraints under these stressed conditions.

3.5.5 GROUNDWATER CLIMATE CHANGE RESULTS

With further drawdown attributed to climate change, the deployable output of the Kielder WRZ Central Zone wellfield reduces from 41.13 to 34.60Ml/d. Most of this reduction is attributable to the loss of all output from Source Kielder 29, as the model shows complete dewatering of this source when climate change factors are applied to the drought runs.

Even with further drawdown attributed to climate change, the deployable output of the Berwick and Fowberry WRZ is not expected to change. At most sources, the additional drawdown is not great enough to alter the current most constraining factors. At Berwick Source 4 [Thornton Bog] the climate change assessments show a small decrease in DO, but as a system the Berwick well field will still be able to meet its 8.40Ml/d treatment capacity. In addition, Berwick Source 4 is due to be replaced by a new source by the end of 2024.

3.6 WATER TRANSFERS

3.6.1 CURRENT WATER TRANSFERS

We currently have only very small transfers of potable water between ourselves and United Utilities.

We have an agreement with United Utilities to export between 0.7Ml/d and 1.3Ml/d from our Wear Valley TW to their network. However, as we are supplying a discrete area, if demand is less than 0.7Ml/d then the export is the lower of the two values. The export has been averaging 0.65Ml/d although for planning purposes we have assumed the export is at the contractual rate of 1.3Ml/d.

We also have an import of potable water from United Utilities at Reaygarth through a 2.5inch meter which has a maximum capacity of 1.9Ml/d. However, the contractual maximum is 0.3Ml/d. Recent average imports have been ~0.01Ml/d, as with the export for planning purposes we have assumed the import is at the contractual rate of 0.3Ml/d.

Both the import and export are seen as secure in all circumstances and so no amendments to them are necessary under drought conditions.

3.6.2 POTENTIAL FUTURE WATER TRANSFERS

Kielder reservoir has a surplus of raw water after the requirements of Northumbrian water household and non-household customers has been met. Consequently, new raw water exports have been considered as part of developing regional plans.

These include:

- A raw water export directly from Kielder reservoir to United Utilities either to support resilience within United Utilities own supply area or to facilitate a transfer of water south into serious water stressed areas with a supply deficit.
- A raw water export from the River Tees to Yorkshire Water, supported by Kielder reservoir via the Tyne Tees Transfer system.

The 100Ml/d raw water export from Kielder reservoir to United Utilities is not included in either Water Resources West's or United Utilities Best Value Plans and so has not been included in Water Resources North's or our Best Value Plans. This is because there are many other supply options with a lower unit cost (i.e. £/Ml) and that provide better value for money.

The 140Ml/d raw water export to Yorkshire Water from the River Tees is included in both the WReN and Yorkshire Water Best Value Plans, albeit that it is not required until 2049, we have included it in our Best Value Plan. We have carried out initial stochastic modelling that showed that with a raw water transfer of 140Ml/d from the River Tees to Yorkshire Water the 1-500 DO for the Kielder WRZ dropped to a return period of 1 in 79 years. Obviously, this is unacceptable so the pumping capacity of Riding Mill was increased by 140Ml/d (to 410Ml/d), to make use of more Kielder reservoir water, this resulted in the 1-500 DO being restored to the final plan value of 837Ml/d.

It should be noted that when providing a 1 in 500 level of supply resilience to our customers, the surplus of water in Kielder reservoir means we can only provide a raw water export to one of the companies and so as things stand, this will be to Yorkshire Water only.

3.7 OUTAGE

3.7.1 OVERVIEW

Outage is defined in the UKWIR report Outage Allowances for Water Resource Planning (1995) as:

"A temporary loss of deployable output"
Outage events can be divided into planned outage and unplanned outage. The UKWIR report defines planned outage as:

"A foreseen and pre-planned outage resulting from a requirement to maintain source-works asset serviceability"

Unplanned outage is defined as:

"An outage caused by an unforeseen or unavoidable legitimate outage event affecting any part of the source-works and which occurs with sufficient regularity that the probability of occurrence and severity of effect may be predicted from previous events or perceived risk".

The recommended methodology described in the UKWIR report Outage Allowances for Water Resource Planning (1995) was used as the basis for calculating outage allowance for previous Water Resource Management Plan submissions. This guidance has not been superseded and so has been used again as the basis for assessing outage allowance for PR24. Although the UKWIR methodology provides a good basis for assessing the outage data, it leaves several areas open to interpretation. Therefore, several assumptions must be made, and the methodology adapted to the available data and the resulting modelling software output.

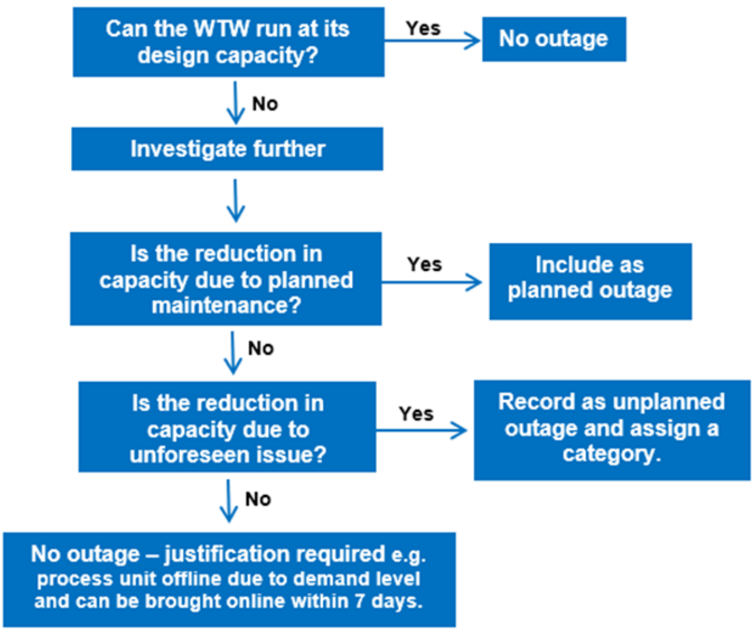
For a detailed report on this section please refer to the Outage Allowance technical report.

3.7.2 DATA COLLECTION AND CALCULATION

To assess the level of actual outage at each WTW the maximum daily treatment capacity and Distribution Input (DI) is collated from the Water Supply Team along with commentary on any constraints to WTW capacity when it is less than maximum design capacity.

Historic outages occurring in the years 2016/17 to 2020/21 have been analysed, considering the following.

- Inclusion of all historic unplanned outage for full and partial events.
- Exclusion of historic planned outage where the reason for the outage is not to be repeated in the planning horizon.
- Inclusion of future planned outage where the outage is known and inflexible, for example due to multi-year capital projects.
- Longer-term unplanned outage events, for example permanent and instant loss of source or progressive increase in pollution, to be included in target headroom calculations.
- Outages were then calculated following the process below.



For our WRMP19, the outage allowance was based on Monte Carlo simulations using a normal distribution to reflect the possible outages at each WTW. For WRMP24 this has been updated to a ‘histogram approach’ where actual outages for each WTW were used to create a discrete distribution, based on ten bins i.e. the entire range of values is divided into a series of 10 intervals, for each WTW that was then ran through a Monte Carlo simulation.

The results that come direct from the Monte Carlo model are outage values against the combined WTW design capacity for the entire WRZ. As the Kielder WRZ combined design treatment capacity is significantly greater than the 1 in 500-year DO, the following calculation is made to calculate the actual outage allowance to be used in the calculation of WAFU across the planning horizon.

Actual outage allowance = WRZ 1 in 500-year DO – (WRZ treatment capacity – total outage allowance)

3.7.3 OUTAGE RESULTS

The UKWIR report 'WRMP 2019 Methods – Risk Based Planning' states that, "…a planning allowance in the range 75% to 90% should be used".

We have chosen to use the figure associated with the 90th percentile as an allowance lower than the 90th in AMP8 and AMP9, a step change in base capital maintenance would be required to further reduce unplanned outage.

The figure associated with the 90th percentile giving an outage allowance for the Kielder WRZ of 70Mld and 0.59 Mld. For the Berwick & Fowberry WRZ.

The results of the calculation detailed in section 3.7.2 are shown in
Table 11 below.

PERCENTILES	KIELDER WRZ OUTAGE ALLOWANCE (MLD)	BERWICK & FOWBERRY WRZ OUTAGE ALLOWANCE (MLD)
0%	-	-
5%	-	-
10%	-	0.00
15%	-	0.05
20%	-	0.09
25%	-	0.14
30%	-	0.19
35%	0.24	0.24
40%	5.60	0.29
45%	10.97	0.33
50%	16.11	0.35
55%	21.67	0.38
60%	27.05	0.41
65%	33.15	0.44
70%	38.60	0.47
75%	45.23	0.50
80%	52.58	0.53
85%	60.50	0.56
90%	70.01	0.59
95%	85.56	0.63
100%	167.05	6.14

TABLE 11: WRZ OUTAGE ALLOWANCES

3.8 LOSSES FROM PROCESSING AND TREATMENT

3.8.1 OVERVIEW

In-line with Environment Agency (2021) supporting guidance, we have considered the following components as part of our determination of total raw water and process losses.

Raw water losses:	Net loss from the resource system comprised of mains/aqueduct (pressure system) losses, open channel/low pressure system losses, and losses from break-pressure tanks and small reservoirs (NRA/UKWIR, 1995a).
Raw water operational use:	Regular washing-out of mains due to sediment build up and poor quality of source water (NRA/UKWIR, 1995a).
Treatment works losses:	Made up of structural water loss and both continuous and intermittent over-flows (NRA/UKWIR, 1995a).
Treatment works operational use:	Treatment process water i.e. net loss that excludes water returned to source water (NRA/UKWIR, 1995a).

TABLE 12: RAW WATER AND PROCESS LOSSES CONSIDERATIONS

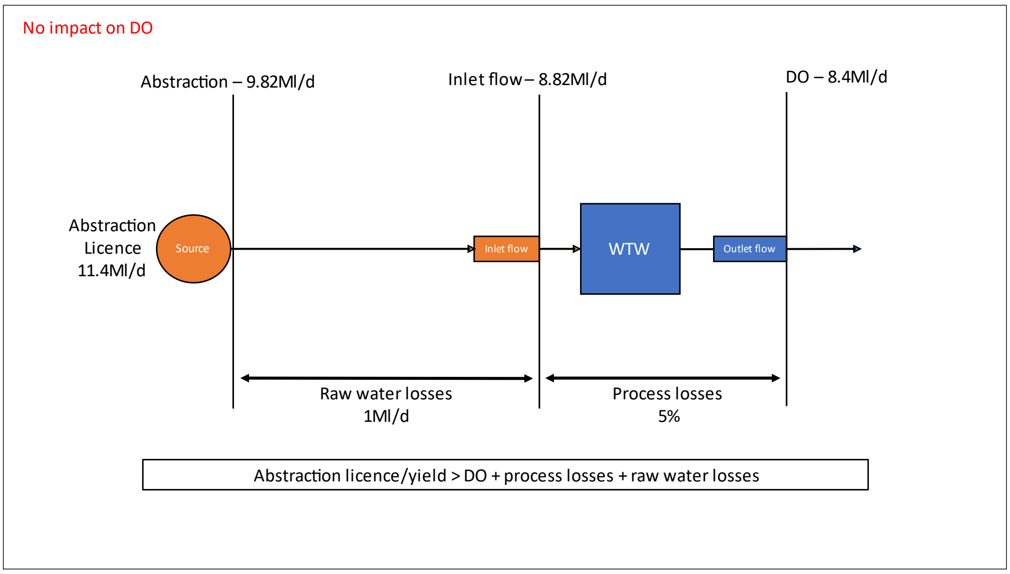
There is only limited operational use on the raw water system within the Kielder WRZ. On an annual basis the pipeline from Catcleugh Reservoir is cleaned and releases are made at Frosterley and Eggleston to maintain water quality in the Tyne-Tees tunnel.

The raw water losses and the treatment works losses / operational use at WTWs can be split into two categories (note the same site can be classified differently for the DYAA and a DYCP scenario):

- Where the abstraction licence / source yield is significantly higher than the WTW design treatment capacity; and
- Where the abstraction licence/source yield is close to the WTW design treatment capacity.

For a detailed report on this section please refer to the Raw Water and Process Losses technical report.

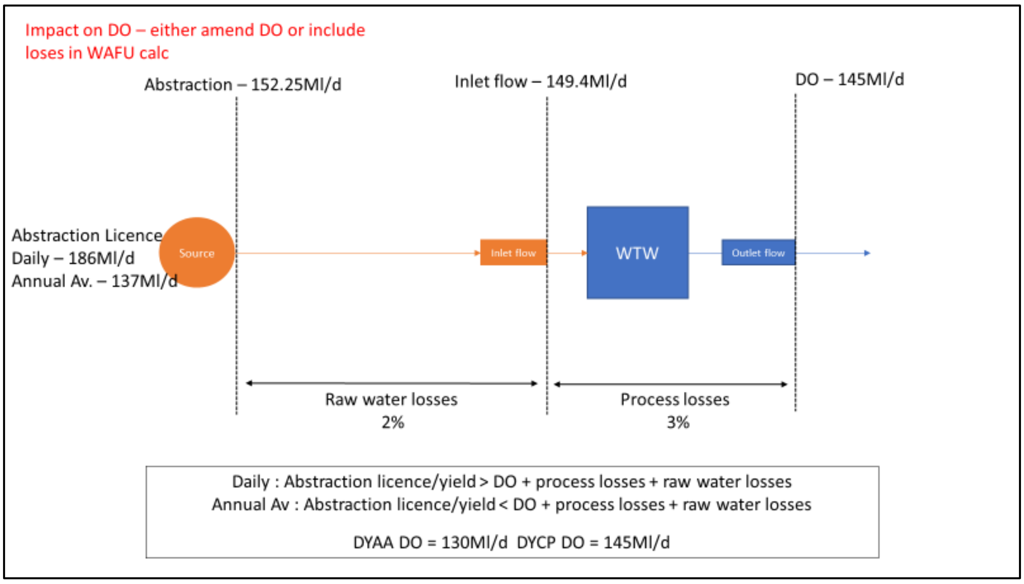
3.8.2 WHERE THE ABSTRACTION LICENCE / SOURCE YIELD IS SIGNIFICANTLY HIGHER THAN THE WTW DESIGN TREATMENT CAPACITY



3.8.3 WHERE THE ABSTRACTION LICENCE/SOURCE YIELD IS CLOSE TO THE WTW DESIGN TREATMENT CAPACITY

In these instances, when accounting for losses, there is insufficient source water available for the site to run at its design capacity.

In this instance the losses do not impact on the capability of the WTW to meet its design capacity and therefore are not included in the WAFU calculation.



Where raw water or process losses have the potential to restrict the amount of water that a WTW can supply, this volume is entered into line 7.6BL of the tables. As per the guidance, the total of raw water losses, raw water operational use, treatment works losses and treatment works operational use has been entered into the WRMP tables (8BL), however the formulae in the tables that calculated WAFU has been amended, see below, to avoid double counting.

Original formulae:

WAFU = (Deployable Output before forecast changes [6BL] + Baseline forecast changes to Deployable Output [7BL]) - (Raw water losses, treatment works losses and operational use [8BL] + Total Outage Allowance [9BL])

Amended formulae:

WAFU = (Deployable Output before forecast changes [6BL] + Baseline forecast changes to Deployable Output [7BL]) - Total Outage Allowance [9BL]

The data from abstraction meters, WTW inlet meters and WTW DI meters have been used, along with site specific operational knowledge, to quantify raw water and process losses.

3.8.4 RESULTS

Table 13 below summarises the total (raw water and process) losses by site. The table also confirms if losses impact on the ability of each WTWs to meet its design treatment capacity.

WTW	ABSTRACTION LICENCE (ML/D)	PR24 DO (ML/D)	TOTAL LOSES (%)	REDUCTION IN DO	
				YES/NO	IMPACT (ML/D)
Mosswood	137	145	4%	Y	4.86
Murton	9.58	8.4	22%	Y	1.76
Broken Scar	304	180	12%	N	
Dalton	11.8	8.3	0%	N	
Dalton North	13.2	10	0%	N	
Fontburn	30	19	7%	N	
Fowberry	3.64	3.2	0%	N	
Fulwell	5.5	5	0%	N	
Gunnerton	N/A	11	2%	N	
Hawthorn	6.2	4.3	0%	N	
Honey Hill	86.37	45	2%	N	
Horsley	180	150	3%	N	
Lartington	145.5	128	6%	N	
Lumley	45.5	42	4%	N	
New Winning	10.6	6	0%	N	
Peterlee	4.5	2.6	0%	N	
Stoneygate	5.3	4	0%	N	
Thorpe	6.8	4	0%	N	
Warkworth	55	42.5	16%	N	
Wear Valley	36.36	34	0.2%	N	
Whittle Dene	181	118	4%	N	

TABLE 13: RAW WATER AND PROCESS LOSSES BY SITE

For the Kielder WRZ, Mosswood WTW is the only WTW where raw water and process losses contribute to a loss of DO. The reduction to WAFU is 4.86Ml/d.

The total raw water losses for the Kielder WRZ are summarised in the table below and have been calculated using the average losses across all the WTWs and the forecasted DI (Baseline DYAA).

Kielder WRZ	2025/26	2030/31	2035/36	2040/41	2045/46
Total raw water and process losses	39.98	39.15	37.47	35.84	34.67

For the Berwick & Fowberry WRZ, Murton WTW is the only WTW where raw water and process losses contribute to a loss of DO. This reduction to WAFU is 1.76Ml/d.
The total raw water losses for the Berwick & Fowberry WRZ are summarised in the table below and have been calculated using the average losses across all the WTWs and the forecasted DI (Baseline DYAA).

Berwick & Fowberry WRZ	2025/26	2030/31	2035/36	2040/41	2045/46
Total raw water and process losses	2.03	2.07	2.05	2.03	2.02

3.9 WATER AVAILABLE FOR USE (WAFU)

Future water supplies are forecast by calculating the water available For Use (WAFU). WAFU is calculated by quantifying the 1-500 Deployable Output (DO) of our raw water sources and treatment works within each water resource zone. Outage, process losses and sustainability reductions (e.g. where our abstraction licences has been reduced to ensure they are sustainable) are then subtracted from DO to give WAFU. Water (raw and potable) imported and exported are then added/subtracted from the WAFU figure to give a Total WAFU value for the WRZ.

The WAFU values, across the planning horizon, for both our WRZ's are summarised in Table 14 and Table 15 below.

Kielder WRZ	2025/26	2030/31	2035/36	2040/41	2045/46
DO	827	827	827	827	827
Climate Change Impact	-19.41	-22.73	-26.13	-29.60	-33.13
Outage	70	70	70	70	70
Process Losses	4.86	4.86	4.86	4.86	4.86
WAFU	730.68	727.36	723.96	720.49	716.96
Water Imported	0.3	0.3	0.3	0.3	0.3
Water Exported (inc NAVs)	5.25	5.27	5.27	5.27	5.27
Total WAFU	725.73	722.39	718.99	715.52	711.99

TABLE 14: KIELDER WAFU

Berwick & Fowberry WRZ	2025/26	2030/31	2035/36	2040/41	2045/46
DO (including sustainable abstraction reductions)	11.58	11.58	11.58	11.58	11.58
Climate Change Impact	0	0	0	0	0
Outage	0.59	0.59	0.59	0.59	0.59
Process Losses	1.76	1.76	1.76	1.76	1.76
WAFU	9.22	9.22	9.22	9.22	9.22
Water Imported	0	0	0	0	0
Water Exported	0	0	0	0	0
Total WAFU	9.22	9.22	9.22	9.22	9.22

TABLE 15: BERWICK & FOWBERRY WAFU

3.10 DRINKING WATER PROTECTED AREAS

Drinking Water Safety Plans and the risk assessments which inform them provide a means of identifying hazards and hazardous events that could arise in the catchment area, from the source up to the customer's tap. We have drinking water safety plans for all of our existing supplies of water from source to tap. However, as we are forecasting a supply surplus in both water resource zones across the planning period, no further supply schemes are required. Consequently, no additional drinking water safety plan risk assessment are required either.

3.11 DRINKING WATER QUALITY

The regulatory framework for drinking water quality and sufficiency of supplies is established in the Water Industry Act 1991 and includes the following requirements.

