PR24

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NORTHUMBRIAN WATER
WATER RESOURCES MANAGEMENT PLAN 2024

October 2024

DOCUMENT CONTROL SHEET

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Document Signoff

Nature of Signoff	Person	Date	Role
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Approver	Heidi Mottram	23/04/24	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
Registered in England & Wales No. 2366703
Registered Office:
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BOARD ASSURANCE STATEMENT

Having reviewed the WRMP24, 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: 18 October 2024

Signed for and on Behalf of the Board:

Heidi Mottram
Chief Executive 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.

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 Water Resources Management Plan 2024 (WRMP24), 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 this WRMP24 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 WRMP24 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 55% by 2049/50, this is a 5% higher reduction than in our draft WRMP24. 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.

Our metering and water effciency strategies will help us meet national targets for reducing customer water demand including reducing Per Capita Consumption (PCC) to 110litres/person/day by 2050.

We have also developed a new non-household water efficiency strategy to support reductions in Business Demand. Working collaboratively with business, retailers, local planning authorities and the Environment Agency, our strategy will enable us to reduce business water demand by 9% by 2038.

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 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 although we will continnue to work with them to explore whether it could be a longer term option to support national water supply resilience. 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. Investigations in our Berwick supply area have confirmed that the **maximum** amount we could take out of each abstraction point is not sustinable. Consequently, we have planned 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 have now developed our part of the 2025-30 WINEP with regulators and stakeholders including the Rivers Trust and have included partnership schemes to deliver multiple benefits including improved water quality, biodiversity net gain and flood risk reduction.

Consultation

We would like to thank all those who submitted a response to the consultation on our dWRMP24. We reviewed them all and prepared a consultation Statement of Response. This confirms the changes we made to our draft WRMP24 as a result of the consultation responses and the reasons for doing so. We submitted our revised draft WRMP24 to the Department of Environment, Food and Rural Affairs (Defra) on 31 July 2023. We then provided Further Information in support of our Statement of Consultation to Defra on 29 March 2024 and submitted a draft final WRMP24, which included those further updates. We received Defra approval to publish this final plan on 21 August 2024.

Heidi Mottram
Chief Executive Officer

CONSULTATION

We developed our draft WRMP24 between April 2020 and October 2022 taking account of:

- pre-consultation feedback from regulators; and
- feedback received during and following a pre-consultation webinar in January 2022 where we shared 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).

We submitted our draft WRMP24 to Defra on 3 October 2022 and then invited statutory consultees, our customers, and other interested stakeholders to comment on it. The consultation took place over a 12 week period between Friday 18 November 2022 and Friday 24 February 2023.

We asked consultees to share their 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.

Consultees were asked to send their written representations on our dWRMP24 to the Secretary of State for Environment Food and Rural Affairs which were then made available to us at the end of the consultation period.

Our regional water resources group, Water Resources North (WReN) has also prepared a regional plan which sets out how it will address the need for resilient and sustainable water supplies at a regional and national level. WReN's regional Plan has informed our Northumbrian Water draft WRMP24 and was consulted on at the same time as our draft Plan.

We prepared a consultation Statement of Response which described:

a. our consideration of the consultation responses;
b. the changes that we have made to the dWRMP24 as a result of the consultation responses and the reasons for doing so and where no change has been made to the dWRMP24, the reason for this; and
c. how we have taken account of the third round of regional reconciliation planning in which water transfers between companies and regions were agreed.

We then provided Further Information in support of our Statement of Consultation to Defra on 28 March 2024 and submitted a draft final WRMP24, which incldued further updates. Our Statement of Response, Further Information, and draft final WRMP24 we were approved by Defra on 21 August 2024 and were directed to publish our final WRMP24 on our website (www.nwg.co.uk/wrmp) by 20 October 2024.

TABLE OF CONTENTS

FIGURES

TABLES

GLOSSARY – PLEASE SEE ACCOMPANYING GLOSSARY OF TERMS

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 has been developed as part of the Price Review 2024 process (PR24) and is known as our Water Resources Management Plan 2024 (WRMP24). This final version has been updated to take account of our consultation statement of response and further information in support of that statement of response, both of which are published on our website (www.nwg.co.uk/responsibility/environment/wrmp/nw-draft-water-resources-management-plan-2024-consultation/) and confirms if and how we have taken into account each of the consultee's responses.

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 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 (standpipes and rota cuts) from 1 in 200 years to 1 in 500 years by 2040;
- Reduce household per capita consumption (PCC) to 110l/head/day by 2049/50 as well as working with retailers to implement actions to reduce Business Demand by 9% by 2037/38;
- 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 (therefore, 100% of newly installed meters will be smart and 0% will be basic/AMR);
- Consider compulsory metering in regions assessed by the Environment Agency (EA) to be a serious water stressed area.
- Adapt to climate change; and
- 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 (if required) 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 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.

We have considered these uncertaines by undertaking stress testing of our final preferred plan (see Section 9).

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 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 climate projections (CP18) which have had a more significant impact on summer river flows, and therefore our Kielder water resource zone deployable output, than the previous climate projections (CP09) did.
- **Non-household demand:** Our latest non-household demand forecast includes new demand with significant increases in raw water (+116Ml/d) and potable water demand (+38 Ml/d) forecast by Teesside businesses.
- **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 carried over Asset Management Period 6 (AMP6) National Environment Programme (NEP) investigations and Asset Management Period 7 (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.
- **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 final preferred plan demand management options.

Our baseline 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

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 .

Figure 1: PR24 Water Resources Planning Framework

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.

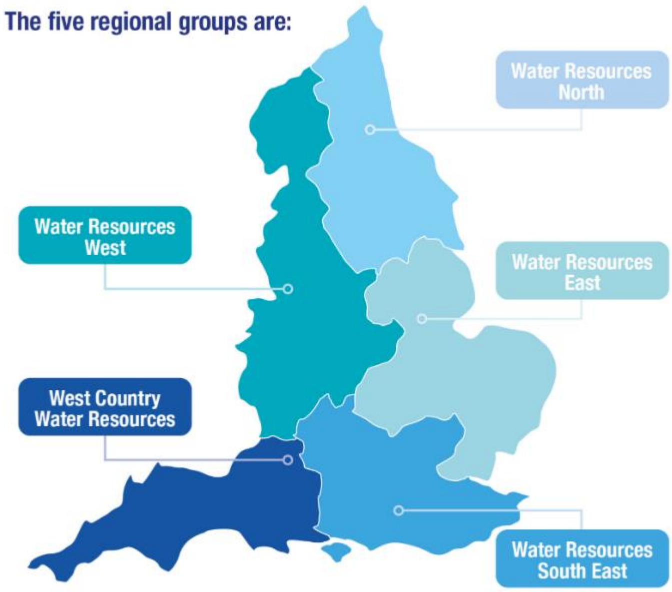


Figure 2: Regional Groups

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/), as shown in Figure 4, which has used the WRNF expectations summarised above to help shape its approach to regional planning and its 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.

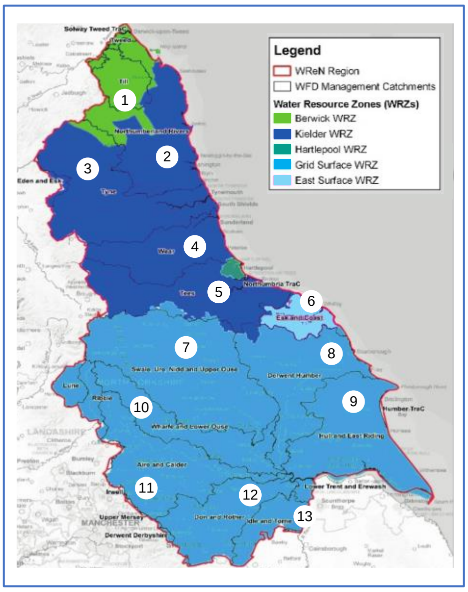


Figure 4: WReN area map

WReN, along with all other regional groups, has developed and consulted on a regional plan 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. A further round of reconciliation meetings were held after consultation on the draft WRMP24s. This concluded that the Kielder reservoir to United Utilities Transfer was still not required as there are other better value options.

Importantly, WReN's regional plan informed the water companies' draft WRMP24s and 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 but our Northumbrian Water WRMP24 plan goes beyond this to reduce leakage by 55% by 2050. 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 Northumbrian Water (NW) plans that there will be no further long-term sustainability reductions required under any of the scenarios. For our Berwick & Fowberry WRZ, this is because all our groundwater abstractions have recently been investigated through our AMP6 and AMP7 WINEP with abstraction sustainability reductions being applied for our WRMP24 baseline supply forecast. 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
- 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 8 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 Tyne Tees Transfer system. However, the capacity of a key Tyne Tees Transfer 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 Tyne Tees Transfer pumping station upgrade. However, this assumes that another potential 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. Our WRMP24 Distribution Input (DI) forecast reflects the latest demand forecasts for industrial Teeside.

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

United Utilities

We have also considered inter-region options including the export of raw water directly from Kielder reservoir to Unitied 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 Water Resources South East (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 revised dWRMP24.

1.3.3. Local planning

In compiling our 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, Scottish Environment Protection Agency (SEPA), and Natural England (NE).
- 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 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 have now developed 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 concluded in March 2023 and we are now preparing scopes for our AMP8 WINEP work ready for submission to the Environment Agency in May 2024. Our AMP8 WINEP is outlined in section 11.2.3.

1.4. CONSULTATION

For a detailed report on this section and customer engagement please refer to the **Stakeholder and Customer Engagement technical report** which is available on request by emailing waterresources@nwl.co.uk

We recognised the importance of pre-consultation in the development of our WRMP24. Stakeholder consultation was undertaken at the regional level through WReN as well as by ourselves.

WReN 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 also held formal pre-consultation meetings with the Environment Agency and Ofwat in January and July respectively.

We consulted on our draft WRMP24 between 18 November 2022 and 24 February 2023. We took into account the consultation responses in the development of our final WRMP24. Our consultation Statement of Response confirms the consideration we have given to each response, and any change made to our WRMP24 and the reason for doing so.

1.5. ASSURANCE

Our draft WRMP24 was 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 for this WRMP24 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 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 our WRMP24, we have considered a number of other plans as summarised in this section.

1.6.1. Government's 25 year environment plan

Table 1 below summarises how we have considered the Government's 25 Year Environment Plan.

Table 1: Considerations of Government's 25 Year Plan

REQUIREMENT	CONSIDERATION IN OUR WRMP24	SECTION IN THIS 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.	3.4 and 3.5
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 and 11.2.3
Use natural capital in decision making	We have used a multi-criteria assessment approach that uses natural capital in decision making	8.2.3
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.	11.2
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 natural environment and rural communities (NERC) driver and a 25 Year Environment Plan driver to deliver gain for the environment.	11.1

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 WRMP24 as well as delivering wider water system resilience.

Table 2 summarises how we have considered Ofwat's guidance 'PR24 and beyond: Final guidance on long-term delivery strategies'.

Table 2: Considerations of Ofwat long-term delivery strategy guidance

REQUIREMENTS	CONSIDERATION IN THIS DWRMP	SECTION IN THIS WRMP24
Clear links between WRMPs and business plans	Our 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 transferred into our Business Plan along with a robust business case.	8.3
Use of long-term adaptive planning	We have used an adaptive planning approach. As a supply surplus is forecast in each of our water resource zones under all scenarios we have considered including the Ofwat Common reference Scenarios, no additional supply sources are included as alternative pathways. A Kielder transfer is included as an alternative pathway, but this does not impact our supply demand balance or create costs for our customers.	9.2
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.	9.1
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 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

1.6.3. Drought plans

This 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 Level 1 to 3 drought actions although we will move from 1 in 250 years to 1 in 500 years for Level 4 drought actions from 2025.

Our Levels of Service are reconfirmed in see Section 2.4.

1.6.4. River basin management plans

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

Table 3: Meeting River Basin Management Plan Objectives

REQUIREMENT	CONSIDERATION IN THIS WRMP24	SECTION IN THIS WRMP24
Prevent deterioration and support achievement of protected area and water body status objectives	We have prepared this 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 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 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 between 2025 and 2030. Our latest thinking is included in this plan.	11.2

1.6.5. Drainage and wastewater management plans

The drainage and wastewater management planning process is the process whereby current and future wastewater needs are evaluated, wastewater management alternatives are developed which will meet these needs, and a final plan is chosen through careful comparison and evaluation of the alternatives. A Drainage and Wastewater Management Plan (DWMP) outlines the level of investment needed to make sure the drainage and wastewater system can cope in the future. Whilst, the process uses a similar approach to Water Resources Management Planning, the DWMP covers the collection, treatment and management of sewerage and wastwater only, whilst the Water Resources Management Plan covers our abstraction of water from the environment to supply customers with drinking water.

Our first DWMP plan was submitted to Defra earlier in the year, and can be found at https://www.nwl.co.uk/services/sewerage/dwmp/. We have ensured our long-term planning for water supply and wastewater is aligned by aligning our methodologies for growth and climate change assumptions.

Any unplanned discharges from water resources assets are self-reported to the Environment Agency, immediately investigated and mitigated until resolved. Measures are identified and put in place to prevent a recurrence. A detailed report is then submitted to the Environment Agency, who review the actions taken.

The risk of a pollution incident impacting our water resources is assessed and quantified as part of the Target Headroom Allowance and included in the supply demand balance - see our WRMP24 Target Headroom Technical Report for more information. Historical incidents are included in the Outage Allowance, which is a forecast of future outage, and incorporated into the Water Available for Use (WAFU) calculation as a deduction from deployable output - see our WRMP24 Outage Allowance Technical Report for more information.

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 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 WRMP24 sets out how our PR24 WINEP will support recovery and enhancement of biodiversity.

2. DEVELOPING OUR PLAN

Overview

This section of our Water Resource Management Plan 2024 (dWRMP24) covers the process we have followed in preparing our WRMP24 preferred plan.

2.1. DEFINING OUR WATER RESOURCE ZONES (WRZ)

2.1.1. 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.

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

- Kielder Potable WRZ
- Berwick & Fowberry Potable WRZ
- Kielder Industrial WRZ (non-potable Industrial Teesside)

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 that the Industrial WRZ can be integrated into the existing Kielder WRZ, as shown in Figure 5. 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.

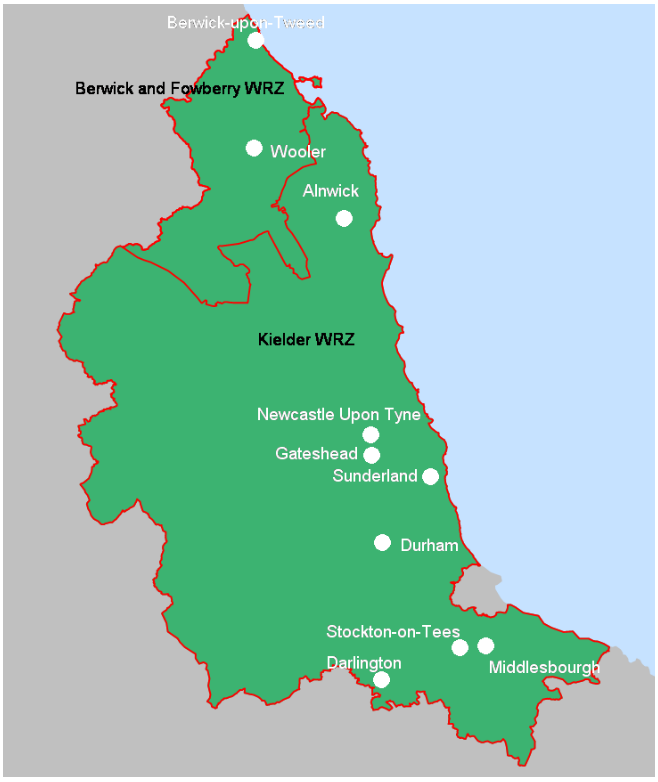


Figure 5: Northumbrian Water's Water Resource Zones

2.1.2. Kielder WRZ

There are three potable supply zones within the Kielder WRZ, shown in Figure 6 as follows:

- Northern Zone: comprising of the North Tyne and Northumberland resources, along with nine WTW which supply the major urban conurbations of Tyneside

- Central Zone: comprising River Wear and Mid Durham resources, along with eleven WTW which supply the major urban conurbations of Wearside alongside Durham and Sunderland
- Southern Zone: comprising of the River Tees and Teesdale Resources, along with two WTW which supply the major urban conurbations of Teesside

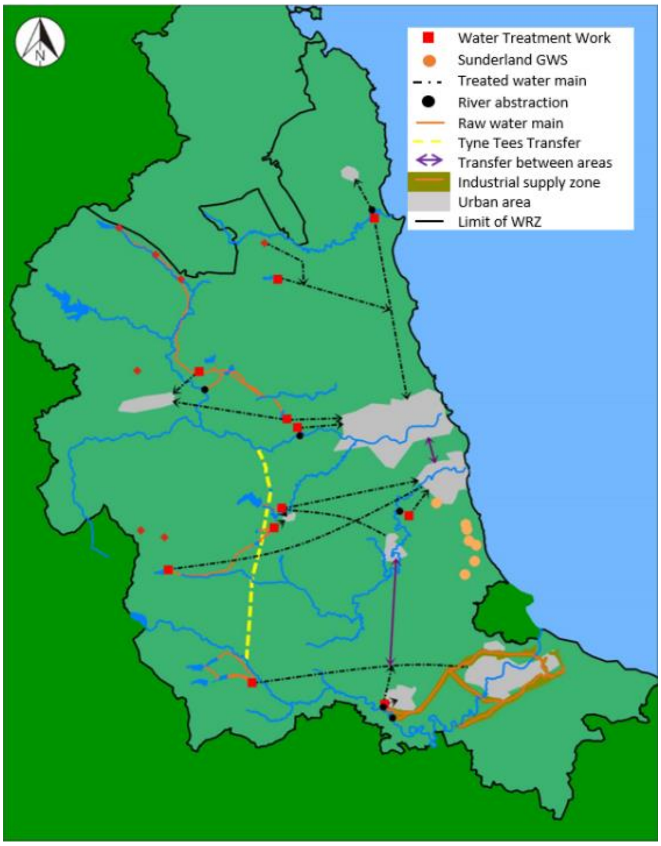


Figure 6: Map of the Kielder WRZ

These potable supply zones are operated in effectively a discrete manner in terms of treatment capacity, but they can all be supported from Kielder Reservoir.

Additionally, there is the non-potable Industrial Supply Zone which supplies the non-potable industrial demand on Teesside. The Industrial Supply Zone abstracts water from the River Tees and therefore can be supported by releases from the Tyne–Tees Transfer system at Eggleston and ultimately supported by Kielder reservoir.

As such all these supply zones (three potable and one non-potable) have the same theoretical risk of restrictions on use and are considered as a single water resource zone.

A more detailed description of the operation of these supply zones is in Section 2.4 of the NW Supply Forecasting WRMP24 Technical report.

2.1.3. Berwick & Fowberry WRZ

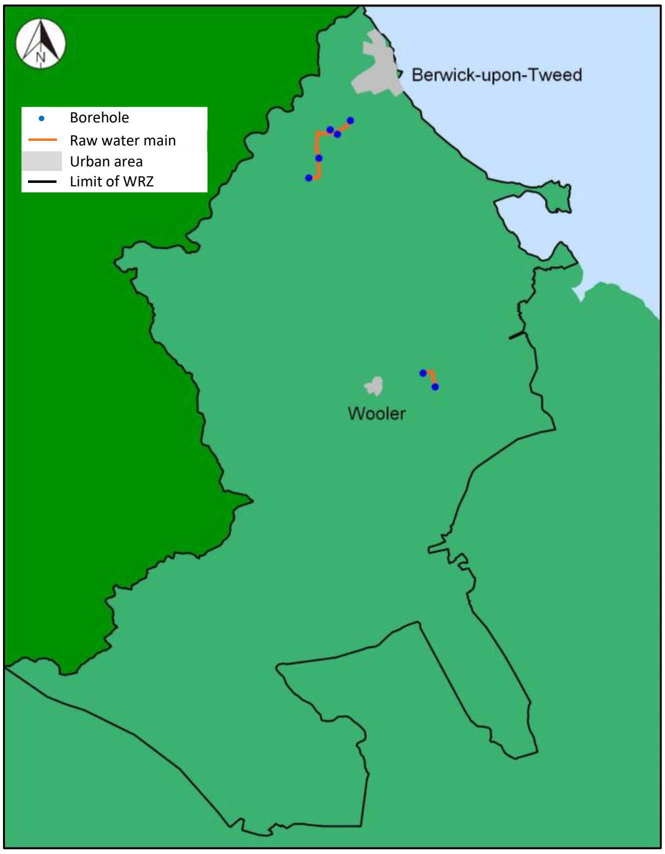


Figure 7: Map of Berwick & Fowberry WRZ

The Berwick and Fowberry WRZ, shown in Figure 7, 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.

2.2. PROBLEM CHARACTERISATION

2.2.1. 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 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 Levels of Service 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.

2.2.2. Risk Composition

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

- Conventional
- Resilience Tested
- 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 4.

Table 4: Risk Composition Guidance

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 Net Present Value (NPV) programmes, or to look at the cost implications of achieving Levels of Service (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 (LoS) 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.

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 previous 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, the WRMP24 guidance indicated that we must follow a 'fully risk based' approach to supply modelling using stochastically generated data sets to explore the yield response to drought severity. Therefore we have undertaken 'Risk Composition 3' approaches for supply side modelling in that each water resource zone has been tested against a range of theoretical drought events and the deployable output determined with a return period of one year in every 500 years on average.

2.3. DROUGHT VULNERABILITY ASSESSMENT

We carried out a partial assessment which uses the principles of the UK Water Industry Research (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 Price Review 2019 (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 Table 5.

Table 5: Failure days for various drought durations and return periods

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

For information on the Lessons learnt from the 2022 drought please refer to the **Lessons Learnt from 2022 Drought Technical report** available on request by emailing waterresources@nwl.co.uk

2.4. 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 categories shown in Table 6.

Table 6: Levels of Service (LoS)

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) ▪ Standpipes where supplies to customer's taps are turned off leaving customers to fill containers from an in-pavement standpipe tap

It is important to note that, in line with government expectations to be resilient to a 1 in 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.

The Kielder WRZ is a surface water dominated, complex, conjunctive use zone with most of sources being directly supported via the Kielder Transfer Scheme. The remaining sources in the Kielder WRZ are supported via Kielder Reservoir due to our ability to transfer water around the potable network.

All our reservoirs have control curves which were designed using historical reservoir inflow sequences from 1926 to 2014 and are intended to minimise the risk of reservoir stocks falling below the emergency storage levels. Reservoirs are placed into various zones depending on the stock level relative to the control curves and can be categorised as follows:

Surplus Zone	**Stock levels are healthy and can maximised to meet demand.**
Conservation Zone	Stock levels are becoming stressed, abstractions from the reservoir are reduced and abstractions from less stressed sources are increased to meet demand.
Drought Zone	Stock levels are highly stressed and there is a risk of crossing into the Emergency Storage zone. Abstractions are restricted to their minimum, typically the local demand that cannot be supported from other sources.
Emergency Storage	A volume of water that is reserved for use during a drought of greater intensity than has been experienced historically. Typically, enough water to maintain compensation flow and local demand for 30 days.
Dead Water	Volume of water that cannot be used for water treatment, either due to siltation of the reservoir or the volume that is below the lowest draw off point.

Drought trigger levels have been assigned to three drought indicator sources in the Kielder WRZ:

- Whittle Dene System (combined storage of Colt Crag, Little Swinburne, West Hallington and East Hallington)
- Derwent Reservoir
- Weardale System (combined storage of Burnhope, Waskerley, Hisehope and Smiddy Shaw)

These reservoirs were chosen as drought indicator sources as they best represent the resource availability in the Kielder WRZ. The operational control curves for the relevant reservoirs were combined for each drought indicator source and then used a basis for the LOS triggers. Further information regarding our operational drought levels/triggers for stragetic reservoirs and boreholes are set out in our 2022 Drought Plan for each of our WRZs.

The Berwick & Fowberry WRZ is 100% groundwater. We have developed a Fell sandstone model and undertaken groundwater modelling in partnership with the British Geological Survey (BGS) to determine the sustainable yields, based on historic data, of all our boreholes in the Berwick & Fowberry WRZ. As part of this work drought triggers for the Fell Sandstone aquifer, based on the BGS modelling results have been developed.

Drought triggers based on the storage level in the aquifer, are as follows.

- Level 1 85% of calculated aquifer saturated thickness remains
- Level 2 75% of calculated saturated aquifer thickness remains
- Level 3 60% of calculated saturated aquifer thickness remains
- Level 4 40% of calculated saturated aquifer thickness remains

Our actual levels of service, as modelled in Aquator XV, based on a DO that is achievable 99.8% of the time (i.e. we are unable to supply this level of demand, on average, one in every 500 years) are shown in Table 7. These levels of service apply for both the Kielder WRZ (inc the Industrial Supply Zone) and the Berwick & Fowberry WRZ.

Table 7: Actual Levels of Service

Restriction	Frequency of restriction	Annual chance of restriction
Level 1: Appeal for restraint	1 in 10 years	10% probability in any one year
Level 2: Temporary Use Ban	1 in 203 years	0.49% probability in any one year
Level 3: Non-Essential Use Ban	1 in 387 years	0.25% probability in any one year
Level 4: Pressure Reduction	1 in 500 years	0.2% probability in any one year

The results of our modelling suggests that we should be planning to implement a level 1 restriction , appeal for restraint, once every ten years on average. We have therefore updated our WRMP19 planned levels of service to reflect the results of the modelling for WRMP24, our previous and updated planned levels of service are shown in Table 8.

Table 8: WRMP19 vs WRMP24 Levels of Service

Restriction	WRMP19 frequency of restriction	WRMP19 annual chance of restriction	WRMP24 frequency of restriction	WRMP24 annual chance of restriction
Level 1: Appeal for restraint	1 in 20 years	5% probability in any one year	1 in 10 years	10% probability in any one year
Level 2: Temporary Use Ban	1 in 150 years	0.66% probability in any one year	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	1 in 200 years	0.5% probability in any one year
Level 4: Pressure Reduction	1 in 250 years	0.4% probability in any one year	1 in 500 years	0.2% probability in any one year

2.5. 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; and
- 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 the non-drought use of tankering from the Kielder WRZ to the Berwick WRZ. Under the following circumstances we would tanker from Kielder WRZ to Berwick WRZ: during short-term periods of peak demand where we are unable to move sufficient water through the network to the outer boundaries of the WRZ; and, during treatment works and/or network outages. Since 2020, we have transferred by tanker an average of 0.013 Ml/d annually into Berwick WRZ from Kielder WRZ.
- 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 Thornton 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; and
- 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.

2.6. 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
Best Value Planning
Demand Forecasting
Environment Report
Groundwater Deployable Output and Climate Change
Leakage *
Lessons Learnt from 2022 Drought
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

For a detailed report on this section please refer to the **Supply Forecasting technical report** which is available on request by emailing waterresources@nwl.co.uk

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 Water Resources Planning Guidline (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; and
- A supply forecast that combines all the elements described into WAFU.

Each of the above components of WAFU is described below.

3.2. DRY YEAR ANNUAL AVERAGE DEPLOYABLE OUTPUT ASSESSMENT

For a detailed report on this section please refer to the **Groundwater Deployable Output and Climate Change technical report** which is available on request by emailing waterresources@nwl.co.uk

3.2.1. Overview

Deployable Output (DO) is the building block in determining Water 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 potable deployable output assessment

There is a significant step change in the definition of DO from that of Water Resource Management Plan 2019 (WRMP19) to Water Resource Management Plan 2024 (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.

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 10.94 Ml/d, reducing to 9.98Ml/d in 2027 due to a potential licence reduction for Fowberry, see Section 3.4.

3.2.4. Non-potable water supplies

Currently the non-potable supply available for the Industrial Supply Zone, based on available assets and licences is 140Ml/d in normal year conditions. Under the Dry Year Annual Average (DYAA) scenario (1-500 DO return period) the available non-potable water for the Industrial Supply Zone reduces to 90Ml/d.

In order to increase the non-potable water supply for the Industrial Supply Zone, we are commited to making the following upgrades to our non-potable infrastructure:

- Apply to the Environment Agency to increase the combined Broken Scar and Blackwell daily limit back to its pre 2016 level of 363.63Ml/d by April 2025.
- Install eel screens at Low Worsall RWPS to allow the site to be operational.
- We will apply to the Environment Agency to request an increase to the annual Low Worsall abstraction licence to a daily rate of 165Ml/d and an annual total 60,225Ml by April 2026.

Once the upgrades are completed, the DYAA non-potable supply for the Industrial Supply Zone increases to 190Ml/d. However, as reflected in the DO planning tables, the 1-500 year potable DO of the Kielder WRZ is reduced by 9Ml/d in April 2026.

If the non-potable demand on Teesside was to exceed 190Ml/d then, based on current infrastructure (i.e. Riding Mill capacity), this would cause a reduction in the Kielder WRZ deployable output. However given the conjunctive use nature and integration of the potable and non-potable demands on Teesside as the household and non-household demands reduce over the planning horizon due to demand management strategies, the supply available to the non-potable industrial customer will increase.

3.3. CRITICAL PERIOD POTABLE DEPLOYABLE OUTPUT

Our baseline (and final plan) supply forecast is based on a DYAA scenario, representing an 'average' year supply output that has an associated return period of 1 in 500 years or less. The guidelines state the supply forecast should also be presented as a Dry Year Critical Period (DYCP) scenario for each WRZ where applicable, i.e., if there is a forecast deficit. DYCP is defined as the peak week, seven day rolling average of daily output.

The DYCP DO is calculated using a spreadsheet approach, as Aquator® cannot be used to determine a DO for the DYCP. In calculating the DYCP DO the following assumptions were made:

- Water Treatment Works maximum capacities or Peak Week Production Capacity (PWPC) used as the constraint.
- Climate change excluded due to the short duration (seven days) of increased abstraction required.
- Outage Allowance reassessed, see section 3.8 for further details.

The derivation of the DYCP DOs for the Kielder and Berwick & Fowberry WRZs are shown in Table 9 and Table 10 below.

Table 9: Kielder WRZ DYCP DO by WTW

WRZ	WTWs	DYCP Capacity (Ml/d)
Kielder	Tosson	3.2
	Fontburn	19
	Warkworth	34
	Whittle Dene	120
	Gunnerton	11
	Horsley	125
	Carrshields	0.06
	Slaggyford	0.04
	Allenheads	0.03
	Bros	0.3
	Mosswood	145
	Honey Hill	40
	Wear Valley	34
	Lumley	25
	Dalton	7
	North Dalton	7.5
	Fulwell	5
	Thorpe	3
	New Winning	5.5
	Peterlee	2.5
	Hawthorn	4
	Stoneygate	3
	Lartington	128
	Broken Scar	145
	Total	**867.13**

Table 10: Berwick & Fowberry WRZ DYCP DO by WTW

WRZ	WTWs	Maximum Capacity (Ml/d)	
		Pre 2027	Post 2027
Berwick & Fowberry	Murton	7.76	7.76
	Wooler	3.64	3.12
	Total	**11.40**	**10.88**

3.4. SUSTAINABILITY CHANGES / REDUCTIONS

Sustainable abstraction is essential to support healthy ecology and the natural resilience of our rivers, wetlands, and aquifers. In preparing our Northumbrian Water (NW) WRMP24 we have considered whether we need to implement any sustainability reductions to support the achievement of environmental objectives for water resources in the Northumbria River Basin Management Plan (RBMP) by preventing deterioration and supporting achievement of protected area and water body status objectives, as well as not preventing a water body from reaching 'good' or 'good potential' status in the future.

The Environment Agency has said that where licence change is necessary to prevent deterioration in England, groundwater licences will either be capped at recent actual abstraction 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.
In the development of our WRMP24 we have considered:

- Whether any of our groundwater licences will need to be capped to Max Peak or Recent Actual on renewal or by March 2030 to reduce the risk of waterbody deterioration under the Water Framework Directive;
- Whether we will need to implement any sustainability reductions on our groundwater licences during Asset Management Period 8 (AMP8), arising from Asset Management Period 7 (AMP7) Water Industry National Environment Programme (WINEP) investigations and options appraisals; and
- Whether we have any un-used abstraction licences that pose a risk of deterioration under the Water Framework Directive and if we can surrender these.

We are not currently anticipating that any of our current AMP7 WINEP groundwater sustainability investigations will result in the implementation of additional sustainability reductions during AMP8.

Further 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 Price Review 2024 (PR24) WINEP, the Environment Agency notified us of two groundwater licences that it considers to be un-used (see Table 11).

Table 11: NW un-used licences

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 Water Body (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 Lea Gate	GB103023075530	

We have agreed that we will surrender these two licences and as such they will not be included within our agreed AMP8 WINEP. As the two licences are not currently in use, they are not included within our baseline WRMP24 DO or supply demand balance.
Additionally, we have also identified that we have a licenced abstratction at Birchtrees that will be revoked in AMP7, therefore it is not included in our baseline WRMP24 DO or supply demand balance.

We have several groundwater abstraction licences with time limited variations which are due for renewal during AMP8. These are listed in Table 12.

Table 12: Northumbrian Water Time Limited Groundwater Licences

ABSTRACTION LOCATION	CURRENT DAILY LICENCE VOLUME	CURRENT ANNUAL LICENCE VOLUME	REVOCATION DATE	POST REVOCATION DAILY LICENCE VOLUME	POST REVOCATION ANNUAL LICENCE VOLUME
FOWBERRY	3.64Ml/d	1160Ml	01/04/2027	3.12Ml/d	810Ml
STONEHAUGH	41m^3/d	15Ml	01/04/2030	25m^3/d	NA
ALLENHEADS	33m^3/d	12Ml	01/04/2030	23m^3/d	8.4Ml

The Environment Agency has confirmed that neither the Stonehaugh or Allenheads licences are considered to pose a risk of deterioration and so will not be subject to capping on renewal and will be renewed with the existing variations remaining in place. Therefore, we have included these licences at their current volume within our baseline WRMP24 DO and supply demand balance.

We have included sustainability reductions within our NW WRMP24 for the Berwick & Fowberry WRZ, due to the unknown sustainability status of the Fowberry licence. The Fowberry licence is due to revert to its original volumes (3.12Ml/d and 810Ml/year) in April 2027, which results in a reduction in DO of 0.96Ml/d for the Berwick & Fowberry WRZ.

During AMP8 we will be conducting investigations into the following sites:

- River Coquet - potential impacts on the downstream watercourse, if we were to use the Warkworth abstraction licence to its full capacity.
- Broken Scar Borehole – The EA have identified this licence poses possible risk of deterioration, particularly under the emergency provisions and is a candidate for AMP8 investigation. It should be noted, however, that the borehole pump is only capable of pumping at a rate of 9.1Ml/d so there is no risk of pumping at the emergency provisions rate. We are investigating bringing a second borehole back into supply, although this would be as duty standby arrangement not to increase the abstraction volume.

3.5. 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 (ED) scenarios that Regional Water Resource Groups and their constituent water companies need to build into their WRMP24s to deliver the step change in resilience and environmental protection required.

We have worked with our regional water resources group, Water Resources North (WReN), and the Environment Agency, to identify a longer-term ED for our region, to deliver longer term sustainability and environmental resilience. The licence and abstraction reductions proposed under ED 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+) 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 ED reductions in deployable output are needed within our WRMP24.

As part of our AMP8 WINEP (2025-2030) we have committed to working with Yorkshire Water and WReN on a joint options appraisal of Environmental Destination in the North East with the intention of confirming actions required within our WRMP29 to move us along the required pathway.

3.6. CLIMATE CHANGE

3.6.1. 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
- Allowance for climate change in the headroom assessment (see section 5)

The UK Climate Projections 2018 (UKCP18) data has been selected as the most appropriate climate change data set as it supersedes the UK Climate Projections 2009 (UKCP09) data used for WRMP19 climate change analysis.

For a more detailed insight into the UKCP18 data and how the climate change modelling was undertaken please refer to the NW Supply Forecast technical report. This is available on request via waterresources@nwl.co.uk.

3.6.2. Surface water climate change analysis

Atkins Consultancy were appointed to develop 12 sets of monthly climate change factors for rainfall and potential evapotranspiration (PET) based on the UKCP18 Representative Concentration Pathway (RCP)8.5 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 regional climate models (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.

3.6.3. 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 13, the RCP6 scaled results have been used in our supply-demand balance.

Table 13: Change to deployable output under RCP8.5 and RCP6

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

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

Table 14: Change to deployable output scaled to RCP6 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

3.6.4. 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.

3.6.5. 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 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.

3.7. WATER TRANSFERS

3.7.1. 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.

3.8. OUTAGE

For a detailed report on this section please refer to the **Outage Allowance technical report** which is available on request by emailing waterresources@nwl.co.uk

3.8.1. Overview

A key element of the Supply Demand Balance for each WRZ is outage allowance, a value expressed in Ml/d, which is deducted from deployable output in the calculation of WAFU, as shown in Figure 8.

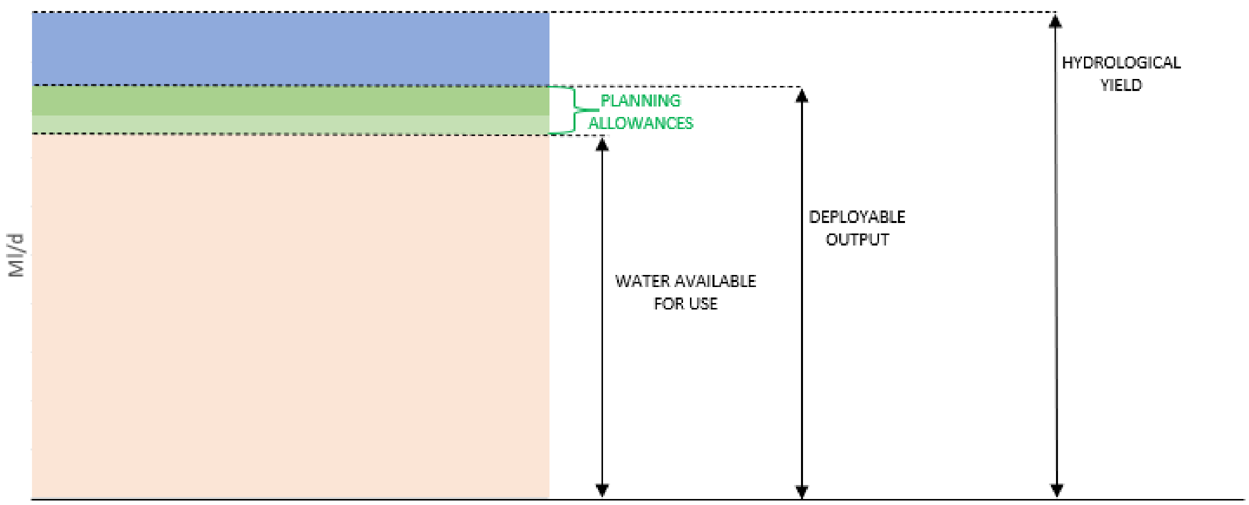


Figure 8: Supply Demand Balance components

Outage is defined in the UK Water Industry Research (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.

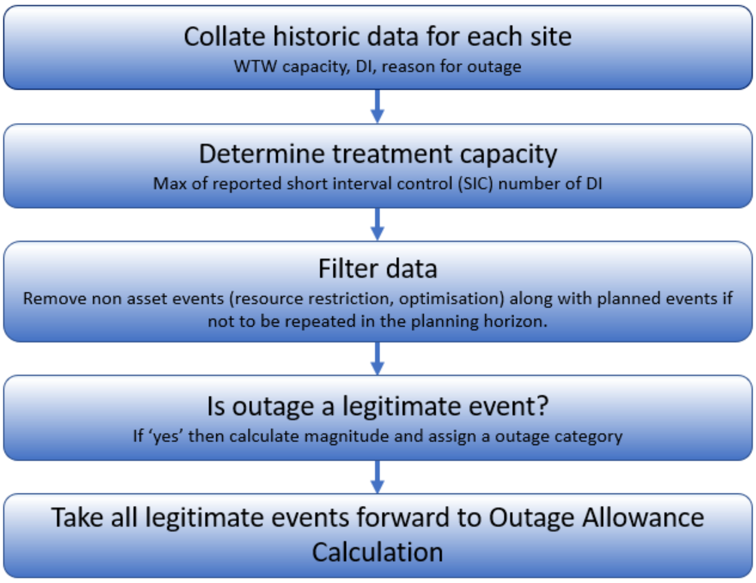
3.8.2. Data collection

Where possible, and appropriate, the same raw data set of water treatment works capabilities and outages is used for the Unplanned Outage (UPO) annual reporting, the Annual WRMP Actual Outage reporting and as the basis for the WRMP Outage Allowance calculation. There are several significant differences between the UPO and the WRMP Actual Outage, mainly that events caused by extreme water quality events, outages of less than 24hrs along with planned outages are excluded from the UPO.

Historic outages occurring in the years 2017/18 to 2021/22 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.



3.8.3. Calculation

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 11 intervals, for each WTW that was then ran through a Monte Carlo simulation.

As Kielder WRZ is a large surface water dominated WRZ, the combined maximum treatment capacity of the WTWs far exceeds the 1-500 deployable output of the WRZ. As the outage has been calculated against the maximum treatment capacity rather than the treatment capacity required for a 1-500 return period DO, there is surplus treatment capacity available in the WRZ to allow for some level of outage without impacting on the ability to supply the 1-500 DO, this is illustrated in Figure 9.

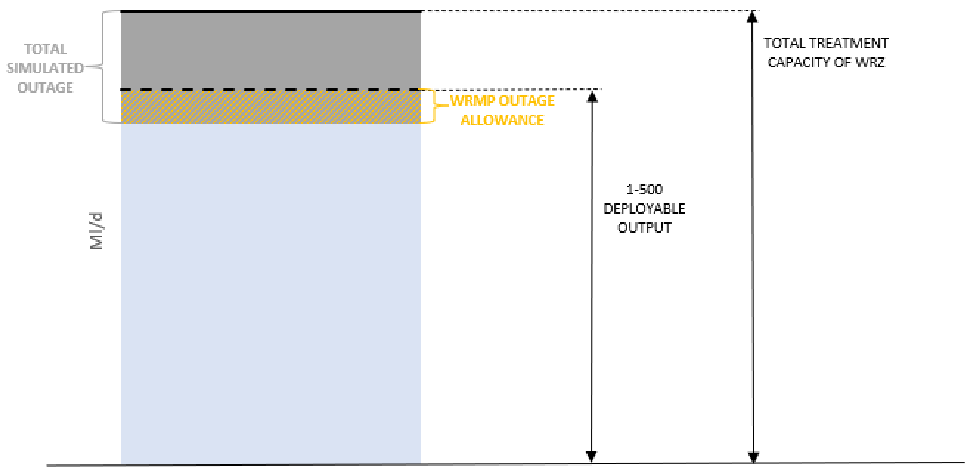


Figure 9: Illustration of surplus treatment capacity

The WRMP outage allowance is calculated using the following formula:

WRMP Outage Allowance = (1-500 DO) – (Total treatment capacity of the WRZ – Total simulated outage)

where,

> Total treatment capacity of the WRZ = sum of the maximum WTW capacities as used in the Aquator XV model.
>
> Total simulated outage = 90th percentile of the monte carlo simulation.
>
> 1-500 DO = 1-500 DO as determined by the stochastic modelling in Aquator XV.

A more detailed description of the methodoly for calculating the Outage Allowance can be found in our WRMP24 Outage Allowance Technical Report.

3.8.4. 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 53.62Ml/d and 0.60Ml/d for the Berwick & Fowberry WRZ.

The results of the calculation detailed in the section above are shown in Table 15.

Table 15: WRZ Outage Allowances

PERCENTILES	KIELDER WRZ OUTAGE ALLOWANCE (Ml/d)	BERWICK & FOWBERRY WRZ OUTAGE ALLOWANCE (Ml/d)
50%	5.32	0.42
55%	10.21	0.44
60%	14.81	0.47
65%	19.88	0.49
70%	25.04	0.51
75%	30.49	0.53
80%	36.72	0.56
85%	43.91	0.58
90%	**53.62**	**0.60**
95%	67.43	0.62

3.9. LOSSES FROM PROCESSING AND TREATMENT

For a detailed report on this section please refer to the **Raw Water and Process Losses technical report** which is available on request by emailing waterresources@nwl.co.uk

3.9.1. 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.

Table 16: Raw Water and Process Losses Considerations

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).

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, an allowance of 0.79Ml/d has been included in the forecast based on an avarge of the five year period 2017-2022 for the Kielder WRZ. There is no raw water operational use in the Berwick & Fowberry WRZ.

The raw water losses and the treatment works losses/operational use at WTWs can be accounted for by analysing abstraction, inlet, outlet and wash water meters. These 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.

Data from abstraction, inlet, outlet and wash water meters have been used, along with site specific operational knowledge, to quantify raw water and process losses for each WTW. It should be noted that the percentage losses for each WTW do not directly correlate into a reduction in WAFU, this is due to the conjunctive nature of the WRZs meaning that WTWs will run at different levels relative to each other depending on the level of demand and optimisation of the network.

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, and therefore included in 'Basseline forecast changes to Deployable Output'. 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 for the Kielder WRZ has been amended, see below, to avoid double counting.

Original formulae:

$$\text{Water Available For Use} = \left(\begin{array}{c}\text{Deployable Output before}\\ \text{forecast changes (6BL)}\\ +\\ \text{Baseline forecast changes to}\\ \text{Deployable Output (7BL)}\end{array}\right) - \left(\begin{array}{c}\text{Raw water losses, treatment works}\\ \text{losses and operational use (8BL)}\\ +\\ \text{Total Outage Allowance (9BL)}\end{array}\right)$$

Amended formulae:

$$\text{Water Available For Use} = \left(\begin{array}{c}\text{Deployable Output before}\\ \text{forecast changes (6BL)}\\ +\\ \text{Baseline forecast changes to}\\ \text{Deployable Output (7BL)}\end{array}\right) - \left(\text{Total Outage Allowance (9BL)}\right)$$

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.

3.9.2. Results

Table 17 summarises the total (raw water and process) losses by site, for the Kielder WRZ. The table also confirms if losses impact on the ability of each WTWs to meet its design treatment capacity.

Table 17: Raw Water and Process Losses by Site

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
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	
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	

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 Table 18 and have been calculated using the average losses across all the WTWs and the forecasted Distribution Input (Baseline DYAA).

Table 18: Kielder Raw Water Losses

Kielder WRZ	2025/26	2030/31	2035/36	2040/41	2045/46
Total raw water and process losses	38.80	39.66	39.84	40.18	40.67

The only WTWs in the Berwick & Fowberry WRZ, where raw water and process losses contribute to a loss of DO is Murton WTW. This has been validated utilising a simplistic excel model with the combined licence representative of the sustainable abstraction for the WRZ, 4% raw water losses assigned to the raw water mains and 4% treatment works losses assigned to the WTW.

3.9.3. Options to reduce raw water losses

Modelling shows that the impact on WAFU of process and raw water losses is of the order of 0.6Ml/d. Given the environmental sensitivity of our Berwick & Fowberry WRZ abstractions, we are committed to the following investigations in the Berwick & Fowberry WRZ:

- Further investigation of raw water leakage, focusing on find and fix, and
- Investigate if there are “gentleman agreements” with local farmers to provide them with a small supply of raw water, and if so, get these measured and recorded as non-potable supply.

3.10. 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 baseline WAFU values, across the planning horizon, for both our WRZ’s are summarised in Table 19 and Table 20.

Table 19: Kielder Potable WAFU

Kielder WRZ	2025/26	2030/31	2035/36	2040/41	2045/46
DO	803	803	803	803	803
Climate Change Impact	18.75	22.06	25.44	28.90	32.42
Outage	53.64	53.64	53.64	53.64	53.64
Process Losses	4.86	4.86	4.86	4.86	4.86
Reduction due to increase in Industrial supply	0	9	9	9	9
WAFU	725.75	713.44	710.06	706.60	703.08
Water Imported	0.3	0.3	0.3	0.3	0.3
Water Exported (incl. NAVs)	4.63	4.63	4.63	4.63	4.63
Total WAFU	721.42	709.11	705.72	702.27	698.75

Table 20: Berwick & Fowberry WAFU

Berwick & Fowberry WRZ	2025/26	2030/31	2035/36	2040/41	2045/46
DO (including sustainable abstraction reductions)	10.94	9.98	9.98	9.98	9.98
Climate Change Impact	0	0	0	0	0
Outage	0.6	0.6	0.6	0.6	0.6
Process Losses	0.51	0.51	0.52	0.52	0.52
WAFU	10.34	8.87	8.86	8.86	8.86
Water Imported	0	0	0	0	0
Water Exported	0	0	0	0	0
Total WAFU	10.34	8.87	8.86	8.86	8.86

3.11. 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.

3.12. 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.

3.13. 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.

3.14. INVASIVE NON-NATIVE SPECIES

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 11.1 as part of our Integrated Environmental Assessment. In summary, INNS has not impacted the DO or WAFU.

4. OUR BASELINE DEMAND FORECAST

For a detailed report on this section please refer to the **Demand Forecast technical report** which is available on request by emailing waterresources@nwl.co.uk

4.1. OVERVIEW

A baseline normal year demand forecast has been produced following the Water Resources Planning Guideline (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 Water Resource Management Plan (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.

4.2. OUR BASELINE DEMAND

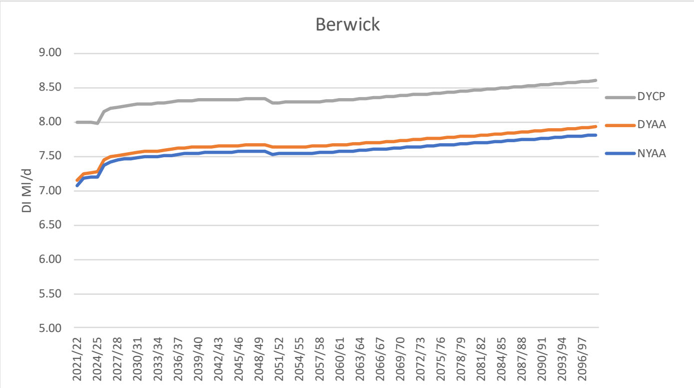
Normal year forecasts have been made against a 2021/22 base year, which has been amended from the published Annual Regulatory report figures to incorporate the rebasing process for properties. This ensures a smooth projection from the base year into the forecast.The reported per capita consumption (PCC) for 2021/22 includes the impact of Covid.

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 are not applied to household consumption.

Baseline forecasts have been produced for the following conditions, Normal Year (NYAA), Dry Year (DYAA) and Dry Year Critical Period (DYCP), as shown in Figure 10.



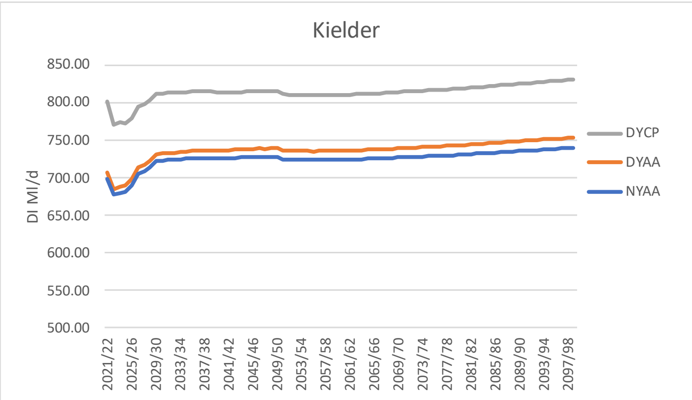


Figure 10: Baseline demand forecast DI for Critical Period (DYCP), Dry Year (DYAA) and Normal Year (NYAA) scenarios.

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 specialised 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 (2021) 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.

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 National Population Projections (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.

Population forecast outputs

In all WRZ's overall population is forecast to increase. Low, medium and high scenario forecasts have been created, as shown in Figure 11, to allow for changes in assumptions and uncertainty within the population forecasts. On average for Berwick this has resulted in a 14.1% increase in total population to 2049/50 and for Kielder a 11.7% increase.

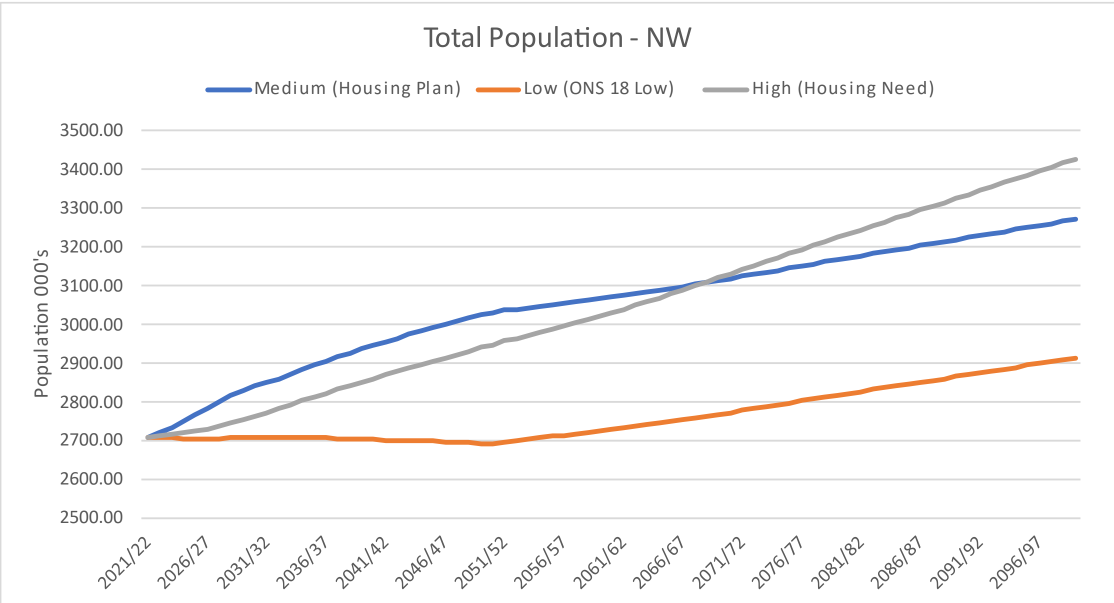


Figure 11: Total Population for the three selected scenarios for NW

WRMP19 vs WRMP24 total population

The difference in our population forecast from our last WRMP and our new WRMP24 for the same years is shown in Table 21.

Table 21: WRMP19 vs WRMP24 total population

Total Population 000's	WRMP19	dWRMP24	WRMP19	dWRMP24
	2025/26		2029/30	
Berwick	21.59	24.74	22.17	25.00
Kielder	2659.07	2677.67	2716.90	2683.42

The change to the population forecasts is appropriate as it takes account of the following reasons:

- It accounts for updated Local Authority Local Housing Plan forecasts. The UK government has stated its determination to accelerate the rate of house building;
- To account for updated ONS population forecasts;
- To rebase properties to the reported property numbers in 2020/21;
- The UK exited from the European Union;
- The unprecedented impact of the Coronavirus pandemic which has impacted population through internal and external migration;
- New Census 2021 data becoming available as part of ONS mid-year estimates.

The above points are in line with the PR24 Water Resources Planning guidelines, for example, Section 6.3 which states 'Use improved and updated population and household data in your final WRMP if it is available and describe how you will do this in your draft plan.'

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 detailed above which has been updated to include data from the most recent Census 2021 and adjusted 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 27.3% increase over 25 years and for Kielder a 15.2% 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, the bias towards low occupancy in optant properties is reduced.

The overall occupancy for all households steadily declines from 2.56 in 2021/22 down to 2.28 in 2049/50 in Berwick (-10.9%) and 2.35 in 2021/22 down to 2.27 in 2049/50 in Kielder (-3.5%).

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 until 2024/25 when our Price Review 2019 (PR19) demand management options end the baseline consumption increases which is predominantly driven by population and property growth, as shown in Figure 12.

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

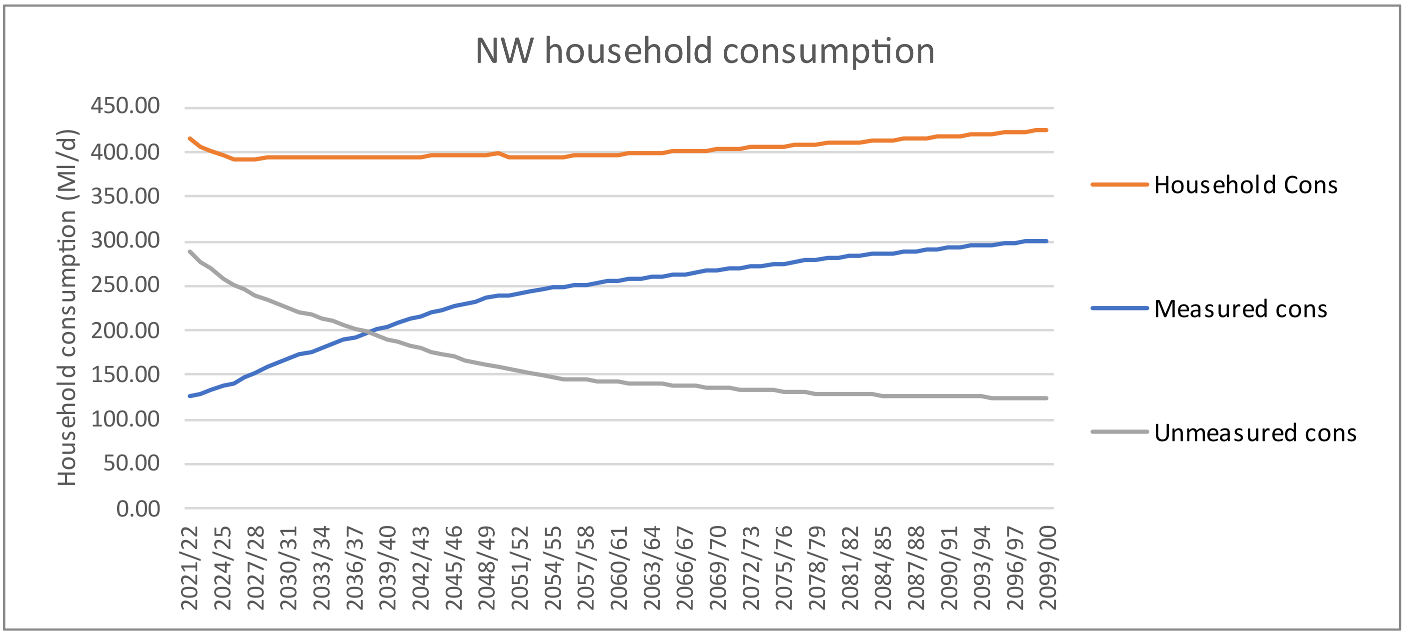


Figure 12: Household consumption, including the split between measured and unmeasured household consumption, one graph per WRZ

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 Water Closet (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, shown in Figure 13, 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 13: 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 PCC for the forecast base year (2021/22). 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.

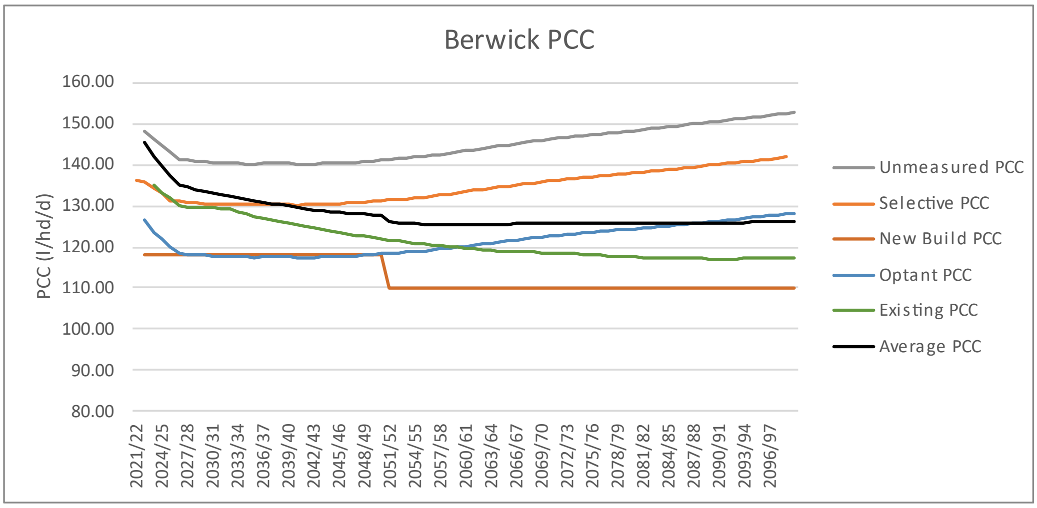
4.4.2. Measured household demand

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 and contact with Local Authorities planning departments.

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. Water Resource commission (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.

Figure 14 depicts the changes in PCC for each meter household type over the baseline forecast. Overall average PCC decreases over the planning horizon.



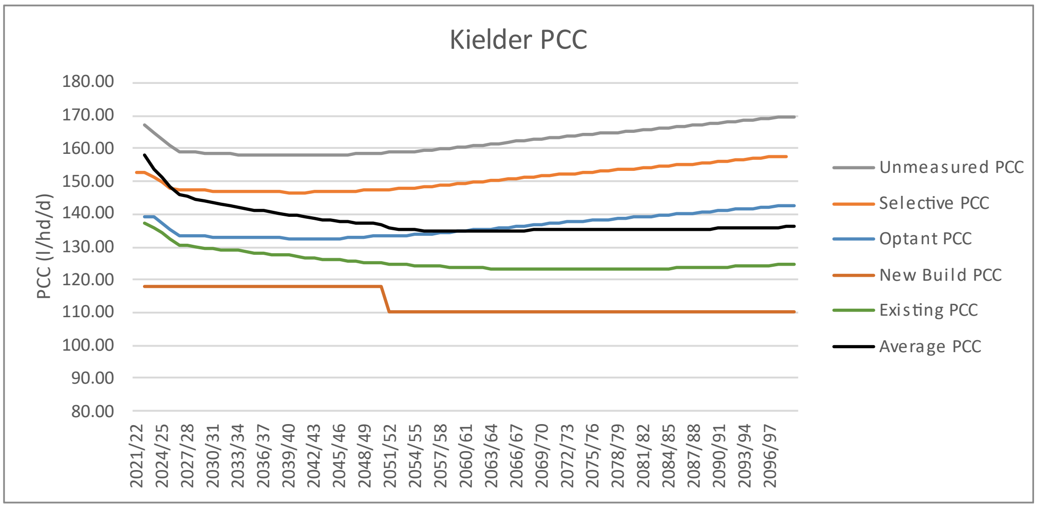


Figure 14: PCCs per meter household type for the planning horizon

4.4.3. 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 Asset Management Period (AMP) regarding the effect of Covid-19 and have been applied to the micro-component PCC baseline demand forecasts.

4.5. 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.

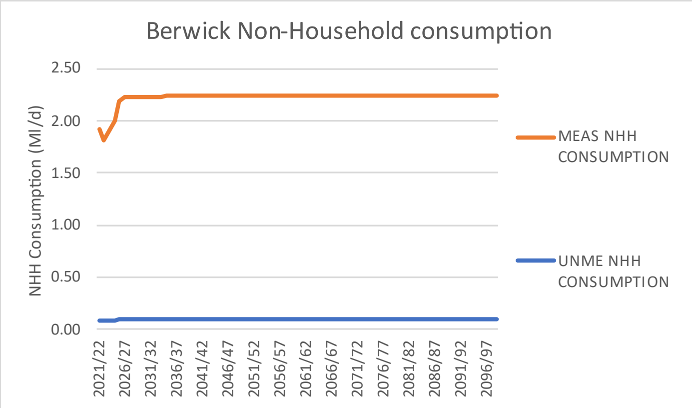
The impact of Covid on non-household demand was applied to the forecast using the model from the Artesia (2020) study and sees non-household demand returning to pre-Covid levels by 2024/25.

We updated the non-household demand forecast between preparing our draft and revised draft WRMP24, to reflect businesses latest forecasts which has resulted in an uplift in both potable and raw water demand. In order to supply the full quantity of raw water by 2026, we will need to construct eel screens on our Low Worsall river intake and vary River Tees abstraction licences to revert licensed quantties back to their original levels. The licences were varied down to reflect what was a reduction in industrial raw water demand at the time.

We are in the process of setting up an Northumbrain Water Limited (NWL) director led group to provide the focus and engagement needed given the significant increase in NHH growth on Teesside.

The resulting forecast, shown in Figure 15, 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 have been fed into the regional plans. Ovarro 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.



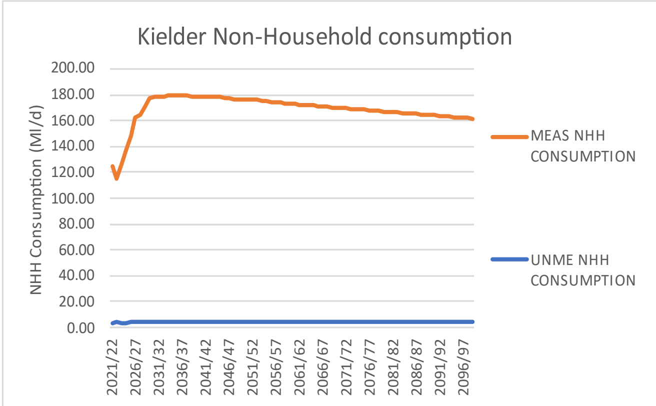


Figure 15: Non-household potable consumption baseline forecast split between measured and unmeasured. One graph per WRZ.

4.6. FORECASTING DEMAND FOR OUR NEW APPOINTMENTS AND VARIATIONS (NAV)

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 37 either already in place or expected in the near future in the Northumbrian Water (NW) area and the majority (95%) of NAV's are for new housing developments within specific areas. We contacted all appointees in Autumn 2022 requesting their draft WRMP24 regarding the NAVs they serve.This data has been used to create a demand forecast for each NAV, including a population and property forecast.