- Section 86 which relates to the appointment and delegated powers of the Chief Inspector of Drinking Water. It includes reference to "such other powers and duties in relation to the quality and sufficiency of water supplied". This is particularly relevant to powers and duties relating to the protection of public health, and to resilience and contingency planning
- Section 68 of the Act, the duty to supply wholesome water. This section states: "It shall be the duty of a water undertaker…so far as reasonably practicable, to ensure, in relation to each

source or combination of sources from which water is so supplied, that there is, in general, no deterioration in the quality of the water which is supplied from time to time from that source or combination of sources".

We have reviewed these duties in relation to existing transfers of water for supply (raw or treated) only as we are not forecasting supply deficits that need new supply schemes.

Raw water quality data from samples collected at abstraction points over the 2012-2021 period has been processed to identify trends and forecast future threats to water quality. Where a deterioration has been identified and this is anticipated to be a water quality risk in the AMP8 or AMP9 period, appropriate interventions are being identified through our business planning process for PR24. This is in line with the Chief Inspector or Drinking Water Long term planning guidance (published July 2022, revised September 2022). As such we may propose two schemes at PR24, one to undertake catchment management activity to arrest deterioration in the long term but also to identify innovative solutions that are effective to mitigate any immediate risk. This is so that customers continue to receive a reliable and sufficient supply of water with no noticeable adverse change while the catchment solution delivers in the medium to longer term.

Deteriorating trends have been identified in the short term to medium term for the parameters of algae, Cryptosporidium, taste and odour compounds MIB and geosmin and nitrate. Options are being identified and costed to find optimal solutions that mitigate the risk of these water quality risks effectively.

3.12 ENVIRONMENTAL PERMITTING REGULATIONS

In 2023, government plans to move the abstraction and impoundment licensing regime into the Environmental Permitting Regulations which will lead to a more modern and consistent regulatory framework. Defra does not expect that this will impact water company licences. Likewise, we do not expect it to affect DO or WAFU.

3.13 INVASIVE NON-NATIVE SPECIES

Invasive Non-native Species (INNS) Aquatic and riparian invasive non-native species (INNS) have significant adverse social, economic and environmental impacts. They can cause the ecological status of waterbodies to deteriorate or fail to achieve their ecological objectives. We have reviewed whether our current abstraction operations will risk spreading INNS or create pathways which increase the risk of spreading INNS.

We have considered INNS in Section 10.1 as part of our Integrated Environmental Assessment. In summary, INNS has not impacted the DO or WAFU.

4. OUR BASELINE DEMAND FORECAST

4.1 OVERVIEW

A baseline normal year demand forecast has been produced following the WRPG for each of the water resource zones (WRZ) Berwick and Kielder. The normal year demand forecast is the building block for the dry year and critical period forecasts and is adjusted to provide figures for two climate change scenarios.

The base building block for demand forecasting is the base year population served and the projected growth in population annually over the WRMP. In line with the WRMP requirement, we have used Local Authority Plan housing growth evidence from all local authorities and have selected the Plan-based scenario as our central scenario. Forecasts have included assessments for household (HH) and non-household (NHH) water use, metering, changes in technology, weather patterns, climate change and the impact of Covid. These influences on demand enable us to make assumptions on future consumption. Our model is designed to produce these different outputs making all calculations and assumptions transparent.

Our demand forecasts are then segmented into measured and unmeasured HH and NHH consumption, leakage, miscellaneous use and exported water (including water use for New Appointments and Variations (NAVs)). They include assumptions and best estimates for areas such as savings associated with metering, customer behaviour changes, and the impact of Covid.

Forecasting the future of demand inherently includes uncertainty. For the long-term water demand forecasting we account for uncertainties including those from; population and housing growth, economic changes, behavioural changes, technological changes, NHH change in water use, weather, climate, government led interventions and private water supplies switching during drought conditions. To understand these uncertainties a suite of demand scenario forecasts has been built covering multiple metering, water efficiency, leakage and growth options.

For a detailed report on this section please refer to the Demand Forecast technical report.

4.2 OUR BASELINE DEMAND

Normal year forecasts have been made against a 2020/21 base year, which has been amended from the published Annual Regulatory report figures to incorporate the rebasing process for properties, as well as normalising the 2020/21 per capita consumptions (PCCs). This ensures a smooth projection from the base year into the forecast.

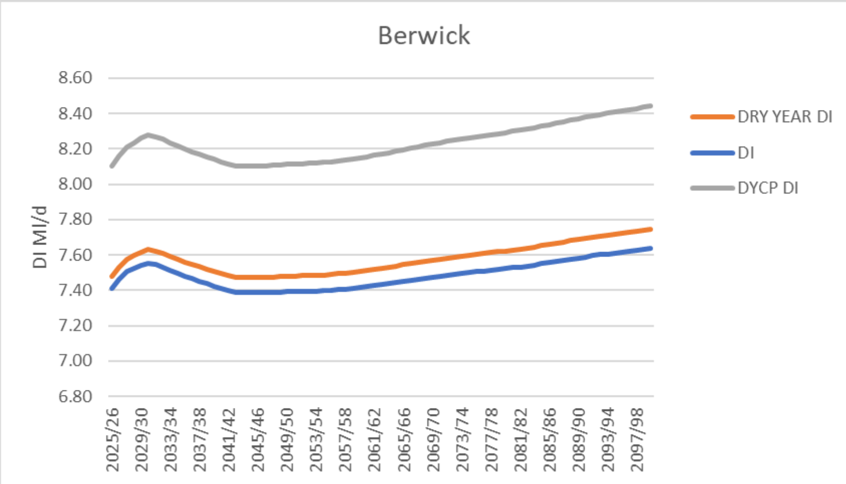
The reported PCC for 2020/21 included both the impact of Covid and dry weather. 2020/21 was classified as a 'dry year,' as it exhibited low rainfall totals and high temperatures, therefore weather-related adjustments have been made to normalise the PCCs for the base year. The impact of Covid remains in the base year.

The baseline demand forecast incorporates the following conditions:

- Customer demand without any further water efficiency or metering interventions from 2025/26 onwards.
- Normal rates of optant, selective and meter replacements from 2025/26
- Leakage remains static from 2025/26
- Population and property growth forecast using Local Authority (LA) Housing Planned growth medium scenario.
- NHH growth forecast with service industries driven by LA Housing Planned growth and new large users requested volumes.

- The impact of climate change on customers' behaviour
- Government led interventions applied to household consumption.

Baseline forecasts have been produced for the following conditions, Normal Year, Dry Year and Critical Period.



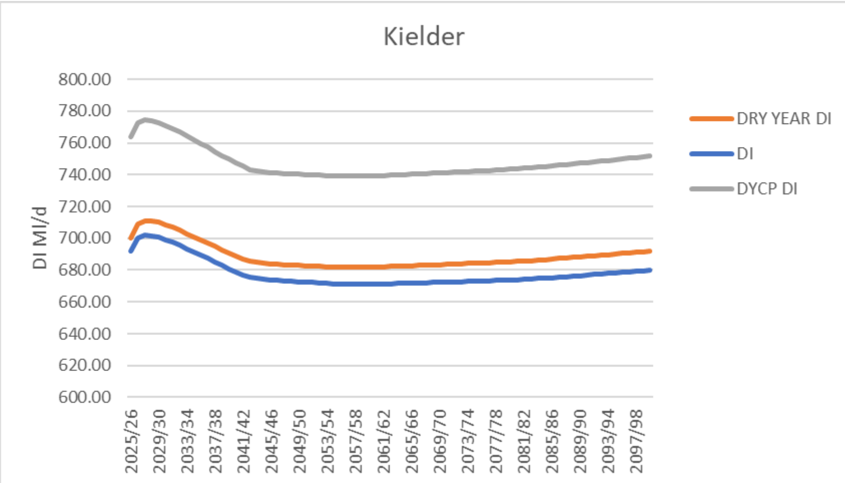


FIGURE 7: BASELINE DEMAND FORECAST DI FOR CRITICAL PERIOD (DYCP), DRY YEAR (DYAA) AND NORMAL YEAR (NYAA) SCENARIOS.

4.3 FORECASTING OUR POPULATION, PROPERTIES AND OCCUPANCY

4.3.1 OVERVIEW

The foundation for demand forecasting is the base year population served and the projected growth of population across the planning horizon, this is a highly specialized fundamental part of the demand forecast, along with property growth. We commissioned specialist consultants Edge Analytics to prepare the population and property growth forecasts for each WRZ in line with best practice methodology following the requirements of the WRPG.

Edge Analytics has a particular expertise in demographic modelling and forecasting and use demographic datasets from ONS, Local Authorities and the latest Census in producing the population forecasts. Robust and timely data inputs are key to the forecasting process, including precise water company geographies; Local Plan evidence from all local authorities; plus, historical and base-year demographic statistics.

4.3.2 POPULATION FORECASTING

The development of growth forecasts to inform WRMP24 plans must be underpinned by evidence on Local Plan housing growth for those Local Planning Authorities (LPA) that overlap the WRZ geography. Water company geographies do not conform to the administrative areas for which population and other demographic statistics are typically available (e.g. district, ward, output area), so area-matching is a critical component of the forecasting framework.

Local Plan development process is often lengthy and complex, with each LPA at a different stage of plan development therefore Edge Analytics' Consilium database has been developed to enable the collection, processing, organisation and delivery of Local Plan evidence, for all LPAs across the UK (including National Parks and Development Corporations).

Edge Analytics' VICUS model combines all the data inputs within best practice forecasting methodologies to enable macro- and micro-level population and property growth scenarios to be derived for the regional group (WReN) and us, under a wide range of assumptions, for 45 scenario horizons that stretch to 2100. The forecasting framework integrates key housing-led scenarios, alongside complementary evidence produced by the Office for National Statistics (ONS), the Greater London Authority (GLA) and the Welsh Government (WG).

Housing-Need, Housing-Requirement and Housing-Plan scenarios present the highest growth outcomes. At the lower end of the spectrum sit the Low ONS-18, Completions and Employment led scenarios.

Selected Scenarios

We have selected three scenarios from Edge Analytics VICUS model for a low, medium and high total population, household population and non-household population and property growth forecast. By selecting three scenarios this ensures we have adequately accounted for an uncertainty surrounding our central ‘medium’ scenario and allows any adaptive planning process to be achieved using a range of scenarios for population and property forecasting.

Medium: The central scenario of Housing Plan has been applied to the baseline forecast in line with WRMP guidelines. The Housing Plan scenario is a housing-led scenario, with population growth underpinned by each local authority’s Local Plan housing growth trajectory. Following the final year of data, projected housing growth in non-London areas returns to the ONS-14 & ONS-16 long-term annual growth average by 2050.

Low: The ONS 18 Low P growth scenario has been selected for a low growth scenario. This is and ONS 2018-based Principal sub-national population projection (SNPP), using a five-year history (2013–2018) to derive local fertility and& mortality assumptions and a low long-term UK net international migration assumption of +90k p.a. for the UK in total.

High: The Housing Need scenario has been selected for a high growth scenario. This is a Housing-led scenario, with population growth underpinned by the trajectory of housing growth associated with each local authority’s Local Housing Need (LHN) or Objectively Assessed Housing Need (OAHN). Following the final year of data, projected housing growth returns to the ONS-18 long-term annual growth average by 2050.
Long Term Growth: A ‘Principal’ (P) long-term growth outlook is selected for the Housing Plan and ONS 18 Low scenarios, extending the scenario horizon to 2100. The principal long-term scenario incorporates the mortality and fertility assumptions of the ONS 2018-based NPP Principal scenario, plus its Principal net international migration assumption of +190k p.a. for the UK in total. It is the medium outlook of three long-term growth outlooks provided by Edge. The ‘High’ (H) long-term growth outlook has been selected for the Housing Need scenario. This incorporates the mortality and fertility assumptions of the ONS 2018-based NPP Principal scenario, plus a high net international migration assumption of +290k p.a. for the UK in total.

Additional sub-populations: Three migrant sub-populations are considered to sit outside the Census definition of 'usual resident' population, whilst potentially contributing to the water-using population within our geographical area of operation. These are short-term residents, irregular migrants and second homes populations. We have added both short-term residents and irregular migrants onto the total household population.

New appointments and variations (NAVs) are limited companies which provide a water service to customers in an area which was previously provided by us, the incumbent monopoly provider. NAV's are increasing within our supply area and the majority (95%) of NAV's are for new housing developments within specific areas. We have matched each NAV against their local plan, and those included in Edge Analytics data have then been excluded from our population and property forecast numbers.

Population forecast outputs

In all WRZ's overall population is forecast to increase. Low, medium and high scenario forecasts have been created to allow for changes in assumptions and uncertainty within the population forecasts. On average for Berwick this has resulted in a 15.6% increase in total population to 2049/50 and for Kielder a 11.0% increase.

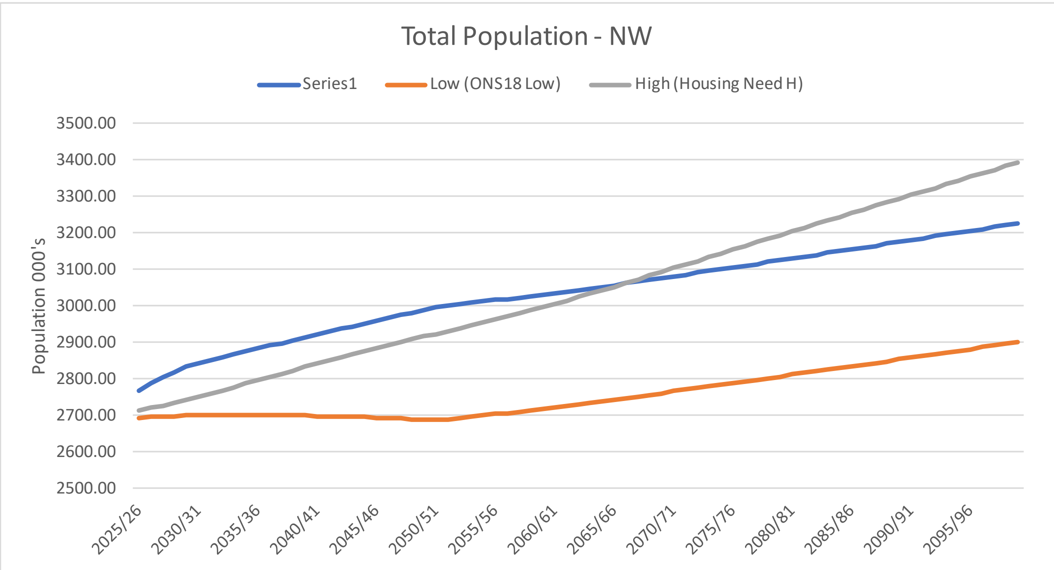


FIGURE 8: TOTAL POPULATION FOR THE THREE SELECTED SCENARIOS FOR NW

4.3.3 PROPERTY FORECASTING

Base year property figures are taken from our customer billing database. We have selected three scenarios from Edge Analytics suite of scenarios to give a low, medium and high property growth forecast. These scenarios are the same as the population scenarios (see section 4.3.2).

The property forecasts include new properties (growth) from the Edge Analytics scenarios and adjust for projected annual disconnections and demolitions. These are based on the average disconnections and demolitions that have occurred over the last five years and remain consistent over the forecast. Base year void property figures are taken from our customer billing database. The forecast number of household voids are a percentage of total household properties. We assume these percentages remain consistent through-out the planning horizon.

The number of properties is forecast to increase in all WRZ's. Low, medium and high scenario forecasts have been created to allow for changes in assumptions and uncertainty within the forecasts. On average for Berwick this has resulted in a 27.9% increase over 25 years and for Kielder a 15.8% increase.

4.3.4 OCCUPANCY FORECASTING

An overall occupancy figure is determined by the Edge Analytics data through total population divided by the total number of billed households for a year to give the overall occupancy rate. However, an overall occupancy figure is at too high a level to be useful for each of the households directly. To ascertain what occupancy to assign to each household metering category[1] several occupancy data sources are used to ensure a best estimate for the base year.

We commissioned specialist consultants Ovarro DA Ltd (Ovarro) to forecast occupancy for the planning horizon by assigning the total household population between the various metering categories. The differences in occupancy between the metering categories are in general expected to reduce over time as properties change ownership and hence, for example, bias towards low occupancy in optant properties is reduced.

The overall occupancy for all households steadily declines from 2.58 in 2020/21 down to 2.29 in 2049/50 in Berwick (-11.0%) and 2.37 in 2020/21 down to 2.25 in 2049/50 in Kielder (-5.1%).

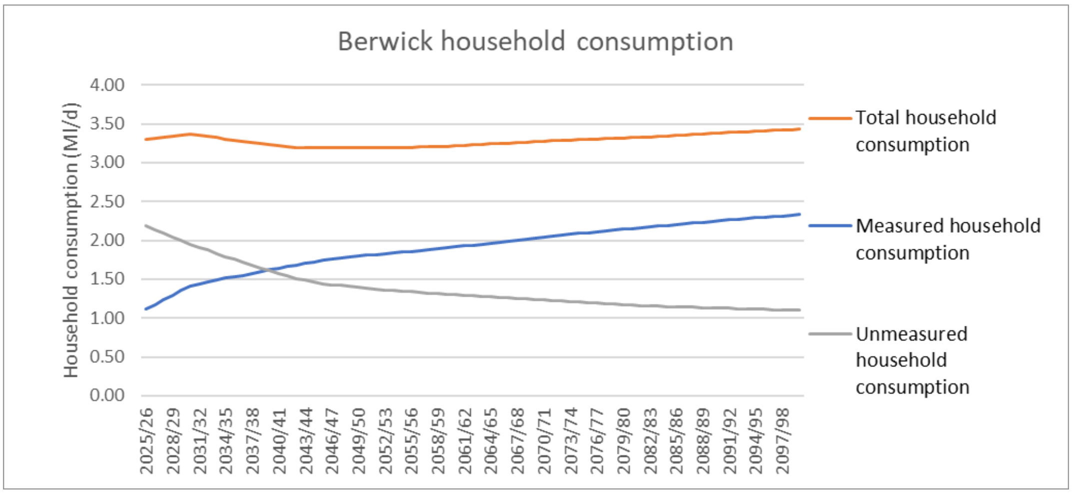
4.4 FORECASTING OUR HOUSEHOLD CUSTOMER DEMAND

The household demand forecast has been developed by considering the population in the following five groups: Unmeasured customers, Existing metered customers, New Homes, Meter Optant customers and Selective / Compulsory metered customers. These groups have been chosen as their consumption characteristics are considered to be distinctly different.

A peer review of the household demand forecasts has been conducted by specialist consultants Crowder. This review has assured the micro-component forecasting method employed for household demand forecast follows the guidelines for WRMP. Amendments and recommendations following the peer review have been applied to the household demand forecasts.

In summary, after an initial decrease (Kielder) and short peak followed by a decrease (Berwick) due to natural optant metering and government led interventions baseline consumption increases which is predominantly driven by population and property growth.

[1] Measured (optant, new build, selective/compulsory, existing) and Unmeasured are the household meter type categories.



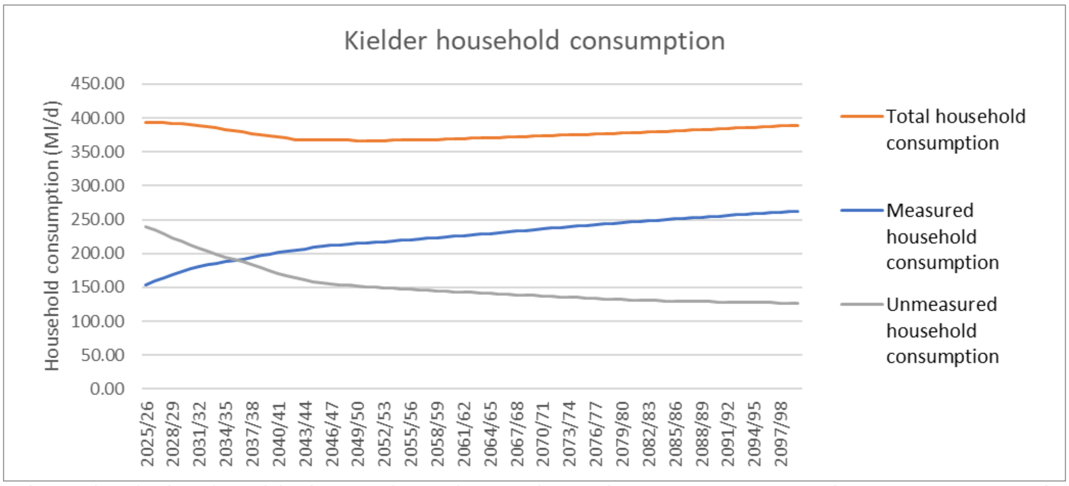


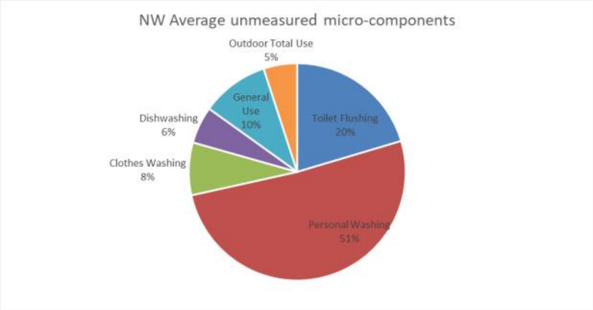
FIGURE 9: HOUSEHOLD CONSUMPTION, INCLUDING THE SPLIT BETWEEN MEASURED AND UNMEASURED HOUSEHOLD CONSUMPTION, ONE GRAPH PER WRZ

4.4.1 UNMEASURED AND EXISTING METERED HOUSEHOLD DEMAND

A micro-component model provides the household consumption and per capita consumption (PCC) forecasts for unmeasured and existing metered households. Micro-components refer to the study of the smaller elements that make up a customer's water use, for example WC flushing, dishwashing, and garden watering, and are used to understand in greater detail the customer's water consumption.

It is important for us to understand the water use of our customers to be able to justify the current and forecasted household consumptions. To demonstrate we have understood our customer's use of water we survey a proportion of our customers on their household water use. For this WRMP we have conducted two surveys in April and October 2021 to ensure we fully understand the impact of Covid on changing behaviours and water use. In total we contacted 83,400 customers and received a total of 7,501 responses.

The results from these surveys give us ownership and frequency data for water using appliances, occupancy by meter household type and behaviours within the home and garden and these, combined with volume data (that of the market currently), allow us to calculate a litres per head per day consumption for measured and unmeasured households at a micro-component level of consumption.



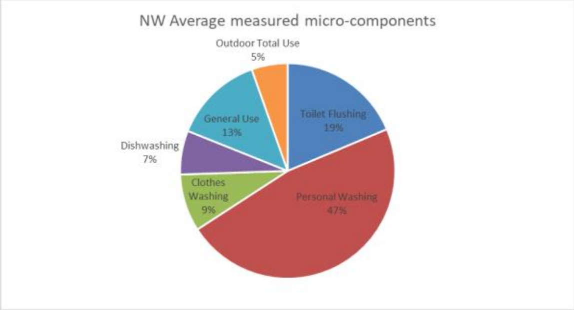


FIGURE 10: AVERAGE MICRO-COMPONENT WATER USES FOR MEASURED AND UNMEASURED PROPERTIES

The results from the micro-components analysis are rebased to the actual measured and unmeasured per capita consumption (PCC) for the forecast base year (2020/21). The base year measured PCC comes from our billed volumes and the base year unmeasured PCC is calculated from our unmeasured consumption monitor.

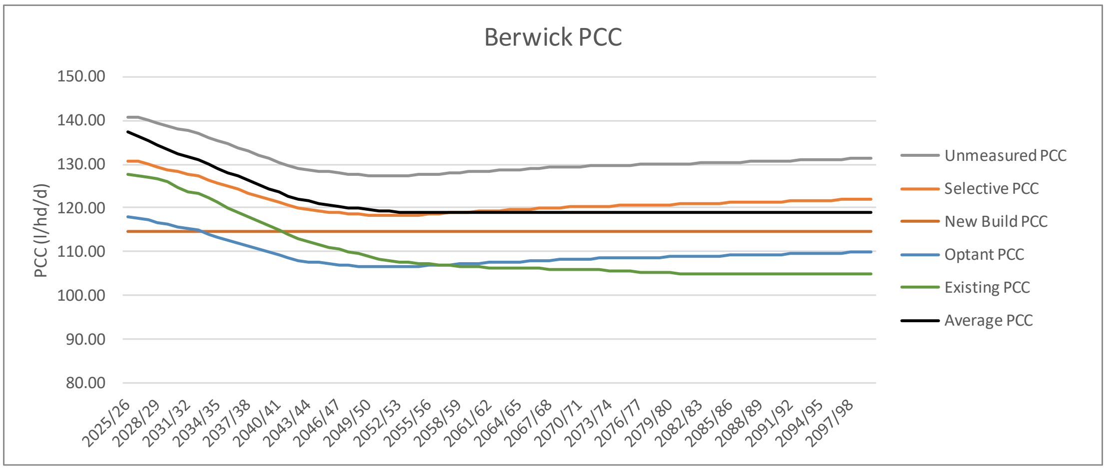
The micro-components are then forecast using a well- established model based upon assumptions using market transformation analysis and the integration of behavioural change with scenarios to include government led interventions (water labelling) and also incorporating the impact of Covid on PCC. The start position and rate of change of the forecast is defined and applied to the duration of the planning horizon. For those components involving white goods, a range of manufactured models and their associated average volumes per use have been identified. Along with this are stated the assumed model lifespan and the dates when lower-volume technologies are expected to be introduced. There is a separate model for Berwick and Kielder.

4.5 MEASURED HOUSEHOLD DEMAND

The micro-component model provides the PCC and household consumption for unmeasured and existing metered households. To determine the PCC and consumption for the remaining metered household types of optant, selective and compulsory an assumption (percentage saving) is applied to the unmeasured PCC. This saving is calculated from an analysis of the average consumption of these metered household types. New build households are assigned a PCC based upon the water efficiency standards in Part G of the Building Regulations as well as analysis of the current consumption we see from our new build properties.

Smart metering is where a smart meter is installed by a water company to measure how much water a customer uses. The meter sends the water use data wirelessly to an in-home display as well as to the water company. Smart meters provide both the customer and water company with accurate and regular updates on how much water is being used and when and eliminates the need for an onsite water meter read. Smart metering our water supplies is increasingly recognised as a crucial element in helping to manage water demand. An additional saving on consumption can be attributed to the installation of a smart meter compared to a dumb meter. Using results from neighbouring water company's smart metering programmes and industry research, we have chosen an additional 3% saving for smart meters compared to dumb meters which relates specifically to behavioural changes in customers only and does not include plumbing loss or supply pipe leakage savings.

Meter under-registration refers to the tendency for water meters installed to under record the amount of water passing through them. It is more prevalent in older, mechanical meters due to wear on internal components. This under-registration leads to an underestimation of consumption on metered properties. As a result, an estimation of under-registration is applied to the measured PCC to account for this. WRc has been running a collaborative program with a number of water companies, including ourselves, to provide annual updates of company specific meter under-registration (MUR) percentage values based on each participant's meter stock. For household customers MUR is 2.92% and non-household customers 4.86%. The resulting MUR is forecast to remain constant for the planning horizon. The graphs that follow depict the changes in PCC for each meter household type over the baseline forecast. Overall average PCC decreases over the planning horizon.



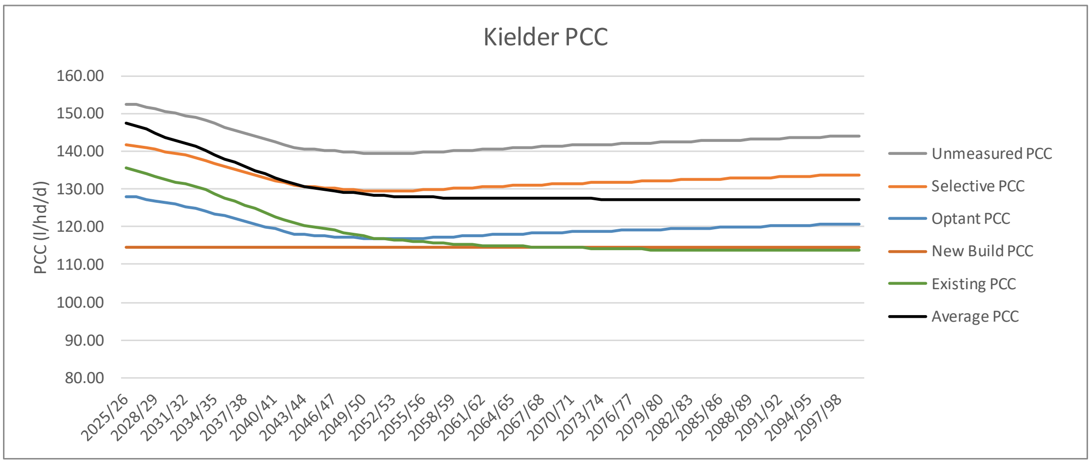


FIGURE 11: PCC'S PER METER HOUSEHOLD TYPE FOR THE PLANNING HORIZON

4.5.1 IMPACT OF COVID

The impact of the Covid-19 pandemic and the associated measures to reduce transmission continue to affect the activities of society and have had an unforeseen outcome within the water industry. The large impact on water consumption in homes and businesses as a result of restrictions and lockdowns, combined with the hot and dry weather of 2020 has resulted in some of the highest peaks in water demand we have ever seen.

The effect of the Covid-19 pandemic is expected to continue to affect PCC and demand in the short to medium term and could potentially cause permanent changes to demand and PCC. There are likely to be longer term impacts as a result of this pandemic such as working from home impacting the distribution and amount of water use during the day, increased hand washing and the staycation effect increasing tourism to areas.

We contributed to and collaborated with Artesia and the industry on a study into the impact of Covid-19. As part of this study Artesia investigated the impact of Covid on demand at an individual company level and have estimated the continued impact of Covid-19 split by household (HH) and non-household (NHH). Full lockdown conditions are predicted to produce the highest increase in consumption in HH's. The new normal is estimated to increase HH consumption by around 3%.

This modelled data from the Artesia study shows that the PCC increase due to Covid is estimated to reduce to between 2-3% by 2025 compared to a 6-8% increase for 2020/21 (base year). These estimates give an idea of how consumption will vary for the remainder of the AMP regarding the effect of Covid-19 and have been applied to the micro-component PCC baseline demand forecasts.

4.6 FORECASTING OUR NON-HOUSEHOLD CUSTOMER DEMAND

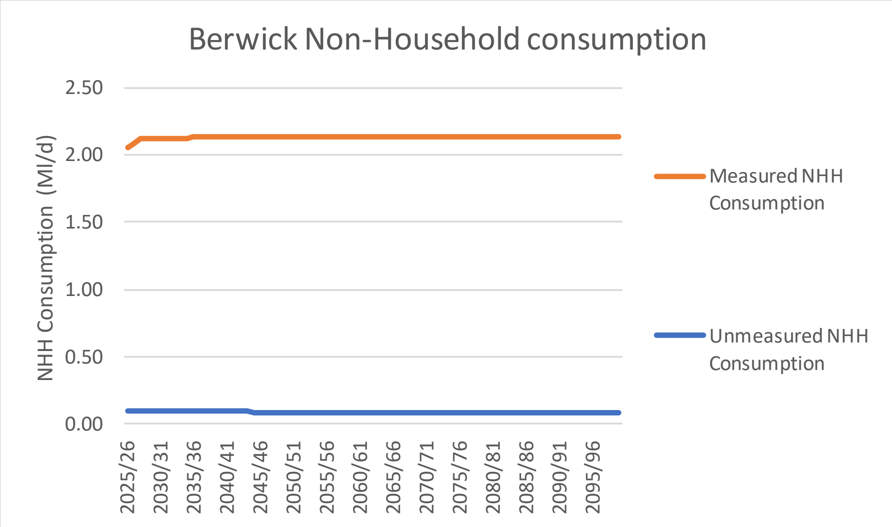
Non-households (NHH's) refer to those premises where the primary use is for non-domestic purposes and can also be referred to as business customers. They also include the population living in communal establishments (for example care homes, hospices, prisons etc.).

In April 2017 there was a major change to the water industry with the creation of the non-household water retail market. Since then, our primary 'customers' for non-household market are the retailers who then in turn bill the end user or non-household customer. For simplicity where we use the term 'customer' will still refer to the end user rather than the retail companies.

To understand our current and future NHH demand we began by analysing our current NHH demand at an industry sector level. We also contacted all Local Authorities located within our operating areas to request information they hold on new NHH developments and growth. In addition, we also contacted all our large users requesting the provision of expected changes to demand in the short and medium term. Our aim is to continue these conversations with Local Authorities, retailers and large users throughout the WRMP24 process and then into the planning horizon to ensure we have a timely awareness of local hot spots for NHH development.

Specialist consultant Ovarro DA Ltd (Ovarro) were employed to provide a non-household demand forecast for each water resource zone using the Local Authority and Large User data we provided, together with our non-household consumption data from the last five years and our population and property forecasts. In addition to the data we provided, Ovarro used employment and Gross Value Added (GVA) ONS data along with large scale commercial project search data to create the demand forecasts. Ovarro used the consumption data for each WRZ, and this was split into three segments in order to analyse underlying trends in different industry sectors. Large known new demands likely to start in the next few years, such as the construction and operation of power generation plants have also been applied on top of the base forecast derived from historical consumption.
The impact of Covid on non-household demand was applied to the forecast using the model from the Artesia (2020) study and sees non-household demand returning to pre-Covid levels by 2024/25.

The resulting forecast is considered the most appropriate central estimate of forward consumption for non-households to 2100. By adjusting the population and employment forecasts, along with large user requested level of consumption, additional scenarios were created to give a low demand and high demand scenario for non-household demand.
The NHH demand forecasts produced by Ovarro DA Ltd have been fed into the regional plans. Ovarro DA Ltd also produced the NHH demand forecasts for other water companies within the regional group and this ensured methodologies aligned between companies and forecasts reflect the output of regional plans.



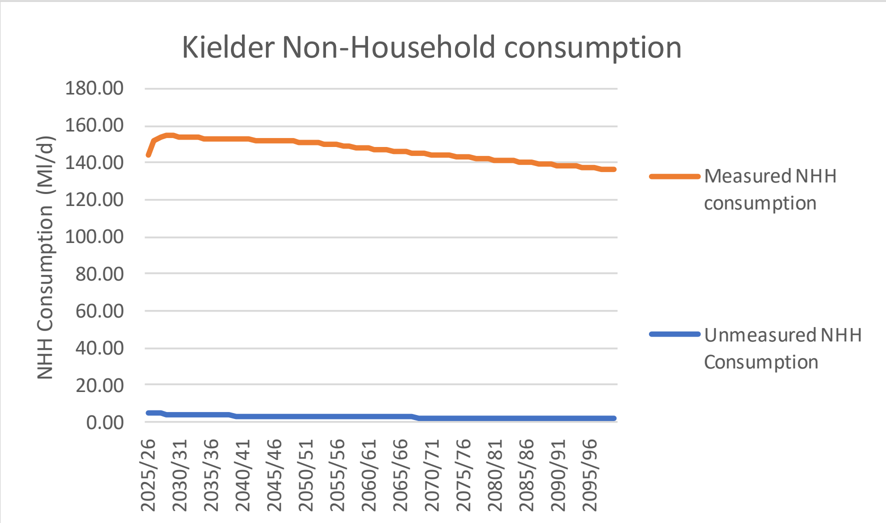


FIGURE 12: NON-HOUSEHOLD CONSUMPTION BASELINE FORECAST SPLIT BETWEEN MEASURED AND UNMEASURED. ONE GRAPH PER WRZ.

New appointments and variations (NAVs) are limited companies which provide a water service to customers in an area which was previously provided by us, the incumbent monopoly provider . NAV's are increasing within our supply area with a total of 30 either already in place or expected in the near future in the NW area. A bulk supply to the NAVs (the incumbent) is agreed based upon the size of the development (e.g. the number of houses on a site). This water is an export and therefore sits outside the household and non-household demand forecasts. We have contacted all appointees in Autumn 2021 requesting their WRMP or relevant data regarding the NAVs they serve. This data has been used to create a demand forecast for each NAV, including a population and property forecast.

4.7 FORECASTING OUR LEAKAGE

We have conducted research into quantifying supply pipe leakage (SPL) to better understand this area of total leakage. Our base year total leakage is taken from the current reported actual leakage from our company water balance for the base year following the consistent reporting performance measures. In line with the WRPG total leakage, including supply pipe leakage, is forecast to remain constant from for the planning horizon for our baseline forecast. The total leakage results for the base year are shown in the table below.

Please refer to section 7.2.1 for discussion on all options for further leakage control that have been assessed.

WATER RESOURCE ZONE	TOTAL LEAKAGE 2020/21 (ML/D)
Berwick & Fowberry	1.70
Kielder	138.30

TABLE 16: TOTAL LEAKAGE 2020/21

4.8 FORECASTING OUR METERING

Our current strategy for our area is to install meters on customer optants and high-water users. In 1990 it became compulsory for all new homes to be fitted with a water meter.

Optant metering is where a customer requests a meter from the company and, assuming the meter can be installed at reasonable cost, the company is required to install a meter free of charge. The customer then pays for their water and sewage on a measured basis.

All water companies in England and Wales have powers to meter domestic properties that are deemed large water users. A high-water user mainly refers to customers who want to use a garden sprinkler, or similar non-handheld watering device, or properties where potable water is used to fill a swimming pool or large pond. This selective metering remains at very low totals (<6 p.a.) for the planning horizon.

By the end of 2024/25 meter penetration is estimated to be 46.63% of domestic properties for our baseline forecast. By the end of the planning horizon the baseline meter penetration is forecast to be 73.85%.

The baseline figures for measured (metered) and unmeasured (metered and un-metered) customers have been derived from our water-balance data and the metering team. In line with the WRPG, customer metering is forecast with no further metering intervention from 2025. The tables below present the annual meter installs expected for optants and selectives through natural optant rates and normal high water user rates. The rate of optant installs naturally decreases as more and more properties become metered over the planning horizon. 100% of meters installed from 2025 onwards will be smart meters.

Please refer to section 7.2.2 for discussion on all options for further metering interventions that have been assessed.

OPTANTS	METER INSTALLED IN 2025/26	METER INSTALLED IN 2030/31	METER INSTALLED IN 2035/36	METER INSTALLED IN 2049/50
Berwick	115	82	10	8
Kielder	13,885	9,918	1,215	992

TABLE 17: METERING OPTANT INSTALLATIONS

4.9 OTHER COMPONENTS OF OUR DEMAND

Operational and unbilled use continue to be assessed by the work carried out as part of annual regulatory reporting. The annual reported figure for operational use covers volumes used for treatment works' use, service reservoir and tower cleaning, third-party bursts, flushing, new mains and rehabilitation. The figure has been applied to the base year of the demand forecast and remains constant for the planning horizon. The annual reported figure for unbilled use includes both legally and illegally unbilled. The base year figure is the average of the last two reporting years and remains constant for the planning horizon. There are also some additional potable bulk supplies (both imports and exports) to the NAV demand that are included in the demand forecast and remain constant for the planning horizon.

OTHER COMPONENTS OF DEMAND	NW ML/D
Operational Use	1.22
Unbilled Use	21.29
Bulk Supplies (excl. NAVs) (net export, including imports)	1.27

TABLE 18: OTHER DEMAND COMPONENTS

4.10 OUR DRY YEAR AND CRITICAL PERIOD UPLIFT

Demand should be forecast under a dry year scenario reassuring our customers that the actions we will take under a dry year scenario will meet their level of service. Our dry years have been selected using historic weather data and demand data that has been examined to identify conditions of a dry year. To estimate the dry year factor we have taken the difference between the household measured and unmeasured PCC's of the most recently determined dry year (2018) and the surrounding normal years (2016/17) and (2017/18) to that dry year. The dry year annual average (DYAA) is calculated by applying the dry year factor percentage increase to measured and unmeasured household PCC's for the forecast, therefore giving an increase from normal year to dry year. The dry year factor remains the same for the planning horizon.

We have included a critical period (CP) planning scenario within our demand forecast to account for a period of peak strain on our system as a result of high demand. For example, high demand because of; prolonged dry weather, high seasonal demand from holidaymakers, heatwaves and winter leakage. To ascertain the uplift to demand due to a critical period (CP) we have followed the methodology from the UKWIR Peak demand forecasting report[2] and the Artesia Water demand insights report[3]. We have calculated separate CP factors for unmeasured and measured households and non-households.