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. Our NAV demand forecast includes forecast growth from existing NAV sites. We have not included any growth assumptions regarding new NAVs which we are currently not aware of. Therefore, we have included all new household growth in our overall demand forecasts.

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.

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 Table 22.

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

Table 22: Total Leakage 2021/22

WATER RESOURCE ZONE	TOTAL LEAKAGE 2021/22 (ML/D)	TOTAL LEAKAGE 2024-2050 (ML/D)
Berwick & Fowberry	1.44	1.52
Kielder	129.02	113.06

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 46.79% of domestic properties for our baseline forecast. By the end of the planning horizon the baseline meter penetration is forecast to be 78.42%.

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. Table 23 presents 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 and 0% of meters will be basic/AMR.

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

Table 23: Metering Optant Installations

OPTANTS	METER INSTALLED 2022-2024/25	METER INSTALLED AMP8	METER INSTALLED AMP9	METER INSTALLED AMP10
Berwick	307	575	411	416
Kielder	46760	69425	49590	50235

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 as shown in Table 24.

Table 24: Other Demand Components

OTHER COMPONENTS OF DEMAND	NW ML/D
Operational Use	1.75
Unbilled Use	24.26
Bulk Supplies (excl. NAVs) (net export, including imports)	1.00

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 CP we have followed the methodology from the UK Water Industry Research (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.

[2] UKWIR (2006) Peak Demand Forecasting Methodology report 06/WR/01/7
[3] Artesia Consulting (2020) Water demand insights from 2018

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 Distribution Input (DI) for a Dry Year and Critical Period scenario.

For information on the Lessons learn't from the 2022 drought please refer to the **Lessons Learnt from 2022 Drought Technical report** available on request by emailing waterresources@nwl.co.uk

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 were used in combination with UK Climate Projections 2018 (UKCP18) 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 UKCP18 climate projections. In order to incorporate the new set of climate projections that were released (UK Climate Projections 2018 (UKCP18)), we contracted Hydrology UK to develop a method that allowed a factor to be applied to the look-up tables.

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

The UKWIR (2013) 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.

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[4] UKWIR (2013) Impact of Climate Change on Water Demand

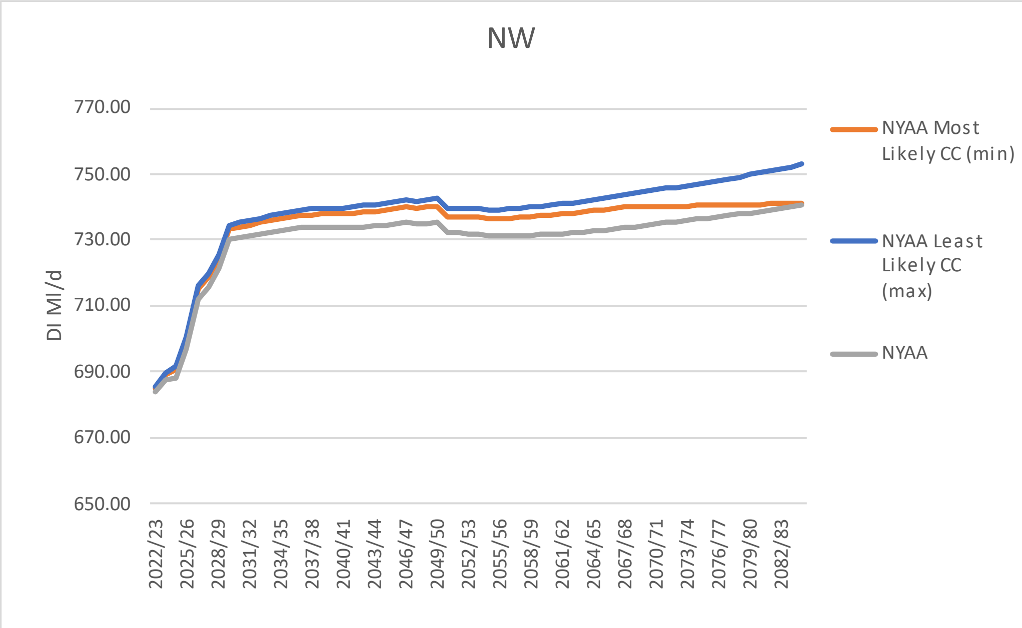


Figure 16: Difference Between Most Likely And Least Likely Climate Change Scenarios Compared To Normal Year

5. ALLOWING FOR UNCERTAINTY

For a detailed report on this section please refer to the **Allowing for Uncertainty Technical Report** which is available on request by emailing waterresources@nwl.co.uk

5.1. OVERVIEW

For this 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.

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 (EA) in their latest 'Water resources planning guideline' (December 2021). Table 24 lists all uncertainty factors included within the original UK Water Industry Research (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 Table 25 for completeness.
- 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 WRMP24.

Table 25: Summary Of Supply-Demand Balance Uncertainty Factors

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.

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 EA 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 (WRMP).

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 Table 26 and Table 27 (at 5-yearly intervals) and in **Error! Reference source not found.** and Figure 18 (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.

Table 26: Headroom Distribution For Berwick & Fowberry WRZ - 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%	-0.19	-0.21	-0.20	-0.24	-0.23	-0.24	-0.22	-0.16	-0.16	-0.18	-0.17	-0.20	-0.20
5%	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.10	0.10	0.10	0.10
10%	0.13	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.14
15%	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.19	0.18	0.18	0.18	0.18
20%	0.19	0.19	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21
25%	0.21	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.24	0.23	0.23	0.23	0.23
30%	0.24	0.24	0.24	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.25	0.25	0.25
35%	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.27	0.27	0.27
40%	0.27	0.28	0.28	0.28	0.28	0.29	0.29	0.29	0.30	0.29	0.29	0.29	0.29
45%	0.29	0.30	0.30	0.30	0.30	0.31	0.31	0.31	0.32	0.31	0.31	0.31	0.31
50%	0.31	0.31	0.32	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.33	0.33	0.33
55%	0.33	0.33	0.34	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.35	0.35	0.35
60%	0.35	0.35	0.35	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.37	0.37	0.37
65%	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39	0.39	0.39	0.39	0.39	0.39
70%	0.39	0.39	0.40	0.40	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.41	0.41
75%	0.41	0.41	0.42	0.42	0.42	0.43	0.43	0.43	0.44	0.44	0.43	0.43	0.43
80%	0.44	0.44	0.45	0.45	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.46	0.46
85%	0.47	0.47	0.48	0.48	0.48	0.49	0.49	0.49	0.50	0.50	0.49	0.49	0.49
90%	0.51	0.52	0.52	0.52	0.53	0.53	0.53	0.54	0.54	0.54	0.54	0.54	0.54
95%	0.59	0.59	0.60	0.60	0.60	0.61	0.61	0.61	0.61	0.62	0.61	0.61	0.61
100%	9.07	8.97	10.51	9.07	9.13	10.60	10.56	9.16	9.30	11.41	9.01	10.65	10.08
Selected	**0.51**	**0.47**	**0.45**	**0.42**	**0.40**	**0.38**	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**
% of DI	*7%*	*6%*	*6%*	*6%*	*5%*	*5%*	*5%*	*5%*	*5%*	*5%*	*5%*	*5%*	*5%*

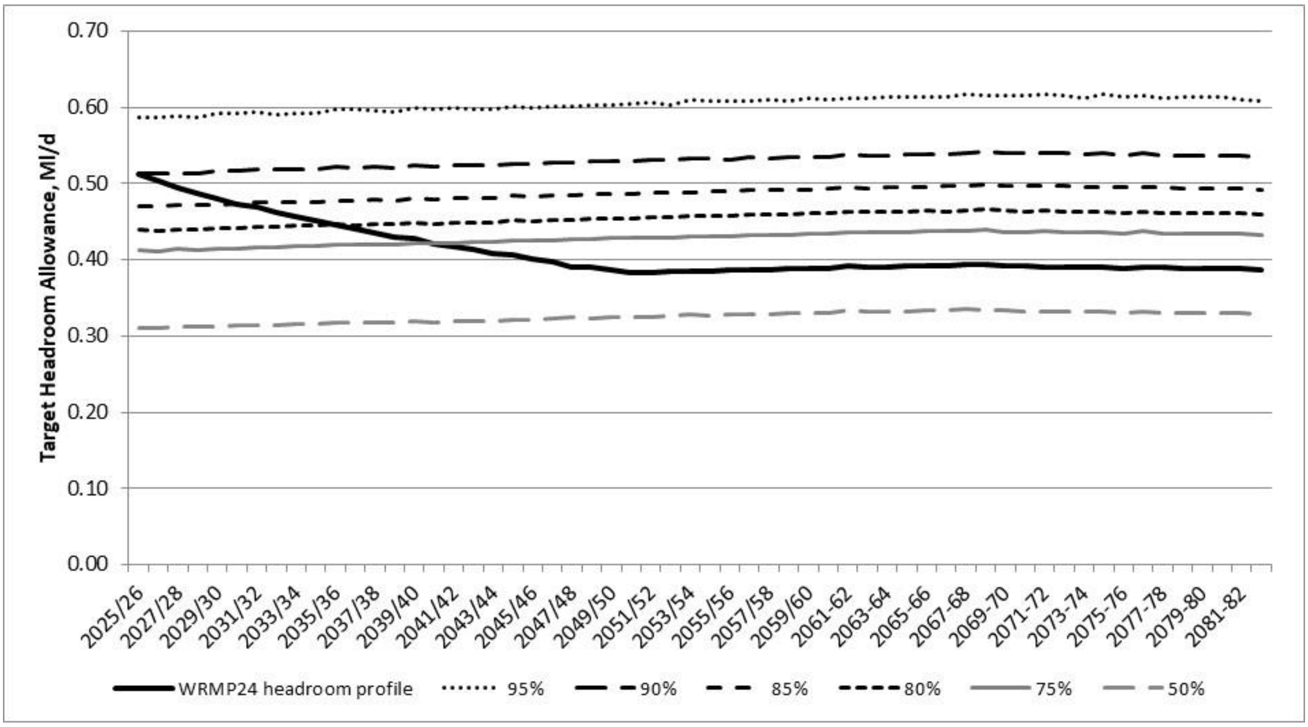


Figure 17: Target Headroom Profile For Berwick & Fowberry Resource Zone - Baseline Dry Year Annual Average Scenario

Table 27: Headroom Distribution For Kielder 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%	-36.52	-41.52	-44.08	-49.12	-46.12	-49.26	-53.06	-53.35	-56.83	-65.31	-64.33	-66.12	-72.97
5%	-15.64	-17.11	-18.47	-20.03	-21.74	-23.58	-25.32	-27.20	-29.35	-31.72	-34.43	-37.31	-39.69
10%	-12.24	-13.33	-14.59	-15.83	-17.30	-18.67	-20.29	-21.75	-23.61	-25.75	-28.22	-30.66	-32.84
15%	-9.97	-10.87	-11.93	-12.97	-14.19	-15.35	-16.62	-17.94	-19.56	-21.51	-23.70	-25.95	-28.03
20%	-8.11	-8.81	-9.80	-10.66	-11.74	-12.72	-13.76	-14.89	-16.32	-18.09	-20.10	-22.05	-23.85
25%	-6.48	-7.11	-7.95	-8.63	-9.62	-10.44	-11.33	-12.26	-13.48	-15.07	-16.91	-18.70	-20.32
30%	-5.02	-5.54	-6.26	-6.90	-7.68	-8.32	-9.13	-9.86	-10.94	-12.36	-14.02	-15.69	-17.15
35%	-3.65	-4.13	-4.72	-5.27	-5.96	-6.44	-7.14	-7.67	-8.61	-9.81	-11.35	-12.86	-14.17
40%	-2.37	-2.77	-3.23	-3.74	-4.31	-4.68	-5.25	-5.65	-6.44	-7.48	-8.92	-10.16	-11.40
45%	-1.11	-1.44	-1.82	-2.29	-2.69	-3.00	-3.43	-3.70	-4.37	-5.30	-6.56	-7.59	-8.78
50%	0.09	-0.16	-0.41	-0.86	-1.14	-1.34	-1.68	-1.87	-2.40	-3.20	-4.34	-5.23	-6.30
55%	1.31	1.11	0.95	0.57	0.38	0.25	0.00	-0.05	-0.47	-1.17	-2.16	-2.91	-3.87
60%	2.54	2.41	2.34	2.03	1.87	1.88	1.71	1.73	1.42	0.81	0.02	-0.68	-1.49
65%	3.81	3.78	3.73	3.50	3.44	3.55	3.44	3.53	3.28	2.81	2.21	1.62	0.87
70%	5.14	5.22	5.16	5.07	5.05	5.26	5.22	5.43	5.25	4.83	4.38	3.94	3.28
75%	6.62	6.73	6.72	6.74	6.78	7.09	7.11	7.43	7.35	6.95	6.62	6.39	5.83
80%	8.18	8.40	8.45	8.56	8.67	9.04	9.19	9.55	9.58	9.26	9.04	8.89	8.52
85%	10.07	10.30	10.43	10.66	10.90	11.29	11.56	12.04	12.04	11.94	11.75	11.76	11.56
90%	12.41	12.75	12.94	13.29	13.55	14.00	14.40	14.95	15.11	15.13	15.09	15.23	15.13
95%	15.78	16.32	16.51	16.98	17.44	17.97	18.57	19.10	19.35	19.63	19.86	20.00	20.12
100%	46.92	47.29	50.62	47.66	50.94	49.20	50.11	48.79	55.96	49.55	52.93	55.88	58.82
Selected	**8.18**	**5.22**	**2.34**	**0.57**	**0.38**	**0.25**	**0.00**	**-0.05**	**-0.47**	**-1.17**	**-2.16**	**-2.91**	**-3.87**
% of DI	*1%*	*1%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*-1%*

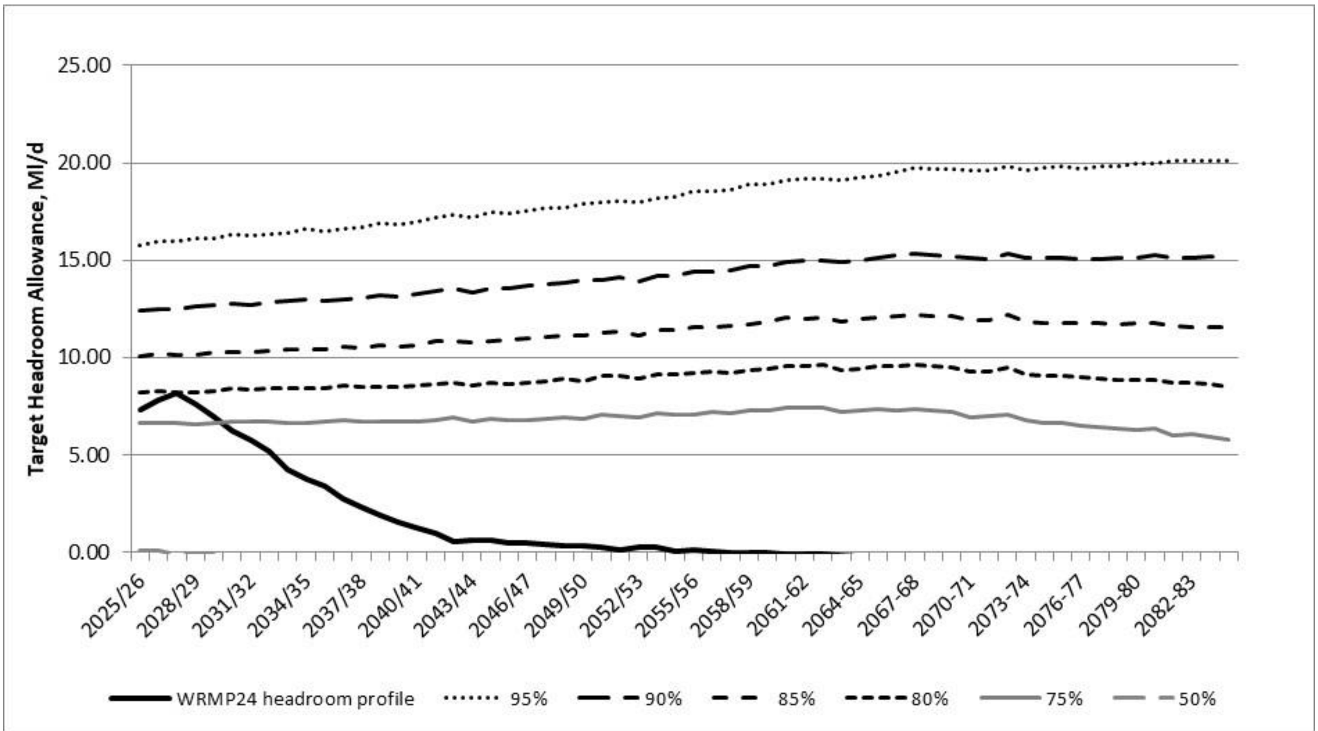


Figure 18: Target Headroom Profile For Kielder Resource Zone - Baseline Dry Year Annual Average Scenario

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 shown in Table 28. 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.

It should be noted that for Kielder Resource Zone, in the dry year annual average scenario, the target headroom values for the selected risk profile (high resilience) dropped below zero from 2056/57 onwards. The target headroom allowance is intended as a margin between supply and demand to allow for uncertainty and therefore it would not be appropriate to utilise negative values within the company's supply-demand balance; all negative target headroom values for Kielder Resource Zone were therefore set to zero for supply-demand balance analysis purposes. This did not affect the dry year critical period scenario, as the effect is due to the shape of the supply-side climate change impact distributions, which are not applicable to the dry year critical period scenario.

Table 28: Summary of Target Headroom Allowance For All Resource Zones

Resource Zone	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)	0.51	0.47	0.45	0.42	0.40	0.38	0.39	0.39	0.39	0.39	0.39	0.39	0.39
	DYCP target headroom allowance (Ml/d)	0.54	0.51	0.49	0.47	0.46	0.45	0.46	0.47	0.48	0.49	0.50	0.51	0.51
Kielder	Risk level (%)	20%	30%	40%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%
	DYAA target headroom allowance (Ml/d)	8.18	5.22	2.34	0.57	0.38	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	DYCP target headroom allowance (Ml/d)	13.49	12.00	10.63	10.75	12.05	13.39	14.64	15.99	17.28	18.12	18.71	19.35	19.68

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

For a detailed report on this section please refer to the **Supply Forecasting technical report** which is available on request by emailing waterresources@nwl.co.uk

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 (WRZ). 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. The supply forecast is a forecast of Water Available for Use (WAFU) and the demand forecast is a forecast of Distribution Input (DI). For each WRZ, a supply demand balance graph has been prepared. The key features on each of the graphs are:

- Demand Forecast (blue 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 (black dashed 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 dry year annual average (DYAA) and dry year critical period (DYCP) supply demand balance graphs for each WRZ are presented in the following sections along with commentary on the key features of interest.

6.2. DRY YEAR ANNUAL AVERAGE SUPPLY DEMAND BALANCE

6.2.1. Kielder Water Resource Zone

Figure 19 shows a baseline potable supply demand balance for the Kielder WRZ, with the supply deficit shown in Table 29. Figure 19 shows a static demand forecast, a small step change in WAFU in 2026 due to a reduction in the potable DO to allow an increase in the non-potable supply availablilty 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 UK Climate Projections 2018 (UKCP18) which have had a more significant impact on summer river flows, and therefore deployable output, than the previous UK Climate Projections 2009 (UKCP09) 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.

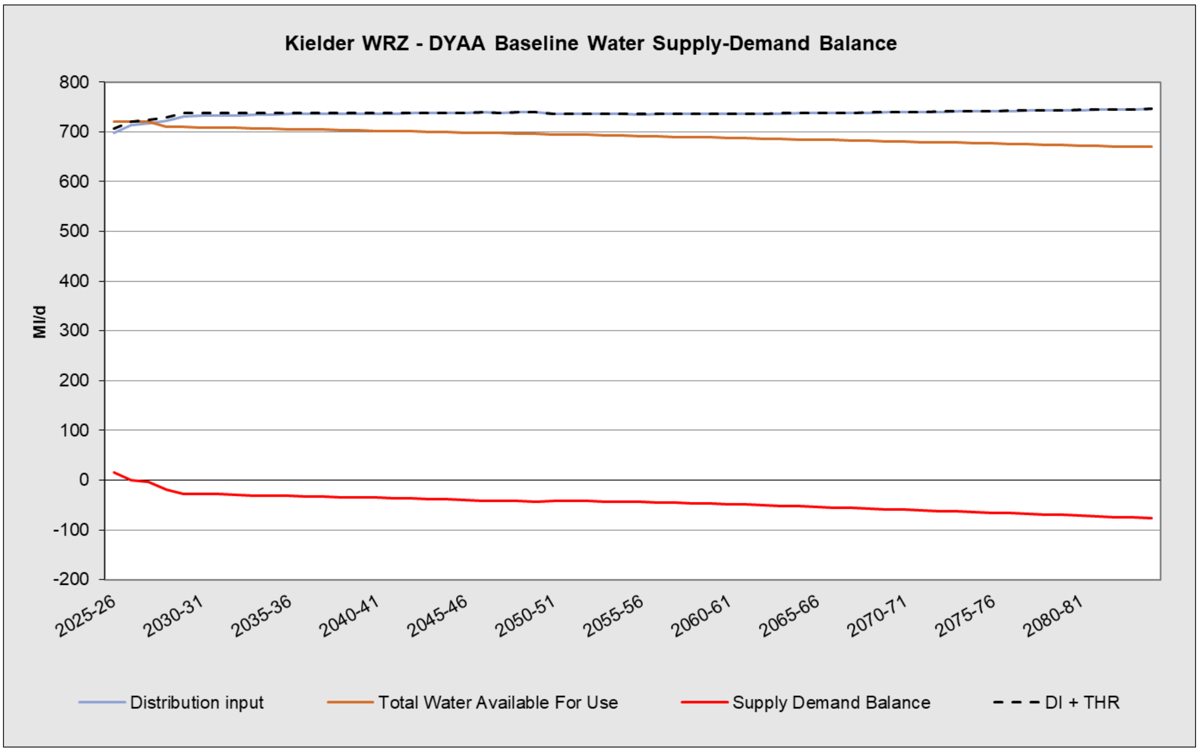


Figure 19: Kielder WRZ Potable Baseline Supply Demand Balance Graph

Table 29: Kielder WRZ Potable Supply Deficit/Surplus

KIELDER WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	-21.73	-23.07	-24.44	-25.70	-27.12
Balance of Supply (including headroom)	-27.46	-28.28	-28.71	-29.44	-30.49

We have a non-potable supply zone (known as the Industrial Supply Zone), located within the Kielder WRZ. This zone is entirley industrial customers that use non-potable water as part of their manufacturing processes. Consequently, there is no variation between the baseline and final plan supply or demand forecasts. For further information on the SDB of the non-potable component of the Kielder WRZ, please refer to Section 8.4.

6.2.2. Berwick & Fowberry Water Resource Zone

Figure 20 shows WAFU, post Asset Management Period 7 (AMP7) sustainability reductions, there is a small step change in 2027 due to the potential sustainability reduction of the fowberry abstraction licence. The supply surplus for Berwick & Fowberry WRZ is shown in Table 30.

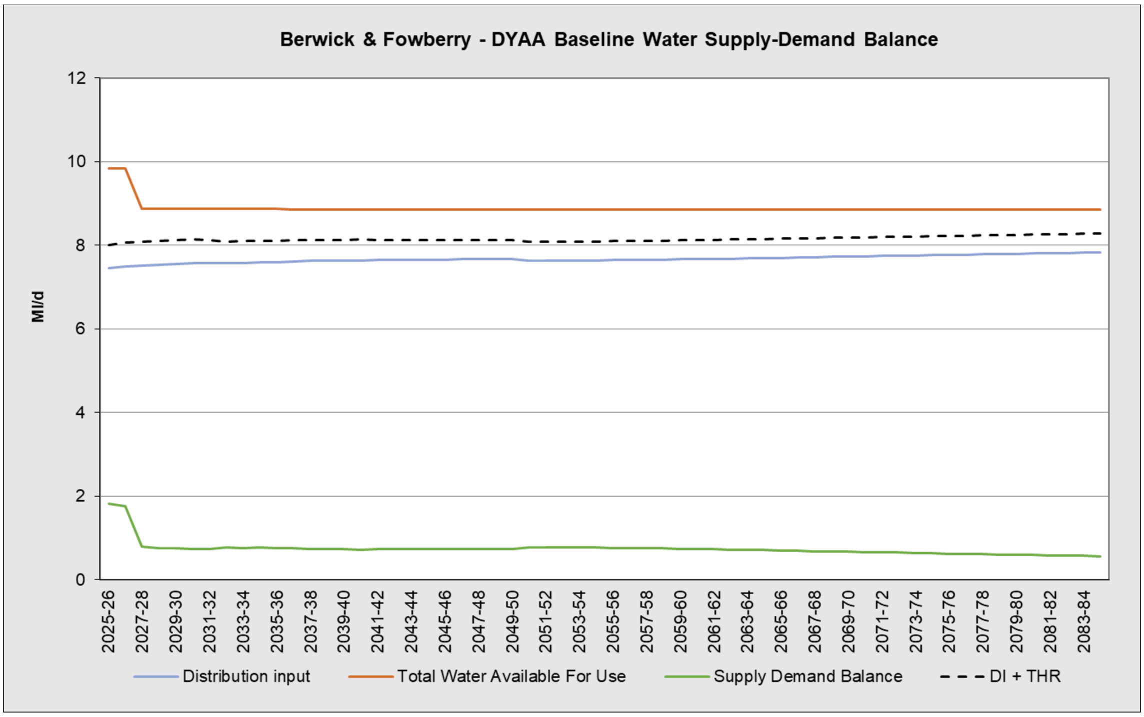


Figure 20: Berwick and Fowberry Baseline Supply Demand Balance Graph

Table 30: Berwick & Fowberry WRZ Supply Deficit/Surplus

BERWICK AND FOWBERRY WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	1.32	1.28	1.22	1.20	1.95
Balance of Supply (including headroom)	0.75	0.77	0.73	0.74	0.73

6.3. DRY YEAR CRITICAL PERIOD SUPPLY DEMAND BALANCE

6.3.1. Kielder WRZ

The baseline DYCP potable supply demand balance for the Kielder WRZ is shown in Figure 21, with the figures for the last year in each AMP highlighted in Table 31.

The supply demand balance graph shows that the Kielder WRZ baseline DYCP forecast is in a slight deficit for the planning horizon.

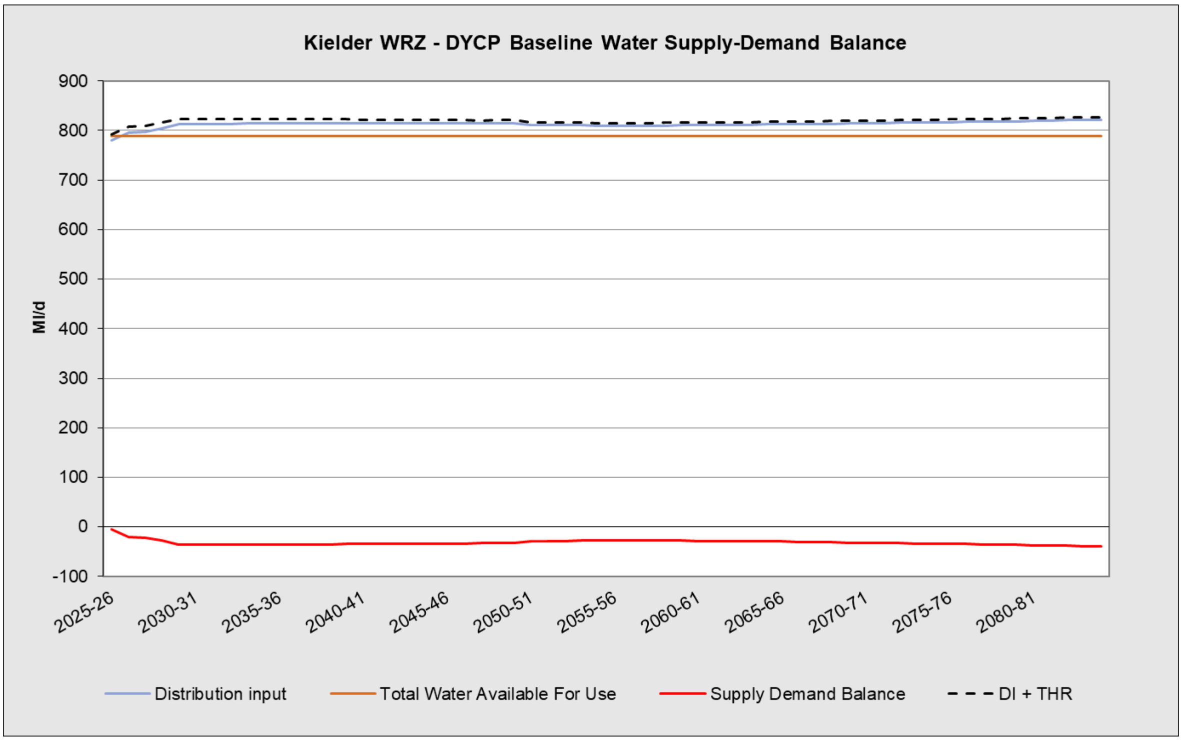


Figure 21: Kielder WRZ Baseline DYCP Supply Demand Balance Graph.

Table 31: Baseline DYCP Supply Demand Balance Figures for the Kielder WRZ

KIELDER WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	-24.36	-26.40	-26.54	-26.64	-27.04
Balance of Supply (including headroom)	-35.59	-35.97	-34.55	-33.41	-32.63

6.3.2. Berwick & Fowberry WRZ

The baseline DYCP supply demand balance for the Berwick & Fowberry WRZ is shown in Figure 22, with the figures for the last year in each AMP highlighted in Table 32.

The supply demand balance graph shows that the Berwick & Fowberry WRZ baseline DYCP forecast is a surplus for the whole planning horizon, with a small step change in 2027 due to the potential sustainability reduction of the fowberry abstraction licence.

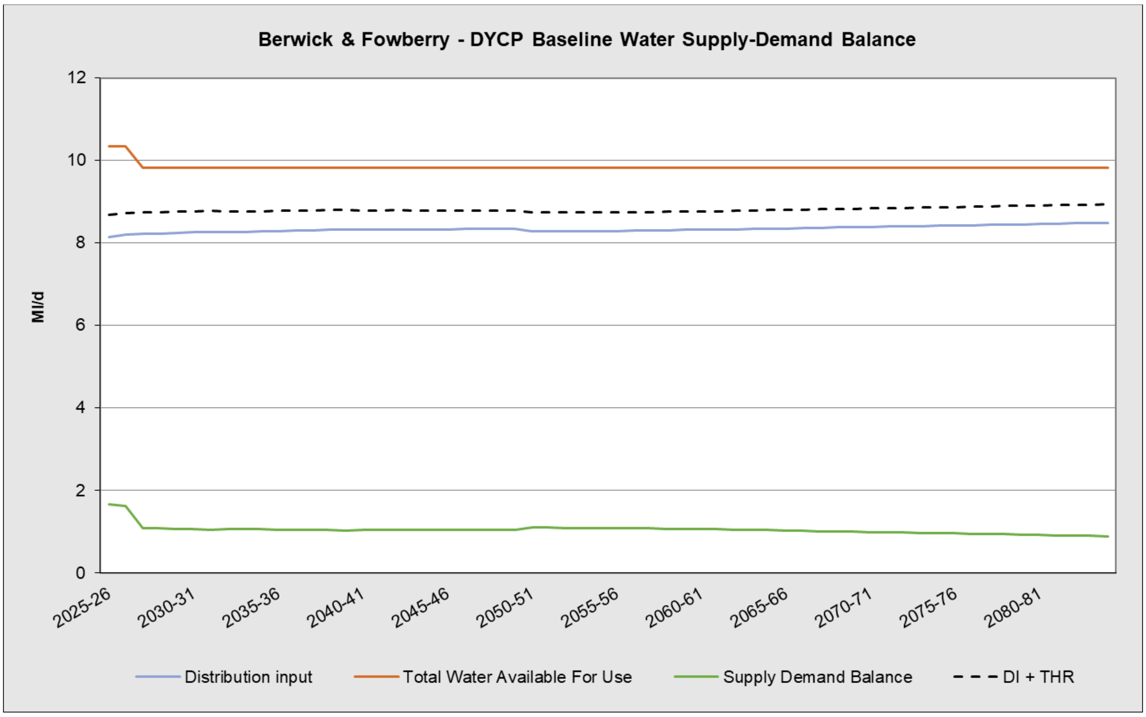


Figure 22: Berwick & Fowberry WRZ Baseline DYCP Supply Demand Balance Graph.

Table 32: Baseline DYCP Supply Demand Balance Figures for the Berwick & Fowberry WRZ

BERWICK AND FOWBERRY WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	1.58	1.55	1.51	1.50	1.49
Balance of Supply (including headroom)	1.07	1.06	1.03	1.04	1.04

6.4. BASELINE SCENARIO TESTING

A Water Resource Management Plan 2024 (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, technology and demand. Common reference scenarios are also described for high and low abstraction reductions, but as no long-term abstraction sustainability reductions under Environmental Destination (ED) are required for our Northumbrian Water (NW) region these have not been included in the scenario testing.