The critical period dry year is calculated by applying the critical period factor percentage increase to measured and unmeasured household consumption and where applicable the NHH demand for the forecast, therefore giving an increase to critical period. The critical period factor remains the same for the planning horizon. See graphs in section 4.2 to see the difference in DI for a Dry Year and Critical Period scenario.

The Dry Year critical period data is not included in the EA Tables as it is not required due to these WRZ's not being in deficit under a CP scenario only or both a DYAA and CP scenario.

4.11 IMPACTS OF CLIMATE CHANGE ON CUSTOMER DEMAND

The UKWIR 'Impact of Climate Change on Water Demand[4]' results have been used to calculate forecasts of climate change impacts on household water demand. This UKWIR project used statistical analysis on five case studies looking at household and micro-component water consumption and non-household water consumption. The weather- demand relationships developed from the case studies have been used in combination with UKCP09 climate projections to derive algorithms for calculating estimates of the impact of climate change of household water demand for each UK region in the format of look-up tables. These look-up tables present the estimated future impacts of climate change on household demand for any river basin between the years 2012-2040 and for a range of percentiles to reflect the uncertainty of the UKCP09 climate projections[5].

For the most-likely effects of climate change the 50th percentile has been chosen (a one in two chance of occurrence). To determine the least likely (maximum) effect of climate change of demand the 90th percentile was selected (a one in ten chance of occurrence). The look-up table values give the percentage change in demand between 2012 and 2040. As these look-up tables were not updated for

[2] UKWIR (2006) Peak Demand Forecasting Methodology report 06/WR/01/7
[3] Artesia Consulting (2020) Water demand insights from 2018
[4] UKWIR (2013) Impact of Climate Change on Water Demand
[5] UKCPO9 data will be updated to UKCP18 data for our revised draft

WRMP24, the projections were extended along the same trajectory until 2100 to cover the demand forecasting horizon.

The report stated that household demand is the only component of demand affected by climate change. Non-household demand is not expected to be affected by climate change. The report also stated that it would be reasonable to assume that all additional water consumption in hotter or drier weather is for outdoor water uses.

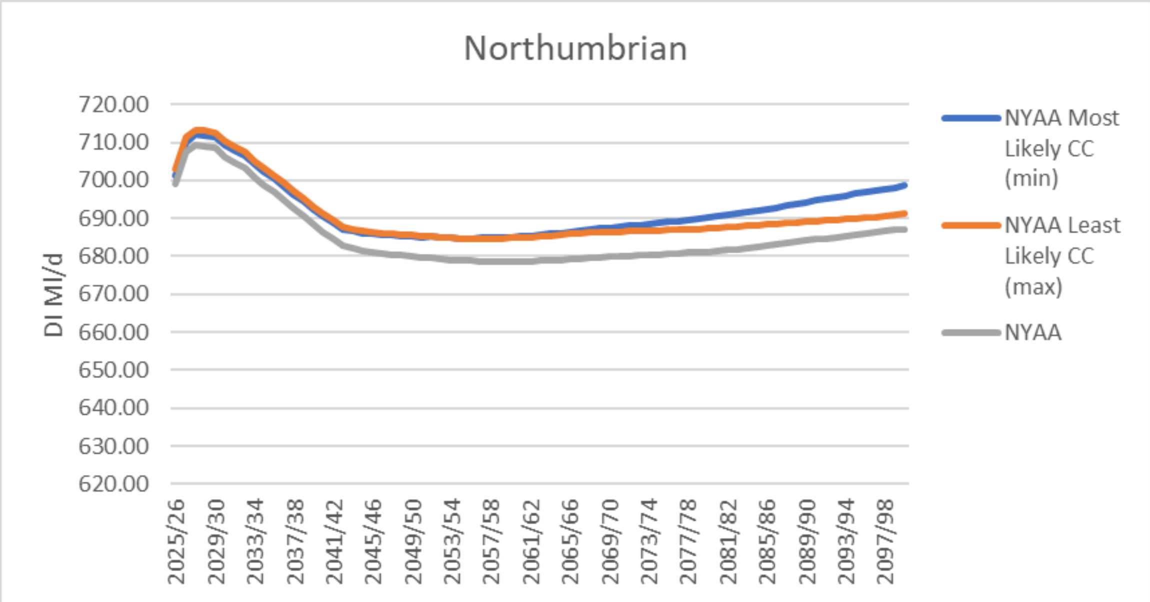


FIGURE 13: DIFFERENCE BETWEEN MOST LIKELY AND LEAST LIKELY CLIMATE CHANGE SCENARIOS COMPARED TO NORMAL YEAR DI

5. ALLOWING FOR UNCERTAINTY

5.1 OVERVIEW

For this draft Water Resources Management Plan 2024 (dWRMP24) submission, we have calculated the supply-demand balance for each of our water resource zones (WRZs) over the 25-year planning period from 2025 to 2050. However, there are a range of factors leading to uncertainty in our supply and demand forecasts. These include: accuracy of meters measuring abstractions and distribution input, variation in the company's future demand forecasts, uncertainty in the future impacts of climate change, risks of future pollution impacts on supply availability, and risks of changes to the company's abstraction licences for sustainability or other reasons.

In order to allow for these factors, at an appropriate level of risk, we have followed industry standard practice by including a margin between supply and demand to allow for potential variations due to uncertainty. This margin is known as 'headroom', and we have calculated appropriate values of headroom for each planning scenario considered in dWRMP24. The headroom value determined for each year across the planning horizon is termed the target headroom allowance. Our approach to the target headroom assessment, as outlined below, is in accordance with statutory guidelines.

For a detailed report on this section please refer to the Allowing for Uncertainty technical report.

5.2 TARGET HEADROOM METHODOLOGY

The aim of calculating a target headroom allowance is to provide a reasonable margin to cover the statistically combined impact of all the relevant uncertainty factors on the supply-demand balance, at a defined level of risk. The target headroom assessment is based on the methodology as outlined in 'An Improved Methodology for Assessing Headroom' (UKWIR, 2002) and referred to by the Environment Agency in their latest 'Water resources planning guideline' (December 2021).

The target headroom assessment is based on the methodology as outlined in 'An Improved Methodology for Assessing Headroom' (UKWIR, 2002) and referred to by the Environment Agency in their latest 'Water resources planning guideline' (December 2021). Table 4 lists all uncertainty factors included within the original UKWIR methodology; note however that some of these factors are excluded from the current assessment, for the reasons outlined below:

- Factors S1, S2 and S3: these are excluded in line with the 2021 Environment Agency guidance that water companies should not include any uncertainty allowance for these factors, and should incorporate future sustainability changes to abstractions within the supply-demand balance;

- Factor S7: this factor is no longer included in the headroom methodology, as it is considered to be an outage issue, but it is listed in the table below for completeness; and

- Factors S9 and D4: these factors relate to supply and demand options selected for the final planning supply-demand balance and have been excluded from the baseline target headroom assessment; uncertainties surrounding selected options have been considered through the adaptive planning approach for the 2024 draft Water Resources Management Plan.

FACTOR	NAME	DESCRIPTION
S1	Vulnerable Surface water licences	Risk of future loss of deployable output due to sustainability changes to surface water abstraction licences for environmental reasons
S2	Vulnerable Groundwater licences	Risk of future loss of deployable output due to sustainability changes to groundwater abstraction licences for environmental reasons
S3	Time Limited Licences	Risk of future loss of deployable output due to non-renewal of time limited abstraction licences
S4	Bulk Imports	Risk of future loss of deployable output due to changes in bulk supply agreements (imports only)
S5	Gradual Pollution	Risk of future loss of deployable output due to pollution and/or water quality issues which cannot be mitigated or recovered
S6	Accuracy of Supply-Side Data	Uncertainty surrounding the accuracy of supply side data e.g. percentage accuracy of abstraction meters
S7	Single Source Dominance	(This factor is no longer used in the headroom methodology)
S8	Impact of Climate Change on Deployable Output	Uncertainty surrounding the future impact of climate change on deployable output (varying estimates of loss depending on scenario)
S9	New Sources	Uncertainty surrounding the available yield of major new resource developments included in the final planning supply-demand balance
D1	Accuracy of Sub-component Demand Data	Uncertainty surrounding the accuracy of demand side data i.e. percentage accuracy of distribution input meters (generally located at service reservoirs)
D2	Demand Forecast Variation	Uncertainty surrounding future demand forecasts which may be higher or lower than assumed in the baseline supply-demand balance
D3	Impact of Climate Change on Demand	Risk of future increases in demand due to climate change impacts (varying estimates of demand effects depending on scenario)
D4	Demand Management Measures	Uncertainty surrounding the impact on future demand of demand management measures including leakage reduction, metering strategy and water efficiency activities.

TABLE 19: SUMMARY OF SUPPLY-DEMAND BALANCE UNCERTAINTY FACTORS

The method involves defining suitable probability distributions for each relevant uncertainty factor, based on available data and appropriate assumptions as agreed through liaison between water resources and operational staff. These individual probability distributions are then statistically combined, using a standard technique called Monte Carlo simulation, into an overall headroom distribution for each resource zone and for each planning year. A profile of target headroom allowance can then be determined from these combined distributions at the required level of risk (e.g. for a 5% risk, the 95% headroom value would be taken).

The outputs of the Monte Carlo simulation are used to determine profiles of target headroom at selected probabilities. The UKWIR methodology and Environment Agency do not specify the level of risk which should be adopted, although the EA water resources planning guideline does state that regulators expect water companies to accept a higher level of risk in the later years of the planning period, as there is more time to address and plan for potential risks further into the future. For dWRMP24, regulatory feedback has also indicated that water companies should take account of the fact that some of the key uncertainties within the supply-demand balance will be addressed through adaptive planning for this cycle of Water Resources Management Plans.

In accordance with the above, we have selected tapered probability profiles for each resource zone. The level of risk has been determined through industry benchmarking, collaborative working with other water companies and our own assessment of appropriate risk levels for each resource zone, relating to the characteristics and level of resilience to uncertainty of each individual zone.

5.3 TARGET HEADROOM RESULTS

The combined headroom distribution for our two resource zones is summarised in tabular form (at 5-yearly intervals) and graphs (for selected percentiles) for each resource zone. The baseline dry year annual average target headroom profile, at the selected annual level of risk, is highlighted on each table and graph.

Confidence level	2025/26 Ml/d	2030/31 Ml/d	2035/36 Ml/d	2040/41 Ml/d	2045/46 Ml/d	2050/51 Ml/d	2055/56 Ml/d	2060/61 Ml/d	2065/66 Ml/d	2070/71 Ml/d	2075/76 Ml/d	2080/81 Ml/d	2084/85 Ml/d
0%	-0.22	-0.26	-0.15	-0.23	-0.17	-0.18	-0.16	-0.17	-0.14	-0.13	-0.22	-0.17	-0.18
5%	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15
10%	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.20	0.20	0.20	0.20
15%	0.21	0.21	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.24	0.24	0.24	0.24
20%	0.24	0.24	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.27	0.27	0.27	0.27
25%	0.26	0.27	0.27	0.28	0.28	0.29	0.29	0.29	0.30	0.30	0.30	0.30	0.30
30%	0.29	0.30	0.30	0.30	0.31	0.31	0.32	0.32	0.32	0.32	0.32	0.33	0.33
35%	0.31	0.32	0.32	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.35
40%	0.34	0.34	0.35	0.35	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.38	0.37
45%	0.36	0.37	0.37	0.37	0.38	0.38	0.39	0.39	0.39	0.39	0.40	0.40	0.40
50%	0.38	0.39	0.39	0.40	0.40	0.41	0.41	0.41	0.42	0.42	0.42	0.42	0.42
55%	0.41	0.41	0.42	0.42	0.43	0.43	0.43	0.44	0.44	0.44	0.44	0.45	0.45
60%	0.43	0.44	0.44	0.45	0.45	0.45	0.46	0.46	0.46	0.47	0.47	0.47	0.47
65%	0.46	0.46	0.47	0.47	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.50	0.49
70%	0.48	0.49	0.50	0.50	0.50	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.52
75%	0.51	0.52	0.52	0.53	0.53	0.54	0.54	0.54	0.54	0.55	0.55	0.55	0.55
80%	0.55	0.55	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.58	0.58	0.59	0.59
85%	0.59	0.60	0.60	0.60	0.61	0.61	0.61	0.62	0.62	0.62	0.62	0.63	0.63
90%	0.64	0.65	0.65	0.65	0.66	0.66	0.67	0.67	0.67	0.68	0.68	0.68	0.68
95%	0.73	0.74	0.75	0.75	0.75	0.75	0.76	0.76	0.77	0.77	0.77	0.77	0.78
100%	11.44	9.56	11.04	9.25	9.64	9.38	10.93	10.89	9.26	10.75	10.50	9.29	9.34
Selected	0.64	0.60	0.56	0.53	0.50	0.48	0.48	0.49	0.49	0.49	0.49	0.50	0.49
% of DI	*9%*	*8%*	*7%*	*7%*	*7%*	*6%*	*6%*	*6%*	*6%*	*6%*	*6%*	*6%*	*6%*

TABLE 20: HEADROOM DISTRIBUTION FOR BERWICK & FOWBERRY WRZ - BASELINE DRY YEAR ANNUAL AVERAGE SCENARIO

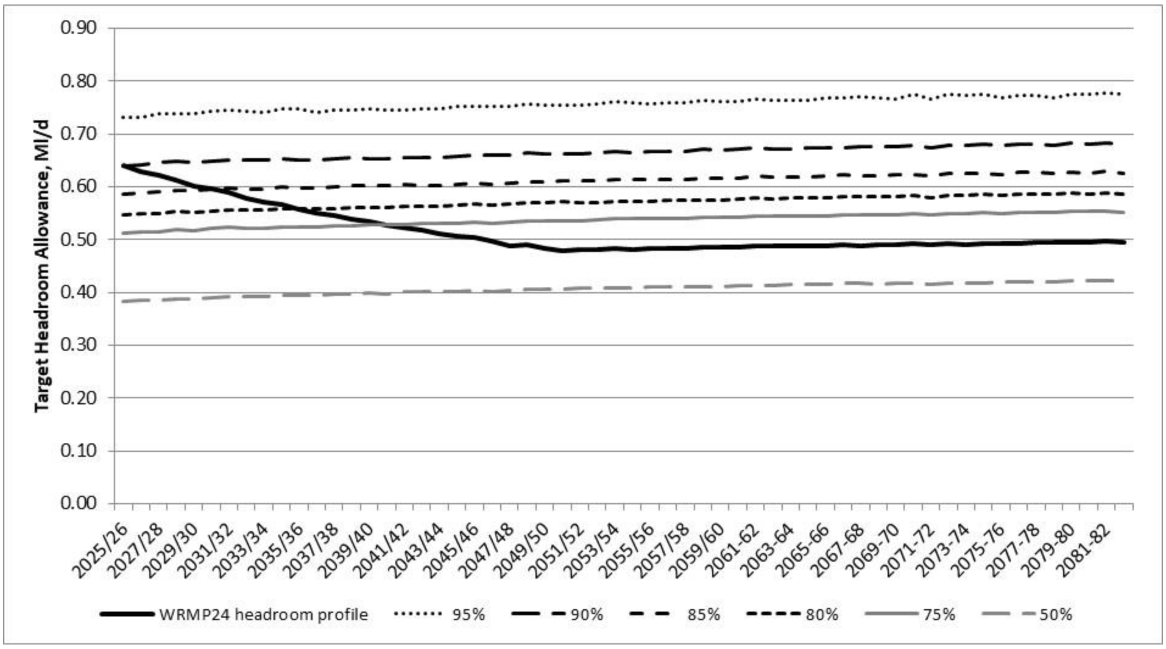


FIGURE 14: TARGET HEADROOM PROFILE FOR BERWICK & FOWBERRY RESOURCE ZONE - BASELINE DRY YEAR ANNUAL AVERAGE SCENARIO

Confidence level	2025/26 Ml/d	2030/31 Ml/d	2035/36 Ml/d	2040/41 Ml/d	2045/46 Ml/d	2050/51 Ml/d	2055/56 Ml/d	2060/61 Ml/d	2065/66 Ml/d	2070/71 Ml/d	2075/76 Ml/d	2080/81 Ml/d	2084/85 Ml/d
0%	-35.67	-40.41	-42.22	-48.20	-44.73	-47.73	-50.71	-51.03	-55.21	-63.77	-62.50	-64.71	-68.15
5%	-13.02	-14.06	-15.05	-16.21	-17.65	-19.41	-20.98	-22.75	-24.76	-26.78	-28.98	-31.17	-33.13
10%	-9.07	-9.68	-10.59	-11.40	-12.63	-13.84	-15.16	-16.53	-18.26	-20.04	-21.95	-23.74	-25.43
15%	-6.40	-6.80	-7.52	-8.17	-9.09	-10.03	-11.12	-12.26	-13.86	-15.37	-17.02	-18.54	-20.02
20%	-4.11	-4.39	-5.01	-5.51	-6.25	-7.06	-7.93	-8.89	-10.24	-11.60	-13.02	-14.39	-15.63
25%	-2.11	-2.30	-2.79	-3.16	-3.81	-4.39	-5.28	-6.02	-7.16	-8.34	-9.55	-10.79	-11.90
30%	-0.24	-0.39	-0.71	-1.07	-1.64	-2.10	-2.79	-3.41	-4.36	-5.36	-6.50	-7.54	-8.56
35%	1.50	1.48	1.17	0.88	0.41	0.11	-0.56	-1.03	-1.85	-2.67	-3.71	-4.59	-5.44
40%	3.23	3.24	3.02	2.71	2.38	2.11	1.57	1.25	0.53	-0.20	-1.10	-1.73	-2.59
45%	4.90	4.96	4.77	4.51	4.29	4.08	3.63	3.43	2.76	2.18	1.40	0.90	0.12
50%	6.67	6.71	6.58	6.31	6.17	6.03	5.66	5.54	4.97	4.51	3.81	3.41	2.74
55%	8.40	8.50	8.42	8.12	8.02	8.02	7.65	7.61	7.18	6.76	6.19	5.87	5.32
60%	10.23	10.35	10.27	10.04	9.91	10.00	9.78	9.74	9.34	9.00	8.60	8.37	7.84
65%	12.17	12.34	12.22	12.02	11.93	12.07	11.88	11.93	11.62	11.28	11.09	10.99	10.46
70%	14.18	14.41	14.31	14.15	14.05	14.30	14.20	14.27	13.99	13.71	13.59	13.64	13.18
75%	16.43	16.77	16.61	16.44	16.38	16.65	16.58	16.81	16.55	16.34	16.27	16.41	16.10
80%	18.98	19.24	19.10	18.99	18.98	19.27	19.38	19.59	19.41	19.24	19.31	19.51	19.26
85%	21.82	22.16	22.07	22.10	22.11	22.34	22.58	22.82	22.68	22.69	22.81	23.03	22.94
90%	25.36	25.82	25.66	25.81	25.90	26.21	26.60	26.81	26.74	26.91	27.12	27.33	27.40
95%	30.33	30.92	30.92	31.19	31.36	31.80	32.23	32.56	32.71	32.86	33.25	33.56	33.71
100%	64.19	67.11	67.80	65.90	67.11	69.08	70.67	66.23	71.15	68.18	71.01	74.16	75.42
Selected	**18.98**	**14.41**	**10.27**	**8.12**	**8.02**	**8.02**	**7.65**	**7.61**	**7.18**	**6.76**	**6.19**	**5.87**	**5.32**
% of DI	*3%*	*2%*	*1%*	*1%*	*1%*	*1%*	*1%*	*1%*	*1%*	*1%*	*1%*	*1%*	*1%*

TABLE 21: HEADROOM DISTRIBUTION FOR KIELDER RESOURCE ZONE - BASELINE DRY YEAR ANNUAL AVERAGE SCENARIO

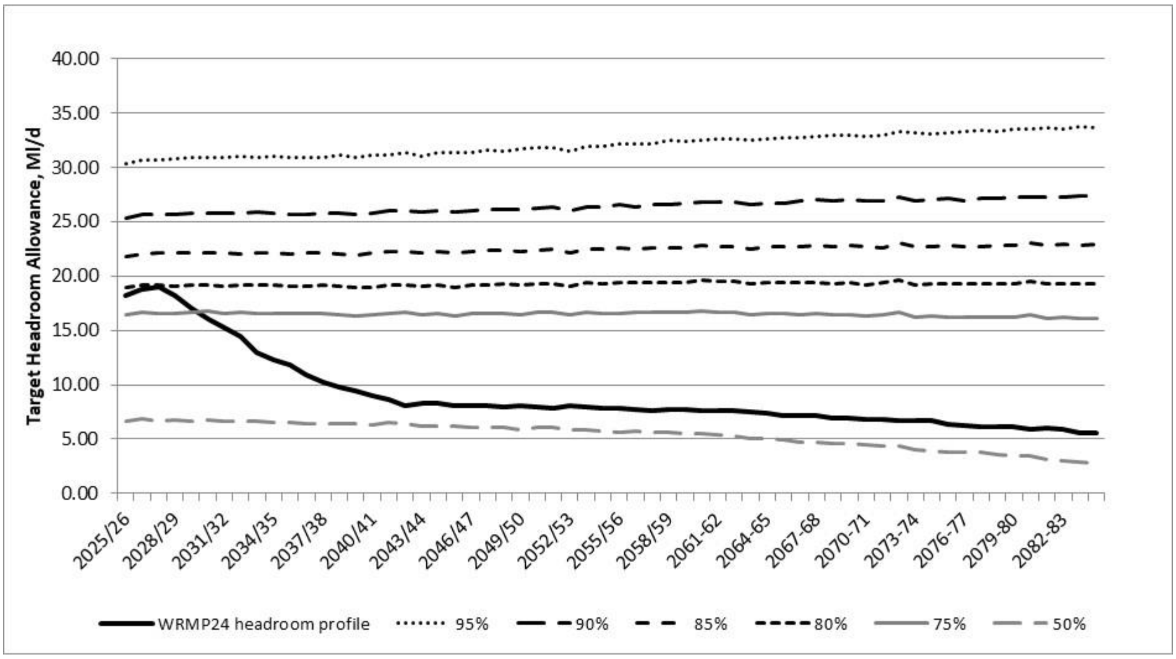


FIGURE 15: TARGET HEADROOM PROFILE FOR KIELDER RESOURCE ZONE - BASELINE DRY YEAR ANNUAL AVERAGE SCENARIO

We also calculated target headroom allowances for the dry year critical period (peak week) scenario, with supply and demand input parameters within the headroom probability distributions adjusted to reflect the relevant critical period forecast data and other changes to model assumptions as appropriate. In particular, the majority of sources and/or supply systems are not impacted by climate change effects in the critical period, as it is generally licence and/or infrastructure constraints which define the deployable output values in this planning scenario.

The baseline target headroom profiles for both planning scenarios (dry year annual average or DYAA, and dry year critical period or DYCP) are summarised below. The selected risk level and associated target headroom allowance, for each of our two resource zones, is presented at 5-yearly intervals across the 25-year planning period, and beyond the statutory period to 2084/85.

WATER	HEADROOM VALUE	2025/26	2030/31	2035/36	2040/41	2045/46	2050/51	2055/56	2060/61	2065/66	2070/71	2075/76	2080/81	2084/85
Berwick & Fowberry	Risk level (%)	10%	15%	20%	25%	30%	35%	35%	35%	35%	35%	35%	35%	35%
	DYAA target headroom allowance (Ml/d)	0.64	0.60	0.56	0.53	0.50	0.48	0.48	0.49	0.49	0.49	0.49	0.50	0.49
	DYCP target headroom allowance (Ml/d)	0.66	0.61	0.57	0.54	0.51	0.48	0.49	0.49	0.49	0.50	0.50	0.50	0.50
Kielder	Risk level (%)	20%	30%	40%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%
	DYAA target headroom allowance (Ml/d)	18.98	14.41	10.27	8.12	8.02	8.02	7.65	7.61	7.18	6.76	6.19	5.87	5.32
	DYCP target headroom allowance (Ml/d)	22.82	18.44	14.43	12.75	13.06	13.49	13.77	14.19	14.45	14.59	14.65	14.90	14.87

TABLE 22: SUMMARY OF TARGET HEADROOM ALLOWANCE FOR ALL RESOURCE ZONES

The target headroom allowance values are lower than those calculated for WRMP19; the main drivers behind this decrease are reduced uncertainty ranges for the demand forecast variation, and for Kielder Resource Zone, which has a surface water-dominated supply system, reduced uncertainty ranges for the impacts of climate change on supply. The latest profiles of dry year annual average headroom allowances reflect a full review for the dWRMP24 assessment, of model assumptions and distribution types, and updates to all input data used to determine model parameters. This has included a comprehensive review of water quality risks at all our groundwater sources, using data on the locations of potential pollution sources from the Ordnance Survey GIS layer combined with likelihood of pollution events for different categories of hazards taken from the Environment Agency's pollution events database.

In line with regulator expectations for dWRMP24, as set out in 'PR24 and beyond: Final guidance on long-term delivery strategies' (Ofwat, April 2022), we have also addressed some of the key uncertainties through an adaptive planning approach. The approach involves testing alternative scenarios and developing alternative pathways which may be implemented should any of these scenarios occur in future. The key uncertainties considered in this process include more extreme climate change impacts and a wider range of demand forecast variation.

6. BASELINE SUPPLY DEMAND BALANCE

6.1 OVERVIEW

The baseline dry year supply and demand forecasts presented in previous sections has been used to produce a Baseline Dry Year Supply Demand Balance for each of our Water Resource Zones. All the known changes to Water Available for Use (WAFU) and the known baseline demand management policies have been included in these calculations.

The baseline supply demand balance calculation is used to identify whether a WRZ is predicted to have a supply deficit at any point over the planning horizon. For each WRZ, a supply demand balance graph has been prepared. The key features on each of the graphs are:

The supply forecast is a forecast of Water Available for Use (WAFU) and the demand forecast is a forecast of Distribution Input (DI).

The key features on each of the graphs are as follows:

- Demand Forecast (the grey dashed line): This is known as Distribution Input and includes all household and non-household demand and among other aspects, an allowance for leakage from our network and from customer's homes;
- Target Headroom profile (the solid blue line): This is an allowance for uncertainties in both the supply and demand forecasts and has been added to the Distribution Input forecast;
- Supply Forecast (the orange line): This is known as Water Available for Use and forecasts how much water is available for use to meet Distribution Input. It takes account of abstraction licence sustainability reductions and other reductions on Deployable Output (DO) as highlighted in section 6.2 and section 6.3;

Climate change has been built into the supply, demand and target headroom forecasts as outlined earlier in this document.

The baseline supply demand balance graphs for each WRZ are presented in the following sections along with commentary on the key features of interest.

6.2 KIELDER WATER RESOURCE ZONE

Figure 16 below shows a baseline supply demand balance for the Kielder WRZ. It shows a static demand forecast and a gentle decreasing trend in WAFU due to the impact of climate change which results in a small supply deficit. Other factors include:

- **Climate change:** We have used the latest CP18 projections which have had a more significant impact on summer river flows, and therefore deployable output, than the previous CP09 projections did;
- **Non-household demand:** Our latest non-household demand forecast includes new demand;
- **1 in 500 supply resilience:** We are required to plan for 1 in 500-year supply resilience from 2040; and
- **New methods:** We have used new statistical methods for forecasting supply and demand, specifically the use of stochastics for supply forecasts.

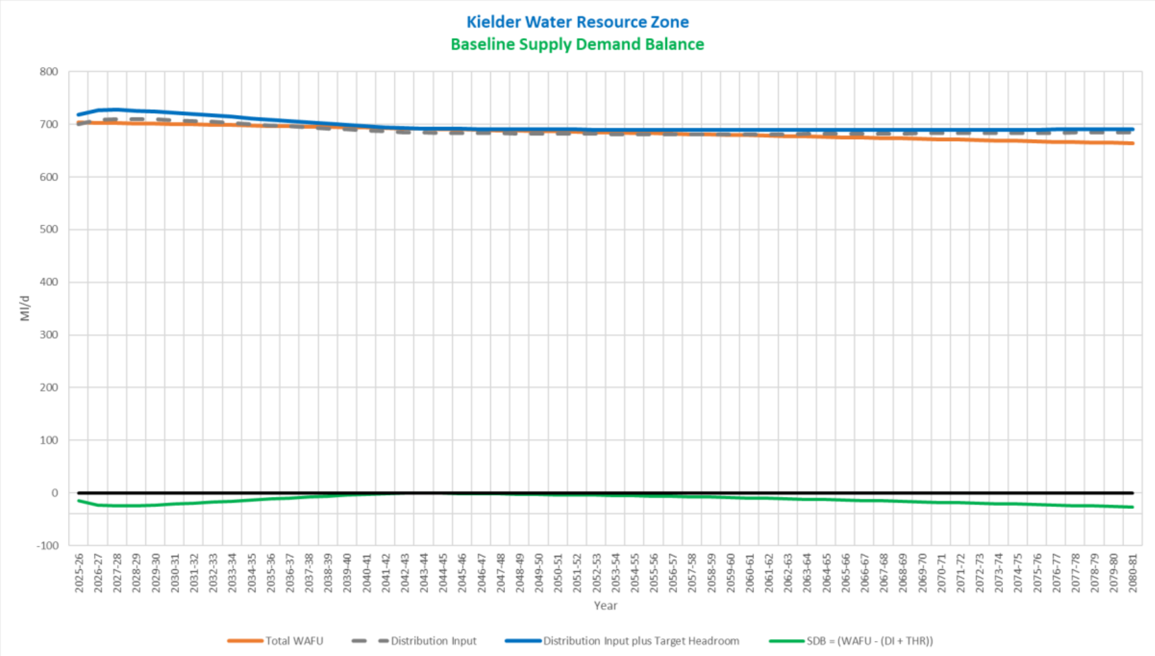


FIGURE 16 KIELDER SDB BASELINE

KIELDER WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP111	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	-8.34	-2.45	4.19	7.18	4.91
Balance of Supply (including headroom)	-23.59	-13.43	-4.41	-0.91	-2.91

TABLE 23: KIELDER WRZ SUPPLY DEFICIT/SURPLUS

6.3 BERWICK AND FOWBERRY RESOURCE ZONE

Figure 15: below shows WAFU, post AMP7 sustainability reductions, remaining level as modelling has shown that climate change does not have a significant impact on recharge of the Fell Sandstone aquifer.

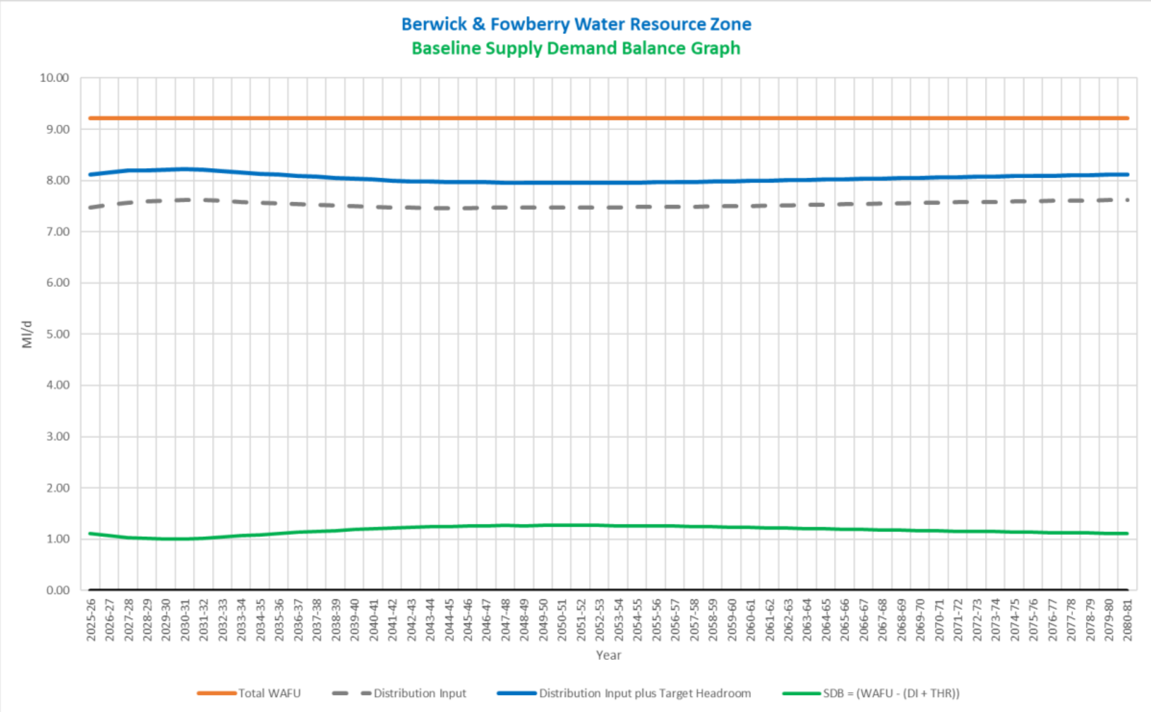


FIGURE 17: BERWICK AND FOWBERRY SDB BASELINE

BERWICK AND FOWBERRY WRZ	END OF AMP	END OF AMP	END OF AMP	END OF AMP	END OF AMP1	END OF PLANNIN G HORIZON
YEAR	2024/25	2029/30	2034/35	2039/40	2044/45	204
Balance of Supply (excluding headroom)	1.83	1.61	1.65	1.72	1.75	1.74
Balance of Supply (including headroom)	1.19	1.00	1.08	1.18	1.25	1.26

TABLE 24: BERWICK AND FOWBERRY WRZ SUPPLY DEFICIT/SURPLUS

7. IDENITIFYING POSSIBLE OPTIONS

7.1 OVERVIEW

We are required to identify possible options:

- Where we have a deficit in our supply-demand balance;
- To supply potential regional or national needs, or supply other sectors;
- To address government expectations, concerns of your customers or local stakeholders; and / or
- To ensure the efficient use of water.

Our Water Available for Use (WAFU) forecast is based on our existing infrastructure constraints (e.g. pumping stations and water treatment works capacities). We are forecasting a small baseline supply deficit in our Kielder Water Resource Zone (WRZ). However, it should be noted that even after our supply requirements have been met. There is still a large surplus of water in Kielder reservoir. An increase in pumping station capacity, specifically the Tyne Tees Transfer system pumping station, would increase our WAFU and restore a supply surplus. However, this is not required as once we have applied the forecast demand savings from our preferred Demand Management Options (DMOs) that are required to meet government expectations for leakage and PCC, a supply surplus is restored across the full planning period. Consequently, we do not need to identify and develop new supply side options to address a supply deficit in our own supply area.

We have investigated water transfer options with neighbouring water companies (United Utilities and Yorkshire Water) and regional water resources groups (Water Resources North and Water Resources West) to supply regional and national need. These are presented in Section 7.2.4 below.

7.2 DEMAND MANAGEMENT OPTIONS

We have identified demand management options that will both meet and exceed government expectations with regards to leakage reduction and Per Capita Consumption (PCC) as well as ensure the efficient use of water. In developing our demand management options, we have considered customers preferences which we confirmed through WRMP24 customer research. A primary consideration for our customers is for us to reduce leakage and to support them in reducing their own water use.

7.2.1 LEAKAGE

In AMP6, the leakage target for the Northumbrian water region was set in line with the Sustainable Economic Level of Leakage (SELL) and remained static over the last four years of the AMP. This level of performance was met in all years except 2017/18 when the “Beast from the East” weather event resulted in an immaterial failure. Due to this approach and the ample water resource position in the North-East, we have been an average performer in the leakage performance tables compared to the rest of the industry.

For AMP7, we implemented the new Ofwat reporting guidelines, published in March 2018, which set out a consistent methodology for calculating leakage across all companies. We also applied the Ofwat requirement to reduce leakage by 15% in 2024/25 from our base position, which meant that 2019/20 was the last year that we used the SELL as a target. Our baseline performance for WRMP24 is to maintain this lower level of leakage for the whole of the planning period. Future base funding will need to be sufficient to prevent deterioration of our existing network and to account for the additional growth in the network.

After a difficult first year in AMP7, we have since delivered a good reduction in leakage of 9.5Ml/d in 2021/22 compared to 2020/21. This means that although we have not met our targets in the first two years of the AMP, based on a three-year rolling average, our annual performance was the lowest it has ever been. We will continue to work towards our 2024/25 target. Some of the key projects that are currently ongoing include:

- Water Balance Review – improve the accuracy of the six main demand components.
- Pressure Management – maintain and optimise the 1080 existing PRVs, identify any potential for new opportunities.
- Active Leakage Control – reduce leakage in our 1,247 DMAs by looking at new ways to identify and locate leaks using digital twins, acoustic loggers and satellite surveys.

We have looked at all the available options following the PALM process (Prevent, Aware, Locate and Mend), which is widely used in the industry to segregate the various stages in the “life of a leak”. It is important to look at the potential improvements in each of these stages to determine the optimum plan for reducing leakage.

Across all these stages, innovation will be a key enabler to deliver a step change in performance. NW are actively working on several trials, and we have been very successful at acquiring funding from the Ofwat Innovation Competition. One of our biggest projects is the National Leakage Research Centre which will provide the facilities to accelerate new ideas in this space and help us towards our future goals.
It is expected that we will deliver the maximum potential benefit from some of these interventions over the next three years as we work towards our AMP7 targets so there may be no further scope for some of these activities in AMP8. For example, there is only a finite number of areas where we can reduce pressure without compromising customer levels of service.

The key options we have considered are increasing our active leakage control activities through the implementation of a smart network of permanently installed hydrophones and increasing the replacement rate of the distribution network to reduce background leakage.
As better data becomes available, including customer consumption profiles from our increasing stock of smart meters or trunk mains leakage estimates from flow balances, we will review our approach on a regular basis.

In line with the work done by the regional water resource groups, a range of leakage scenarios have been modelled based on the following criteria, as a percentage reduction from the original base position (the three-year average between 2017/18 and 2019/20):

- High demand, a 30% reduction in leakage by 2049/50
- Medium demand, a 40% reduction in leakage by 2049/50
- Low demand, a 50% reduction in leakage by 2049/50

Leakage which occurs on customer supply pipes is included within the total leakage figure but is reported separately within the WRMP tables. We estimate this volume based on the leakage allowances we apply to customer bills, and it currently accounts for about 20% of the reported leakage. For the WRMP forecast we have applied an equivalent percentage reduction in household supply pipe leakage to each of the three leakage scenarios.

In WRMP24 there are some minor changes to the leakage figures in WRMP19 due to the final impact of moving to the consistent reporting guidelines in 2020/21. Also, there is a small change to the baseline position that was previously applied, moving from the 2019/20 PC to the three-year average performance between 2017/18 and 2019/20.

In WRMP19 we committed to a 10% reduction per AMP up to 2045, if this approach was extended by a further AMP, then the 50% reduction is achieved by 2049/50. In WRMP24 we have replaced this with a glidepath to hit the different percentage reductions in 2049/50 from the 2019/20 base position.

To align with the national commitment, we have selected the 50% reduction by 2049/50 for our preferred plan.

For a detailed report on this section please refer to the Leakage technical report.

7.2.2 METERING

Reducing per capita consumption is a key deliverable in demand management and water meters are seen as one of the main tools in helping to reduce PCC.

Since 1989 all new properties are metered as the only way of charging for water and sewage services as, assigning new rateable values ceased. A number of diverse reasons drive the move from an unmeasured water supply, where the occupant is charged according to the rateable value of the property, to a metered supply. At Northumbrian Water we have been running optant and selective discretionary usage metering schemes since the legislation was introduced to do so.

In AMP7 we made a move to install only smart meters on all household premises and we propose to continue this through AMP8. Although every household meter now installed is smart, these are split into two categories: smart capable and smart active. A smart active meter is a meter that is connected to the network, and we are receiving hourly data. Smart capable meters, have the ability to be connected to the network at a later date, but are not currently activated. In the short term this will enable drive by or walk by reading to ensure customers on a meter will always receive bills based on a reading. By 2030 we aim to link all current smart capable meters to a wide area network.

Whilst new property meter installations do not make up our DMO metering options, these do contribute to a large number of meter installations throughout the AMP. As mentioned above, every household meter now installed is smart capable and, in AMP8, all new properties will also have the smart point installed, so these meters will be smart active, as we will have coverage across both regions.