We have undertaken baseline sensitivity analysis for both WRZs focusing on the Ofwat common reference scenarios. High demand, low demand, fast technology and slow technology do not have baseline forecasts as they are Demand

Mangement Options (DMOs) in the final plan. The baseline forecasts for the remaining scenarios, high and low climate change, are set out inTable 33 and Table 34.

Table 33: Baseline Low and High Climate Change Supply Demand Balance Figures for the Kielder WRZ

KIELDER WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Low Climate Change	-13.54	-15.22	-16.06	-17.95	-19.95
High Climate Change	-54.00	-62.20	-69.64	-78.28	-87.14

Table 34: Baseline Low and High Climate Change Supply Demand Balance Figures for the Berwick & Fowberry WRZ

BERWICK AND FOWBERRY WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Low Climate Change	1.31	1.26	1.20	1.18	1.16
High Climate Change	1.28	1.22	1.17	1.14	1.12

6.5. WRMP24 BASELINE SDB STARTING POSITION COMPARED TO WRMP19

Table 35 shows the supply demand balance (SDB) starting position of the WRMP24 planning period compared to the SDB in the final WRMP19 2024-25 year, including explanations for any differences between plans.

Table 35: SDB WRMP19 and WRMP24

	Kielder WRZ		Berwick WRZ	
	WRMP19	WRMP24	WRMP19	WRMP24
DO	836	803	11.6	10.94
Climate Change	-12.07	-18.75	0	0
Raw water losses	17.99	4.86	0.3	0.49
Outage	57.6	53.62	0.28	0.6
Target Headroom	52.35	8.18	2.23	0.57
Water Imported	0.01	0.3	0	0
Water Exported	0.7	4.63	0	0
DI	659.88	697.82	6.86	7.44
SDB	**35.42**	**15.44**	**1.93**	**1.81**

The differences are due to:

- **DO:** The reduction is due to a move to stochastic modelling along with increasing resilience from 1-200 to 1-500.
- **Climate Change:** The increase in the impact is due to updating from UKCP09 to UKCP18.
- **Raw water losses:** The reductions are in line with the conclusions of reviewing which raw water losses actually impact on DO and those which don't.
- **Water Imported:** The increase is because we have used the contractual volume rather than recent actual.
- **Water Exported:** The increase is due to moving to contractual volume along with including New Appointments and Variations (NAVs) in the export figure.
- **DI:** The increase in Per Capita Consumption (PCC) is mainly due to Covid and an increase in population (~20,000 additional people than forecast in PR19).

7. IDENTIFYING POSSIBLE OPTIONS

For a detailed report on this section please refer to the **Options Appraisal Technical Report** which is available on request by emailing waterresources@nwl.co.uk

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 Per Capita Consumption (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 (WReN) and Water Resources West WRW)) to supply regional and national need. These are presented in Section 7.3 below.

7.2. DEMAND MANAGEMENT OPTIONS

We have identified demand management options that will both meet and exceed government expectations with regards to leakage, PCC and non-household demand reduction as well as ensure the efficient use of water. In developing our demand management options, we have considered customers preferences which we confirmed through Water Resource Management Plan 2024 (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

For a detailed report on this section please refer to the **Leakage technical report** which is available on request by emailing waterresources@nwl.co.uk

In Asset Management Period 6 (AMP6) the leakage target 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 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, Northumbrian Water (NW) 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 delivered a good leakage reduction in both of the following two years. This means that although we have not met our performance commitment in the first three years of the AMP, based on a three-year rolling average, our annual performance in 2022/23 was the lowest it has ever been. We will continue to work towards our 2024/25 target and 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 Pressure Reducing Valves (PRVs) and 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 two 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 (2017/18):

- High demand, a 30% reduction in leakage by 2050
- Medium demand, a 40% reduction in leakage by 2050
- Low demand, a 55% reduction in leakage by 2050

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.

Our supply pipe repair policy is that if a customer has a leak on their private supply pipe, we will advise them to fix it as soon as possible. Customers are required to repair the leak within 30 days of the leak being confirmed.

When installing a meter, we will check the supply pipe to establish if there is a leak. If a leak is detected in the supply pipe that can be repaired without additional excavation when the meter is installed, we will repair it at our expense. If, as a result of that check, a leak is detected that cannot be repaired without additional excavation, we will notify customers.

Currently, we do not offer free repairs to our wider customer base. However, we will support repairing a leak where a customer is financially vulnerable.

While smart metering will enable many individual and societal benefits, including quicker leak visibility and, ultimately, leak repair, responsibility for water and supply pipes and repairs to these will not change in this scenario.

Smart meters will not provide universal visibility of supply pipe leakage as some meters will be installed internally, and some properties cannot be metered. Where meters are installed externally, and leakage markers are flagged, we will proactively highlight this and investigate.

A common industry approach to customer supply pipe leakage will offer customers a consistent approach and improved experience by making it easier for them to know their rights and responsibilities than those of their water company.

We believe customers' continuing responsibility for their supply pipes provides the fairest and most balanced approach overall. It is the right approach that other companies should follow, particularly as more smart meters are installed throughout the country. However, we will provide additional support for customers unable to fund repairs themselves, supporting our commitment to eradicating water poverty.

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 reported performance in 2017/18.

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 would be achieved by 2050. In WRMP24 we have replaced this with a glidepath to hit the different percentage reductions in 2050 from the 2017/18 base position. A glidepath profile was selected based on the affordability and deliverability of our plan. It would be more expensive to reduce leakage quicker and then maintain at a lower level over the remaining planning period. The 15% target reduction in the current AMP is very challenging to meet and further reductions will only get harder and more expensive to deliver in future. There is some uncertainty around how the long-term targets can be achieved, as we try to drive beyond the unavoidable annual real losses (UARL), so an iterative approach is most appropriate to learn and improve our assumptions as we progress.

Our preferred plan is to deliver a 55% reduction in leakage by 2050 which is a 5% increase in leakage reduction compared to our draft WRMP24. This means that we are committed to a 50% reduction companywide (40% by 2050 in ESW), in line with the national target. We believe this is a fair approach based on the current leakage performance in each region and the ability to deliver future targets.

We have considered alternative scenarios for leakage including a profile for reducing leakage faster in AMP8 to hit the interim 2032 target, with the remainder of the planning period to 2050 having a linear delivery profile. The demand savings and costs of this alternative scenario are summarised in Table 36.

Table 36: Alternative Leakage Scenario AMP8

Scenario	AMP8 Demand Saving Ml/d	AMP8 Totex £M	25 year Totex £M
Central Preferred Plan	9.4	14.4	607.4
Higher AMP8 Reduction	18.7	38.9	805.3

We do not consider this feasible because:

- This would require double the volume of leakage reduction that is currently in our preferred plan for AMP8.
- The rate of reduction is higher than anything that has been delivered before, yet leaks will become smaller and harder to find as we drive leakage levels down.
- There is a significant additional cost in AMP8 and up to 2050, even though the end point is the same, a 55% reduction by 2050.
- Reflecting a linear delivery profile is important to maximise efficiency in terms of employing and training resources to enable and support additional find activity.

Our preferred final plan strategy is to continue with a linear leakage reduction delivery profile. Nevertheless, we recognise the importance of implementing sustainable reductions. Consequently, we will strive to outperform our leakage target where feasible and efficient to do so and will work collaboratively to develop innovative approaches to reducing leakage.

7.2.2. Metering

For a detailed report on this section please refer to the **Metering technical report** which is available on request by emailing waterresources@nwl.co.uk

Household 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 household 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, this is due to the meter being located in an area where the supporting infrastructure has not yet been installed. 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. From 2025, all newly installed meters will be smart capable, therefore, 100% of newly installed meters will be smart capable and 0% willl be basic/AMR. Tables showing the %age of smart and non-smart meters for each year across AMP 8 & 9, can be found in Section 3.2 of the Technical Report. By 2030 we aim to link all current smart capable meters to a wide area network and by 2035 we aim to replace all existing basic/AMR meters to smart meters, meaning that by 2035 all of our meter stock will be smart.

For clarity, meter definitions are as follows:

Basic meters are meters that require manual reads of consumption data through direct access to the meter installation.

AMR meters are meters using automated meter reading (AMR) technology. This enables consumption data to be read remotely without having to directly access the meter or property for a manual reading.

AMI meters are meters using advanced metering infrastructure (AMI) technology. This enables consumption data to be read remotely without having to directly access the meter or property for a manual reading. Consumption data is transferred to the company through an integrated system of smart meters, communications networks, and data management systems. Such systems have the capability to:

- Record consumption data and allow ready access to this data by customers (directly or via contractors/agents) and the company at near real time, with data updated daily at a minimum, and made available at a minimum granularity of 1-hour intervals, or such greater frequency and/or granularity as reasonably requested by the customer or its contractors/agents;
- Enable automated leak alarms to be communicated to the customer and company; and
- Communicate with the internet.

AMI meters (capable) are meters which are capable of acting as AMI meters but are not currently. This could be due to the meter being located in an area where the supporting infrastructure has not yet been installed. It is assumed that such meters will be operating as AMR meters.

AMI meters (active) are meters which are acting as AMI meters.

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 the region.

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.

Smart meters are a really effective tool to influence customers behaviours and promote water efficiency and also to identify customer side leakage. Once we get smart meters at scale, we can also manage the leakage on our network much better, as it will be easier to determine what is real consumption and what is being lost to leakage. Smart meters are not a 'silver bullet' and some customers are very reluctant to change behaviour, but at scale the evidence suggests that they have a positive impact.

In order to effectively manage supplies in an increasingly climate stressed world, we need to reduce water consumption and drive down leakage, both of which are a cost-effective way to contribute to achieving supply demand balance.

We're focussing our main efforts on deploying smart meters to our most water stressed areas first. 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 new meter data management system (MDMS). This will allow us to handle such large volumes of data much more efficiently.

Data security and supporting governance is a key priority for us and something we take seriously as an organisation. Hourly smart data will only be utilised for legitimate business use cases including proactive leakage detection, water balance calculation, accurate billing and helping our customers understand and take control of their consumption. Granular data will only be available to the registered bill payer. Smart meter data will not be used for other purposes without being subject to suitable aggregation and anonymisation, to ensure no individual customer can be identified from, this is something that is governed tightly within Northumbrian Water Limited (NWL).

The additional consumption data will also greatly benefit the demand calculations, in particular on customers that have had a meter installed under the Whole Area Metering (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 household metering demand management options, which can be seen in Table 37. The Northumbrian Water area has a surplus of supply over demand and the area is not classed as seriously water stressed. Therefore, compulsory metering cannot be considered.

Table 37: Metering Options

OPTION NAME	OPTION
Option 1:	In Option 1 we will only have in place optant and reactive replacement schemes. 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:	Option 2 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. 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, Option 2 also includes a proactive replacement programme to replace all existing basic/AMR 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:	Option 3 is identical to Option 2, 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:	Option 4 includes 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, Option 4 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:	Option 5 is identical to Option 4, 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.

Our preferred household demand management metering option for Northumbrian Water is option 2 and, whilst our forecast meter penetration by 2050 is lower than some other Companies, the North East is not classed as seriously water stressed and enjoys a surplus of water resources provided by Kielder reservoir and the Tyne Tees Transfer. Consequently, we feel there is not the need to request funding to deliver universal metering, which, in turn, would unnecessarily increase customer bills. However, we do acknowlede that optant numbers have started to decline, so are introducing enhanced optant and whole area metering schemes to increase meter penetration. Whole area metering installations, will not see the property billed by reference to volume, however, the customer will be issued comparison bills and given the option to move to measured charges. The number of properties metered under this scheme, but not charged by reference to volume, is presented in Table 38.

A revision from the dWRMP is that we are opting for an external first location policy for our Optant Metering shceme, to maximise the benefits of having smart meters installed, most notably, picking up supply pipe leakage at a much earlier stage than with basic/AMR meters being read 6 monthly.

Table 38 shows the number of household smart meter installations for each Option in AMP 8 in both the Kielder and Berwick WRZs, we do not plan to install basic/AMR meters under these options and as such, 100% of newly installed meters will be smart.

The street by street (whole area metering) installations in Table 38, will not be charged by reference to volume, however, these customers will be given comparison bills to enable them to decide whether a measured tariff would be beneficial to them.

Table 38: HH smart meter installation options for Berwick and Kielder AMP8 & AMP 9

	AMP 8					AMP 9				
Kielder WRZ	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**
Optant	69,500	0	0	0	0	69,500	0	0	0	0
Enhanced Optant	0	79,278	79,345	79,345	87,275	0	69,500	69,500	69,500	69,500
Street by street metering (whole area metering)	0	16,938	24,750	24,750	12,375	0	18,648	0	0	12,375
Street by street metering (whole area metering) optants & change of occupier	0	2,826	5,643	5,643	2,576	0	3,720	1,782	1,782	3,220
Reactive Replacement	13,120	11,000	13,120	13,120	13,120	13,120	10,000	0	0	13,120
Proactive Replacement	0	230,557	438,540	438,540	214,730	0	210,690	0	0	210,690

	AMP 8					AMP 9				
Berwick WRZ	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**
Optant	500	0	0	0	0	500	0	0	0	0
Enhanced Optant	0	690	625	625	690	0	500	500	500	500
Street by street metering (whole area metering)	0	1,812	250	250	125	0	0	0	0	125
Street by street metering (whole area metering) optants & change of occupier	0	33	57	57	100	0	0	18	18	100
Reactive Replacement	130	0	130	130	130	130	0	0	0	130
Proactive Replacement	0	3,571	3,295	3,295	1,615	0	0	0	0	1,555

Some of the metering options proposed are very ambitious and will see over 2,000 meter installs/replacements per week in the Kielder WRZ and just over 100 meter installs/replacements per week in the Berwick WRZ. However, in the Berwick WRZ, after year 1 of AMP 8, this number reduces to around 2 optant installations per week, as we plan to replace all meters and meter all existing unmeasured properties under the WAM scheme in year 1). Therefore, we're looking at end to end install operational efficiency and organisational design changes to optimise the use of existing resource in this region. However, we also recognise that to achieve this number of installs will require us to work with installation partners to increase our install capacity. The procurement process to secure these contracts has already commenced, with an expectation that the partner/s will be on-boarded in Q1 of 2024 to allow ramp up time before AMP8 commences.

Non- Household Metering

A change from our dWRMP to our revised dWRMP is that we are proposing to meter all currently unmeasured Non-Household (NHH) premises with a smart meter and replace all existing NHH basic/AMR meters with smart meters across AMP 8 & AMP 9. Further smart networks will be rolled out across our Northumbrian Water region over the remainder of AMP 7 and into AMP 8. We plan to install/replace NHH meters where the network is switched on first to maximise the benefits of the additional data the smart network provides.

With the industry facing challenging targets to reduce non-household consumption by 9% by 2037/38, we support the National Meter Strategy on data sharing and will continue to be involved in industry discussions. Our meters will take data readings on an hourly basis with a 15-minute night line. There will be no charge for this data, although we need to agree how this data will be made available and shared. This will be decided once the NHH National Metering Strategy Projects delivers its recommendations at the end of March 2024. Initially, one billing reading per month will be uploaded to CMOS under the terms of the CP142 change proposal – this makes Wholesalers responsible for meter reading submission for settlements purposes, where a smart meter is installed at the premise. We recognise that some NHH customers have chosen to have loggers fitted to their meters to provide more granular data and we will ensure that our future smart meters continue to allow this addition.

Furthermore, Northumbrian Water has joined with UK Power Networks, GitHub, Hewlett Packard Enterprise, LinkedIn, Microsoft and R2 Factory to make private sector data more accessible.

The Industry Data for Society Partnership (IDSP) is a first of its kind, and will see information shared, such as energy consumption, generation, and efficiency data, with the hope of better visualising and understanding how to address the global challenges such as advancing environmental sustainability and inclusive economic growth.

The pace of install in AMP 7 has been impacted by several factors:

- Covid – field resource was stood down for a period of time, internal installs put on hold and customer demand for meters (optants) was significantly impacted in the first 2 years of the AMP.
- Global chip shortage – limited our ability to receive the volume of meters we had ordered which curtailed our install progress. The global supply chain did not recover until Q1 2023. Available stock was prioritised for our Essex & Suffolk regions, where water resources are more seriously stressed.
- Delay in procuring enduring communication infrastructure across Essex & Suffolk – this process was delayed by 12 months as early assessment of the market indicated that a number of emerging technologies such as LoRaWAN and NBIOT were still in their infancy and making an early decision on an enduring communication network would be premature in the absence of seeing these technologies progress as alternative technology choices.

Whilst we are not forecasting to meet our WRMP19 targets for meter installations, we have demonstrated progressive year on year increases in install volume, which provides confidence we can scale our operational capabiliity to meet AMP 8 targets and therefore this is no plan to change the baseline plan for 2025-30.

We are confident the pace of deployment and our ambition to be fully smart by 2035 balances our ability to deliver the demand, leakage and customer benefits of smart metering in a timely manner with the cap on resource and asset availability as the wider industry gears up to install meters at scale.

We have laid strong foundations in internal capability, system change, organisational design and partnerships to ensure we are in a strong position for success. We are also in the process of tendering for install partners framework contracts, which will deliver flexibility to scale resource and install volumes from the end of AMP7.

Meter installations volumes are reported on a monthly basis and we hold quarterly review meetings to monitor progress against target and implement actions accordingly to increase installations, should we be falling behind target. This may include changes to the installation mix e.g. dialling up or dialling down proactive installs in the place of new installs, or trigger marketing campaign activity to drive inbound customer demand for meters. This drumbeat of progressive governance is already in place and effective in driving install mix optimisation. We will also keep in place our Smart Programme Board, which has membership of three of our Executive Leadership Team and key stakeholders from the business, to ensure continued governance and oversight of performance. Progress will continue to be reported in our Annual Report.

The development of near real time data dashboards is in progress which will show the impact of smart meter installations on PCC, water demand and customer side leakage, allowing us to confidently report Ml/d benefits associated to smart meter installations.

We are in the final stages of a competitive tender to select an enduring comms and meter provider for our Northumbrian operating region, which will secure the best-fit technology for the next 15 years. Key requirements to ensure we procure the optimal meter technology are:

- Best-in-market expected battery life of 15-years, with a 10- year warranty.
- The ability for the meter to operate in both AMI and AMR mode simultaneously, meaning that in the event of non-communication from the meter, we can collect a reading via walk by or drive by (currently not available from any other meter provider).
- The ability to take both hourly readings and in addition, 15-minute readings across the nightline (2am – 4am) aiding more accurate customer side leakage detection (currently not available from any other meter provider).
- Low minimum flow to trigger measurement.
- Fast lead times from order to delivery to protect effective deployment.
- Communications infrastructure is compatible with multiple meter providers to protect against future supply chain issues.

7.2.3. Water efficiency

For a detailed report on this section please refer to the **Water Efficiency technical report** which is available on request by emailing waterresources@nwl.co.uk

Our household and non-household water efficiency strategies and interventions form a key part of the Demand Management Options for our WRMP24.

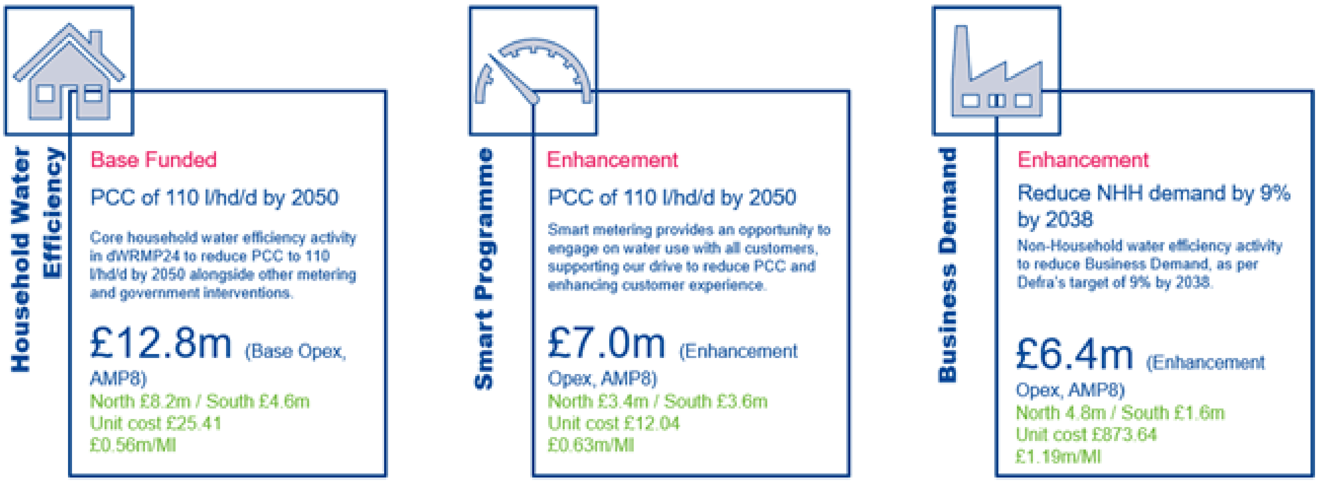
We have been widely regarded as an industry leader in the field of water efficiency. This long-standing reputation is a result of the successful delivery of effective water efficiency strategies over the years, enhanced by sharing the various project outcomes with many stakeholders, including regulators and Government.

Water efficiency has remained a key strand of our demand management undertakings throughout AMP7. 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-five 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.

Included in our plan are three core elements of water efficiency delivery, as outlined in the graphic below. The interventions are the output of fully cost options appraisals following the appropriate methodologies and guidelines provided by the Environment Agency. The graphic below outlines our commitments across both our Northumbrian Water and Essex & Suffolk Water operating regions combined. For a detailed report on this section please refer to the Water Efficiency technical report. The technical report includes the anticipated benefit for each options within the three core areas highlighted above. The method which has been used followed the guidelines produced by the Environment Agency.



The Water Efficiency Strategy will support delivery of our long-term targets to reduce Per Capita Consumption to 110 litres per person per day by 2050 and reduce Business Demand by 9% (excluding growth) by 2038.

Water companies alone cannot deliver the deep reductions in household consumption and business demand. A range of key stakeholders need to play their part. The Government has a particularly important role in delivering what are indeed its own targets. We welcome the Government's Roadmap to Water Efficiency, in particular its commitment to deliver the mandatory water efficiency labelling scheme by 2025, the review of the Building Regulations 2010 and the desire to work across government to integrate water efficiency into energy efficiency advice and retrofit programmes. It is important to emphasise that such committed actions are crucial in delivering the goal of reducing PCC to 110 litres per person per day by 2050. Indeed, the impact (water savings) of such government interventions are built into the demand forecasts (lower estimate). Such policy change will support delivery of the deep demand reductions required. Without implementation, it will not be possible to achieve them.

We fully support the Waterwise Water Efficiency Strategy 2030 (published in September 2022) and played an active role in its creation. The national strategy clearly outlines the need for demand management and the important roles of various stakeholders including wholesale water companies, retail water companies, Government, regulators, environmental charities and other sectors. Our household and non-household water efficiency strategies align to the national strategy across several of the Strategic Objectives. We lead the working group for Strategic Objective 7 (water efficiency measures are included in building retrofit programmes) and are actively involved in working groups supporting delivery of other Strategic Objectives.

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. Working in partnership is key to driving deeper and sustainable water efficiency impact. Indeed, taking a collaborative approach with various partners and stakeholders will be fundamental to reducing both Per Capita Consumption to 110 litres per person per day and Business Demand by 9% by 2038 (excluding growth).

As well as this, innovation will underpin all our water efficiency activity moving forward. Water efficiency has always played a key part in our Innovation Festivals with devoted sprints held each year focusing on various challenges around water efficiency. We have fully engaged with Ofwat's Water Breakthrough Challenge as it is a great opportunity to access funding for collaborative work to solve big challenges, receiving full funding for our Water Literacy programme. A shift further into customer engagement will also allow more effective and sustainable behaviour change while understanding customers further to benefit from sustained savings.

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

7.2.3.1 Household

Three Water Efficiency option scenarios were created as part of this process as shown in Table 39. Medium was selected as the preferrred option. This incorporates a focus on the highest water users, while also offering support to all customers through home flow restiction (flow controllers), leaking toilet idenfitication and repair, and digital engagement. The high option scenario increases the scale of four of the options that have not been delivered previously (Find and Fix Teams – bulk supply, Toilet Rebates, Home Flow Restrctions, and Unmeasured Property Engagement.)

Further information on each option and on our current and proposed educational interactions is presented in our WRMP24 Water Efficiency Technical Report (Section 3.3.1 onwards).

Table 39: Summary of water efficiency options

SCENARIOS	LOW	MEDIUM	HIGH
Options within scenarios	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	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	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
Annual Impact (l/hd/d)	0.49	0.97	1.08

7.2.3.2 Non-Household

We have developed a new non-household water efficiency strategy. In Table 40 we set out a summary of the Water Efficiency Strategy that will deliver a reduction in non-household demand of 9% by 2037/38 (excluding growth) against a 3-year average baseline taken in 2019/20. We have committed to a relative target (9% reduction excluding growth) instead of an absolute target (9% reduction of overall NHH demand). Our NHH demand growth forecasts are among the highest in the industry and therefore we have devised a programme of NHH interventions that will deliver a 9% reduction against a baseline excluding growth. We have not committed to anything beyond 2037/38 currently. We will use the learning during AMP8 to develop our PR29 strategy for 2038 and beyond. Further detail can be found in the Water Efficiency Technical Report.

The first five years (AMP8) have a lower commitment before increasing in AMP9 and again into the first three years of AMP10. This will enable us to grow our understanding, learn from and collaborate with retailers/non-households/stakeholders, and iterate our plans while delivering options that are like the household domestic use. This all prepares us for a scaling up of activity in AMP9 and the first three years of AMP10.

We have engaged a range of organisations to develop our non-household water efficiency strategy. These include Water Resources East (WRE), Market Operator Service Ltd (MOSL), water retailers, wholesale water companies and consultants.

We have shared our plans as they have developed with our two largest retailers, Wave and Everflow, who make up c.90% of our NHH connections. This is both to ensure alignment and avoid any barriers. Up to and after 2025 we will continue to interact to identify the best ways of delivering together. Discussion focused on the relationships Retailers have with their customers could lead to a higher level of engagement, with funding required for Retailers to take this on over and above their current level of engagement. Decisions of how to best to manage this will be agreed ahead of delivery from April 2025 with Retailers involvement. We will continue to build on these relationships, with a concerted effort on driving long-term and impactful relationships with water retailers.

Table 40: Summary of water efficiency options

Intervention	Quantity in AMP8	Saving in AMP (Ml/d)
5.2 Information Provision	900	0.07
5.3 Infrastructure and Leak Investigation	2,105	0.65
5.4 Water Efficiency Solutions for Domestic-type Use	1,402	1.32
5.5 Water Efficiency Solutions for Mixed-type Use	305	0.30
5.6 Consultancy for Industry	30	1.31

Performance data is recorded in our Water Efficiency Target Tracker (WETT) which collates water efficiency activity and water saved. We hold monthly performance reviews to review these metrics and where necessary, interventions are be made to address any under-performance.

7.3. WATER EXPORT OPTIONS

7.3.1. Overview

Kielder reservoir has a surplus of raw water after the requirements of our household and non-household customers have been met. Consequently, as illustrated in Figure 23, new raw water exports have been considered as part of developing regional plans.

Figure 23: Raw water export options

The schemes 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. As agreed with Yorkshire Water, we have particularly focused on a 140Ml/d option known in Yorkshire Water's WRMP as DV7a(vi) Tees to York Pipeline - NWL import 140 Ml/d option. New Yorkshire Water assets would include a new pump 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.
- A 15Ml/d export of treated water from our Darlington WTWs to Yorkshire Water.

7.3.2. Potential transfer to United Utilities

A significant programme of modelling has been undertaken by us and United Utilities to explore the availability of raw water to export. As illustrated in Figure 24, there is a circular link between the availability and utilisation of the transfer. The availability may depend on how the transfer is utilised by United Utilities, in terms of rate and timing. The utilisation, which influences the benefits to United Utilities, is dependent upon the availability of the water from us.

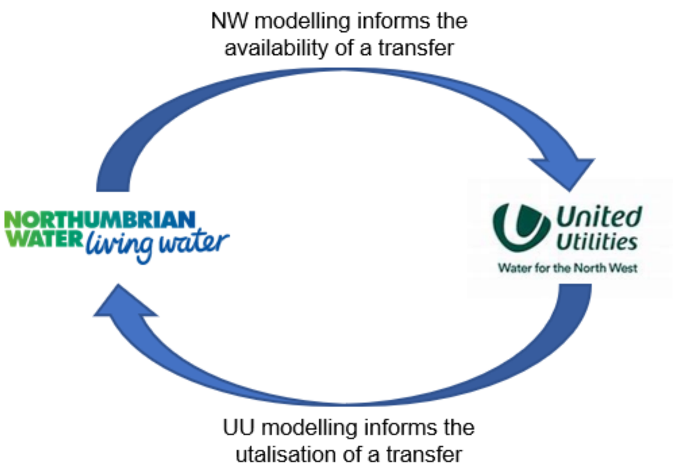


Figure 24: Potential raw water transfer to United Utilities

The availability of a transfer from Kielder reservoir was established by determining the maximum volume of water that can be transferred in accordance with the proposed utilisation patterns from United Utilities, without leading to a simulated failure of the Kielder WRZ of more often than 1 in 500 years.

To run the two models in a consistent and coordinated manner, with one model output providing input for the other, a common scenario basis was required for simulations, including running at agreed demand levels, and with coherent hydrological and climate change scenarios.

On the basis of availability, a 100Ml/d raw water export from Kielder reservoir to United Utilities (UU) is feasable. However, it 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) that provide better value for money.

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. However, the Kielder reservoir to UU Transfer was not considered to be resource constrained when considered on its own.

Since consulting on our draft WRMP24, we have re-confirmed with United Utilities its position on importing raw water from NWL. United Utilities has confirmed that it now considers its headroom position to be more resilient and so the Kielder Reservoir to UU Transfer (100Ml/d) has still not been included in either its preferred final plan or any adaptive pathways.

Water Resources North and Water Resources West have also considered the Kielder reservoir to United Utilities Transfer as an option to support security of supply and increase resilience for other water companies. A robust reconciliation process has been followed by the regional groups with the last round still concluding that the transfer was not required. This is largely because of the high unit costs (£/Ml/d) associated with the scheme and that there were other better value feasible options.

While the the Kielder reservoir to UU Transfer is not included in UU's preferred plan or adaptive pathways, we have presented a scenario in Section 9.3 that illustrates the changes to our preferred final plan that would be required to allow the Kielder reservoir to UU transfer to proceed. The only change would be that the Tees to York transfer would need to be removed as the surplus of water in Kielder reservoir is not sufficient to support both schemes in addition to the rising demand for raw water on Teesside.

7.3.3. Potential transfer to Yorkshire Water

As part of Yorkshire Water's Best Value Planning approach, they undertook cost benefit optimisation modelling that looked at a number of different options to reduce their supply deficit in their Grid WRZ, this is presented in Section 9 of their WRMP (https://www.yorkshirewater.com/about-us/resources/water-resources-management-plan/). In terms of alternative options for Northumbrian Water to support the transfer, only the Tees was considered due to the geographical proximity to Yorkshire Water's supply area, and the existing infrastructure in place to regulate the Tees (Cow Green reservoir and the TTT) to support the transfer to YW.

A range of raw water export options from the River Tees to Yorkshire Water (YW) have been considered (15, 50, 80 and 140Ml/d), supported by Kielder reservoir via the Tyne Tees Transfer system as required, to assess the impact of various transfers to YW on the Kielder WRZ. YWs modelling identified the 140Ml/d transfer from the river Tees as a preffered plan solution to their defificts, and as such have included it in their best value plan.

In order to assess the effect of such a transfer on the availability of water in the Kielder WRZ we carried out stochastic modelling, the results of which 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. Clearly, 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 827Ml/d. Therefore in order for us to supply a raw water transfer of 140Ml/d to YW, significant investment would need to be made by YW to upgrade the pumping capacity at Riding Mill along with the electical supply to Riding Mill as well as installing their own abstraction pumps on the river Tees.

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.

Since consulting on our draft WRMP24, we have re-confirmed with Yorkshire Water its position on importing raw water from NWL. Yorkshire Water has confirmed that the Tees to York Transfer (140Ml/d) is still in its preferred final plan although it is now needed by 2040 and not 2050. However, the 15Ml/d treated water export to YW is not required.

7.3.4. Kielder Strategic Resource Option (SRO)

Along with Yorkshire Water and United Utilities, we have included a funding allowance in our PR24 Business Plan to progress a Kielder Strategic Resource Option (SRO). The SRO will further investigate raw water exports to Yorkshire Water, United Utilities and potentially further south, while ensuring sufficient resources are available for us to support growth in our supply area, including non-household growth on industrial Teesside.

We have worked with Yorkshire Water and United Utilities in collaboration with Water Resources West (WRW) and Water Resources North (WReN) to develop an outline scope for the SRO. Subject to the funding being approved, we expect to start the to deliver the Kielder SRO programme of works in April 2025.