Smart meters connected to a communications network bring many benefits for both NW and our customers. Work has been underway in AMP7 to enhance our existing customer app and web capability, to allow customers with a smart active meter to view their consumption over various time frames, receive alerts and alarms regarding consumption, alerts where there is suspected customer side leakage and get water saving tips.

With smart metering we move from 6 monthly consumption readings to 24 readings per day. Due to the significant volume of additional data that is now being captured by the smart meters, we are in the process of implementing a replacement meter data management system (MDMS). This will allow us to handle such large volumes of data much more efficiently.

The additional consumption data will also greatly benefit the demand calculations, in particular on customers that have had a meter installed under the WAM approach where the customer has not switched, as this will give us far more consumption data on unmeasured properties than we have not had available previously.

Recent customer research shows the predominant reason for electing for a meter is financial and customers who live in low occupancy premises with a high rateable value, tend to opt for a meter to lower their water and sewage bills. Following a number of years of optant installation being in the region of 16,000, we have seen these numbers drop slightly in AMP7 and are not forecasting to meet our WRMP19 metering targets.

For dWRMP24 we have looked at 5 different metering demand management options, which can be seen in the table below. The Northumbrian Water area has a surplus of supply over demand in its Kielder WRZ and the area is not classed as seriously water stressed. Therefore. compulsory metering cannot be considered.

OPTION NAME	OPTION
Option 1: Optant programme - Low Impact	In the low impact scenario only optant and reactive replacement schemes are in place. This scenario assumes that there is no longer an ambition for all meters to be smart ‘enabled’ and as such there is no proactive replacement scheme. There is no promotional activity regarding meters and no selective installation schemes.
Option 2: Enhanced optant and WAM programme- Medium Impact 1 -(fully smart by 2035)	This scenario includes an enhanced optant scheme with campaigns to promote meters. There would also be a ‘whole area metering’ programme in place, where we would install meters in existing boundary boxes, however, the customer will not automatically be charged by the meter. These customers would be given comparison bills to enable them to decide whether a measured tariff would be beneficial to them.

OPTION NAME	OPTION
	If a customer opts to switch to a measured tariff, they will have the same rights to revert to an unmeasured tariff within 2 years of them switching, as a customer applying for a meter would. Any change in occupation on these premises that have not switched to the measured tariff, will be automatically charged by the meter when a new occupier moves in. As well as the reactive replacement programme the medium option also includes a proactive replacement scheme to replace existing meters with smart 'enabled' meters i.e., meters which send hourly readings via a communications network. Meters under this scheme are replaced when financially viable to do so over AMP 8 and AMP 9 to reach the stated ambition of all meters being smart 'enabled' by 2035.
Option 3: Enhanced optant and WAM programme- Medium Impact 2 -(fully smart by 2030)	Identical to medium impact 1 other than the proactive replacement programme is accelerated to achieve a fully smart meter portfolio by 2030. This is to achieve the demand reduction benefits of smart enabled meters sooner.
Option 4: Targeted enhanced optant and WAM programme: High Impact 1 (smart by 2035)	High impact scenarios for the Kielder WRZ include a targeted enhanced optant scheme, whereby customers who would benefit financially from a switch to measured billing, will be proactively contacted to encourage sign up, as well as targeted campaigns to DMAs where the supply demand situation would benefit from a higher percentage of meter penetration. As well as the reactive replacement programme the medium option also includes a proactive replacement scheme to replace existing meters with smart 'enabled' meters i.e., meters which send hourly readings via a communications network. Meters under this scheme are replaced when financially viable to do so over AMP 8 and AMP 9 to reach the stated ambition of all meters being smart 'enabled' by 2035.
Option 5: Targeted enhanced optant and WAM programme: High Impact 2 (smart by 2030)	Identical to High impact 1 other than the proactive replacement programme is accelerated to achieve a fully smart meter portfolio by 2030. This is to achieve the demand reduction benefits of smart enabled meters sooner.

TABLE 25: METERING OPTIONS

Our preferred option for Northumbrian Water is option 5, due to a surplus of supply in AMP8, but acknowledging that optant numbers have started to decline, so introducing enhanced optant and whole area metering schemes.

For a detailed report on this section please refer to the Metering technical report.

7.2.3 WATER EFFICIENCY

As part of the Demand Management Options for NW's Draft Water Resource Management Plan (dWRMP). Water Efficiency plays a key role in the strategy for PCC reduction across AMP 7 and continues into AMP 8.

We have been widely regarded as an industry leader in the field of water efficiency. This long-standing reputation is a result of the successful delivery of effective water efficiency strategies over the years, enhanced by sharing the various project outcomes with many stakeholders, including regulators and Government. In AMP7, the Environment Agency and Defra accepted our WRMP's water efficiency proposals to annually reduce PCC by 7.7 l/person/day for NW and 9.2 l/person/day for ESW by delivering water efficiency activities.

Water efficiency has remained a key strand of our demand management undertakings throughout AMP6. Having initiated the first water efficiency retrofit programme in 1997, we are able to demonstrate the successful delivery of industry-leading projects, schemes and initiatives spanning over twenty years. These activities have resulted in quantifiable water savings, unrivalled customer experiences and a significant contribution to the water efficiency evidence base. Our strategy has, and continues to be, designed to create water efficiency programmes that make genuine long-term savings in water, as cost effectively as possible.

Behavioural change engagement, incentivisation, flow regulation and a leap into the digital space for water efficiency support our option scenarios for the next dWRMP. We believe the options we have put forward allow us to ensure we are achieving sustainable high levels of water savings, the options will also allow us to increase the effectiveness of our water efficiency retrofit projects, put stronger emphasis on the measurement of water savings, develop interest in the sustainability of savings, and create determined focus on the delivery of sustained behaviour change across the industry. All while continuing to proactively share and disseminate the results, experience and learning far and wide.
Our key drivers for establishing a strong option plan as part of the dWRMP for PR24 emphasise and are driven by new ways of doing things with this current AMP and applying our learnings into 2025 and beyond. The key focus of the strategy is targeting our highest using customers to establish understanding and removal of barriers to efficient practices to maximise water savings, over a longer period.

As part of the methodology, it was decided that activities which will be used for the Water Efficiency options, cost per litre and savings per property were considered. An activity was only considered if the options was less than three pounds per litres saved and saved 30 litres (or more) litres per day to achieve a substantial reduction in PCC.
The options have been created to ensure that we can continue working towards our ambitious target of 118 by 2040. The method which has been used followed the guidelines produced by the Environment Agency.

A consideration which will be actioned is collaboration across the water efficiency space amongst the water industry, this approach is fundamental to work with others to better our understanding and practices across the UK industry to learn and better our water saving potential.

As well as this, innovation will underpin all our water efficiency activity moving forward, a shift further into customer engagement to allow more effective and sustainable behaviour change while understanding customers further to benefit from sustained savings. Three Water Efficiency option scenarios were created as part of this process.

SCENARIO	OPTION	DEMAND SAVING (L/HD/D)
Low	▪ Top 5% Highest Users Visits ▪ Unmeasured property engagement ▪ Internal leakage repair – visits ▪ Find and Fix Teams - bulk supply ▪ New Homes - Flow restrictions ▪ Older Homes - Flow restrictions	0.49
Medium	▪ Top 5% Highest Users Visits ▪ Unmeasured property engagement ▪ Internal leakage repair – education and visits ▪ Find and Fix Teams - bulk supply ▪ Educational interactions (Digital) ▪ Digital Engagement ▪ National Campaign ▪ Toilet Rebates ▪ Home Flow restrictions	0.97
High	▪ Top 5% Highest Users Visits ▪ Unmeasured property engagement ▪ Internal leakage repair – education and visits ▪ Find and Fix Teams - bulk supply ▪ Educational interactions (Digital) ▪ Digital Engagement ▪ National Campaign ▪ Toilet Rebates ▪ Home Flow restrictions	1.08

TABLE 26: WATER EFFICIENCY OPTIONS

Please refer to our Annual Performance Report here for more detailed information about the impact of the Covid-19 pandemic.

For a detailed report on this section please refer to the Water Efficiency technical report.

7.2.4 WATER EXPORT OPTIONS

Kielder reservoir has a surplus of raw water after the requirements of our household and non-household customers have been met. Consequently, new raw water exports have been considered as part of developing regional plans. These include:

- A range of raw water exports directly from Kielder reservoir to United Utilities either to support resilience within United Utilities own supply area or to facilitate a transfer of water south into serious water stressed areas with a supply deficit. We have undertaken more detailed assessments with United Utilities on a 100Ml/d export. New United Utilities assets would include a new abstraction licence, reservoir intake and pumping station and a raw water strategic pipeline.
- A range of raw water export from the River Tees to Yorkshire Water, supported by Kielder reservoir via the Tyne Tees Transfer system. We have particularly focused on a 140Ml/d option. New Yorkshire Water assets would include a new pump in a currently empty NWL pumping station bay and a raw water strategic pipeline. Additionally, an upgrade of Riding Mill Pumping Station would also be required including the installation of an additional pump and a new electrical supply.

The Kielder to United Utilities export has not been included in either Water Resources West's or United Utilities Best Value Plans and so has not been included in Water Resources North's or our Best Value Plans. This is because there are many other supply options with a lower unit cost (i.e. £/Ml) which provide better value for money.

The 140Ml/d River Tees to Yorkshire water option is included in WReN, Yorkshire Water and our own (see Section 8) Best Value Plans albeit it is not required until 2040. We have also considered a 10Ml/d export of treated water from our Darlington WTWs to Yorkshire Water although this is not in Yorkshire Water's Best Value Plan.

It should be noted that modelling has confirmed that when providing a 1 in 500 level of supply resilience to our customers, the surplus of water in Kielder reservoir means we can only provide a raw water export to one of the companies and so as things stand, this will be to Yorkshire Water only.

7.3 DROUGHT PERMITS AND DROUGHT ORDERS

Drought permits and drought orders are drought management actions that, if granted, can allow more flexibility to manage water resources and the effects of drought on public water supply and the environment. However, we do not have any drought permits or drought orders in our Northumbrian Water Drought Plan, largely because of the resilience provided by Kielder reservoir and the Tyne Tees Transfer and so do not need them.

8. OUR BEST VALUE PLAN

8.1 OVERVIEW

The aim of the WRMP is to present a long-term plan to ensure a secure supply of wholesome drinking water for customers and to protect and enhance the environment.

Best Value Planning occurs after the following steps:

- development of a baseline supply demand forecast for the plan identifying that water resources zones are in deficit over the planning period,
- and options appraisal and development of feasible supply and demand options to address the deficit.

The baseline supply demand balance for the Berwick and Fowberry WRZ confirms a 1 in 500 supply surplus across the planning period. Consequently, no further supply side options are required.

The baseline supply demand balance for the Kielder WRZ confirms a supply deficit across the planning period. However, once the demand savings from our preferred demand management options that are required to meet government expectations are applied, a supply surplus is then confirmed for the full planning period.

For a detailed report on our options appraisal please refer to the Options Appraisal technical report.

8.2 BEST VALUE PLAN OBJECTIVES

We have set the following objectives to achieve though our Best Value Plan:

- Achieve a secure, resilient and sustainable supply of water for our customers, moving to a 1 in 500 level of resilience by 2049/50;
- Protect and enhance the environment, ensuring our abstractions are sustainable both in the short and long term;
- Reduce leakage from our network and from customer's homes, contributing to a national target of 50% reduction from 2017/18 levels by 2049/50;
- Reduce customer demand to 110l/head/day by 2049/50; and
- For all our meters to be smart meters by 2035.

Our objectives have been chosen because they align with:

- Our own Purpose, Vision and Values
- Our current performance commitments and ODIs
- Water Resources North's regional plan objectives
- Government expectations for water companies WRMP24s including outcomes of the 25 Year Environment Plan and our local River Basin Management Plans; and
- The overall requirements of the PR24 Water Resources Planning Guideline.

8.3 OUR FINAL BEST VALUE PLAN

8.3.1 SUPPLY OPTIONS

As we are forecasting final plan supply surpluses in both our WRZs, there is no need to identify, develop and appraise new supply options. Consequently, our Best Value Plan comprises only demand management options.

8.3.2 DEMAND MANAGEMENT OPTIONS

Our preferred demand management options are those to meet government expectations and are summarised in Table 27 below.

SCHEME	AMP8 COST (£m)
Leakage Active Leakage Control to reduce leakage by 50% by 2049/50	14.4
Metering Replacement of existing meters with smart meters by 2035 and Enhanced Optant Smart Metering	77.8
Water Efficiency Programme In home interventions and digital engagement to reduce PCC to 110l/head/day by 2049/50	8.2
Total	100.4

TABLE 27: OUR PREFERRED DEMAND MANAGEMENT OPTIONS

Leakage

To align with the national commitment, we have selected the 50% reduction by 2049/50 compared to our 2019/20 three-year average baseline leakage levels (i.e. average of 2017/18, 2018/19 and 2019/20) for our preferred plan. In WRMP19 we committed to a 10% reduction every five years up to 2045. If this approach was extended by a further five year period, then the 50% reduction is achieved by 2049/50. In WRMP24 we have replaced this with a glidepath to hit the different percentage reductions in 2049/50 from the 2019/20 base position.

Metering

Customers paying by the volume of water they use is the fairest way of charging customers and we have promoted the benefits of this widely. Our preferred metering option includes enhanced optant metering and whole area metering schemes with fully smart meters by 2035. This has been selected due to the surplus supply in 2025-30, but acknowledges that natural optant metering numbers have declined in recent years. Importantly, we would like to do this using smart water meters. They have many benefits and will provide information to customers so that they can make more informed choices about how they use water. They will also help customers identify when they might have a leaking pipe or toilet and will help us support high water use customers become more water efficient.

Water efficiency

We plan to upscale this important work from 2025 to help our customers use less water. These schemes along with our smart metering programme and government interventions in relation to White Goods Labelling and Updating Building Regulations will enable us to meet our PCC target of 110l/hd/d by 2049/50.
Our baseline supply demand balance forecasts have been updated to reflect the demand savings from our preferred demand management options and are presented as final plan supply demand balances graphs in Figures 8 and 9 below.

As confirmed above, the savings from these options increases the supply surplus in the Berwick WRZ and restores a supply surplus in the Kielder WRZ.

8.3.3 SUPPORTING CUSTOMERS

While many customers will find they can financially benefit from moving to a water meter, for some there is a risk that they will be worse off, and we will take a holistic and customer-centric approach to the installation of water meters and the range of support we offer. We know from our Vulnerability Research in 2016 that awareness of the extra support available is very low in our customer base, so this support may not be reaching customers who need it most. We have done a lot since then to ensure customers are receiving all the support they can get, and we need to do more in 2025-30 if we introduce a compulsory metering scheme.

To support customers we will proactively communicate the benefits of opting a meter clearly stating what having a meter means for bills and the way they pay, and what financial and non-financial support options are available. Communication will be share across a range of different channels, and in multiple languages, to support all key demographics and ethnicities and we will review opportunities to create a dedicated, multi-disciplinary, team to support the experience for customers and provide a single point of access to the range of services we offer.

To support the elderly and those with visible and non-visible disabilities we will offer alternative meter placement if the location would result in the customer being otherwise unable to access and read a meter for themselves and targeted financial support will be given to customers in financial hardship through schemes like social tariffs and WaterSure, which is a scheme intended to assist customers who may use higher than average amounts of water. We will also use tariffs, and investigate opportunities for new, innovative, tariffs to support households, especially multi-generational households, and provide peace of mind through investigating options to offer additional value-add services. We will research options to postpone switching to measured bills if this would help customers budget improve overall affordability and we will work to understand additional opportunities arising from the Digital Economy Act which may enable us to provide further support to hard-to-reach customers.

8.3.4 INTER AND INTRA REGIONAL TRANSFERS

As agreed with Yorkshire Water, our Best Value Plan includes a 140Ml/d export to Yorkshire Water's supply area in 2040. We will continue to work with Yorkshire Water and Water Resources North in developing this option.

8.4 FINAL PLAN SUPPLY DEMAND BALANCE

8.4.1 OVERVIEW

We have carefully followed the WRPG and believe we have prepared a robust draft WRMP. The baseline supply demand balance in Section 6 of this report has confirmed the nature of the balance of supply for each WRZ. A final planning scenario supply demand balance calculation has been prepared for each of the WRZ's which includes a final plan DI forecast based on our leakage, metering and water efficiency strategies (see section 7) going forwards.

A final planning scenario supply demand balance graph and tabled summary data (with and without target headroom) is presented for each WRZ in the following sections.

8.4.2 KIELDER WRZ

The baseline supply demand balance graph for the Kielder WRZ confirmed a small supply deficit throughout the planning period.

The final plan supply demand balance shown in Figure 8 below shows a supply surplus across the planning period from 2025 to 2084. This is due to demand side drought measures increasing our 1-500 deployable output, along with demand for water decreasing as a result of our metering, water efficiency and leakage strategies.

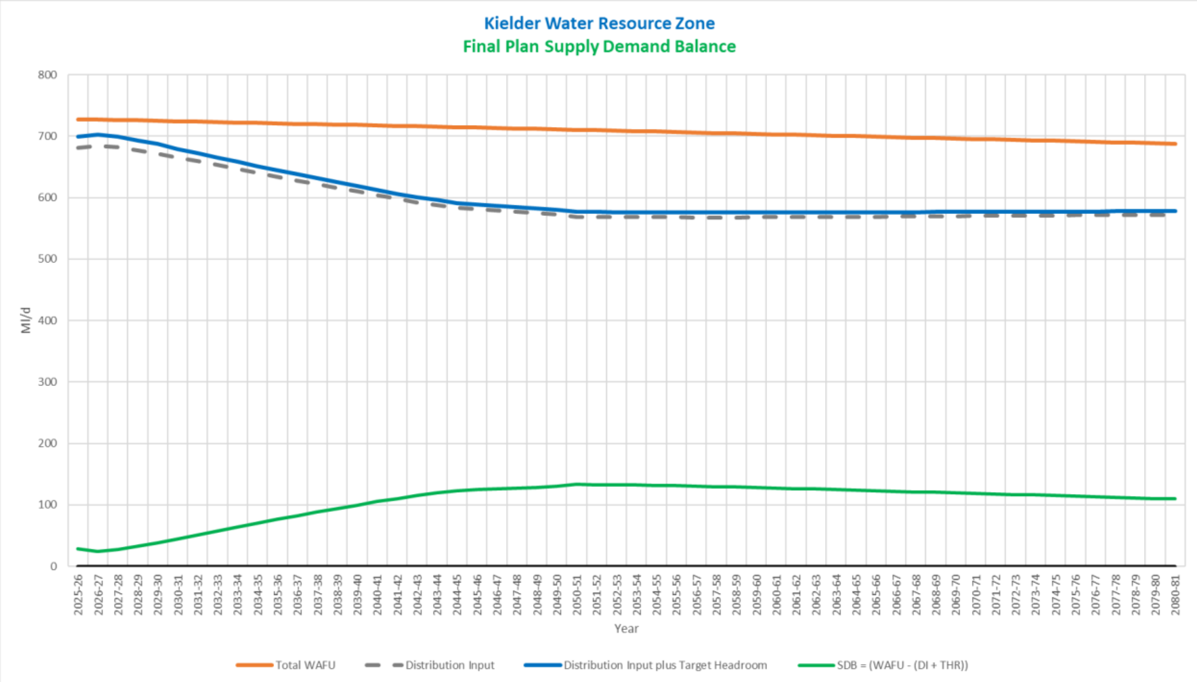


FIGURE 18: KIELDER WRZ DRAFT WRMP FINAL PLANNING SUPPLY DEMAND BALANCE

KIELDER WRZ	END OF AMP7	END OF AMP8	END OF AMP9	END OF	END OF AMP111	END OF PLANNING HORIZON
YEAR	2024/25	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	45.83	53.17	81.73	108.32	131.29	138.12
Balance of Supply (including headroom)	27.03	37.92	70.75	99.71	123.18	130.28

TABLE 28: KIELDER WRZ SUPPLY SURPLUS

8.4.3 BERWICK AND FOWBERRY WRZ

The baseline supply demand balance graph for the Berwick and Fowberry WRZ showed that a supply surplus was maintained across the full planning period. The supply surplus in the final plan supply demand balance shown in Figure 19 is slightly higher reflecting our final plan metering, water efficiency and leakage strategies.

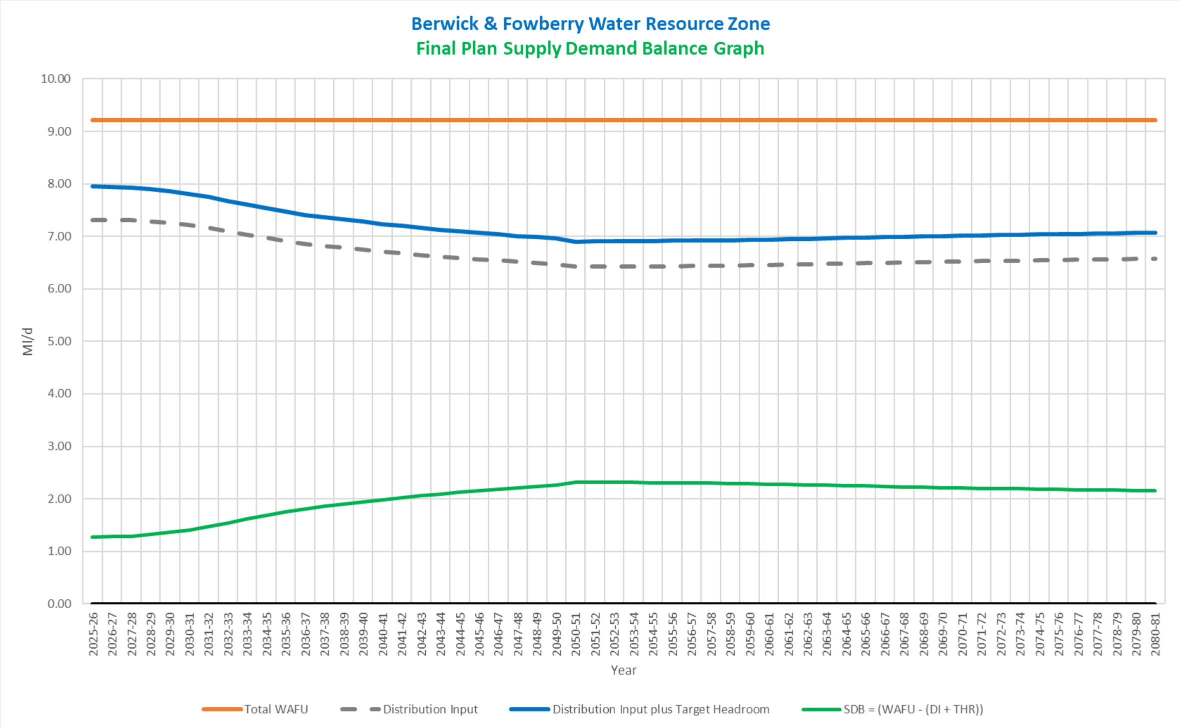


FIGURE 19: BERWICK AND FOWBERRY DRAFT WRMP FINAL PLANNING SUPPLY DEMAND BALANCE

BERWICK AND FOWBERRY WRZ	END OF AMP7	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP111	END OF PLANNING HORIZON
YEAR	2024/25	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	1.83	1.96	2.24	2.47	2.63	2.74
Balance of Supply (including headroom)	1.19	1.36	1.68	1.94	2.12	2.26

TABLE 29: BERWICK AND FOWBERRY WRZ SUPPLY SURPLUS

8.5 FINAL PLAN SCENARIO TESTING

8.5.1 OVERVIEW

A WRMP24 requirement is to undertake sensitivity testing to different planning assumptions. Ofwat has set out common reference scenarios with high and low parameters for climate change, demand and environmental ambition, details of which can be seen in the table below. No long-term abstraction sustainability reductions under Environmental Destination are required for our Northumbrian Water region and so they have not been included in the scenario testing.

We have undertaken this sensitivity analysis for both WRZs focusing on the Ofwat common reference scenarios. No supply deficits are caused by any of the scenarios and so we are confident that our best value plan which only comprises DMOs is sufficient to maintain a 1:500-year supply surplus in both WRZs and is a is a no regrets plan.

All demand forecasts provided for final planning scenario testing are adjusted to include an uplift from normal year demand to dry year.

OFWAT	SUPPLY	DEMAND COMPONENT	CLIMATE CHANGE
Preferred Plan	Final Plan 1-500 Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	**Growth**: Uses population, property and occupancy forecasts derived from local plans published by the local council. **Building regulations and product standards**: Assumes the introduction in 2025 of a mandatory government-led scheme to label water-using products. **DMOs**: Final plan DMOs	UKCP18 RCM projections, RCP8.5, 50th percentile scaled to RCP6.0.
Peak Week (Dry Year Critical Period)	Final Plan Critical Period Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	UKWIR Peak demand forecasting report. Artesia Water demand insights report. Berwick, demand uplift unmeasured HH 25%, Measured 28% Kielder, demand uplift unmeasured HH 18%, Measured 21%	UKCP18 RCM projections, RCP8.5, 50th percentile scaled to RCP6.0.
Low Climate Change	Final Plan 1-500 Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	Preferred Plan with: UKWIR 'Impact of Climate Change on Water Demand. Most-likely effects of climate change the 50th percentile	UKCP18 probabilistic projections, RCP2.6, 50th percentile
High Climate Change	Final Plan 1-500 Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	Preferred Plan with: UKWIR 'Impact of Climate Change on Water, least likely (maximum) effect of climate change of demand the 90th percentile	UKCP18 RCM projections, RCP8.5, 50th percentile.
High Demand	Final Plan 1-500 Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	**Growth**: Uses population, property and occupancy forecasts derived from local authority housing need forecasts. **Building regulations and product standards.** Assumes the introduction in 2025 of a mandatory government-led scheme to label water-using products. **DMOs**: Low demand DMOs	UKCP18 RCM projections, RCP8.5, 50th percentile scaled to RCP6.0.
Low Demand	Final Plan 1-500 Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	**Growth:** Uses population, property and occupancy forecasts derived from ONS population and household projections. **Building regulations and product standards**: Assumes the introduction in 2025 of a mandatory government-led scheme to label water-using products. **DMOs**: High demand DMOs	UKCP18 RCM projections, RCP8.5, 50th percentile scaled to RCP6.0.
Slow Technology	Final Plan 1-500 Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	**Growth**: Uses population, property and occupancy forecasts derived from local plans published by the local council. **Building regulations and product standards:** Assumes no change over the period to 2050. **DMOs**: Low demand DMOs	UKCP18 RCM projections, RCP8.5, 50th percentile scaled to RCP6.0.
Fast Technology	Final Plan 1-500 Deployable Output, 90th percentile Outage Allowance, Low Risk Target Headroom	**Growth:** Uses population, property and occupancy forecasts derived from ONS population and household projections. **Building regulations and product standards**: Assumes the introduction in 2025 of a mandatory government-led scheme to label water-using products. **DMOs**: High demand DMOs	UKCP18 RCM projections, RCP8.5, 50th percentile scaled to RCP6.0.

TABLE 30: SUPPLY AND DEMAND SCENARIO TESTING

8.5.2 KIELDER WRZ RESULTS

The table below compares the supply demand balance for the Kielder water resource zone for our central planning scenario against each of the Ofwat common reference scenarios and peak week demand (dry year critical period).

Scenario Name	End of AMP8	End of AMP9	End of AMP10	End of AMP11	End of AMP12
Preferred Plan	37	70	99	122	129
Peak Week (DYCP)	47	84	116	143	150
Low Climate Change	59	95	128	155	165
High Climate Change	14	43	69	88	92
High Demand Scenario	33	60	81	99	103
Low Demand Scenario	35	69	99	125	133

TABLE 31: KIELDER – CENTRAL SCENARIO AGAINST OFWAT COMMON REFERENCE SCENARIOS

8.5.3 BERWICK & FOWBERRY WRZ RESULTS

The table below compares the supply demand balance for the Berwick & Fowberry water resource zone for our central planning scenario against each of the Ofwat common reference scenarios and peak week demand (dry year critical period).

SCENARIO NAME	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF AMP12
Preferred Plan	1.5	1.9	2.2	2.4	2.6
Peak Week (DYCP)	0.8	1.1	1.4	1.6	1.7
Low Climate Change	1.5	1.9	2.2	2.4	2.6
High Climate Change	1.5	1.9	2.2	2.4	2.6
High Demand Scenario	1.3	1.6	1.8	1.9	2.0
Low Demand Scenario	1.4	1.7	2.0	2.2	2.3

TABLE 32: BERWICK – CENTRAL SCENARIO AGAINST OFWAT COMMON REFERENCE SCENARIOS

8.6 FINAL PLAN ADAPTIVE PROGRAMMES

Adaptive planning is a framework that is used to manage risk and uncertainty in the Best Value Plan. An adaptive plan presents:

- a central pathway and preferred programme representing the most likely future (based on the uncertainties); and
- alternative pathways and programmes should our supply and/or demand forecasts out-turn differently.

We have prepared our baseline and final plan supply demand forecasts using central (most likely) planning assumptions although these have uncertainties including:

- how water company and government measures to reduce customer demand, known as per capita consumption (PCC), will reduce over time;
- how quickly the climate will change and as it does, how this will affect rainfall patterns and totals, river flows, reservoir refill and groundwater recharge; and
- how resilient the environment will be to climate change and whether water company abstraction licences will need to be reduced further in the future to ensure enough water is left in the environment so that it is able to be resilient to future climate change.

Consequently, we have undertaken sensitivity testing (see Section ?) to understand whether our central (most likely) final plan supply demand balance, and therefore our Best Value Plan, is sensitive to less likely (low or high) planning assumptions on demand, climate change and environmental destination abstraction sustainability reductions.

Defra and the EA expect water companies to adopt an adaptive planning approach where:

- there is significant uncertainty, particularly in the first 5-10 years of the planning period;
- a strategic decision needs to be made in the plan's medium term but where there is a long lead in time; or
- there is large long-term uncertainty which might lead to consideration of different preferred options.

The sensitivity testing has shown that under all scenarios, a supply surplus is maintained in both our WRZs across the planning period. Consequently, we do not need our preferred Best Value Plan to be an adaptive plan.

8.7 OUR FINAL PLAN JUSTIFICATION

8.7.1 OVERVIEW

This section presents our justification for our Best Value Plan and summarises how we have met key requirements in developing it.

8.7.2 DELIVERING OUR PLANS AFFORDABLY

We have developed an efficient Best Value Plan using a best practice decision making process involving EBSD cost modelling and multi-criteria assessment.

We know that clean and clear water is a priority for our customers. The investment that Ofwat allows for these plans will help us to continue to provide this essential service long into the future, but the cost of investments will be added to customer bills.

We know that this is a difficult time for customers with the current cost of living pressures that we are experiencing. Alongside our dWRMP24 we continue to work hard to make sure that our bills remain affordable for all. We were the first company in the industry to commit to reaching zero water poverty by 2030, a target that we are currently ahead of, and we are proud to have the lowest bills in England. We are committed to intergenerational equity and we will ensure that there is no cross subsidy between current customers and future customers.

There is a lot more that water companies need to do in the future than has been delivered in the past meaning we require a much larger investment across all areas of our business, for example, meeting the Government's targets to reduce storm overflows will represent 'the largest infrastructure project to restore the environment in water company history'.

We are working hard with our partners to meet the challenge, but the scale of new work is substantial. We have developed our plans with our customers in mind to manage the impact on customer bills while making sure there will be enough water in the region in the future.

We will consult customer and stakeholders to understand their preferences and priorities on the final WRMP January 2023 and then the draft PR24 Business Plan as a whole 'acceptability research programme' later in the year. We will be able to give a more holistic view of the possible impact on bills across all services so we can build future plans that meet those priorities and balance the need for investment with affordability.

The impact of the 'best value plan' that we are proposing would be around an 11% impact on charges in the region.

As the cost of living and utility bills rise, we understand it's a difficult time for many. If customers are struggling to pay their bills or falling into debt, we ask that they get in touch. There are many ways we can help our customers, from payment breaks and low-income discounts to advice on saving water which can help lower your energy bills too.

8.7.3 HAVE WE MET OUR WRMP24 OBJECTIVES?

Table 33 below reproduces the objectives and summarises how we believe our Best Value Plan will deliver them.

WRMP24 BEST VALUE PLAN OBJECTIVE	ACHIEVED?	
Achieve a secure, resilient and sustainable supply of water for our customers, moving to a 1 in 500 level of resilience by 2040		Our Best Value Plan delivers 1 in 500 supply resilience immediately.
Protect and enhance the environment, ensuring our abstractions are sustainable both in the short and long term		The outcomes of previous WINEPs have been incorporated into our baseline supply forecasts. This includes abstraction licence sustainability reductions which have been applied to our Berwick & Fowberry WRZ Fell Sandstone groundwater sources. For this dWRMP24, no additional abstraction licence reductions are currently required before 2050 under Environmental Destination. However, we will continue to work closely with the Environment Agency to understand whether the water needs of the environment change as the climate changes and whether our abstraction licences need to change. The five-year water resources planning process provides an important review point and allows Environmental Destination assessments to be reviewed.
Reduce leakage from our network and from customer's homes, contributing to a national target of 50% reduction from 2017/18 levels by 2049/50		Our Best Value Plan meets government expectations and includes activities to reduce leakage by 50% by 2049/50.
Reduce customer demand to 110l/head/day by 2049/50		Our Best Value Plan meets government expectations and includes water efficiency activities which along with our smart metering programme and government interventions (white good labelling), should reduce customer demand to 110l/head/day by 2049/50.
For all our meters to be smart meters by 2035		Our Best Value Plan includes a metering strategy whereby all new and replacement meters will be smart meters.

TABLE 33: ACHIEVING OUR WRMP24 OBJECTIVES

8.7.4 HAVE WE MET GOVERNMENT EXPECTATIONS?

A further check in justifying our Best value Plan is whether we have met government expectations. These are reproduced in Table 34 along with a statement on how they have been met.

GOVERNMENT EXPECTATIONS	ACHIEVED?	
Provide a secure and clean water supply as expected by customers in a way that provides value for customers, society and the environment over the long term		Our plan does not require additional supply schemes. We will continue to invest in our source to tap assets to ensure so that we can continue to provide a secure and clean water supply.

GOVERNMENT EXPECTATIONS	ACHIEVED?	
		We will continue to monitor the effect of our abstractions on the environment and will ensure any required changes are made in a timely way.
Improve supply resilience by planning to raise customer levels of service for a Level 4 drought plan restrictions (stand pipes and rota cuts) from 1 in 200 years to 1 in 500 years by 2040;	✓	Our Best Value Plan delivers 1 in 500 supply resilience immediately.
Reduce household Per Capita Consumption (PPC) to 110l/head/day by 2049/50 as well as working with retailers to implement actions to assist non-household users to sustainably reduce their water use;	✓	Our Best Value Plan meets government expectations and includes water efficiency activities which along with our smart metering programme and government interventions (white good labelling), should reduce customer demand to 110l/head/day by 2049/50.
Reduce leakage by 50% from 2017/18 levels by 2049/50 with water companies helping customers reduce water demand and water lost through leaks by adopting consistent approaches to support repair and replacement of supply pipes.	✓	Our Best Value Plan meets government expectations and includes activities to reduce leakage by 50% by 2049/50.
Install smart meters as a standard	✓	Our Best Value Plan includes a metering strategy whereby all new and replacement meters will be smart meters.
Consider compulsory metering in regions assessed by the Environment Agency (EA) to be a Serious Water Stressed Area	✓	We have considered compulsory metering but this is not allowed because the North East region is not classified by the Environment Agency as being a Serious water Stressed Area.
Adapt to climate change	✓	Our baseline supply and demand forecasts assume a must likely level of climate change over the planning period. This results in drier summers which mean there will be less water available than would otherwise be the case. However, our final plan confirms a supply surplus in both our WRZs until 2085. Based on our current operations, we are on track to be Carbon Net Zero by 2027. Our demand management options will reduce the amount of water that leaks from our network and our customers use of water. This means we will use less energy, and therefore produce fewer carbon emissions, in abstracting, treating and distributing water into our customer homes than otherwise would be the case.
Demonstrate a step change in rectifying overreliance on unsustainable water sources	✓	We have reconfirmed our sustainable levels of abstraction with the Environment Agency and have used these levels in our baseline deployable output assessments.

TABLE 34: MEETING GOVERNMENT EXPECTATIONS

8.7.5 DOES OUR BEST VALUE PLAN REFLECT WReN'S REGIONAL PLAN?

The process of developing WReN's Best Value Plan has informed the development of our own Best Value Plan. The same baseline supply and demand forecasts have been used for both plans. All feasible WReN options have been considered in our decision-making process for selecting our Best Value Plan. Our Best value Plan options are all included in WReN's Best Value Plan

8.7.6 BOARD ENGAGEMENT IN DEVELOPING OUR BEST VALUE PLAN?

We have engaged with our Board at key milestones in the development of our Best Value Plan including review of our baseline supply demand balance forecasts and development of demand management and supply options.

8.7.7 OUR PLANNED PER CAPITA CONSUMPTION

One of our WRMP24 objectives and a government expectation is to reduce PCC to 110/l/hd/d by 2049/50.

The selected demand management options for our final preferred plan have ensured we meet this target. By 2050/51 the average PCC for NW is 107.26 l/hd/d. The table below gives an overview of the PCC results, and the PCC forecast is shown in the graph that follows.

AVERAGE PCC (L/HD/D)	PCC IN 2025/26	PCC IN 2050/51	DIFFERENCE L/HD/D	PERCENTAGE DECREASE
Northumbrian	142.26	107.26	-35.01	-25%
Berwick	132.91	105.91	-26.99	-20%
Kielder	142.35	107.27	-35.08	-25%
NW	142.26	107.26	-35.01	-25%
NWG	143.95	109.83	-34.12	-24%

TABLE 35: PCC TARGETS – FINAL PREFERRED PLAN

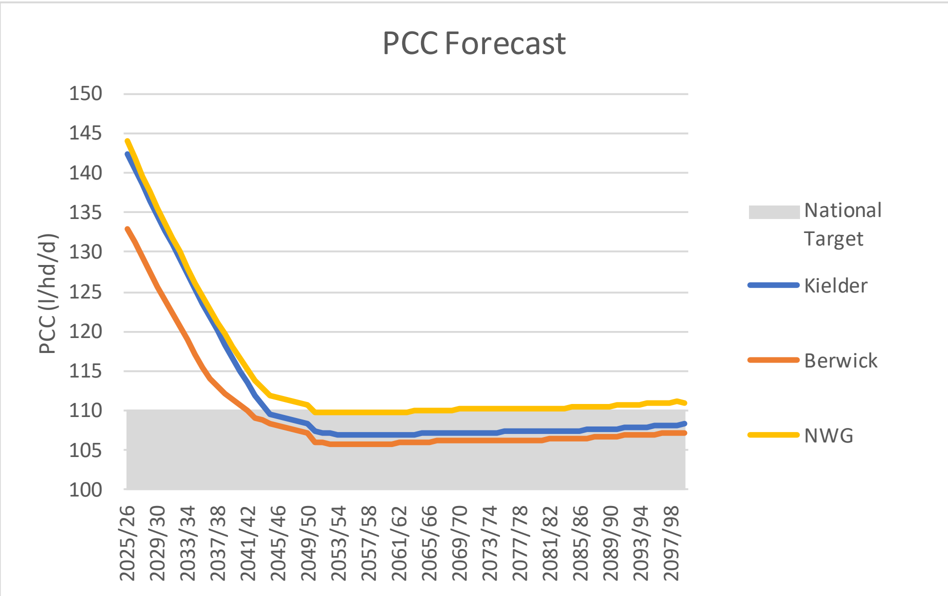


FIGURE 20: PCC FORECAST

9. ALTERNATIVE PLANS

9.1 OVERVIEW

We are required to present the following plans in this draft WRMP24:

- Ofwat Core Plan;
- Least Cost Plan ;
- Best Value Plan (Our Preferred Final Plan); and
- Best Environment Plan.

9.2 OFWAT CORE PLAN

The Core Plan represents the options needed to meet government expectations on demand management and on sustainable abstraction as well as any no or low regret options that are required to maintain a supply surplus in all years of the planning period.