7.4. 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

For a detailed report on this section please refer to the **Best Value Planning technical report** which is available on request by emailing waterresources@nwl.co.uk

8.1. OVERVIEW

This section presents our final preferred plan which will ensure a secure supply of wholesome drinking water for customers and will protect and enhance the environment. Our preferred final plan has been developed to:

- address any forecast baseline supply deficits (see Section 6);
- ensure we meet government expectations and national targets for:
    - Leakage reduction (50% reduction by 2050)
    - Per Capita Consumption (PCC)
        - 122l/head/day by 2038
        - 110l/head/day by 2050
    - Non-household demand reduction:
        - 9% reduction by 2038
    - Distribution input reduction:
        - 20% reduction by 2038; and
- support other water companies through exports of water to address their supply deficits.

Early on in the development of our draft Water Resource Management Plan 2024 (dWRMP24), we developed a low, medium (central) and high option for demand management which included options to reduce leakage and PCC. Since publishing our draft WRMP24, we have also developed a preferred strategy to reduce non-household water demand. The demand savings from the **central** demand management programme are needed in order to meet the national leakage and demand reduction targets. Once the demand savings are applied to our final plan demand forecast, the outcome is that:

- a potable supply surplus is restored in the Kielder Water Resources Zone (WRZ) early in Asset Management Period 8 (AMP8) which increases over the planning period; and
- a supply surplus is maintained in the Berwick & Fowberry WRZ which also increases over the planning period.

Consequently, no further supply options needed to be developed within our WRZs.

Section 8.2 below provides an overview of the full decision making process that we would have followed if we had needed to develop new supply options to address supply deficits in one of our WRZs.

8.2. DECISION MAKING PROCESS

8.2.1. Overview of Process

Figure 25 illustrates the process for determining a Best Value Plan. The process was developed to align with both the Water Resources Planning Guideline 2021 and UKWIR's 2020 guidance 'Deriving a best value water resources management plan'.

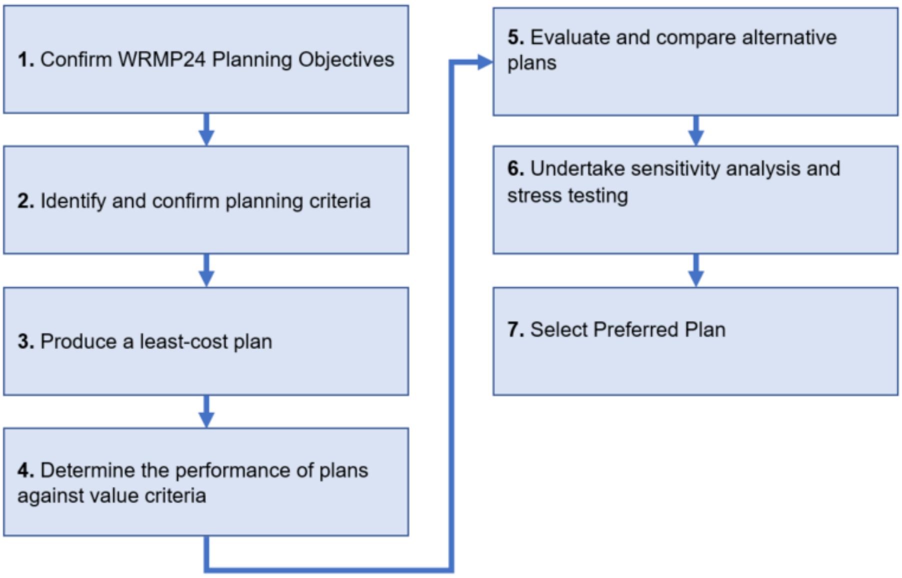


Figure 25: Overview of best value planning approach

The following groups were involved in the decision making process:

Water Resources Management Plan 2024 Delivery Group comprising:

- Water Resources & Supply Strategy team (Inc. demand planning)
- Water Supply (Treatment) team
- Water Networks team
- Water Quality team
- Conservation
- Customer team (inc. Water Efficiency, Customer Research and Wholesale teams)
- Regulation team

Water Directorate Leadership Team comprising:

- Water Director
- Head of Strategy & Planning
- Head of Water Supply
- Head of Water Network
- Head of Water Quality

Executive Leadership Team

- All NWL directors

Northumbrian Water Limited (NWL) Board

8.2.2. Confirm WRMP24 Planning Objectives

Our Purpose is:

Caring for the essential needs of our communities and environment, now and for generations to come.

We do this by providing reliable and affordable water and wastewater services for our customers and by making a positive difference by operating efficiently and investing prudently, to maintain a sustainable and resilient business.

Our Vision is:

To be the national leader in the provision of sustainable water and wastewater services.

Our Values are shown in Figure 26.

Figure 26: Our Values

8.2.3. Identify and Confirm Planning Criteria (Best Value Plan Metrics)

Our Best Value Plan metrics are aligned with those used by Water Resources North (WReN) for their regional plan and are summarised in Table 41.

Table 41: Summary of best value assessment criteria

BEST VALUE CRITERIA DESCRIPTION	DESCRIPTION
PWS Drought resilience	Number of years over the planning period the Public Water Supply (PWS) drought resilience to 1 in 500 is achieved.
Biodiversity	The change in biodiversity metric units is based on assumptions related to change to land use/habitat due to the option and its footprint relative to the baseline*
Natural Capital	Monetised (£NPV) impact of the option on natural capital e.g., change to land use, recreation.
Leakage reduction	Volume of leakage reduction achieved over the planning period (Ml/d).
PCC reduction	Volume of PCC reduction achieved over the planning period (litres/head/day).
Flood risk management (non-drought resilience)	Qualitative assessment based on Strategic Environment Assessment (SEA) objective 4.3: To reduce and manage flood risk, taking climate change into account. Options are graded -4 to +4 and the programme score based on the average grade.
Multi-abstractor benefit	Qualitative assessment based on SEA objective 4.1 To maintain or improve the quality of rivers, lakes, groundwater, estuarine and coastal waterbodies and 4.2 To avoid adverse impact on surface and groundwater levels and flows and ensure sustainable management of abstractions. Options are graded -4 to +4 for each objective and the programme score based on the average grade.
Carbon	Capital/embedded and operational total tCO2e of programme
Customer preferred option type	Options to be ranked 1 to 3 based on customer preferences from the outputs of the WReN Customer Research June 2021 (Appendix 7). (Leakage and water efficiency score 3, enhancement of existing supply options score 2 and new supplies such as desalination and increased abstraction score 1.) Programmes are compared by the benefit (Ml/d) provided by each of the 3 categories.
Human and social well-being	SEA objectives associated with human and social well-being: 2.1 To protect and improve health and well-being and promote sustainable socio-economic development, 2.2 To protect and enhance the water environment for other users, 6.1 To maintain and improve air quality, 6.2 To minimise greenhouse gas emissions, 7.1 To conserve and enhance the historic environment, heritage assets and their settings and protect archaeologically important sites and 8.1 To protect and enhance designated and undesignated landscapes, townscapes and the countryside. Options are graded -4 to +4 and the programme score based on the average grade.
Financial Cost	Total cost (Totex) of the programme £NPV
Option Deliverability	Individual options will be scored (1 to 5) for deliverability / cost confidence. The programme score is based on the average score for all options included in the solution.
PWS Drought resilience	Number of years over the planning period the PWS drought resilience to 1 in 500 is achieved.
Biodiversity	The change in biodiversity metric units is based on assumptions related to change to land use/habitat due to the option and its footprint relative to the baseline*

8.2.4. Produce a Least Cost Plan

Our least cost plan includes central demand management options that enable us to meet national targets for leakage reduction, Per Capita Consumption and reduction in non-household demand. These demand management options maintain a supply surplus in the Berwick & Fowberry WRZ and restore a supply surplus in the Kielder WRZ early in AMP8. Consequently, no additional supply options were needed for our own resilience and / or security of supply. However, if we had needed to develop additional supply options, then we would have used a least cost optimiser known as EBSD or Economics of Balancing Supply and Demand model. The EBSD model considers the supply-demand balance for each water resource zone at annual timesteps and selects options to address deficits based on a cost per Ml/d and the earliest available date of supply for relevant options. The tool does not consider other monetised criteria such as carbon or other societal and environmental impacts and benefits. As such the model results represent a least-cost plan with no optimisation.

Our preferred final plan does include the Tees to York Transfer option (See Section 8.3.5) and this utilises some of the water resource surplus that we have after the needs of our own household customers and non-household businesses have been met. However, the costs of this option will be covered by Yorkshire Water and so we have included it in our Least Cost Plan without the need for least cost modelling.

8.2.5. Determine the performance of the plan against performance criteria (Metrics)

We have undertaken an assessment of the performance of our plan against our best value metrics. The results of this assessment are presented in Section 8.5.3 below.

8.2.6. Evaluate and compare alternative plans

We have considered the following alternative plans in Section 10:

- Ofwat Core Plan (no/low regret programme)
- Least Cost Plan
- Best Value Plan (Our Preferred Final Plan)
- Best Environment Plan

8.2.7. Undertake Sensitivity Analysis and stress testing

We have undertaken sensitivity analysis and stress testing of our preferred plan. The process and results of the testing is presented in Section 9.

8.2.8. Select preferred plan

Using the outcomes of the decision making process described above, we have selected our preferred final plan. This is presented in Section 8.3 below.

8.3. OUR FINAL BEST VALUE PLAN

8.3.1. Overview

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

The baseline supply demand balance for the Kielder WRZ confirms a potable supply deficit across the planning period. However, we have taken an interative process to addressing the supply deficit. In the first instance we have applied the demand savings from the central demand management options that are needed to meet national targets for leakage reduction and demand reductions to the final plan Distribution Input (DI) forecast. The outcome of this is that a potable supply surplus is then restored for the full planning period. We have assessed our preferred plan against both our WRMP24 objectives and metrics. The results of this assessment are presented in Section 8.5.2 and 8.5.3.

Our Final Best Value Plan is illustrated in Figure 27.

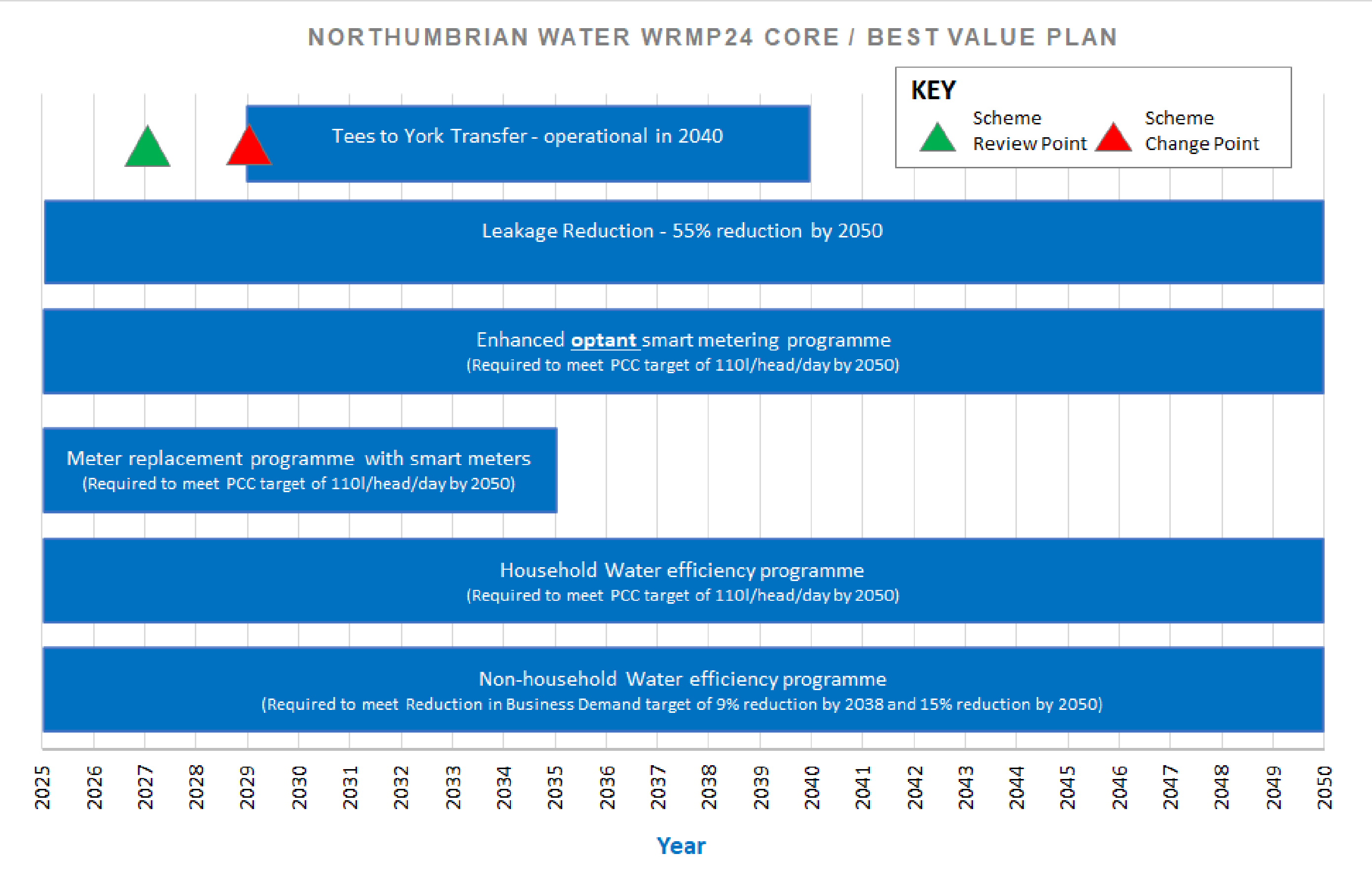


Figure 27: Northumbrian Water Final Preferred Best Value Plan

8.3.2. Demand management options

Our preferred demand management options are those to meet national leakage and demand reduction targets and are summarised in Table 42 and Table 43. We can confirm that our demand management options use 2020/21 prices and that no adjustment for inflation has been made to any forecasted costs.

Table 42: Preferred Final Plan AMP8 Demand Management Option Costs

SCHEME	AMP8 COST (£m)
Leakage Active Leakage Control to reduce leakage by 55% by 2049/50	14.4
Metering Replacement of existing meters with smart meters by 2035 and Enhanced Optant Smart Metering	74.8
Water Efficiency Programme In home interventions, digital engagement and activity related to smart metering, to reduce PCC to 110l/head/day by 2049/50 Non-household water efficiency to reduce Business Demand by 9% by 2037/38 (excluding growth)	26.2
Total	115.4

Table 43: Our Preferred Demand Management Options Base Costs

AMP	Leakage Programme		Optant Metering Programme		Smart Metering Programme		Household Water Efficiency Programme	
	Opex (£M)	Capex (£M)	Opex (£M)	Capex (£M)	Opex (£M)	Capex (£M)	Opex (£M)	Capex (£M)
AMP7	55.92	43.94	£0	£0	£0	£11.25	1.03	0
AMP8	65.39	46.68	£0	£0	£0	£32.28	8.204	0

Leakage

In our WRMP19, we committed to a 10% reduction in leakage per AMP up to 2045. For our draft WRMP24, we extended the approach by a further AMP allowing us to reduce leakage by 50% by 2050 from the 2017/18 base position. A glidepath profile was selected based on the affordability and deliverability of our plan.

Between preparation of our draft and revised draft preferred plans, we increased the target to deliver a 55% reduction in leakage by 2050. This means that we are committed to a 50% reduction companywide (40% by 2050 in ESW), in line with the national target. We believe this is a fair approach based on the current leakage performance in each region and the ability to deliver future targets.

We believe that this ambitious target is achievable but from a deliverability perspective, given the wider PR24 investment programme, only as a linear programme. It would be more expensive to reduce leakage faster and then maintain it at a lower level over the remaining planning period. The 15% target reduction in the current AMP is very challenging to meet and further reductions will only get harder and more expensive to deliver in future. There is some uncertainty around how the long-term targets can be achieved, as we try to drive beyond the unavoidable annual real losses (UARL), so an iterative approach is most appropriate to learn and improve our assumptions as we progress. Additionally, there is not a driver to front end load the programme as the linear programme still means we will have a 1 in 500 year supply surplus by the end of year 1. We would not want a slower demand management programme than the linear programme as we do need to deliver demand savings in year 1 to elimiate the baseline supplyd deficit.

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. Smart meters 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 have taken onboard comments to include Non-Household (NHH) premises in our smart metering strategy and confirm they are now included. We are proposing to meter the remaining NHH premises that are still unmeasured and will replace existing NHH basic/AMR meters with smart ones. The smart network will be established across the Northumbrian Water (NW) region over AMP8, and our strategy will be to install and replace NHH meters to smart in areas where the smart network is switched on first.

Water efficiency

We plan to significantly 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 mandatory water efficiency labelling and updating Building Regulations will enable us to meet our PCC target of 110l/hd/d by 2049/50.

We have developed a new water efficiency strategy to help reduce non-household demand by 9% by 2037/38 (excluding growth).

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 Figure 28 and Figure 29.

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.

Demand Management Options: Monitoring, Reporting and Interventions:
We recognise the importance of monitoring the performance of our demand management programmes, specifically in relation to leakage reduction and household and non-household consumption. Our Water Service Planning function is responsible for monitoring and reporting our outturn performance against Performance Commitments (PCs) and Outcome Delivery Incentives targets through weekly reporting and monthly and annual score cards. Monthly and annual performance information is reported to our Water Leadership Team and Executive Leadership team and importantly to

our Strategy and Tactical teams who adjust our strategies and / or short and medium term tactical plans to rectify any under-performance. We have also made a commitment to the Environment Agency to discuss our latest leakage and consumption performance at our quarterly Environment Agency Liaison Meetings. Additionally:

- Leakage performance is monitored weekly against a target profile to assess the current position and to influence any changes required to operational delivery. The annual average level of leakage is reported to Ofwat as part of APR and compared to our performance commitments to identify whether we are on or off track to meet our target reductions. We are currently, alongside all water companies, providing quarterly updates on performance to Ofwat.
- Actual meter installation numbers against target numbers are reviewed monthly and reported to Metering and Customer leadership teams. As with leakage, our operational / tactical plans are adjusted to rectify any underperformance. For example, this may include changes to the installation mix e.g., dialling up or dialling down proactive installs in the place of new installs or trigger marketing campaign activity to drive inbound customer demand for meters. This drum beat of progressive governance is already in place and is effective in driving install mix optimisation.
- The development of near real time data dashboards is in progress which will show the impact of smart meter installations on PCC, water demand and customer side leakage allowing us to confidently report Ml/d benefits associated to smart meter installations.
- Performance of each water efficiency option, in terms of volume of activity and water saved, is monitored monthly in detail to ensure we remain on target. Progress also feeds into a PCC Tactical Plan which in turn is monitored monthly through our PCC Focus Group which is chaired by our Customer Director. On an annual basis, all volumes of activities and water savings from water efficiency options are recorded in our Water Efficiency Target Tracker (WETT).
- Non-potable demands are reported as part of the Annual Review process, along with any changes to the available non-potable supply.

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 for 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 shared 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. Supply options

As we are forecasting final plan supply surpluses in both our WRZs with only demand management options needed to meet national targets for leakage and demand reduction, the only supply option needed in our final plan is to re-commission our Low Worsall intake on the River Tees in order to meet growth in demand for non-potable water to industrial customers on Teesside. This includes applying to vary the abstraction licence (at our Low Worsall and Blackwell intakes) to increase licensed quantities back to 2016 levels, and to install eel screens at Low Worsall prior to the river intake being used again. Given Low Worsall is an existing intake and designed specifically to supply industrial Teesside, the Environment Agency agreed that it was reasonable not to consider alternative supply options. However, we have included the scheme in our WRMP24 environmental assessments. Consequently, there has not been a need to identify, develop and appraise any further new supply options for Northumbrian Water Security of Supply for resilience.

In the unlikely event that a supply side option is needed in the future, because we have a surplus of water in Kielder reservoir, then the primary option would be the upgrade of Riding Mill pumping station which forms part of the Tyne Tees Transfer.

8.3.5. Inter and intra-regional transfers

Given the size of Kielder reservoir, after our own long-term needs have been met, there is a surplus of raw water resources in the Kielder water resources zone. Consequently, we have considered exports of raw and potable water to other water companies.

Our preferred final plan includes a raw water export to Yorkshire Water known as the Tees to York Transfer. Based on Yorkshire Water's preferred plan, this is needed in 2040. However, working with the regional groups and water companies, Yorkshire Water is committed to undertaking further assessment of all current options, including the Tees transfer, as well as developing other suitable options. Once the further assessments have been completed, they will review their preferred plan in 2027 to confirm whether the Tees to York Transfer scheme remains in it or whether it is replaced by another scheme. If it remains in their preferred plan, delivery of the scheme will then start in 2029.

At this point in time, we are not aware of any other water users (e.g. agriculture) who might benefit from the Tees to York Transfer. However, as part of ongoing Yorkshire Water assessments, further investigation can be undertaken to estbalish whether there are partnership opportunities for co-funding and co-delivery.

8.4. FINAL PLAN SUPPLY DEMAND BALANCE

We have carefully followed the Water Resources Planning Guidance (WRPG) and believe we have prepared a robust WRMP24. 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.

8.4.1. Dry year annual average

Kielder WRZ

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

The final plan potable supply demand balance shown in Figure 28 and Table 44 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.

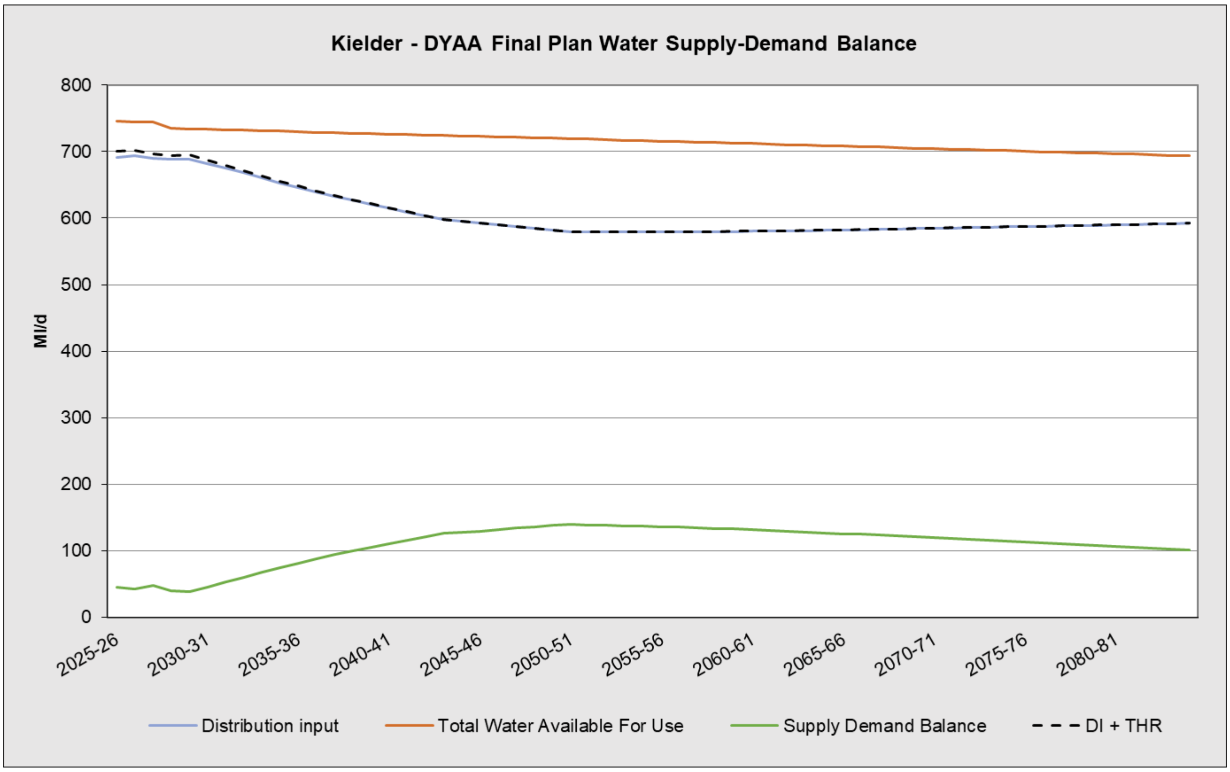


Figure 28: Kielder WRZ WRMP24 Final Planning Potable Supply Demand Balance

Table 44: Kielder WRZ Potable Supply Surplus

KIELDER WRZ	AMP8					END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029/30**	**2034/35**	**2039/40**	**2044/45**	**2049/50**
Balance of Supply (excluding headroom)	53.81	50.95	54.64	46.59	44.71	77.85	105.98	128.38	138.50
Balance of Supply (including headroom)	45.63	43.34	47.69	40.32	38.98	75.07	105.00	127.89	138.37

Industrial Supply Zone (non-potable supply)

A final planning scenario non-potable supply demand balance graph and tabled summary data for the Industrial Supply Zone is presented in Figure 28 and Table 45. There is a forecasted surplus for the whole planning horizon, except for a minor deficit in 2027/28 fof 0.79Ml/d. However, we confirm that the potable water surplus in the Kielder water resource zone can be used to offset this small deficit. This is because the Industrial Supply Zone is integrated within the Kielder WRZ and the yield from the river Tees (as supported by Kielder reservoir) can be used to supply either potable or non-potable demand on Teesside. This will reduce the dry year annual average headroom of the potable Kielder WRZ by just 0.79Ml/d and will eliminate the non-potable deficit in 2027/28. As the potable headroom can be used to eliminate the dry year annual average non-potable deficit, then there is therefore no risk of a deficit in a normal year either.

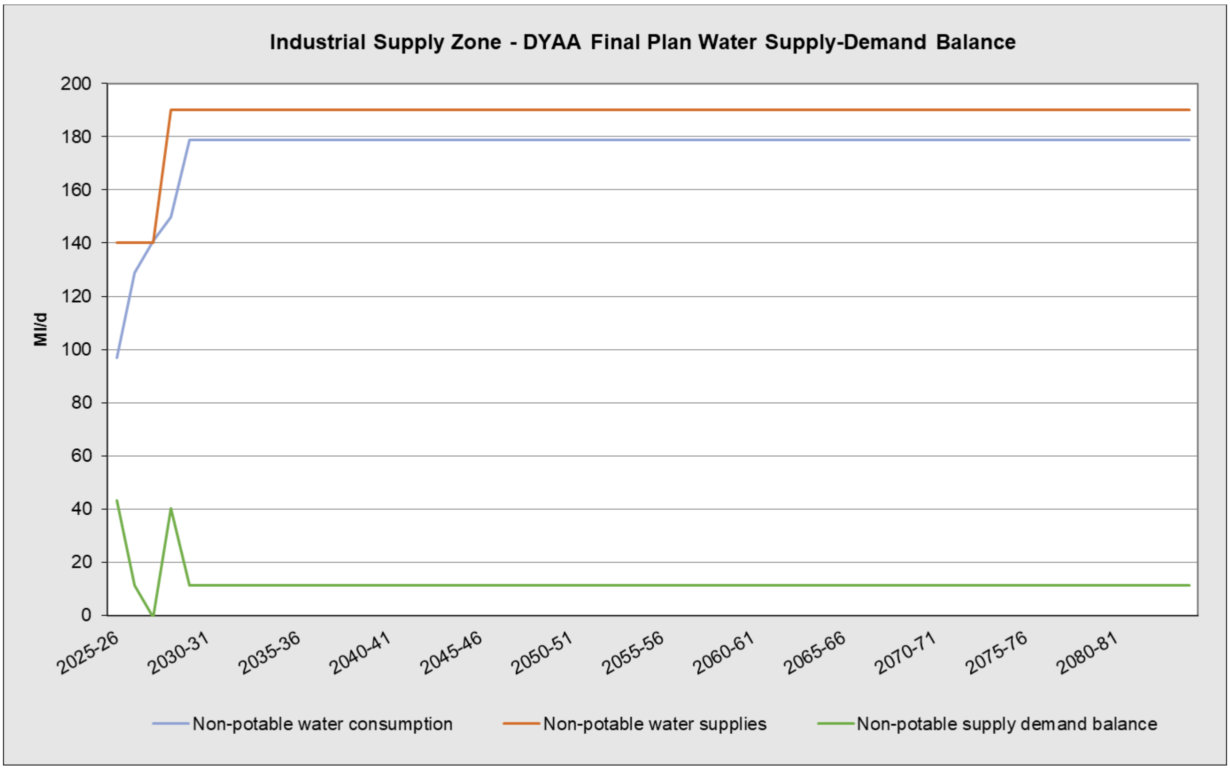


Figure 29: Industrial Supply Zone Final Plan Supply Demand Balance

Table 45: Industrial Supply Zone Supply Demand Balance

INDUSTRIAL SUPPLY ZONE	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply	11.21	11.21	11.21	11.21	11.21

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 30 and Table 46 is slightly higher reflecting our final plan metering, water efficiency and leakage strategies.

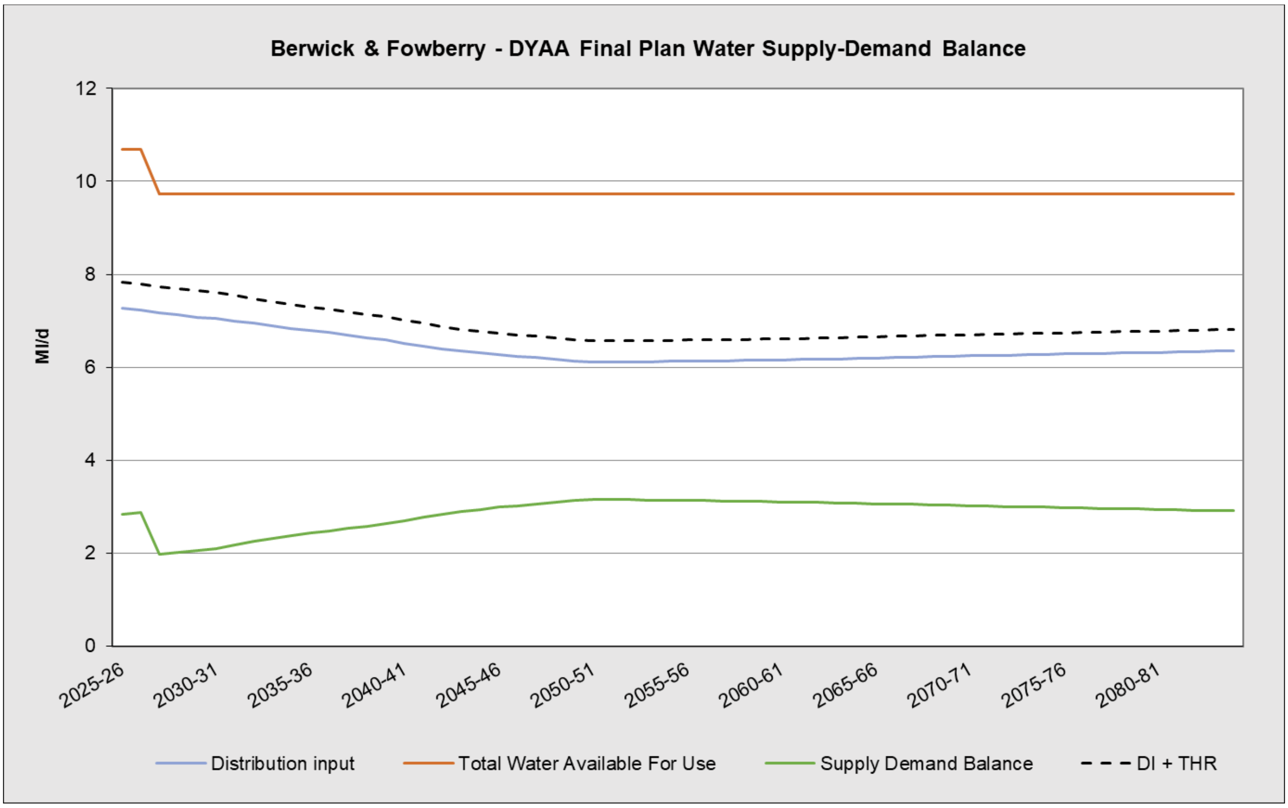


Figure 30: Berwick and Fowberry Final Plan Supply Demand Balance

Table 46: Berwick & Fowberry WRZ Supply Surplus

BERWICK AND FOWBERRY WRZ	END OF AMP7	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2024/25	2029/30	2034/35	2039/40	2044/45	2049/50
Balance of Supply (excluding headroom)	2.57	1.82	2.08	2.35	2.64	2.83
Balance of Supply (including headroom)	2.01	1.25	1.57	1.85	2.22	2.37

8.4.2. Dry year critical period

We have developed a critical period supply demand balance to demonstrate our resilience under a period of peak strain on our systems. This is based on a peak week demand and supply forecast. The Best Value Plan critical period supply demand balances for each WRZ are presented below.

KIELDER WRZ

A final planning scenario potable supply demand balance graph and tabled summary data for the Kielder WRZ is presented in Figure 31 and Table 47 respectively. There is a forecasted surplus for the whole planning horizon under the dry year critical period scenario (DYCP).