The baseline supply demand balance is the same as our Best Value Plan. A small baseline supply deficit was forecast for the Kielder WRZ. However, once the demand savings from our preferred demand management options (i.e., those required to meet the governments targets for leakage and PCC), are applied to our final plan demand forecast, then a supply surplus is restored and no further supply schemes are required.

The Berwick WRZ already has a baseline supply surplus forecast for all years of the planning period and so the core plan for this WRZ only includes our preferred demand management options.

Consequently, the Core Plan is the same as our Best Value Plan.

9.3 LEAST COST PLAN

The Least Cost Plan is determined using only economic cost information and as its name suggests, is the plan with the lowest cost to restore a supply surplus in all years of the planning period should there have been a baseline supply deficit forecast. The Least Cost Plan does not consider other monetised criteria such as carbon or other societal and environmental impacts and benefits.

The baseline supply demand balance is the same as our Best Value Plan. A small baseline supply deficit was forecast for the Kielder WRZ. However, as described for the Core Plan above, once the demand savings from our preferred demand management options are applied to our final plan demand forecast, then a supply surplus is restored and no further supply schemes are required.

Consequently, the Least Cost Plan is the same as our Best Value Plan and Core Plan.

9.4 BEST ENVIRONMENT PLAN

The Best Environment Plan presents a plan with the lowest level of abstraction from existing sources (high ED scenario) as well as the lowest level of leakage and PCC.

No further abstraction sustainability reductions are required under any of the Environmental Destination scenarios for our Kielder and Berwick & Fowberry WRZs. Additionally, our preferred plan for the Northumbrian Water region is already to reduce leakage by 50% by 2049/50 and reduce PCC to 110l/head/day by 2049/50.

Therefore, the Best Environment Plan baseline supply demand balance is the same as our Best Value Plan and only needs our preferred demand management options to restore a supply surplus across the planning period.

Consequently, the Best Environment Plan is the same as our Best Value Plan and Core Plan.

10. ENVIRONMENT & SOCIETY

10.1 INTEGRATED ENVIRONMENTAL ASSESSMENT

The sections below outline how we have considered the environment and society in developing our WRMP24. Although we are not presenting any supply side options in our WRMP24, as part of the development of our plan, we have undertaken various environmental assessments, including Strategic Environmental Assessment (SEA) of our demand management options (DMOs) and of the 140Ml/d raw water export from the River Tees to Yorkshire Water. Earlier on in the process of preparing this draft WRMP24, it was not clear whether we would have a supply surplus in the Berwick & Fowberry WRZ and so we precautionarily identified a number of feasible supply options and we completed Strategic Environmental Assessment (SEA), Habitats Regulations Assessments (HRA), Water Framework Directive Assessments (WFD), Biodiversity Net Gain (BNG) assessments, Natural Capital (NC) assessments and Invasive Non-Native Species (INNS) assessments on these. We have used these assessments to aid our decision-making on options development and the selection of preferred options within our WRMP24, with the aim of developing a WRMP that meets legislative requirements and provides environmental net gain.

As our preferred demand management options, required to meet Government expectation on leakage reduction and PCC, restore a supply surplus in our Kielder WRZ, the Integrated Environmental Assessment (IEA) focuses on demand management options and the regional export options.

Our preferred plan includes demand management options (DMOs) that will meet government aspirations including options to reduce leakage by 50% by 2049/50; an enhanced optant smart metering programme where all existing meters will be replaced with smart meters by 2035; and a water efficiency programme which with our smart metering programme, should achieve a PCC of 110l/head/d by 2049/50. These options increase actual headroom in the Berwick WRZ and address the baseline deficit in the Kielder WRZ. All options were assessed as part of the integrated environmental assessment, albeit leakage was assessed as a 40% reduction by 2049/50. A 50% reduction in leakage by 2049/50 will further reduce abstraction.

Earlier on in the process of preparing this draft WRMP24, it was not clear whether we would have a supply surplus in the Berwick & Fowberry WRZ and so we precautionarily identified a number of feasible supply options. However, our baseline supply demand balance confirms a supply surplus across the planning period and so supply options are no longer needed. Nevertheless, for information and for future reference, should the supply demand position change in future planning periods, we also cover these options in the IEA.

We have completed a Strategic Environmental Assessment (SEA) and prepared an environmental report, for our WRMP24, including assessing our individual demand and potential supply side options, the 140Ml/d raw water export from the River Tees to Yorkshire Water, and our plan as a whole.

The Environmental Report is provided in the accompanying document 'Northumbrian Water – Water Resources Management Plan 2024 - Environmental Report' (Mott Macdonald 2022) and reviews the feasible options for our WRMP24, to identify any potential positive or negative environmental effects.

The scoping stage of our SEA set the context and scope for our SEA and Environmental Report. Our SEA Scoping Report set out our SEA Objectives, presented a review of the policies, plans and programmes relevant to our WRMP24 and included a review of current baseline environmental and socioeconomic information for our region, under the topic headings of biodiversity, flora and fauna; water; flood risk; soil; air; climatic factors; population, human health and economy; historic environment; landscape; material assets and natural capital. We issued our NW WRMP24 SEA Scoping Report for consultation in June 2022 and received responses from the Environment Agency and Historic England. We have considered the responses in the development of our WRMP24 SEA.

As a precursor to the SEA, high-level environmental screening (HLS) assessments for the NW WRMP24 supply side options, being considered at the time, were completed in January and February 2022. These were undertaken to highlight environmental risks and constraints at an early stage in the options development process, in accordance with UK Water Industry Research (UKWIR) guidance[6]. The environmental screening findings were used to inform rejection of options to avoid potentially significant environmental effects, and to identify suitable mitigation measures to be incorporated into option development. The results were also taken forward into the WRMP SEA and HRA assessments. The assessment was split into construction effects and operational effects and the level of effect was assigned using a qualitative scale ranging from positive effects (minor, moderate, major) to negative effects (minor, moderate, major), with neutral used for no or negligible effects. The SEA process produced a series of four metrics for each supply side option summarising the output information. The four metrics were positive construction, negative construction, positive operation, and negative operation. The results from our SEA are summarised in the Tables below.

[6] Environmental Assessments for Water Resources Planning (21/WR/02/15) UKWIR (March 2021)

		Biodiversity				Soil	Water					Air	Climatic Factors		Landscape	Historic Environment	Population and Human Health				Material Assets	
Option	**Effect**	**1.1**	**1.2**	**1.3**	**1.4**	**2.1**	**3.1**	**3.2**	**3.3**	**3.4**	**1.1**	**1.2**	**1.3**	**1.4**	**2.1**	**3.1**	**3.2**	**3.3**	**3.4**	**1.1**	**1.2**	**1.3**
BOT-ABS-002	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0
	Negative	-	0	0	0	0	-	-	0	0	0	-	-	0	-	-	-	0	-	-	-	-
BOT-ABS-007	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0
	Negative	--	-	0	0	0	-	0	0	0	0	-	-	0	-	-	-	0	-	-	-	-
BOT-TRA-001	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0
	Negative	-	-	0	0	0	-	0	0	0	0	-	-	0	-	-	-	0	0	-	-	-
BOT-TRA-002	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0
	Negative	-	--	0	0	0	-	0	0	0	0	-	-	0	-	-	-	0	0	-	-	-
BOT-TRA-004	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0
	Negative	-	-	0	0	0	-	0	0	0	0	-	-	0	-	-	-	0	0	-	-	-
DMO-Medium	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	-	0	0	-	-	0	-	-	0	0	-	-	0	-	-	-	0	0	0	-	-
DMO-High	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	-	0	0	-	-	0	-	-	0	0	-	-	0	-	-	-	0	0	0	-	-
DMO-Low	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	0	0	0	0	-	0	0	0	0	0	-	-	0	-	-	-	0	0	0	-	-

TABLE 36: SUMMARY OF CONSTRUCTION PHASE SEA RESULTS

		Topic																				
		Biodiversity				Soil	Water					Air	Climatic Factors		Landscape	Historic Environment	Population and Human Health				Material Assets	
Option	**Effect**	**1.1**	**1.2**	**1.3**	**1.4**	**2.1**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**4.1**	**5.1**	**5.2**	**6.1**	**7.1**	**8.1**	**8.2**	**8.3**	**8.4**	**9.1**	**9.2**
BOT-ABS-002	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0
	Negative	-	0	0	0	0	--	-	0	--	-	0	-	-	0	0	0	0	0	0	0	0
BOT-ABS-007	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0
	Negative	-	0	0	-	0	0	0	0	--	-	0	-	-	0	0	0	0	0	0	0	0
BOT-TRA-001	Positive	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	+	0	0	0
	Negative	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0
BOT-TRA-002	Positive	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	+	0	0	0
	Negative	-	0	0	-	0	0	0	0	-	0	0	-	0	0	0	0	0	0	0	0	0
BOT-TRA-004	Positive	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	+	0	0	0
	Negative	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0
DMO-Medium	Positive	+	+	0	+	0	0	+	+	+	+	0	+	++	++	0	+	++	++	0	0	0
	Negative	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DMO-High	Positive	++	++	0	++	0	0	++	++	+++	+++	0	+	++	++	0	++	+++	+++	0	0	0
	Negative	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DMO-Low	Positive	0	0	0	0	0	0	0	+	+	+	0	+	+	0	0	+	+	+	0	0	0
	Negative	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 37: SUMMARY OF OPERATIONAL PHASE SEA RESULTS

A Yorkshire Water transfer (DV6(vi) or DV7a(vi)) has also been through the NW SEA process in order to determine the likely effects on the region. The SEAs for these options were undertaken separately, by Yorkshire Water and included within their WRMP24, however the results have been applied to the Northumbrian Water SEA objectives using the Northumbrian Water scoring system, for comparison and completeness. The results of assessments have been provided by Yorkshire Water and have been utilised here to present a complete assessment.

		Biodiversity				Soil	Water					Air	Climatic Factors		Landscape	Historic Environment	Population and Human Health				Material Assets	
Option	**Effect**	1.1	1.2	1.3	1.4	2.1	3.1	3.2	3.3	3.4	3.5	4.1	5.1	5.2	6.1	7.1	8.1	8.2	8.3	8.4	9.1	9.2
Construction																						
DV6(vi)	Positive	0	++	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	---	-	-	0	---	0	0	0	0	0	--	0	0	--	--	--	0	0	-	0	--
DV7a(vi)	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	---	-	-	0	---	-	0	0	0	0	--	0	0	--	--	--	0	0	--	0	-
R51	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	-	0	0	0	-	-	-	0	0	0	-	0	0	-	--	-	0	0	-	0	-
Operation																						
DV6(vi)	Positive	0	0	0	0	0	0	0	0	0	0	0	0	+++	0	0	+++	0	0	0	0	0
	Negative	0	0	0	0	0	--	-	---	0	0	0	---	0	0	0	0	0	0	0	---	0
DV7a(vi)	Positive	0	++	0	0	0	0	0	0	0	0	0	0	+++	0	0	+++	0	0	0	0	0
	Negative	0	0	0	0	0	0	-	-	0	0	0	---	0	0	0	0	0	0	0	---	0
R51	Positive	0	++	0	0	0	0	0	0	0	0	0	0	++	0	0	++	0	0	0	0	0
	Negative	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	--	0

TABLE 38: YORKSHIRE WATER TRANSFERS SEA RESULTS

In addition to the SEA, other environmental assessments of the proposed supply side options were undertaken. The results of these assessments are provided in the accompanying Environmental Report[7] and appendices. Demand management options have not been subjected to further assessments owing to the lack of physical footprint of these options.

[7] Mott Macdonald (2022) 'Northumbrian Water – Water Resources Management Plan 2024 - Environmental Report'

10.2 WATER INDUSTRY ENVIRONMENT PROGRAMME (WINEP)

10.2.1 OVERVIEW

As part of our 5-year planning process we agree a list of actions we will take to further improve the environment. This is known as the Water Industry National Environment Programme (WINEP). The WINEP is designed to protect the environment around the rivers and aquifers we abstract from, the reservoirs we use to store water, the environments we discharge to, and our land holdings.

10.2.2 AMP7 WINEP (2020 to 2025)

In the current planning period, known as AMP7, we have carried out a number of investigations to better understand the effect of our operations on the environment and to make changes where needed. The locations and scope of these investigations were agreed with our environmental regulator the Environment Agency, and the resulting changes to our operations have the Environment Agency's approval. We have agreed to:

- Reduce abstraction from some of our groundwater sources in the Berwick & Fowberry Water Resource Zone to make sure our abstractions do not exceed aquifer recharge rates.
- Change the timing and volumes of releases of water from several of our reservoirs to reflect a more natural flow, with higher winter flows and lower summer flows, as well as 'spate' releases to ensure river conditions which allow migratory fish to move up and downstream at keys times of their annual life cycles.
- Install screens on our river abstraction intakes to ensure eels do not become entrapped.
- Build fish passes or easements on structures (e.g. Weirs) that we own which prevent fish from moving naturally up and down rivers.
- Address the impacts that reservoirs have on the natural 'form' of rivers, for example by adding gravel to rivers which are depleted of natural sediment by the presence of a dam wall.

We continue to work closely with land managers and farmers to improve the quality of water at our abstractions; better quality water requires less treatment, therefore using less energy and chemicals. In AMP7 we have focused particularly on reducing pesticides, nitrates and cryptosporidium in our raw water, as well as addressing the problem of colour in water from degraded peatland. In AMP7 we have:

- Engaged with farmers through events and one-to-one visits and offered grants to support them to make changes to their farm infrastructure or change their farming practices to minimise the loss of nitrates and pesticides from their land.
- Supported the Pennine Peat Life Programme to regenerate degraded peatlands which supply the upland reservoirs in the Tees catchment.
- Supported partner organisations to deliver projects which take a holistic approach to improving river habitat, increasing biodiversity, and addressing the impacts of climate change, focusing on the South Tyne catchment.

Invasive Non-native Species (INNS) are a threat locally and nationally. We are working with regulators and stakeholders to reduce the risk of spreading INNS by monitoring for them, carrying out risk assessment for existing and proposed new operations, installing washdown facilities at reservoirs with public access, and ensuring we follow appropriate biosecurity measures in all our operations.

10.2.3 AMP8 WINEP (2025 to 2030)

We are working closely with our regulators and stakeholders to identify what needs to be included in the WINEP for delivery in 2025 to 2030. We have been set a challenge by our regulators to aim for even more ambitious environmental outcomes for AMP8, and we have been 'thinking big' around how we can deliver more for our water environments and for our customers. Some of our proposals build on investigations we have undertaken in AMP7, while others build on our success in supporting partners to deliver holistic environmental projects.

From a water resources perspective our overall aim is to create resilience in rivers and aquifers so they are able to support healthy habitats and diverse and abundant wildlife in the face of climate pressures, as well as providing for our own water supply needs. We are working closely with other environmental organisations to identify the opportunities to develop bigger and better projects which will deliver multiple benefits for the environment. By aligning our aims and ambitions with those of others we will be able to deliver far more than we could alone, and working in this way means our spending can be used to lever additional funding to deliver more for our environment and for people.

We will present our proposals in our revised dWRMP24 in May 2023, which will then be submitted to our regulators for review.

10.3 CLIMATE CHANGE AND GREEN HOUSE GAS EMISSIONS

10.3.1 RESILIENT WATER SUPPLIES

Our climate is changing and so we recognise the importance of taking a proactive approach to mitigating and adapting to climate change to both protect the environment and to maintain resilient water supplies. In developing this preferred plan, we have accounted for the effects of climate change on forecast supply and demand. Our supply and demand forecasts have assumed a most likely (central) level of climate change using the RCP6.5 scenario from Climate Projections 2018 (CP18). In many cases, climate change does not have a significant effect on groundwater recharge and so does not impact the deployable output of our groundwater sources. However, climate change does impact our surface water sources and in the case of our Kielder WRZ, has reduced deployable output.

Nevertheless, our Best Value Plan only includes demand management options (see section 8) and these maintain a supply surplus across the planning period without the need to develop new supply schemes.

Reducing water company and customer side leakage and customer demand (PCC) means we will abstract less water from the environment, particularly during dry weather when river flows are lower.

We are currently working with our regulators and environmental stakeholders to identify if there are further river restoration schemes that could be included in our PR24 WINEP and that would result in greater resilience to future climate change.

10.3.2 GREENHOUSE GAS EMISSIONS FROM CURRENT OPERATIONS

Since 2008, we have reported our annual greenhouse gas emissions which arise from our operations at a group level (i.e. Northumbrian Water and Essex & Suffolk Water). Figure 1 shows a trend of consistent emissions reductions.

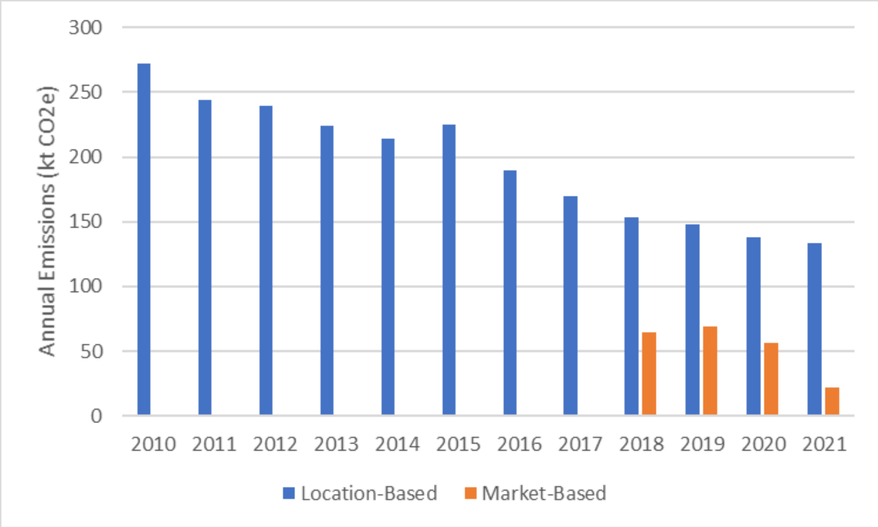


FIGURE 21: NORTHUMBRIAN WATER AND ESSEX & SUFFOLK WATER OPERATIONAL EMISSIONS 2010 TO 2021

This reduction reflects a structured approach to emissions management through the implementation of a Net Zero plan, initiated in 2009 and updated annually. Figure 1 shows two types of emissions measurement – "Location-Based" and "Market-Based" with the latter reflecting where we have purchased fully renewable energy. In 2021/22, our operational emissions were 133ktCO_2e and 22ktCO_2e on a location and market basis respectively.

The significant reductions shown in Figure 1 have been achieved through a range of innovative energy and efficiency actions.

In 2022, new solar arrays have been added at sites in our Northumbrian Water operating region, with a sixth expected in early 2023. This will add a total of 13GWh per year of green energy generation to the 25GWh of renewables already at our sites. With the addition of these sites, we will generate 27GWh of renewable electricity in 2022/3, rising to 40GWh in 2023/4 – equivalent to that needed to power more than 12,000 homes. This is in addition to injecting a further 135GWh of green gas into the grid every year, which is enough to heat a further 8,000 homes.

The investment in renewables is helping us take a step closer to our ambitious goal of achieving Net Zero in 2027, having helped our carbon emissions fall more than 90% since 2010.
As well as solar, our Northumbrian Water reservoirs and water treatment works are also home to nine hydroelectric power stations, three of which are operated by third parties.

Additionally, we were the first and are still the only water company to use 100% of our Northumbrian Water sewage sludge to create green energy. Through a process called Advanced Anaerobic Digestion (AAD) at treatment works in North Tyneside and Teesside, energy generated through AAD is injected into the gas grid as renewable gas. Other work that has helped it achieve its carbon reductions to date has included:

- Using a first of its kind ten-year deal to source around 30% of our electricity demand from offshore wind farms; and
- Powering all 1,886 of our Northumbrian Water and Essex and Suffolk Water sites using renewable electricity, through which we achieve 77,000 tonnes of CO2 savings each year.

10.3.3 GHG EMISSIONS ARISING FROM OUR PREFERRED WRMP

Our final Best Value Plan only includes demand management options to reduce leakage, to replace our meter stock with smart meters, to install smart meters through our enhanced optant programme and to undertake in home water efficiency activity to reduce PCC. All these activities will reduce our forecast Distribution Input and therefore the amount of water that we need to abstract, treat and distribute. Consequently, there will be a marginal reduction in our carbon emissions. These will be quantified for our revised draft Plan.

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