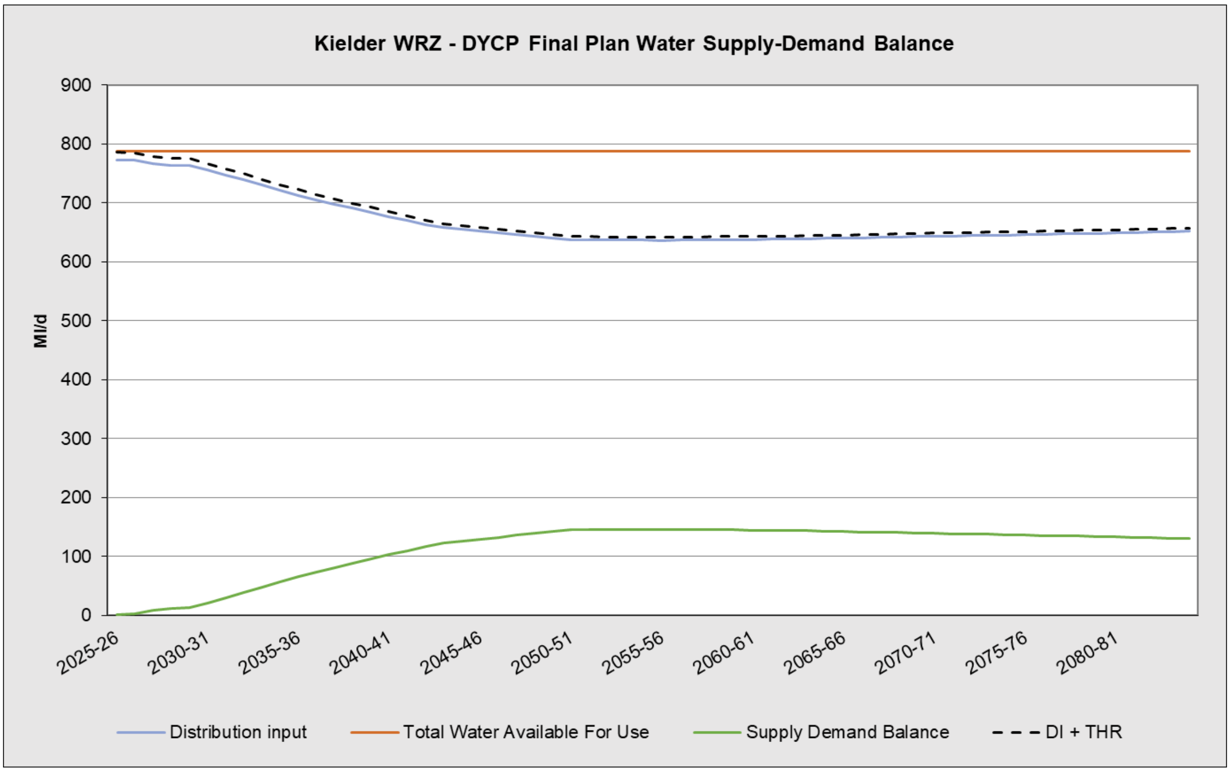


Figure 31: Kielder WRZ DYCP Final Planning Potable Supply Demand Balance

Table 47: Kielder WRZ DYCP Potable Supply Surplus

KIELDER WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Supply Demand Balance	12.71	57.37	95.54	126.42	142.37

BERWICK & FOWBERRY WRZ

A final planning scenario supply demand balance graph and tabled summary data for the Berwick & Fowberry WRZ is presented in Figure 32 and Table 48 respectively. There is a forecasted surplus for the whole planning horizon under the dry year critical period scenario.

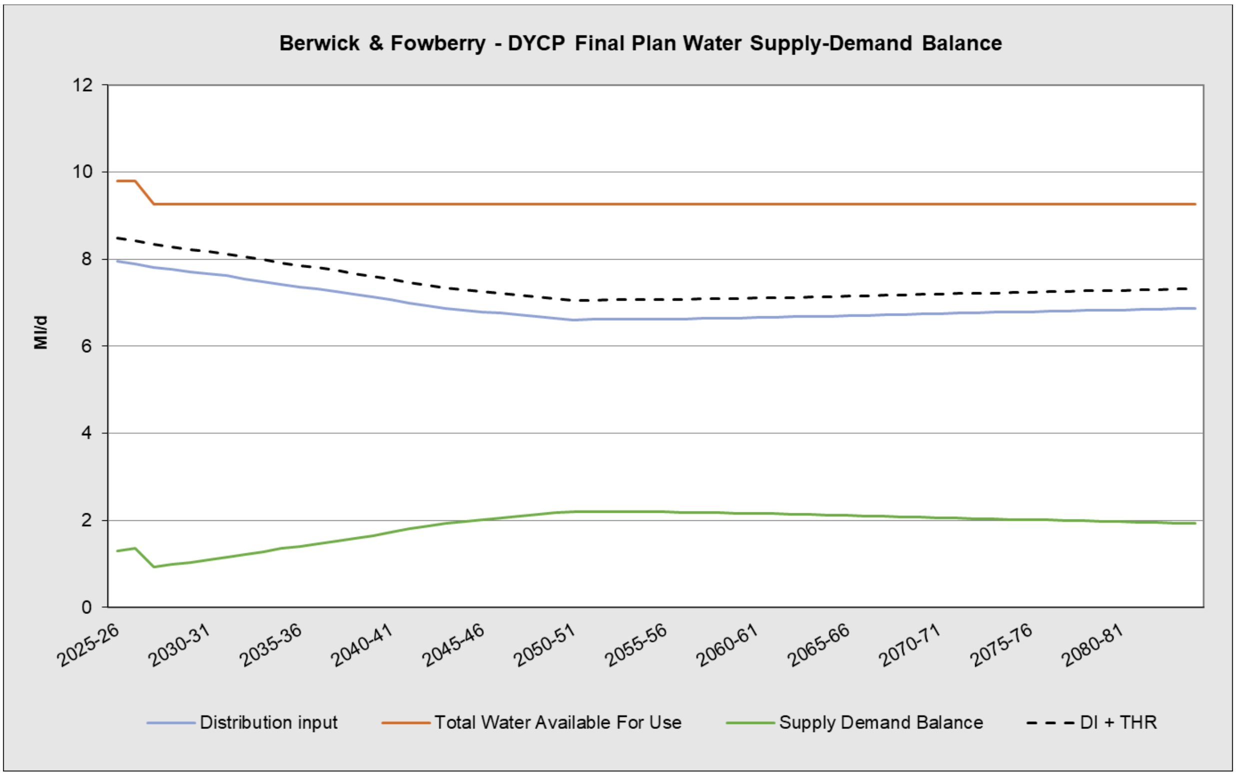


Figure 32: BVP DYCP supply demand balance graph for Berwick & Fowberry WRZ

Table 48: BVP DYCP supply demand balance figures for the Berwick & Fowberry WRZ

BERWICK & FOWBERRY WRZ	END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF PLANNING HORIZON
YEAR	2029/30	2034/35	2039/40	2044/45	2049/50
Supply Demand Balance	1.04	1.35	1.65	1.97	2.17

8.5. OUR FINAL PLAN JUSTIFICATION

8.5.1. Overview

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

8.5.2. Have we met our WRMP24 objectives?

Table 49 reproduces the objectives and summarises how we believe our Best Value Plan will deliver them.

Table 49: Achieving our WRMP24 Objectives

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 Water Industry National Environment Programmes (WINEP) 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 household customer demand to 110l/head/day by 2049/50 and non-household customer demand by 9% by 2037/38.	✓	Our Best Value Plan meets government expectations and includes water efficiency activities which along with our smart metering programme and government interventions should reduce customer demand to 110l/head/day by 2049/50. We have developed a new non-household water efficiency strategy to reduce business demand by 9% by 2038 (excluding growth).
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.

8.5.2.1 Summary of Performance of Preferred Final Plan against non-SEA Metrics

Table 50 presents a summary of the performance of our preferred final plan against non-SEA metrics.

Table 50: Performance of preferred programme against non-SEA metrics

Metric	How we will measure the metric	Leakage Reduction Strategy To contribute to meeting national target of 50% reduction by 2050	Water Efficiency Strategy To reduce PCC to 110l/head/day by 2050	Enhanced Optant Metering Strategy To reduce PCC to 110l/head/day by 2050	Smart Meter Strategy To reduce PCC to 110l/head/day by 2050	NHH demand Reduction Strategy To reduce non-household demand by 9% by 2038	Tees to York Transfer Operational by 2040
		Fully costed strategy to meet national target. The WRPG requires us to consider going beyond 50% reduction where this is feasible. We reviewed our strategy for our revised draft WRMP24 and concluded that a further 5% reduction, increasing our target to a 55% reduction by 2050, is possible. Consequently, we have included this in our final preferred plan.	Fully costed strategy which contributes to meeting national PCC targets.	Fully costed strategy which contributes to meeting national PCC targets.	Fully costed strategy which contributes to meeting national PCC targets. Supports government expectation for all new meters to be smart meters.	Fully costed strategy which contributes to meeting national non-household demand reduction targets.	Raw water transfer to Yorkshire Water. Scheme costs sit in Yorkshire Water's WRMP24.
PWS Drought resilience	Number of years over the planning period the PWS drought resilience to 1 in 500 is achieved.	Along with all other preferred plan demand management strategies in this table, the associated demand savings mean that we are able to offer 1 in 500 resilience for the full planning period without the need to develop new supply schemes.	Along with all other preferred plan demand management strategies in this table, the associated demand savings mean that we are able to offer 1 in 500 resilience for the full planning period without the need to develop new supply schemes.	Along with all other preferred plan demand management strategies in this table, the associated demand savings mean that we are able to offer 1 in 500 resilience for the full planning period without the need to develop new supply schemes.	Along with all other preferred plan demand management strategies in this table, the associated demand savings mean that we are able to offer 1 in 500 resilience for the full planning period without the need to develop new supply schemes.	Along with all other preferred plan demand management strategies in this table, the associated demand savings mean that we are able to offer 1 in 500 resilience for the full planning period without the need to develop new supply schemes.	This scheme is a 140Ml/d raw water export includes an upgrade of Riding Mill pumping station (part of the Tyne Tees Transfer). The pumping station upgrade means that the transfer does not reduce the Kielder water resource zone Deployable Output (DO) or Water

Metric	How we will measure the metric	Leakage Reduction Strategy To contribute to meeting national target of 50% reduction by 2050	Water Efficiency Strategy To reduce PCC to 110l/head/day by 2050	Enhanced Optant Metering Strategy To reduce PCC to 110l/head/day by 2050	Smart Meter Strategy To reduce PCC to 110l/head/day by 2050	NHH demand Reduction Strategy To reduce non-household demand by 9% by 2038	Tees to York Transfer Operational by 2040
							Available for Use (WAFU).
Leakage reduction	Volume of leakage reduction achieved over the planning period (% reduction by 2050).	The central leakage reduction programme in our preferred final plan is for a 55% reduction in leakage by 2050 and so meets the national target for reducing leakage by 50% by 2050.	Our Water Efficiency strategy will focus on high users and utilising data from smart meters, will help identify leakage on customers side of the meter.	N/A	N/A	N/A	N/A
Household PCC reduction	Forecast PCC by 2050 (litres/head/day)	N/A	Our Water Efficiency strategy will support customers, particularly high users (i.e., those with a higher than average PCC) to reduce their water use. The demand savings from this strategy will contribute to reducing PCC to 110l/head/day by 2050 as well as restoring a supply surplus in the Kielder water resource zone.	Our supply area is categorised by the EA as being a moderate Water Stressed Area and so compulsory metering of all customers is not allowed. Nevertheless, we consider being billed based on a measured supply (i.e., metered) to be a fair way of paying for water and one which encourages the efficient use of water. Consequently, we have included in our preferred plan an Enhanced Optant Metering Strategy whereby we will actively encourage our customers to switch to a metered supply. The demand savings from	Our Water Efficiency and Optant Metering strategies are not sufficient on their own to deliver the demand savings that are needed to reduce PCC to 110l/head/day by 2050. Consequently, we have also included a smart metering strategy in our preferred plan. We will ensure that every non-household property has a smart meter by 2035 and that all existing metered household and non-household properties have a smart meter by	N/A	N/A

Metric	How we will measure the metric	Leakage Reduction Strategy To contribute to meeting national target of 50% reduction by 2050	Water Efficiency Strategy To reduce PCC to 110l/head/day by 2050	Enhanced Optant Metering Strategy To reduce PCC to 110l/head/day by 2050	Smart Meter Strategy To reduce PCC to 110l/head/day by 2050	NHH demand Reduction Strategy To reduce non-household demand by 9% by 2038	Tees to York Transfer Operational by 2040
				this strategy will contribute to reducing PCC to 110l/head/day by 2050 as well as restoring a supply surplus in the Kielder water resource zone in early AMP8.	2035. For deliverability reasons, we have chosen a linear profile for this programme. Smart meters will deliver a 3% demand saving through encouraging behavioural change and by supporting customers in the identification of plumbing losses such as leaky loos or leaks from pipes on their side of the meter. The demand savings from this strategy will contribute to reducing PCC to 110l/head/day by 2050 as well as restoring a supply surplus in the Kielder water resource zone in early AMP8.		
Customer preferred option type	Options to be ranked 1 to 3 based on customer preferences	**Score: 3** Participants were presented with five actions Northumbrian Water could take to	**Score: 2** Compared to our other ambitions, PCC receives a lower level of customer support.	**Score: 3** Of all metering options, Opt-in metering had the highest level of support compared to smart	**Score: 2** Smart metering had the lowest level of support compared to the other metering related	**Score: 3** Two external sources suggest water efficiency is not a priority to business	**Score: 3** Participants support water trading, but with caveats in place; that it doesn't

Metric	How we will measure the metric	Leakage Reduction Strategy To contribute to meeting national target of 50% reduction by 2050	Water Efficiency Strategy To reduce PCC to 110l/head/day by 2050	Enhanced Optant Metering Strategy To reduce PCC to 110l/head/day by 2050	Smart Meter Strategy To reduce PCC to 110l/head/day by 2050	NHH demand Reduction Strategy To reduce non-household demand by 9% by 2038	Tees to York Transfer Operational by 2040
		help customers and businesses reduce the amount of water they use. The highest rated option was 'company side leak reduction', supported by 84% of participants.		metering. 71% of participants supported opt-in metering at any level ('definite' or 'possible' support). 47% offered their 'definite support'.	WRMP options presented (opt-in). 58% of participants supported opt-in metering at any level ('definite' or 'possible' support). 31% offered their 'definite support'.	customers. There is no evidence that our customers share the ambition to reduce NHH demand by 9% by 2038.	result in a threat to their own supply and that other WRMP options are exhausted first. As confirmed above, subject to the upgrade of Riding Mill pumping station, the DO and WAFU of Kielder water resource zone are not affected by this scheme and NWL continue to enjoy a 1 in 500 year level of supply resilience.
Financial Cost	Total cost (Totex) of the programme £NPV	2025-30: £14.4M 2030 – 2050: £593M	2025-30: £11.63M 2030 – 2050: £31.25M	2025-30: £26.35M 2030 – 2050: £49.69M	2025-30: £45.44M 2030 – 2050: £90.45M	2025 -2030: £4.795M 2030 – 2050 £6.150M	The cost of this scheme will be met by Yorkshire Water and so is not considered in Yorkshire Waters WRMP24 and not in our WRMP24.
Option Deliverability	Individual options will be scored (1 to 5) for deliverability / cost confidence. The programme score is based	**Score: 4** Our Leakage Reduction Strategy has a linear delivery profile between 2025 and 2050. This is because we consider a linear profile	**Score: 4** Our Non-Water Efficiency Strategy has a linear delivery profile between 2025 and 2050. This is because we	**Score: 4** Our Enhanced Optant Meter Strategy has a linear delivery profile between 2025 and 2050. This is because we consider a linear profile	**Score: 4** Our Smart Meter Strategy has a linear delivery profile between 2025 and 2035. This is for deliverability reasons. We have considered	**Score: 4** Our Non-household Demand Strategy has a linear delivery profile between 2025 and 2038. This is for deliverability reasons.	**Score: 4** This scheme will be developed by Yorkshire Water who has a review point in 2027 and expects to start delivering the

Metric	How we will measure the metric	Leakage Reduction Strategy To contribute to meeting national target of 50% reduction by 2050	Water Efficiency Strategy To reduce PCC to 110l/head/day by 2050	Enhanced Optant Metering Strategy To reduce PCC to 110l/head/day by 2050	Smart Meter Strategy To reduce PCC to 110l/head/day by 2050	NHH demand Reduction Strategy To reduce non-household demand by 9% by 2038	Tees to York Transfer Operational by 2040
	on the average score for all options included in the solution.	reduces deliverability risks allowing us to more easily recruit and maintain teams. Additionally, we consider that a linear delivery profile provides greater flexibility if other demand management options under- or over perform or non-household growth is larger than expected.	consider a linear profile reduces deliverability risks allowing us to more easily recruit and maintain teams. Additionally, we consider that a linear delivery profile provides greater flexibility if other demand management options under- or over perform or non-household growth is larger than expected.	reduces deliverability risks allowing us to more easily recruit and maintain teams. Additionally, we consider that a linear delivery profile provides greater flexibility if other demand management options under- or over perform or non-household growth is larger than expected.	deferring some of the programme to AMP9 but consider this would cause deliverability issues in AMP9.		scheme in 2029 so that it is operational by 2040. Yorkshire Water will continue to work with NWL and WReN to undertake further detailed engineering design.

8.5.3. Performance of our preferred final plan against SEA Metrics

The central demand management options in our preferred final plan were the only options that would enable us to meet national targets for leakage reduction, per capita consumption and reductions in non-household demand. However, have undertaken an assessment whereby each option has been assessed against the Strategic Environmental Assessment (SEA) objectives using defined effect assessment and evaluation criteria based on relevant spatial datasets and professional judgement. The methodology used and the results of the assessment are described in a report entitled "Environmental Best Value Plan Assessment of Northumbrian Water Demand Management Options".

The assessment indicated whether the proposed option would help meet or prevent achievement of the SEA objectives. If it contributed to the SEA objectives, then a positive effect was recorded. If the option prevents an SEA objective being met, then a negative effect was recorded. The assessment focused on high-level issues as identified through the objectives, sub-objectives, and key receptors and assets. Note that it was not undertaken to the level of detail that an Environmental Impact Assessment (EIA) would be.

The assessment was split into construction effects and operational effects. An option may have both positive and negative effects under a SEA objective, and rather than combining these effects to cancel each other out, both positive and negative effects were reported separately.

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. A narrative justification was provided to support the assessment using this scale. The SEA Scoring criteria matrix is outlined in Table 51.

Table 51: SEA Scoring Criteria

SEA Scoring Criteria	SEA Metrics
+++	8
++	4
+	1
0	0
-	-1
--	-4
---	-8
?	

The temporal scale of effects was considered based on whether it would be permanent or temporary, and the duration of the effect. Permanent changes were considered as those which are irreversible (e.g., land use change from woodland to development) or will last for the near future (e.g., noise from road traffic). Temporary effects were considered as those which are reversible and are generally related to construction (e.g., construction traffic).

Where potential negative effects were revealed, mitigation measures (measures to avoid, reduce or offset negative effects) were identified as part of the assessment process and fed back into iterative option development. Options with major and moderate negative effects were required to include appropriate mitigation or be flagged for rejection. Enhancement opportunities were also identified where the option could be used for the benefits of people and/or wildlife, e.g., reservoirs provide an opportunity to establish wetland habitats, or for recreational benefits.

The effects of each option were assessed pre-mitigation and post-mitigation (residual effects). It was assumed that all options would include standard environmental controls including:

- Constructions works will be undertaken according to existing best practice to manage impacts on site, such as dust creation, noise and vibration, and disturbance.
- Environment Agency Pollution Prevention Guidance will be followed during construction.
- Best practice construction management includes using construction environment management plans (CEMPs), construction and logistics plans (including construction traffic management plans (CTMPs), waste management plans, etc.).
- Sites would be surveyed for species/habitats prior to construction. Non-native species would be identified, and methods/works put in place to avoid spreading them during construction.
- Construction sites situated in a flood zone will have appropriate plans in place to manage the site in the event of flooding, e.g., management of materials and/or equipment likely to cause pollution.
- Construction health of workers would be managed on site using good practice such as avoidance, or personal protective equipment. Where in-river working is proposed, the potential for the transmission of waterborne infectious diseases (e.g., Leptospirosis, Cyanobacteria, Gastro-intestinal illness, and Hepatitis A) during construction of the new infrastructure would be managed appropriately.
- Construction sites will be in adherence to the Considerate Contractor Scheme, including engagement with the local community.
- Construction methods to be used are sympathetic and reduce effects on the surrounding landscape e.g., suitable hoardings.
- Any required consents will be obtained prior to undertaking works, e.g., tree preservation orders, listed building consent.
- Safe access will be available for pedestrians, vehicles, bicycles, horses, etc during construction. Any roads, footpaths, cycleways that are closed during construction will be re-instated to their original or better condition following completion of the works.
- The Water Framework Directive (WFD) assessment assumes that standard best practice construction measures and operational procedures are employed, meaning that some options are assumed to be compliant with the objectives of the WFD and require no further assessment.
- Where options involve disturbance of land for pipeline laying, the land will be restored to its original or better condition on completion of the works.
- Where options involve works crossing roads or public rights of way, appropriate diversions and signage will be implemented, and roads/paths will be restored to their original or better conditions following completion of the works.
- Where options involve loss of agricultural land, Northumbrian Water policy on compensation, land requisition will be followed.
- Options that use energy, either during construction and/or operation, will use the energy mix available at the time from the UK energy grid.

The results of the Demand Management Option (DMO) Best Value Plan work are shown in Table 52, Table 53 and Table 54, outlining the scores generated from the Best Value Plan scoring matrix for each of the criteria descriptions.

The main driving factors that differentiate the residual construction scores of the three option scenarios of low, medium and high are:

- A score of -0 was assessed for biodiversity impact in regard to the low option scenario, whereas both the medium and high option scenarios recorded scores of -2. Potential for minor negative residual construction effects on biodiversity due to construction potentially occurring in close proximity for activities required to resolve leakage issues, contributes to a negative medium and high scenario construction score in comparison to the lower scenario, which scored neutral. This is also contributed to by potential minor negative effects of leakage works and metering with the potential to contaminate nearby vulnerable habitats for both the medium and high scenarios, with the lower scenario scoring neutral construction effects for biodiversity.

- The multi-abstractor benefit scores resulted in 0 for the low option scenario and -2 for both the medium and high option scenarios. Minor negative construction effects for water objectives involving potential contamination of water resources differentiated the scoring between low and the medium and high DMO scenarios.

The main driving factors that differentiate the residual operation scores of the three option scenarios are:

- The low and medium DMO scenarios scored minor positive operational effects for water objectives due to improved water efficiency and more water being kept in the environment, whereas the high scenario scored both moderate positive and major positive effects due to improved water efficiency resulting in less abstraction for human consumption and more water being kept in the environment. As well as the moderate positive operational effects for the high option scenario due to improvements in water efficiency resulting in resilience of asset efficiency to water scarcity. This resulted in more positive operational scores in regard to the multi-abstractor benefit criteria.
- The high DMO option also scored moderate positive effects for three biodiversity objectives due to improved water efficiency and leakage works resulting in lower water demand, therefore less extraction of water from natural environmental for human consumption takes place. This, benefiting designated sites and their qualifying features, as well as potential indirect benefits on chalk streams due to keeping water within the natural environment, resulted in more positive operational scores in regard to the biodiversity impact criteria.
- The human and social well-being objective will result in major positive operational effects for two of the population and health objectives due to increased resilience due reduced future demand and water efficiency advice to vulnerable groups. This in comparison to the moderate and minor positive operational effects on the same objectives for the medium option and low option scenarios respectively.

Table 52: Low DMO Scenario Scores

Option and Stage	Low Option Construction Score	Low Option Operation Score
Biodiversity Net Gain	0	0
Biodiversity Impact	0	0
Flood Risk Management	0	0
Multi-Abstractor Benefit	0	3
Human and Social Well-being	-2	3
Remaining SEA Objectives	-6	1
SEA Overall Cumulative Score	-8	8

Table 53: Medium DMO Scenario Scores

Option and Stage	Medium Option Construction Score	Medium Option Operation Score
Biodiversity Net Gain	0	1
Biodiversity Impact	-2	2
Flood Risk Management	0	0
Multi-Abstractor Benefit	-2	8
Human and Social Well-being	-2	9
Remaining SEA Objectives	-6	5
SEA Overall Cumulative Score	-12	25

Table 54: High DMO Scenario Scores

Option and Stage	High Option Construction Score	High Option Operation Score
Biodiversity Net Gain	0	4
Biodiversity Impact	-2	8
Flood Risk Management	0	0
Multi-Abstractor Benefit	-2	28
Human and Social Well-being	-2	20
Remaining SEA Objectives	-6	5
SEA Overall Cumulative Score	-12	65

8.5.4. Delivering our plans affordably

We have developed an efficient Best Value Plan using a best practice decision making process involving Economic Balance of Supply and Demand (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 have consulted customers and stakeholders to understand their preferences and priorities on our final WRMP and then the draft PR24 Business Plan as a whole 'acceptability research programme'. Overall, the additional investment we need to address all the challenges in our plans means that, combined water and wastewater bills will need to rise significantly by around a 17% impact on charges in the region by 2030.

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.

8.5.5. 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 55 along with a statement on how they have been met.

Table 55: Meeting Government Expectations

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. 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 (standpipes 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 reduce Business Demand by 9% by 2038.	✓	Our Best Value Plan meets government expectations and includes water efficiency activities which along with our smart metering programme and government interventions (mandatory water efficiency labelling), should reduce customer demand to 110l/head/day by 2049/50. We have developed a new non-household water efficiency strategy to reduce business demand by 9% by 2038 (excluding growth).
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 55% by 2049/50. This is 5% higher than the national target.
The Environment Act 2021 sets a target to reduce the use of public water supply in England per head of population by 20% by 2037-38 from the 2019-20 baseline.	✓	Our Best Value Plan meets this government expectation with DI per head of population reducing by 20% from 2019-20 baseline.
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.

8.5.6. Environment Improvement Plan interim targets

Table 56 shows how our best value plan performs against the government's Environment Improvement Plan (EIP) interim targets in relation to demand management. This is based on a reduction from our 2019/20 annual reported value.

Table 56: Meeting EIP interim targets

ENVIRONMENT IMPROVEMENT PLAN	INTERIM TARGETS ACHIEVED?
Reduce per capita consumption (PCC) to 122 litres per head per day by 2038 and 110 litres per head per day by 2050.	<table><tr><th></th><th>Baseline 2019/20</th><th>2038</th><th>2050</th></tr><tr><td>NW dry year annual average</td><td>147 l/hd/d</td><td>121 l/hd/d</td><td>110 l/hd/d</td></tr><tr><td>NWG dry year annual average</td><td>152 l/hd/d</td><td>122 l/hd/d</td><td>110 l/hd/d</td></tr></table> We meet these interim targets for PCC under a dry year annual average scenario at a NWG level.
Reduce leakage by 16% by 2025, 20% by 2027, 30% by 2032. 37% by 2038 and 50% by 2050.	<table><tr><th></th><th>Baseline 2019/20</th><th>2025</th><th>2027</th><th>2032</th><th>2038</th><th>2050</th></tr><tr><td>NW Total annual leakage Ml/d</td><td>134.8</td><td>114.6</td><td>110.8</td><td>101.5</td><td>90.3</td><td>61.1</td></tr><tr><td>NW leakage reduction</td><td></td><td>15%</td><td>18%</td><td>25%</td><td>33%</td><td>55%</td></tr></table> We have committed to a 50% leakage reduction by 2050 across our combined operating regions of Northumbrian and Essex & Suffolk Water. We do not meet the interim targets due to the reduction glidepath we have applied, which is more cost effective and allows for incremental improvements each year.
Reduce non-household water use by 9% by 2038 and 15% by 2050.	<table><tr><th></th><th>Baseline 2019/20</th><th>2038</th></tr><tr><td>NW Non-household consumption Ml/d</td><td>143.2</td><td>130.3</td></tr><tr><td>NW non-household reduction</td><td></td><td>9%</td></tr></table> We have committed to reduce business demand by 9% by 2038 (excluding growth) based on 2019/20 baseline contributing to Defra's ambition. We have not committed to anything beyond 2037/38 currently. We believe we will learn a lot of this period and will consider increasing our commitment post 2038 in future resource plans.
Reduce the use of public water supply in England per head of population by 9% by 2027, 14% by 2032 and 20% by 2038.	<table><tr><th></th><th>Baseline 2019/20</th><th>2027</th><th>2032</th><th>2038</th></tr><tr><td>DI per capita</td><td>0.26</td><td>0.24</td><td>0.23</td><td>0.21</td></tr><tr><td>NW demand reduction (excluding growth in Teeside) (NYAA)</td><td></td><td>7%</td><td>14%</td><td>21%</td></tr></table> We meet two of three interim targets for reduction in demand per head under a normal year annual average scenario excluding the non-household growth at Teeside. We meet the 2038 target under a dry year annual average scenario as well excluding Teeside growth.

8.5.7. 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.

8.5.8. 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.

8.5.9. 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 2049/50 the normal year average PCC for NW is 108 l/hd/d and the dry year average PCC is 110 l/hd/d. Table 57 gives an overview of the dry year annual average PCC results, and the PCC forecast is shown in Figure 33.

Table 57: PCC Targets – Final Preferred Plan- DYAA

AVERAGE PCC (L/HD/D)	PCC IN 2017/18	PCC IN 2018/19	PCC in 2019/20	PCC IN 2024/25	PCC in 2037/38	PCC IN 2049/50
Berwick	145	140	139	140	113	104
Kielder	147	149	147	151	121	110
NW	147	149	147	151	121	110
NWG	150	154	152	152	122	110

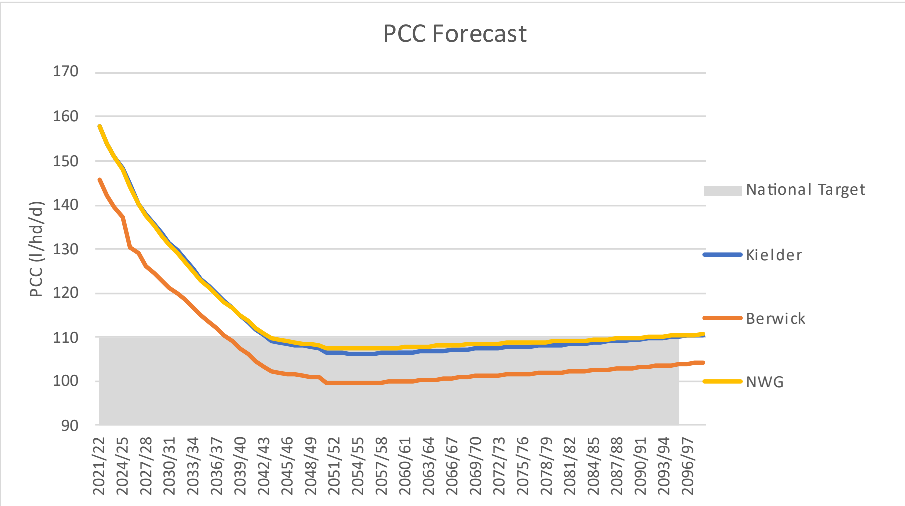


Figure 33: PCC Forecast

8.5.10. Ofwat Public Value Principles

Ofwat has developed a set of principles to help guide water companies in exploring and delivering better social and environmental outcomes. The principles, known as Public Value Principles, are intended to support water companies in developing the best solutions.

Table 58 describes how we have taken account of these principles in developing our preferred final plan.

Table 58: Ofwat Social and Environmental Principles

	Ofwat Principle Description	How are preferred final plan support Ofwat's Public Value Principles
Principle 1	Companies should seek to create further social and environmental value in the course of delivering their core services, beyond the minimum required to meet statutory obligations. Social and environmental value may be created both in direct service provision and through the supply chain.	In part A of our Pre-Acceptability customer engagement, participants were asked which areas for investment mattered most to them – 'Metering, encouraging water efficiency and tackling leakage to ensure we have enough water in the future' ranked first of the 14 areas presented. Our final preferred plan includes a leakage reduction programme to reduce leakage by 55% by 2050, 5% higher than the national target. This will reduce the amount of water we abstract from rivers, reservoirs and groundwater, treat at our water treatment works and pump through our network resulting in reduced chemical and energy use, and therefore operational costs, and reduced carbon emissions. As part of our PR24 WINEP, we have put forward schemes under the 25 Year Environment Plan driver. As part of this, we plan to collaborate and where appropriate, partner with third parties to lever in addition funding to deliver greater benefits for the environment and our customers.
Principle 2	Social and environmental benefits should be measurable, lasting and important to customers and communities. Mechanisms used to guide activity and drive decision-making should support this, for example through setting and using company purpose, wide external engagement and explicit consideration of non-financial benefits.	Our central preferred final plan includes a wider programme of demand management options which we forecast will reduced leakage by 55% by 2050, reduce PCC to 110l/head/d by 2050 and reduce non-household demand by 9% by 2038. As with our leakage reduction programme, this will reduce the amount of water we abstract from rivers, reservoirs and groundwater, treat at our water treatment works and pump through our network resulting in reduced chemical and energy use, and therefore operational costs, and reduced carbon emissions. We consider this to be a measurable and lasting environmental benefit. Our customer research concluded that customers strongly support reducing leakage from our water network and reducing demand through our water efficiency programmes. However, customer's views of metering are mixed with there being more support for traditional water meters over smart water meters. However, we still need to include our smart meter programme in our preferred plan otherwise we will not achieve the demand savings necessary to meet PCC targets. We do not have an alternative option to smart metering that would deliver the same demand savings.
Principle 3	Companies should be open with information and insights on operational performance and impacts (both good and bad). This will support stakeholder engagement, facilitate collaboration and	We will measure our performance against the national leakage and demand reduction targets annually and report these in our WRMP Annual Review report which we submit to the EA and Ofwat by 30 June of each year.

	Ofwat Principle Description	How are preferred final plan support Ofwat's Public Value Principles
	help identify opportunities for delivering additional social and environmental value.	We will also publish our performance in our Annual Performance Report and it is made available in comparison to all other water and wastewater companies in England and Wales at DiscoverWater (en-GB)
Principle 4	Delivery of social and environmental value outcomes should not come at greater cost to customers without customer support.	Our preferred plan only includes: • demand management options that are needed to meet national targets for leakage and demand reduction; and • a raw water trade to Yorkshire water known as the Tees to York Transfer. In terms of the demand management options, our customer research concluded that customers strongly support reducing leakage from our water network and reducing demand through our water efficiency programmes. In our 2021 WReN customer engagement, participants were supportive of water trading, so long as there was no threat to their own water supply. *'If we have more than we need, then sell it to other areas and put our bills down that would be good.' (HH Post Family; NW)* However, customer's views of metering are mixed with there being more support for traditional water meters over smart water meters. However, we still need to include our smart meter programme in our preferred plan otherwise we will not achieve the demand savings necessary to meet PCC targets. Additionally, in the case of our smart metering programme, we are not seeking it deliver wider social and environmental benefits over and above reducing customer PCC which in turn will help reduce their water bills. Any wider environmental gain is from reduced PCC and reduce abstraction, treatment and distribution, is coincidental. The Government has signalled that they will introduce legislation to bring in water labelling (a Government-led intervention for water efficiency) from 2024 and promote more water efficient water using products. Therefore, we have felt, along with the regional group (WReN) that we should include a reduction in the household consumption demand profile to reflect this. This is at no additional cost for us as is funded by the Government.
Principle 5	Companies should consider where and how they can collaborate with others to optimise solutions and maximise benefits, seeking to align stakeholder interests where possible, and leveraging a fair share of third-party contributions where needed. Companies' public value activities should not displace other organisations who are better placed to act.	Stakeholder collaboration has been central to the Price Review 2024 (PR24) water resources planning process. Both our WRMP24 and Water Resources North's regional plan have been developed in parallel with the regional plan helping to inform our final preferred plan. For example, we have agreed at a regional level that we will meet the national targets for leakage and demand reduction. Where opportunities are identified, we will continue to work collaboratively to deliver environmental schemes in our part of the AMP8 WINEP, leveraging a fair share of third-party contributions to maximise benefits. A good example of this has been in AMP6 and 7 where we have worked with the North Pennines AONB with our contributions to peat restoration levering in 9 times our contribution. We will work collaboratively on our household Water Efficiency programme and will support regional groups and environmental NGOs with their own water efficiency campaigns to encourage behavioural change regarding water use.
Principle 6	Companies should take account of their capability, performance and circumstances	In developing our WRMP24, we have considered our capability, performance and circumstances with respect to delivering greater

	Ofwat Principle Description	How are preferred final plan support Ofwat's Public Value Principles
	in considering the scope for delivering greater social and environmental value.	social and environmental value. Deliverability has been a key consideration given the size of our WRMP24. For example, while it is desirable to front end load our leakage reduction strategy, there is not a need from a security of supply perspective and doing so, in our view, would bring in unnecessary risk of under-performance. While we are being proactive utilising innovative technologies to improve leakage detection, some of these technologies will take time to develop and implement. We will work collaboratively in reducing non-household demand in order to meet the national target of reducing non-household demand by 9% by 2038. In doing so, we will actively pursue alternative funding sources that will help reduce NHH demand inline or quicker than our forecasts and to deliver wider benefits. A similar approach will be taken with the 25 Year Environment Plan schemes in our WINEP and particularly so where a holistic water management approach is required that could deliver multiple social and environmental benefits.

9. FINAL PLAN SCENARIO TESTING

9.1. OFWAT COMMON REFERENCE SCENARIOS

A Water Resource Management Plan 2024 (WRMP24) requirement is to undertake sensitivity testing of the central (most likely) supply demand balance forecast to different planning assumptions.

Ofwat has set out common reference scenarios with high and low parameters for climate change, technology and demand, details of which can be seen in Table 58. Common reference scenarios are also described for high and low abstraction reductions, but as no long-term abstraction sustainability reductions under Environmental Destination (ED) are required for our Northumbrian Water (NW) region these have not been included in the scenario testing. The impact of these scenarios would be the same as our preferred pathway and so are not presented separately.

We have undertaken this sensitivity analysis for both Kielder and Berwick & Fowberry Water Resource Zones (WRZs). All demand forecasts provided for final planning scenario testing are adjusted to include an uplift from normal year demand to dry year.

No supply deficits are caused by any of the scenarios and so we are confident that our best value plan, which only comprises Demand Management Options (DMOs), is sufficient to maintain a 1:500-year supply surplus in both WRZs and so is considered a no regrets plan.

We have also presented alternative scenarios for:

- Raw water exports, namely the Kielder Reservoir to United Utilities Transfer instead of the Tees to York Transfer; and
- An optimised smart metering scenario.

The results of the scenario testing are presented in Table 59.

Table 59: Supply and demand scenario testing

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 local councils. **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	UK Water Industry Research (UKWIR) Peak demand forecasting report. Artesia Water demand insights report. Demand uplift unmeasured HH 25%, Measured 23%	None
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.

9.1.1. Kielder WRZ results

Table 60 compares the potable supply demand balance (SDB i.e. supply surplus in Ml/d) for the Kielder WRZ for our central planning scenario against each of the Ofwat common reference scenarios and peak week demand (dry year critical period).

Table 60: Kielder WRZ Potable Supply Demand Balance (Ml/d) for the Central Scenario Against Ofwat Common Reference Scenarios

SCENARIO NAME		END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF AMP12
Preferred Plan	SDB	39	75	105	128	138
Peak Week (DYCP)	SDB	13	57	96	126	142
Low Climate Change	SDB	51	88	118	141	152
	Change from Preferred Plan	12	13	13	13	14
High Climate Change	SDB	11	41	65	81	85
	Change from Preferred Plan	-28	-34	-40	-47	-53
High Demand Scenario	SDB	27	43	61	73	79
	Change from Preferred Plan	-12	-32	-44	-55	-59
Low Demand Scenario	SDB	54	96	132	161	177
	Change from Preferred Plan	15	21	27	33	39
Slow Technology	SDB	9	19	28	34	38
	Change from Preferred Plan	-30	-56	-77	-94	-100
Fast Technology	SDB	49	87	122	148	162
	Change from Preferred Plan	10.26	11.82	16.50	20.19	23.42

This confirms that a supply surplus is maintained under all adverse scenarios (e.g. high climate change, high demand and low technology).

9.1.2. Berwick & Fowberry WRZ results

Table 61 compares the supply demand balance for the Berwick & Fowberry WRZ for our central planning scenario against each of the Ofwat common reference scenarios and peak week demand (dry year critical period).

Table 61: Berwick & Fowberry WRZ Supply Demand Balance (Ml/d) for the Central Scenario Against Ofwat Common Reference Scenarios

SCENARIO NAME		END OF AMP8	END OF AMP9	END OF AMP10	END OF AMP11	END OF AMP12
Preferred Plan	SDB	2.64	2.89	3.14	3.41	3.58
Peak Week (DYCP)	SDB	2.12	2.41	2.69	3.00	3.19
Low Climate Change	SDB	2.63	2.87	3.12	3.39	3.56
	Change from Preferred Plan	-0.01	-0.01	-0.02	-0.02	-0.02
High Climate Change	SDB	2.62	2.86	3.10	3.37	3.54
	Change from Preferred Plan	-0.02	-0.03	-0.03	-0.03	-0.04
High Demand Scenario	SDB	2.55	2.73	2.92	3.08	3.19
	Change from Preferred Plan	-0.09	-0.16	-0.22	-0.33	-0.39
Low Demand Scenario	SDB	2.71	3.02	3.33	3.65	3.86
	Change from Preferred Plan	0.07	0.13	0.19	0.24	0.27
Slow Technology	SDB	2.37	2.44	2.50	2.59	2.67
	Change from Preferred Plan	-0.27	-0.45	-0.63	-0.82	-0.92
Fast Technology	SDB	2.65	2.94	3.25	3.55	3.74
	Change from Preferred Plan	0.01	0.06	0.11	0.14	0.16

9.1.3. Cost impact of common reference scenarios

The interventions for the preferred plan, low and high climate change and low and high abstraction reductions scenarios are all the same and so the costs are also the same. This is because low and high climate change scenarios do not impact the interventions we need to make, and we do not need to make fewer or additional abstraction reductions under any of the scenarios.

Under the slow technology scenario, we assume that we make fewer interventions as slower technological progress reduces our ability to make interventions. Conversely under a fast technology scenario we can make more interventions to deliver greater demand and leakage reductions due to rapid progress in technology.

The high demand scenario is a scenario to see the impact of a large Distribution Input (DI) in our water resource zones due to the combination of high growth and low activity from our demand management options. Similarly, a low demand scenario shows the impact of a low DI due to low growth and a high level of interventions delivering greater demand and leakage reductions.

The demand management level of activity is the same under a slow technology and high demand scenario therefore this produces the same cost for these scenarios. Under a fast technology and low demand scenario the demand management activity is also the same so equates to the same costs for these scenarios. See Table 62 and Table 63.

For the purposes of this analysis, no adjustment has been made to costs across scenarios to reflect differences in efficiency gains and the resulting higher or lower cost reductions from total factor productivity growth in the wider economy.

Please note that we do not meet all of our targets under all of the scenarios. For example, we do not meet our 2038 or 2050 targets for per capita consumption (PCC) reduction in the slow technology or high demand scenario, and similarly in the high technology or low demand scenario we meet these targets earlier than under the preferred plan. For further information on these issues and how these scenarios interact with other areas of our business over the long term, please refer to our forthcoming long-term delivery strategy, to be published in October 2023.

Table 62: Totex for common reference scenarios (£m 2020/21 prices) split base and enhancement

Common Ref. Scenario Name		
Base costs £M (2020/21 prices)	**AMP8**	**AMP9**
Preferred Plan Low and high climate change Low and high abstraction reduction	£ 46.23	£ 47.25
Slow technology High Demand	£ 16.74	£ 20.39
Fast technology Low Demand	£ 40.77	£ 48.87
Common Ref. Scenario Name		
Enhancement costs £M (2020/21 prices)	**AMP8**	**AMP9**
Preferred Plan Low and high climate change Low and high abstraction reduction	£ 59.78	£ 64.11
Slow technology High Demand	£ 32.47	£ 34.07
Fast technology Low Demand	£ 64.06	£ 62.39

Table 63: Totex for common reference scenarios (£m 2020/21 prices) AMP8-AMP12

Common Ref. Scenario Name					
TOTEX £M (2020/21 prices) (WRMP Costs)	AMP8	AMP9	AMP10	AMP11	AMP12
Preferred Plan Low and high climate change Low and high abstraction reduction	£106.00	£111.36	£46.75	£126.77	£419.85
Slow technology High Demand	£49.20	£54.47	£22.58	£ 25.71	£29.85
Fast technology Low Demand	£104.82	£111.26	£46.75	£126.77	£419.85

9.2. FINAL PLAN ADAPTIVE PROGRAMMES

9.2.1. Adaptive Planning Process Overview

Adaptive planning is a framework that is used to manage risk and uncertainty in the Best Value Plan. 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.

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.

The purpose of an adaptive planning approach is to plan for the long-term taking account of uncertainty so we can adapt to new information to act in the short term. To embed this approach into our wider business, we have developed a set of adaptive planning principles based on those set out in the Government's '[Accounting for the effects of climate change - Supplementary Green Book]', pp.18-19.

Our adaptive planning principles are:

1. **Focus on outcomes:** Identify and plan to deliver outcomes that matter for customers, the environment and wider society.
2. **Accept and assess uncertainty:** Recognise what we do not know and identify and plan for a broad range of possible futures.

3. **Plan flexibility in:** Develop options that enable us to adapt to new information e.g., modular designs and investing to keep options open.

4. **Monitor continuously:** Gather new information regularly to inform decision making process.

5. **Embed in decision making:** Build decisions on adaptive pathways explicitly into project delivery governance.

6. **Plan investments that are low regret and/or keep options open:** We should invest when the available evidence indicates an investment will be 'low or no regrets' or where investment is required to keep options open or to minimise the cost of future options.

Our business plan and long-term delivery strategy have been developed and will be implemented in line with these principles.

9.2.2. Is our WRMP24 an adaptive Plan?

We have concluded that our WRMP24 does **not** need include any adaptive pathways. This is because the sensitivity testing in Section 9.1 has confirmed that our preferred final plan supply demand balance is not sensitive to less likely (low or high) planning assumptions on demand, climate change, abstraction sustainability reductions and technology with a supply surplus being maintained in both our WRZs across the planning period for all scenarios. This reflects previous investments in water resources, in particular the Kielder reservoir and the Tyne Tees Transfer.

In preparing our plan, we considered adaptive pathways for the following scenarios:

- a higher non-potable Teesside demand than that allowed for in our central (most likely) preferred plan
- a final plan scenario where Yorkshire Water (YW) loses its Severn Trent Derwent Reservoir Transfer in 2035 thus meaning the Tees (NW) to York (YW) transfer is needed in 2040
- the Kielder to reservoir to United Utilities Transfer (100Ml/d):

However, for the following reasons, we concluded that there was sufficient certainty such that adaptive programmes are not required:

- **A higher non-potable Teesside demand than that allowed for in our central (most likely) preferred plan:** This is because we updated our demand forecast between preparation of our draft and revised draft WRMP24 to reflect Teesside business' latest conservative potable and raw water demand forecasts (up to 190Ml/d), and because we have concluded that we can supply this demand. However, we will need to make some base investment in a mothballed river intake and pumping station and will need to vary two abstraction licences to return licensed quantities to pre-2018 levels when Teesside raw water demand was historically higher. We understand that we will need to make these applications to the Canal & Rivers Trust (CRT) who will then submit formal applications to the Environment Agency to vary the licences. This will increase the duration of the process and so we will build this into our programme to ensure the licences are determined in a timely manner prior to needing the high licenced quantities.

- **A final plan scenario where Yorkshire Water loses its Severn Trent Derwent Reservoir Transfer in 2035 thus meaning the Tees (NW) to York (YW) transfer is needed in 2040:** This is because Yorkshire Water confirmed in its revised draft WRMP24 that the Tees to York transfer is now needed in 2040 (previously 2050). YW is committed to full assessment of the Tees transfer and to developing and accessing alternative options. We work collaboratively with YW through Water Resources North (WReN) as part of this process; or

- **The Kielder to reservoir to United Utilities Transfer (100Ml/d):** This is because this option is not included in United Utilities' (UU) or Water Resources West's preferred final plans or in any formal adaptive programme because there are other better value schemes which address United Utilities' and other region groups supply deficits. However, we have presented a scenario (see Section 9.3 – Final Plan Scenario Testing), where, through future regional reconciliation, Yorkshire Water discount the Tees to York Transfer but the Kielder to United Utilities Transfer is picked for national resilience. This is likely to be the only situation in which this scenario would occur, not least because the surplus of water in Kielder reservoir is not sufficient to support both. Otherwise, our preferred final plan contains the same demand management options and does not include any new supply options.

We still consider our plan to be an adaptive plan as, while we have not identified any necessary adaptive pathways, we have followed our adaptive planning principles:

- Our activities will focus on delivering the outcomes that customers, society, government and regulators expect of us by reducing leakage and PCC.
- By examining the need for adaptive pathways, and considering alternative scenarios, we have gained confidence our plan will deliver across a broad range of potential futures.
- The investments we are planning - in water efficiency, metering and leakage reduction - are by their nature flexible. It would be straight forward to ramp this activity up or down in future and so we have flexibility built into our long-term plan.
- We will continue to monitor our supply and demand position through the normal processes.
- Our governance arrangements will allow us to respond to changes in needs through and strategic and tactical planning processes.
- The investments we are planning are low regret as reducing PCC and leakage and increasing metering will aid us in delivering a more resilient service and the outcomes expected of us across a broad range of futures.

9.3. KIELDER RESERVOIR TO UNITED UTILITIES SCENARIO

Since consulting on our draft WRMP24, we have re-confirmed with our neighbouring water companies (United Utilities and Yorkshire Water), their position on importing raw water from Northumbrian Water Limited (NWL). Yorkshire Water has confirmed that the Tees to York Transfer (140Ml/d) is still in its preferred final plan although it is now needed by 2040 and not 2050. United Utilities has confirmed that it now considers its headroom position to be more resilient and so the Kielder Reservoir to UU Transfer (100Ml/d) has still not been included in either its preferred final plan or any adaptive pathways. Additionally, Water Resources North and Water Resources West (WRW) has considered the Kielder reservoir to United Utilities Transfer as an option to support security of supply and increase resilience for other water companies. A robust reconciliation process has been followed by the regional groups which concluded that the Kielder reservoir to UU Transfer was not required. This is largely because of the high capital cost associated with the scheme and that there were other better value feasible options. Consequently, our preferred final plan only includes the Tees to York Transfer. It is important to note that while our resource assessments have confirmed that we only have sufficient water resources to implement one of the two schemes (i.e. not both), the Kielder reservoir to UU Transfer was not considered to be resource constrained when considered on its own.

We note Regulartors' Alliance for Progressing Infrastructure Development (RAPID) would like us to continue to develop the Kielder reservoir to United Utilties Transfer should:

i. the outcome of future regional reconiliation rounds be different (e.g. if another regions currently preferred Strategic Resource Option (SRO) was no longer considered feasible and was discounted); or
ii. if Yorkshire Water conclude following further options appraisal that the Tees to York Transfer is not needed after all.

Consequently, we have continued to work with both United Utilities and Yorkshire Water after our respective revised draft WRMPs were submitted. Funding will be required to further investigate the export options and, if needed, to progress as a SRO. We have therefore included a funding allowance in our draft Business Plan submission.

As United Utilities currently do not include the transfer in their preferred plan or adaptive pathways, we assume that any such transfer would not be needed until later in the period. For indicative purposes we therefore assume that United Utilities may make a decision by 2044 for supply to commence by 2055. This alternative scenario is illustrated in Figure 34.

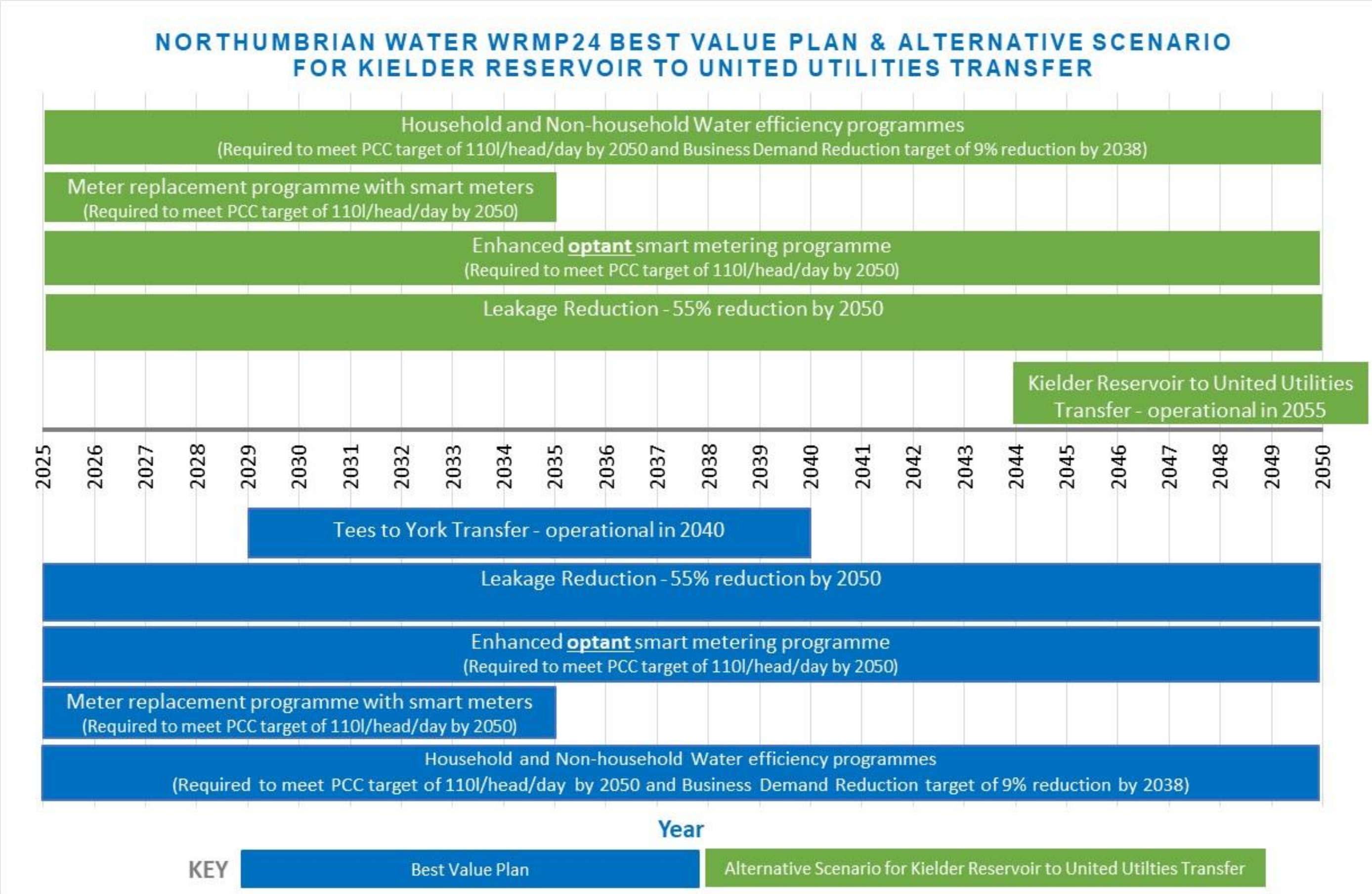


Figure 34: Northumbrian Water WRMP24 Preferred Plan verses Alternative Kielder Reservoir to United Utilities Transfer Scenario

9.4. OPTIMISED SMART METERING SCENARIO

Our final preferred plan includes demand management options that are needed to meet national leakage and demand reduction targets. For deliverability reasons, our preferred plan uses a linear delivery profile although the demand savings are still sufficient to maintain a supply surplus in the Berwick & Fowberry WRZ and to restore a supply surplus in the Kielder WRZ early in Asset Management Period 8 (AMP8). The demand savings in the Kielder WRZ result in a supply headroom of 39Ml/d by the end of AMP8 and so we have considered an optimised smart metering programme whereby a proportion of the programme is deferred to AMP9.

Our preferred plan is to deliver the smart metering programme by 2035 using a linear profile with 50% of the programme being delivered in AMP8 and 50% in AMP9. However, we have looked at the scenario of delivering 25% of the programme in AMP8 and 75% in AMP9. Whilst under this scenario, the interim PCC target of 122l/head/day by 2037/38 would still be achieved, as 100% of the meters will still have been replaced with smart meters by 2034/35, the AMP8 demand savings would be less. The 25/75 scenario would result in an increase in AMP8 PCC of +0.32 l/head/day compared to our preferred plan as well as a potential increase in leakage (customer side leaks may take longer to be identified), meter-under-registration and distribution input. This could result in an additional demand of 2.59Ml/d in AMP8 and 2.24Ml/d in AMP9.

We have also considered further scenarios whereby only 50% and 75% of the smart meter programme is delivered by the end of AMP 9. In both cases, the PCC target of 118 l/head/day by 2040 was not met with PCC being 0.25-0.49 l/head/day higher in 2050 resulting in an increase in distribution input in AMP9 of 4.28-6.79Ml/d. All scenarios are shown in Figure 35 and Table 64.

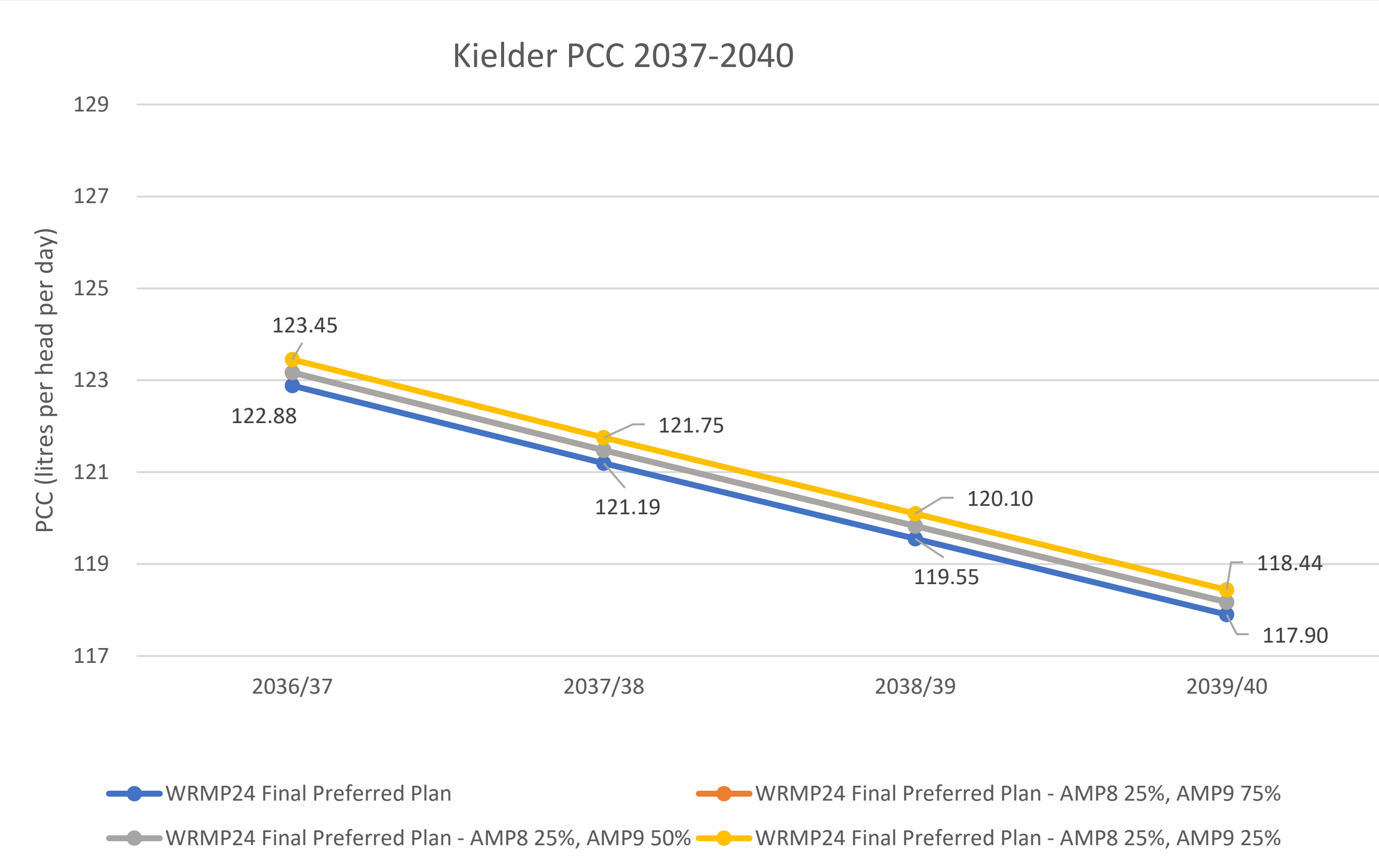


Figure 35: Kielder impact of optimised replacement smart metering strategy on PCC

Table 64: Kielder Optimised smart saving scenarios increase to total demand.

SCENARIO NAME	END OF AMP8	END OF AMP9
AMP 8 25%, AMP9 75%	2.59	2.24
AMP8 25%, AMP9 50%	2.59	4.28
AMP8 25%, AMP9 25%	2.59	6.79

While deferring a proportion of the smart metering programme to AMP9 still allows us to meet the interim PCC target of 122l/head/day by 2037/38, we have discounted this as a feasible option in favour of our smart metering preferred plan which is still being based on a linear delivery profile (i.e., split equally across AMP8 and 9). This is for the following reasons:

Asset Availability: A linear profile spreads the risk of unforeseen challenges with smart meter availability. For example, we have seen a significant impact of both Covid lockdowns and the war in Ukraine on component availability the latter of which is ongoing. Spreading the number of smart meter installs equally over two amps therefore spreads the risk. We also expect to see a significant growth in smart meter installs across the industry in 2025-2035 which will put further significant pressure on the manufacture and supply of smart meters and so a linear approach protects us against supply and demand constraints across the industry as a whole;

- **Availability of skilled workforce:** With a surge in smart meter installs across the industry in AMP8 and AMP9 there is going to be a significant demand on skilled workforce to support the installs and in life management of the assets. Increasing installation and replacement activity not only puts pressure on asset and field activity but also support services e.g. our planning and scheduling teams and contact centres. A linear rollout profile allows us to partner with outsource agencies or to recruit, develop and retain skilled resource at the right levels for both AMP8 and AMP9 reducing the impact of a spike in additional headcount and associated cost in AMP9;
- **Meter Replacement Success Rate**: 25% of our meters are internal and therefore require appointments to be made with customers. Pilot activity has indicated that only 20% of customers respond to these requests to book an appointment and it takes 3.5 contacts per household to secure a replacement. So spreading these installs equally across AMP8 and AMP9 allows us to better manage the risk of no access and ensure higher rates of replacement success. If we fail to secure an appointment in AMP8 we can re-try in AMP9, however If we push them out into AMP9 there is a higher risk of still having a significant number of meters that we have not been able to replace due to access issues;
- **Future AMP impacts of a nonlinear approach:** Pushing more metering activity into AMP9 creates a lumpy replacement profile for future years. As the smart meters we are installing have a 15 year life time that means we are going to have a significant AMP of meter replacement activity again in 2045-2050 (assuming no change in technology). This would mean a spike in metering investment in this AMP and a need to re-increase resource and capacity across the end-to-end value chain to be able to deal with this hump; and
- **Supply Demand Blance Flexibility**: A linear profile provides greater flexibility if other demand management options under-perform or if non-household growth is higher than expected.

Given the baseline supply deficits forecast in our Kielder water resource zone and uncertainties in reducing PCC, we will continue to plan to deliver our leakage and metering programmes against a linear delivery profile. However, we commit to reviewing our demand management strategies during the development of our WRMP29 in 2027 and will optimise our smart metering programme at that point.

10. ALTERNATIVE PLANS

10.1. OVERVIEW

We are required to present the following plans in this Water Resource Management Plan 2024 (WRMP24):

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

10.2. OFWAT CORE PLAN

Our Core Plan is illustrated in Figure 36 and includes no or low regret options that are required to maintain a supply surplus in all years of the planning period. In our case, our core plan only includes options needed to meet national targets for leakage reduction (50% reduction by 2050 albeit our plan is for 55% reduction), Per Capita Consumption (110l/head/day by 2050) and Reductions in Non-household Demand (9% reduction by 2038 and 15% reduction by 2050).

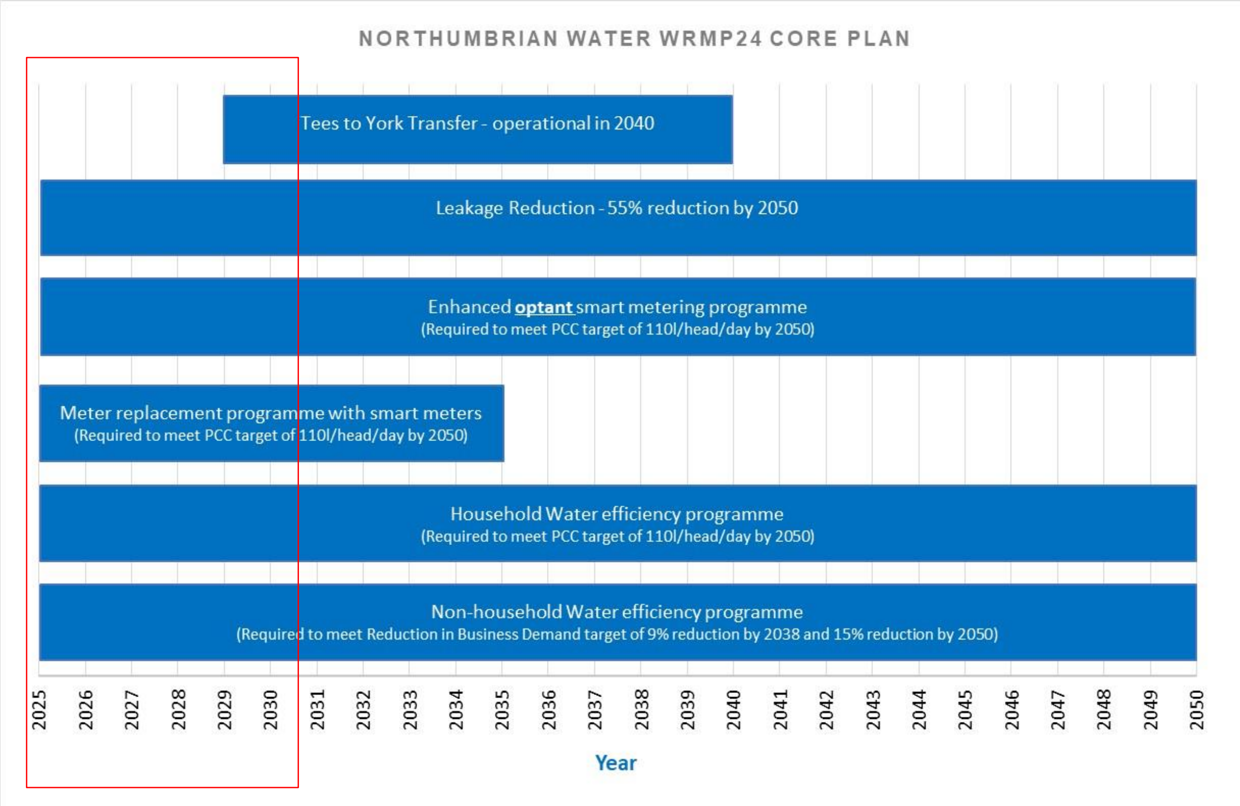


Figure 36: NWL Core Plan

We consider our central Demand Management Options (DMOs) provide the additional option value described in the Water Resources Planning Guideline (WRPG) as they result in sufficient headroom that provides further flexibility in the future should it be needed.

The baseline supply demand balance for our core plan is the same as our Best Value Plan. A small potable 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 per capita consumption (PCC)), are applied to our final plan demand forecast, then a supply surplus is restored and no further supply schemes are required.

The Berwick & Fowberry 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.

10.3. 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 potable 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.

10.4. BEST ENVIRONMENT PLAN

The Best Environment Plan presents a plan with the lowest level of abstraction from existing sources (high Environmental Destination (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 (NW) 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.

11. ENVIRONMENT & SOCIETY

For a detailed report on this section please refer to our supporting **Environment Report** which is available to download from our website at **Water Resources Management Plan (nwg.co.uk)**

11.1. INTEGRATED ENVIRONMENTAL ASSESSMENT

The sections below outline how we have considered the environment and society in developing our Water Resource Management Plan 2024 (WRMP24). Although we are not presenting any new 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), the Teesside Industrial Supply option and of the proposed water export to Yorkshire Water (YW). Earlier on in the process of preparing this WRMP24, it was not clear whether we would have a supply surplus in the Berwick & Fowberry Water Resource Zone (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 present the environmental assessments for our DMOs and the assessments on potential supply side options in a separate Environmental Report. However, due to our supply demand position only the Strategic Environmental Assessment (SEA) for our DMOs and Teesside Industrial Supply option are relevant to our preferred plan. The environmental assessments completed on potential Berwick supply side options are presented for information only and have not contributed to our decision-making.

As our DMOs are not associated with changes in land-use, do not have a physical footprint and do not require planning permission, the completion of 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 are not relevant for these options. We have completed these assessments where relevant for the Teesside Industrial Supply option.

The Environmental Assessments for the proposed water export to YW are detailed within Yorkshire Water's Environmental Report for their revised WRMP24. We have worked with Yorkshire Water to ensure it has sufficient information about the wider environmental implications of the Tees to Yorkshire transfer option, including the operation of the Kielder System and Cow Green, to be able to fully assess the transfer's environmental impacts within its final WRMP24. The outcomes of these assessments, where they have been made available, are summarised within our Environmental Report, especially in terms of potential cumulative and in-combination effects with our DMO-Preferred package of options.

We will continue to work collaboratively with Yorkshire Water through Water Resources North (WReN). While the export to Yorkshire Water is not needed until 2040, Yorkshire Water is committed to a full assessment of all options including the Tees transfer and developing other suitable alternative options which will be fully assessed, including cumulative SEA assessments for all options. We will work closely with YW, going forwards as part of the Kielder Strategic Resource Option (SRO), to ensure all NWL aspects have been considered including Kielder reservoir, the Tyne Tees Transfer, Cow Green Reservoir and associated protected sites and the River Tees itself.

We present our Environmental Report 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, the Teesside Industrial Supply option and the regional export options.

Our preferred plan includes demand management options (DMOs) that will meet government aspirations including options to reduce leakage by 55% by 2049/50[5]; 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 and a reduction in non household (NHH) demand of 9% by 2037/38. 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.

Earlier on in the process of preparing this 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 Environmental Report.

We have completed a Strategic Environmental Assessment (SEA) and prepared an Environmental Report, for our WRMP24, including assessing our demand management packages, potential Berwick supply side options, the Teesside Industrial Supply option and the 140Ml/d raw water export from the River Tees to Yorkshire Water, and our plan as a whole.

We have also considered a ‘sensitivity scenario’ that could be taken forwards instead of the Best Value Plan (DMO Preferred Scenario, Teesside Industrial Supply option and Yorkshire Water Transfer built in 2040) and considered this within our Environmental Report. The scenario is:

- Scenario 1: Demand Management Preferred Option, Teesside Industrial Supply option and Transfer to United Utilities with the earliest available delivery date of 2040.

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

11.1.1. SEA scoping

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 Northumbrian Water

[5] The proposed leakage reduction of 55% in our Northumbrian region, when taken together with the 40% reduction proposed in our Essex & Suffolk Water area, is designed so that as whole business we will achieve the government’s aspiration to reduce leakage by 50% by 2050.

(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.

11.1.2. SEA High Level Screening

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 of the High Level Screening assessment are provided in Appendix J of the Environment Report.

11.1.3. SEA Results

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 Table 65 and Table 66.

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

Table 65: 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	-	-	-	-
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	-	-	-
Supplying Teesside Industrial Water	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	0	-	-	0
DMO-Preferred	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 66: Summary of operational 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
Supplying Teesside Industrial Water	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
DMO-Preferred	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

A Yorkshire Water transfer DV7a(vi)) has also been through the NW SEA process in order to determine the likely effects on the region. The SEA for this option was 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, as shown in Table 67 have been provided by Yorkshire Water and have been utilised here to present a complete assessment.

Table 67: Yorkshire Water transfer SEA results

		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																						
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	-
Operation																						
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

The outcomes of the SEA are summarised below. The full SEA assessment spreadsheets for all options considered for inclusion in Northumbrian Water's WRMP24 are available in Appendix K of the Environment Report.

Summary of SEA of Berwick Upon Tweed Supply Side Options

Construction

- During the construction phase, most of the options are not anticipated to result in significant residual effects to the SEA objectives. Only BOT-ABS-007 and BOT-TRA-002 result in moderate negative effects to biodiversity objectives. These are as a result of potential construction phase effects on designated sites and to habitats required to deliver BNG. Other effects during the construction phase are considered to be minor and therefore not significant.
- During construction, there are not anticipated to be any significant positive environmental effects. There are potential minor positive effects related to increased employment opportunities during the construction phases however this is not deemed to be significant.

Operation

- During the operational phase, there are considered to be moderate, and therefore significant, residual negative effects to water and biodiversity objectives for BOT-ABS-002, and to water objectives for BOT-ABS-007. This is associated with changes to abstraction activities and outfall for existing water sources in the region, as well as to potential changes in the water table, resulting in likely negative effects on designated sites and their qualifying features.
- During operation, there are anticipated to be no significant residual positive effects to SEA objectives. Any residual positive effects during the operation phase are considered to be minor, and therefore not significant. All options will have minor positive effects on population and human health, while TRA-001, 001 and 004 also have minor positive effects on water objectives.

Summary of SEA of Teesside Industrial Supply Option

Construction

- During the construction phase, there are considered to be no significant residual negative or positive effects to SEA objectives as a result of the Supplying Teesside Industrial Water Option. Minor adverse effects were identified for six objectives during the construction phase, further details can be found in Appendix K of the Environment Report.

Operation

- During the operation phase potential significant residual negative effects were identified for the objective 'To avoid spreading and, where required, manage invasive and non-native species (INNS)' due the physical transfer of untreated water between two locations. No other significant residual adverse effects were identified. Positive effects were identified for securing resilient water supplies for the health and wellbeing of customers. Potential minor adverse effects were identified for the option Supplying Teesside Industrial Water due to the risks associated with increased abstraction on the potential for effects on water quality, biodiversity and the natural systems resilience to drought.

Summary of SEA of Yorkshire Water Option

Construction

- During the construction phase, there are considered to be a number of major and moderate, and therefore significant, residual negative effects posed by the Yorkshire Water option (DV7a(vi)) to biodiversity, soil, air quality, landscape, historic environment, and population and human health SEA objectives. These are as a result of the proposed pipelines close proximity to designated sites, its required temporary land take within a large quantity of greenfield, best and most versatile agricultural land, and a small quantity of Agricultural Land Classification Grade 2 (land of medium to high value), its anticipated temporary adverse effects on local air quality in surrounding urban areas and its potential to cause nuisance from noise, dust and vibration as a result of construction and vehicle movements, its proximity to AONB, scheduled monuments and numerous listed buildings in which there is potential for temporary adverse construction effects on the setting of these designations coming from construction activities and vehicle movements, its temporary disruption to a range of recreational facilities, and its significant use of materials. Any other residual negative effects are considered to be minor, and therefore not significant.
- During construction, there are not anticipated to be any significant residual positive effects to SEA objectives. There is also anticipated to be no minor positive effects.

Operation

- During the operational phase, there are considered to be major, and therefore significant, residual negative effects posed by the Yorkshire Water option (DV7a(vi)) to climatic factors and material assets SEA objectives. These are as a result of the proposed pipelines significant use of materials and the large quantity of embodied carbon emissions associated with this, as well as from carbon emissions associated with anticipated HGV movements and construction activities, and from electricity requirements required for pumping during operation. Any other residual negative effects are considered to be minor, and therefore not significant.

- During operation, there are anticipated to be major and moderate, and therefore significant, residual positive effects to biodiversity, climatic factors, and population and human health SEA objectives. These are as a result of potential beneficial opportunities for areas of habitat affected by construction through compensatory planting and habitat enhancement, in particular grassland and woodland habitat local to the scheme, the proposed pipeline helping to secure a supply-demand balance over the next 25 years, thus helping to maintain essential public water supplies and therefore help maintain public health and well-being, as well as improved resilience to the threats of climate change. No minor positive effects are anticipated.

Summary of Northumbrian Water Demand Management Options SEA

Construction

- During the construction phase, there are considered to be no significant residual negative effects to SEA objectives as a result of all three demand management option scenarios. Any residual negative effects during the construction phase are considered to be minor, and therefore not significant. The DMO-Preferred option scenario (the preferred option included in the Best Value Plan), and the DMO-High option scenario were assessed as having minor negative effects to objectives in all SEA topics, with the DMO-Low option scenario having minor negative effects to objectives in all SEA topic apart from water.
- During construction, none of the demand management option scenarios were considered to have significant residual positive effects to SEA objectives. Additionally, no minor positive effects were anticipated.

Operation

- During the operational phase, none of the demand management option scenarios were considered to have significant residual negative effects to SEA objectives. Additionally, no minor negative effects were anticipated.
- During operation, there are anticipated to be significant residual positive effects to water and population and human health SEA objectives as a result of all three demand management option scenarios, with DMO-Preferred and DMO-High also having significant residual positive effects to climatic factors objectives. Positive effects are generally associated with improved water efficiency and leakage works, resulting in lower water demand, and therefore less extraction of water from natural environments for human consumption. This could, for example, increase resilience of water supplies and natural systems to droughts, help to enhance or maintain surface water quality, flows and quantity, as well as providing other significant positive effects. Through improved water efficiency, and leakage reduction of 55% by 2050, the DMO-Preferred scenario is anticipated to yield an annual water saving of 52,246.1 Ml for the year 2074/75 (143.14 Ml/d average). The DMO-High scenario (improved water efficiency and 50% leakage reduction by 2050) is anticipated to yield an annual water saving of 63,919.1 Ml for the year 2074/75 (183.34 Ml/d average). The DMO-Low scenario (improved water efficiency and 30% leakage reduction by 2050) is anticipated to yield an annual water saving of 30,324.2 Ml for the year 2074/75 (83.08 Ml/d average).

11.1.4. Other environmental assessments

In addition to the SEA, other environmental assessments of the proposed Berwick supply side options were undertaken. The results of these assessments are provided in section 5.6 of the accompanying Environmental Report[7] and appendices. Information relating to the Teesside Industrial Supply option for WFD and HRA and the Yorkshire Water option for BNG, WFD and NCA assessments has also been included in the accompanying Environmental Report. Demand management options have not been subjected to further assessments owing to the lack of physical footprint of these options.

11.1.5. Cumulative and in-combination effects

In order to appropriately consider the effects of the NW WRMP, it is important to not only consider the options in isolation, but also consider how the options might interact and combine to yield positive or negative effects on the SEA objectives. As such the cumulative and in-combination effects of the Best Value Plan and the sensitivity scenario have been considered in combination with other projects, plans and programmes in the Northumbria Region. The outcomes of these assessments are reported in detail in sections 6.4, 6.5 and 6.6 of the Environment Report. The cumulative effects of the Yorkshire Water transfer option (DV7a(vi)), in-combination with other options considered as part of Yorkshire Water's Best Value Plan and other plans programmes and projects, is considered to be reported in the Environmental Report published by Yorkshire Water as part of their final WRMP.

Potential intra-plan cumulative effects during construction were identified to seven SEA Topics: Biodiversity, Soil, Air, Landscape, Historic Environment, Population and Human Health, and Material Assets. Potential intra-plan cumulative effects during operation were identified to three SEA Topics: Biodiversity, Climatic Factors, and Population and Human Health. Cumulative narratives are provided in Table 6.4 and Table 6.6 in the accompanying Environmental Report. These provide a high-level assessment of how cumulative effects may arise for each SEA Objective flagged as having potential cumulative effects. In summary, as one of the options included within the Best Value Plan is a demand management option, in which specific locations of works to be undertaken are not yet known, no detailed assessment of cumulative effects can be made at this stage. Instead, the potential for cumulative effects can only be highlighted for further investigation once more detailed information on specific activities required as part of the demand management scenario are known. As such, cumulative effects might occur where activities required to resolve leakage issues could coincide geographically with construction of the Yorkshire Water transfer option, or from where they could occur one after another within a short period of time and at the same location.

The potential for cumulative effects with other plans, programmes, and projects (inter-plan effects) has also been assessed and is reported in section 6.6 of the Environment Report. A two-stage approach was taken to determine the Inter-Plan Effects. Step 1 involved a strategic cumulative assessment of the interactions with other policies, plans and programmes which is applicable across the WRMP24, including a review across other water company WRMP24s, Drought Plans, RBMPs and the regional Water Resource Plan. Step 2 involved a plan based cumulative effects assessment. The plans, programmes and strategic projects considered included: large existing and emerging Local

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

Plan allocations; Nationally Significant Infrastructure Projects; Hybrid Bills; Transport and Works Act Orders for large-scale transport infrastructure and Minerals and waste applications. At the time of writing, there are 13 Nationally Significant Infrastructure Projects (NSIPs) located within the Northumbrian Water region at various stages. These are detailed in Table 6.7 in the accompanying Environmental Report. Due to the nature of the preferred demand management option (DMO-Preferred), it is possible for potential cumulative effects with all of these NSIPs, as they are all within the potential zone of influence of the option.

11.1.6. Mitigation measures and enhancement opportunities

Mitigation and enhancement measures are covered in more detail in Section 7 and Table 7.1 of the accompanying Environmental Report. Mitigation and enhancement measures were suggested as part of the SEA options assessment process and are recorded in the assessment tables in Appendix K of the Environment Report. The outcome of the assessments (reported in Sections 5 and 6 of the Environment Report) and summarised in Tables 65 and 66 above, are the residual effects, which means that it is assumed that the identified mitigation has been applied (to the option) and the reported effects are those that remain. It is noted that the HRA Appropriate Assessment and WFD Level 2 assessment – within Appendix F – HRA, and Appendix G – WFD of the Environment Report, respectively, for specific supply-side options, contain additional description of mitigation relevant to the focus of those assessments. Options that have been included within NW WRMP24 Best Value Plan (BVP) are those which at this stage of option development have the lowest / acceptable environmental impacts. Any options with unacceptable environmental impacts were considered unfeasible. However, as detailed design progresses for the selected options and more information becomes available, if HRA or WFD compliance issues emerge, and identified mitigation is not considered sufficient, then previously rejected, alternative supply-side options would be re-visited.

11.1.7. Monitoring

Monitoring the effects of implementing the WRMP are covered in more detail in Section 8 and Table 8.1 of the accompanying Environmental Report. Monitoring is required to track environmental effects to show whether they arise as anticipated in the SEA appraisal, to help identify any adverse effects and trigger deployment of any of the mitigation measures. The monitoring recommendations are based on the Best Value Plan as described in this report. As options are brought forward for development, further monitoring requirements may be set out in planning applications, or in any Northumbrian Water voluntary best-practice monitoring plans accompanying scheme development.

11.1.8. Next steps

Following adoption of the WRMP24, a Post-Adoption statement will be produced which outlines how the SEA process has influenced the development of WRMP, how consultation comments were taken into consideration and how the WRMP will be monitored. This summary will indicate how the NW WRMP24 was influenced as a result of the SEA process and consultation.

11.2. WATER INDUSTRY ENVIRONMENT PROGRAMME (WINEP)

11.2.1. 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.

11.2.2. 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.

11.2.3. AMP8 WINEP (2025 to 2030)

We have worked closely with our regulators and stakeholders to identify what will 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 received confirmation of our draft agreed AMP8 WINEP from the Environment Agency on 3 July 2023. However, as the PR24 WINEP remains subject to on-going government approval and further refinement, the Environment Agency has asked that we do not release information about our WINEP outside of our company at this time[8].

11.3. CLIMATE CHANGE AND GREEN HOUSE GAS EMISSIONS

11.3.1. 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.

Although we are aiming to reduce our emissions in line with the Paris Agreement goals, this will not be enough to mitigate the impacts of climate change. The 2023 Intergovernemntal Panel on Climate Change (IPCC) report on climate change warns with high confidence that it is likely that heating will exceed 1.5°C, and that current global commitments may be insufficient to limit heating below 2°C. The impacts from extreme weather in the UK over recent years highlight the urgency of adapting to climate change. As a result, managing risk in the face of climate change involves planning for the worst-case scenario. So, we are adapting to a world that is 2°C warmer in 2050 and preparing for 4°C by the end of the century.

[8] Northumbrian Water_030723_WINEP letter.pdf

Across our business, we are committed to continue delivering reliable and resilient services by anticipating change, planning ahead, and by making the right long-term decisions. This is set out in our Climate Adaptation Report[1], and our long-term strategies and plans. We use latest the latest climate information and scenarios (UKCP18) to understand and plan for the effects of increased drought, flood risk and other climate impacts on our assets and services.

In developing our preferred final plan, we have accounted for the effects of climate change on forecast supply and demand following the methods setout in the Water Resources Planning Guideline (WRPG). 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 by 38Ml/d by 2050. Nevertheless, our Best Value Plan only includes demand management options (see section 8) to meet national leakage and demand reduction targets 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, customer demand (PCC) and non-household demand will benefit the environment as it will mean we will abstract less water from the environment, particularly during dry weather when river flows are lower, leaving more water in rivers, reservoirs and groundwater aquifers.

11.3.2. 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 37 shows a trend of consistent emissions reductions.

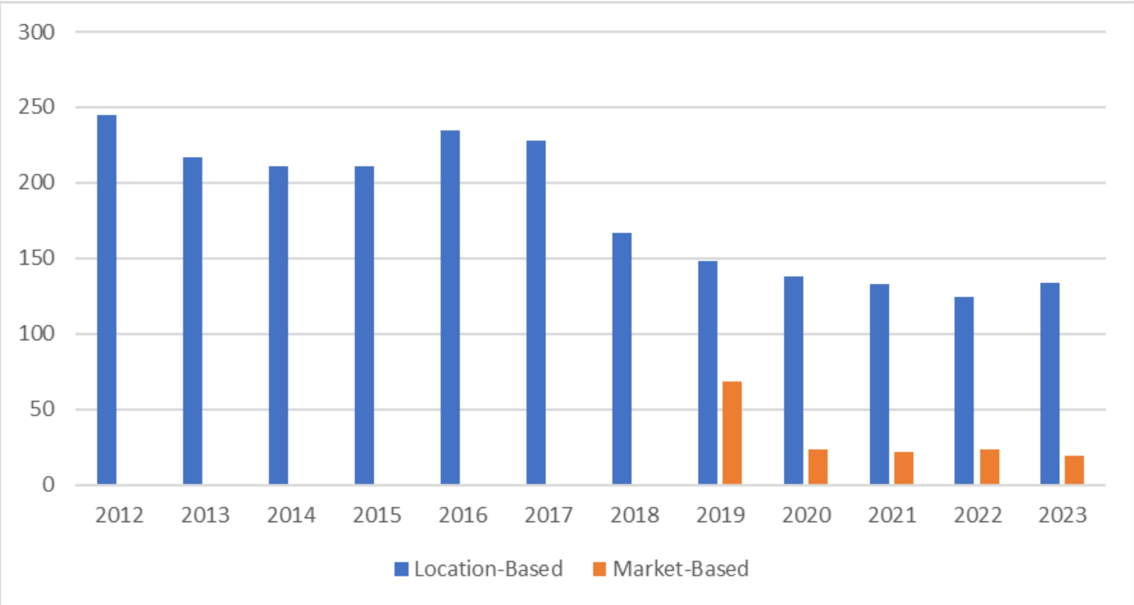


Figure 37: Northumbrian Water and Essex & Suffolk Water Operational Emissions 2012 to 2023

This reduction reflects a structured approach to emissions management through the implementation of a Net Zero plan, initiated in 2009 and updated annually. Figure 37 shows two types of emissions measurement – "Location-Based" and "Market-Based" with the latter reflecting where we have purchased fully renewable energy. In 2023/24, our operational emissions were 133ktCO2e and 19ktCO2e on a location and market basis respectively.

The significant reductions shown in Figure 37 have been achieved through a range of innovative energy and efficiency actions.

In 2022 and 2023, six large-scale solar arrays have been added at sites in our Northumbrian Water (NW) operating region. 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 the equivalent amount of electricity as that needed to power 12,000 homes. This is in addition to injecting 135GWh of green gas into the grid every year, which is enough to heat a further 8,000 homes.

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 78,000 tonnes of CO_2 savings each year.

11.3.3. Emissions of greenhouse gases from WRMP24 final plan options

In accordance with section 37A(3)(b), we present in Table 68 emissions of greenhouse gases which are likely to arise as a result of our final plan options. Our preferred final plan includes our demand management option to meet national leakage and demand reduction targets by 2050 including:

- Leakage reduction strategy
- Enhanced Optant Metering Strategy
- Smart Metering Strategy
- Non-household Demand Reduction Strategy

The only supply option is the Tees to York Transfer which is for Yorkshire Water and so the greenhouse gas emissions for that scheme sit within their plan.

Table 68 confirms the greenhouse gas emissions from each of our final plan demand management options.

Table 68: Carbon emissions from our WRMP24 final plan

Intervention's Carbon Impact	Description	AMP8	AMP9	AMP10	AMP11	AMP12
Smart Metering (tCO2e)	Includes embodied carbon of meter and average 10km journey in a diesel van per install.	40,838	39,953	-	-	-
Intensive ALC (tCO2e)	Includes embodied carbon of 2m excavation around pipe, encapsulation collar and average 10km journey in a diesel van per leak repair.	3,003	6,005	9,008	12,060	12,157
Permanent Acoustic Logging (tCO2e)	Modelled as per smart meter, assumption that logger and meter will have similar embodied carbon and similar journey distance.	-	876	1,202	1,738	1,750
Mains Renewal (tCO2e)	Includes excavation, pipe replacement (including material and transport of pipe), reinstatement and materials transport and disposal of surplus excavated material.	-	-	-	80,449	409,811
Water Efficiency (tCO2e)	Includes average 10km journey in a diesel van for each water efficiency visit.	216	217	216	216	216
Total (tCO2e)		44,057	47,052	10,426	94,464	423,934

The following approach was used to assess carbon emissions:

- Key activities associated with each intervention that are likely to generate significant carbon emissions identified.
- Focus on capital and embodied carbon emissions covering cradle to built asset boundary, e.g., embodied carbon of materials, transport, construction effort and waste disposal. Operational emissions for these interventions are likely to be comparatively small and further work is required to identify the specific additional operational emissions impact and how much of the additional transport for meter reading/maintenance will be covered within existing fleet transport distances.
- Emissions factor data from Inventory of Carbon and Energy for construction materials, Defra annual conversion components for transport, CESMM4 cost and carbon price book for construction activities and material disposal.

  Carbon assessment has inherent uncertainty in regard to the representativeness of the emissions factors used compared to the actual carbon intensity of material and activities and also the top-down nature of the scope captured for each of the DMO interventions. However, the assessment does provide a good comparative assessment on the scale of expected emissions from each of these interventions at a programme level.

Further detail of the greenhouse gas emissions from our final plan options is provided in a Technical Report entitled Green House Gas Emissions from Demand Management Options. This is available on request via waterresources@nwl.co.uk.

11.3.4. How greenhouse gas emissions from WRMP24 final plan options will contribute individually and collectively to its greenhouse gas emissions overall

Table 68 confirms how greenhouse gas emissions from the options in our final plan will contribute individually and collectively to our overall greenhouse gas emissions. Our current emissions (scope 1, 2 and 3) are in the region of 478,000 tonnes CO_2e/annum on a location basis and following the expanded reporting Scope required by Ofwat as of 2022/23. This expanded scope includes well to tank emissions arising from energy, supply chain emissions for purchased goods and services, supply chain emissions from chemicals and our capital programme.

11.3.5. Delivering net zero greenhouse gas emissions targets and commitments

This section describes the steps we will take to reduce greenhouse gas emissions and how they will support the delivery of our net zero greenhouse gas emissions commitment and the UK government's net zero greenhouse gas emissions targets and commitments.

Our focus is to achieving Net Zero Scope 1, 2 and 3 emissions by 2050. We will do this by:

- reducing greenhouse gas (GHG) emissions from our own activities; and
- working in partnership to reduce GHG emissions across our supply chain.

Minimising greenhouse gas emissions from our activities

As discussed in our Business Plan, we are on track to deliver the absolute reduction in operational emissions on a market basis that we envisaged when we set our ambitious goal of net zero operational emissions (scope 1 and 2) by 2027. In 2019/20 our emissions were 69kTCO_2e, in our most recent reporting year we have reduced these emissions to 19kTCO_2e – a 72% reduction.

We stated our goal of Net Zero by 2027 in our previous draft WRMP24. However, the science and approach used to calculate emissions continues to improve and evolve. Our understanding of wastewater process emissions has progressed significantly, these are materially higher than originally estimated. Additionally, we have expanded our areas of emissions management to include our entire upstream supply chain. Taking these two areas into account, we therefore no longer consider that that net zero operational emissions by 2027 is the correct target and have set ourselves a long-term target of reaching net zero for all emissions (scope 1, 2 and 3) by 2050.

Our emissions reporting has already achieved ISO14064-1 accreditation – demonstrating accurate and transparent reporting. Our commitment to continual improvement is real and we want to have systems in place to support our path to achieving Net Zero and ensure we are accountable to our commitments. For this reason, we also plan to adopt the PAS2080 standard for managing carbon in building and infrastructure by 2025.

Case Study 4: Creating Green Energy (Effective climate action, Valuing resources and eliminating waste)

We are industry leaders in using our customers' waste to create green energy.

We were the first, and are still the only, water company to use 100% of the sludge from our wastewater treatment to create energy, literally power from poo – and this is a significant part of how we are already well on our way to Net Zero.

Advanced Anaerobic Digestion plants on Tyneside and Teesside process around 2 million cubic metres of sludge to generate 135GWh of green gas that we inject into the grid every year, which is enough to heat 8,000 homes.

The residual inert "cake" is then transported to be used as fertiliser. The switch from moving liquid sludge to transporting solids has also meant 90,000 tankers per annum have been replaced by 10,000 trailers, reducing our carbon emissions even further.

Both sites also utilise gas-to-grid plants to pass energy produced into the National Grid.

In line with our previous call to action of adapting to the CCRA's principles of adapting to 2ºC and preparing for 4ºC, we are working towards validating our long-term goals with the Science Based Targets initiative (SBTi) whereby our greenhouse gas (GHG) emission reductions will be aligned with the Paris Agreement (limiting global warming to 1.5°C above pre-industrial levels..

We are exploring additional options for energy management and efficiency performance across the business and will align our energy management system with ISO50001 compliance. A gap analysis has been undertaken to ensure we focus on areas which will strengthen our energy management processes and opportunities. Additionally, our Energy Savings Opportunity Scheme Action Plan will set out the energy related improvements that we plan to make over the next 5 years, this plan will be published in March 2025.

Our commitment is to:

- reduce process emissions of methane and nitrous oxide in the most efficient and affordable way;
- accelerate the timeline for phasing out fossil fuel vehicles, aiming for no new fossil fuel HGVs by 2035 and other vehicles by 2030; and
- 100% of our electricity will come from additional renewable generation by 2040.

We're looking at what commitments we will be making towards reaching Net Zero and will confirm that in our Environment Strategy.

As the National Grid decarbonises and emissions from electricity use fall, process emissions of nitrous oxide and methane from water and wastewater treatment make up a larger proportion of our total emissions. These emissions present a great challenge, as at present there are limited feasible or affordable alternatives to our current treatment methods, and capturing these emissions is expensive. We will focus our innovation efforts to identify the best approaches to reduce our process emissions, working closely with others as we do.

As part of our journey to Net Zero we will decarbonise our fleet of vehicles. In 2020, we began this transformation with Nissan EV200s being added to our fleet and will continue adding more elective vehicles in place of conventional vehicles. After 2030, as part of the Government's plan to reduce emissions, no new petrol and diesel cars and vans will be sold in the UK. The technology to support the transformation of HGVs is more complex, but we are aiming for all new HGVs to be fossil fuel free by 2035.

We are proud to be an industry leader in the generation of renewable energy. Our investment in offshore wind since 2018 enables us to power all of our 1,886 sites and around 30% of our total electricity demand using this source of renewable energy. We will maintain a focus on this area as we work towards our 2040 renewable generation goal, having committed to adding 30MW of new renewable generation to our asset base by 2027, including solar (six new solar arrays are being installed and commissioned in 2022/23, adding 13.3GWh per year of green energy generation to the 25GWh of renewables already at our sites).

We also aim to achieve ISO50001 accreditation to sustain improvements in energy efficiency and reductions in GHG emissions (our emissions reporting has already achieved ISO14064-1 accreditation – demonstrating accurate and transparent reporting). Our commitment to continual improvement is real and we want to have systems in place to support our path to achieving Net Zero and ensure we are accountable to our commitments. For this reason, we also plan to adopt the PAS2080 standard for managing carbon in building and infrastructure by 2025. This looks at the whole value chain and aims to reduce carbon and cost through intelligent design, construction, and use.

Working in partnership to reduce emissions from others

We commit to reduce embodied carbon by 50% for new assets by 2050 (compared to 2020 levels). To continue to provide world class water and wastewater services while also protecting and regenerating the natural environment, we are planning to deliver a large investment programme. This new investment will result in embodied carbon – the GHG emissions associated with materials, manufacturing, construction, transportation and installation. We are constantly looking for innovative opportunities to ensure our investment programme minimises the amount of both embodied and operational (for example from ongoing energy requirements) emissions. Through partnerships with contractors, suppliers, and others, we will work towards reducing embodied carbon associated with new assets by 50%.

We will also actively seek opportunities to sequester and lock-in carbon by using catchment and nature-based solutions where possible. We will continue to work with others, such as our contribution to the North Pennines National Landscape team to support their peatland restoration programme to enhance carbon storage. As peatlands store carbon indefinitely, restoring upland and lowland peatlands to a natural condition is vital, particularly as healthy functioning peatlands also deliver many wider benefits for society.

Understanding and reporting carbon is fundamental to managing and reducing emissions, and we are committed to transparency in emissions reporting as we work towards our Net Zero goal. We aim to have 95% of our scope 3 emissions reported by 2026. Addressing Scope 3 emissions requires considerable supply chain engagement and full life cycle analysis. The greater the scope of reporting, the more elements of a company's value chain are engaged with emissions awareness and by extension, reduction.